| Four Forest Restoration Initiative Scoping Log - January 20, 2011 to April 20, 2011 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Address** | | | | | | |
| **Letter #** | **Name/Organization** | **Street** | **City** | **State** | **Zip Code** | **Email** | **Date Received** | **Date Authored** |
| 1 | Tom Bondell | N/A | N/A | N/A | N/A | adesertwillow@npgcable.com | 1/28/2011 | 1/28/2011 |
| 2 | Ed Nelson | P.O. Box 2215 | Sedona | AZ | 86351 | Nelson2215@msn.com | 1/29/2011 | 1/29/2011 |
| 3 | Bowen | N/A | N/A | N/A | N/A | Bowen841@aol.com | 2/2/2011 | 2/2/2011 |
| 4 | Debbie Manelli/Bob Lee & Sons Tree Service | P.O. Box 339 | Payson | AZ | 85547 | info@bobleetreeservice.com | 2/2/2011 | 2/2/2011 |
| 5 | Steven Sesnie | N/A | N/A | N/A | N/A | Steven.Sesnie@nau.edu | 2/4/2011 | 2/4/2011 |
| 6 | Bruce Rogers | 4808 W. Desert Hills Drive | Glendale | AZ | 85304 | brogers@adr.com | 2/5/2011 | 2/3/2011 |
| 7 | Sharon Galbreath | | | | | sharoneg@q.com | 2/7/2011 | 2/7/2011 |
| N/A | Bruce H. Powell - **in project record** | P.O. Box 5547 | Lake Montezuma | AZ | 86342 | N/A | 2/7/2011 | Unknown |
| 8 | Steve Gatewood | N/A | | | | wildwoodvb@earthlink.net | 2/10/2011 | 2/10/2011 |
| 9 | Arizona Department of Environmental Quality | 1110 West Washington Street | Phoenix | AZ | 85007 | www.azdeq.gov | 2/11/2011 | 2/2/2011 |
| 10 | Workshop Notes- USFS generated | N/A | N/A | N/A | N/A | N/A | 2/16/2011 | 2/16/2011 |
| 11 | Sara Presler, City of Flagstaff, Mayor | 211 W. Aspen | Flagstaff | AZ | 86001 | N/A | 2/17/2011 | 2/15/2011 |
| 12 | Sara Reif, Arizona Game and Fish Department | 3500 S. Lake Mary Road | Flagstaff | AZ | 86001 | Sreif@azgfd.gov | 2/17/2011 | 2/17/2011 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 13 | Mark T. Altaha, White Mountain Apache Tribe Historic Preservation Office | | | | | markaltaha@wmat.us | 2/17/2011 | 2/17/2011 |
| 14 | Liz Boussard | 6755 E. Eagle Crest Drive | Flagstaff | AZ | 86004 | lboussard@q.com | 2/18/2011 | 2/18/2011 |
| 15 | Pat and Jack Williamson | N/A | N/A | N/A | N/A | azpatty@commspeed.net | 2/20/2011 | 2/20/2011 |
| 16 | Robert Brito | 9029 W. Mackenzie Drive | Phoenix | AZ | 85037 | rabjabrito@cox.net | 2/22/2011 | Unknown |
| 17 | Paul Summerfelt, Greater Flagstaff Forests Partnership | 1300 S. Milton, #209 | Flagstaff | AZ | 86001 | www.gffp.org | 2/22/2011 | 2/16/2011 |
| 18 | Denise Boggs, Conservation Congress | P.O. Box 5 | Lewiston | MT | 59457 | | 2/24/2011 | 2/24/2011 |
| 19 | Workshop Notes- USFS generated | N/A | N/A | N/A | N/A | N/A | 2/24/2011 | 2/24/2011 |
| 20 | John E. Ryberg | 3875 W. Pike | Camp Verde | AZ | 86322 | N/A | 2/26/2011 | 2/26/2011 |
| 21 | Steven W. Webber, Lands Team Lead, Department of Energy, Western Area Power Administration | P.O. Box 281213 | Lakewood | CO | 80228-8213 | starcevi@wapa.gov | 3/1/2011 | Unknown |
| 22 | Leah Baker, Planning and Environmental Coordinator, Bureau of Land Management, Phoenix District Office | | | | | lbaker@blm.gov | 3/4/2011 | 3/4/2011 |
| 23 | Gary Gumbel | 8388 Garden Home Trail | Snowflake | AZ | 85937 | ggum1947@hotmail.com | 3/4/2011 | 3/4/2011 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 24 | Bill Bunger | N/A | N/A | N/A | N/A | b_bunger59@yahoo.com | 3/6/2011 | 3/6/2011 |
| 25 | Dorothy Holasek | P.O. Box 1340 | Snowflake | AZ | 85937 | N/A | 3/7/2011 | 3/7/2011 |
| 26 | Cyndy Cole, Arizona Daily Sun | N/A | N/A | N/A | N/A | Ccole@azdailysun.com | 3/7/2011 | 3/7/2011 |
| 27 | Paul Summerfelt, Greater Flagstaff Forests Partnership | 1300 S. Milton, #209 | Flagstaff | AZ | 86001 | www.gffp.org | 3/8/2011 | 3/7/2011 |
| 28 | Joy Nicholopoulos, Regional Director, U.S. Fish and Wildlife Service | Ecological Services, P.O. Box 1306, Room 6034 | Albuquerque | NM | 87103 | | 3/8/2011 | 3/8/2011 |
| 29 | Fred Amator | 14247 W. Broadway Rd. | Goodyear | AZ | 85338-4006 | famator@aol.com | Unknown | 3/9/2011 |
| 30 | Rick Erman | N/A | N/A | N/A | N/A | ermanaz77@msn.com | 3/10/2011 | 3/10/2011 |
| 31 | Paul Summerfelt, Greater Flagstaff Forests Partnership | 1300 S. Milton, #209 | Flagstaff | AZ | 86001 | www.gffp.org | 3/11/2011 | 3/11/2011 |
| 32 | Tom Collazo,Associate State Director, The Nature Conservancy | 1510 East Fort Lowell Road | Tucson | AZ | 85719 | tcollazo@TNC.ORG | 3/11/2011 | 3/11/2011 |
| 33 | Scott Hunt, State Forester, Arizona State Forestry | 1110 West Washington Street | Phoenix | AZ | 85007 | ScottHunt@azsf.gov | 3/11/2011 | 3/11/2011 |
| 34 | Ethan Aumack, Asteve Gatewood, Four Forest Restoration Initative | N/A | N/A | N/A | N/A | www.4fri.org | 3/11/2011 | 3/11/2011 |
| 35 | Ethan Aumack, Grand Canyon Trust | N/A | N/A | N/A | N/A | eaumack@grandcanyontrust.org | 3/12/2011 | 3/12/2011 |
| 36 | Rick Erman, Friends of Anderson Mesa | 3435 East Windrose Drive | Phoenix | AZ | 85032 | ermanaz7746@msn.com | 3/13/2011 | 3/13/2011 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 37 | Rick Erman | N/A | N/A | N/A | N/A | ermanaz7746@msn.com | 3/14/2011 | 3/14/2011 |
| 38 | Chad Hanson, John Muir Project of Earth Island Institute | P.O. Box 697 | Cedar Ridge | CA | 95924 | cthanson1@gmail.com | 3/14/2011 | 3/14/2011 |
| 39 | Taylor McKinnon, Center for Biological Diveristy and Sharon Galbreath, Grand Canyon Chapter, Sierra Club | N/A | N/A | N/A | N/A | tmckinnon@biologicaldiversity.org | 3/14/2011 | 3/14/2011 |
| 40 | Richard Spotts | 1125 W. Emerald Drive | St. George | UT | 84770-6026 | spotts@infowest.com | 3/14/2011 | 3/14/2011 |
| 41 | Ron Sieg, Regional Supervisor, Arizona Game and Fish Department | Region 2, 3500 S. Lake Mary Road | Flagstaff | AZ | 86001 | www.azgfd.gov | 3/14/2011 | 3/14/2011 |
| 42 | Paul Summerfelt, Greater Flagstaff Forests Partnership | 1300 S. Milton, #209 | Flagstaff | AZ | 86001 | admin@gffp.org | 3/14/2011 | 3/14/2011 |
| 43 | Herrington, Lunt, Martin, Lee, Tenney, Eastern Arizona Counties Organization | P.O. Box 2010 | Payson | AZ | 85547 | | 3/14/2011 | 3/14/2011 |
| 44 | Susan MacKay | 9059 Charolais Trail | Snowflake | AZ | 85937 | | 3/7/2011 | 3/14/2011 |
| 45 | Sara Presler, City of Flagstaff, Mayor | 211 W. Aspen | Flagstaff | AZ | 86001 | www.flagstaffaz.gov | 3/14/2011 | 3/14/2011 |
| 46 | W. Wallace Covington, The Ecological Restoration Institute, NAU | P.O. Box 15017 | Flagstaff | AZ | 86011 | www.eri.nau.edu | 3/14/2011 | 3/14/2011 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 47 | Ethan Aumack, Marcus Selig, Matt Williamson, Grand Canyon Trust | | | | | eaumack@grandcanyontrust.org | 3/14/2011 | 3/14/2011 |
| 48 | Frank Welsh | 7654 South 41st Place | Phoenix | AZ | 85042 | welshfj@yahoo.com | 3/15/2011 | 3/15/2011 |
| 49 | Scott Hunt, State Forester, Arizona State Forestry | 1110 West Washington Street | Phoenix | AZ | 85007 | | 3/16/2011 | 3/11/2011 |
| 50 | Leigh J. Kuwanwisima, Director Hopi Cultural Preservation Office, The Hopi Tribe | P.O. Box 123 | Kykotsmovi | AZ | 86039 | | 3/25/2011 | 3/21/2011 |
| 51 | Rick Erman | N/A | N/A | N/A | N/A | ermanaz7746@msn.com | 4/2/2011 | 4/2/2011 |
| 52 | Marjorie Herkenham | 35 Kaibab Drive | Sedona | AZ | 86336 | herk@sedona.net | 4/3/2011 | 4/3/2011 |
| 53 | 4FRI Stakeholders | N/A | N/A | N/A | N/A | | 4/20/2011 | 4/20/2011 |
| 54 | Taylor McKinnon, Center for Biological Diveristy | See Letter #39 | | | | | 5/5/2011 | 5/5/2011 |

2011-01-28 #1

**Paula Cote/R3/USDAFS**
03/15/2011 03:36 PM

To 4FRI Comment Database@FSNOTES
cc
bcc
Subject Fw: Comment: Four Forest Restoration Initative 01-28-2011

Paula Cote'
NEPA Specialist
Coconino National Forest
Four Forest Restoration Initiative (4-FRI)
1824 S. Thompson Street
Flagstaff, Arizona 86001
(928) 226-4686
Fax (928) 527-3620
pcote@fs.fed.us

----- Forwarded by Paula Cote/R3/USDAFS on 03/15/2011 03:32 PM -----

**"Tom Bondell" <adesertwillow@npgcable.com>**
01/28/2011 12:11 PM

To <pcote@fs.fed.us>
cc
Subject Fw: Comment: Four Forest Restoration Initative

**From:** Tom Bondell
**Sent:** Friday, January 28, 2011 12:07 PM
**To:** 4FRI_comments@fs.fed.us
**Subject:** Fw: Comment: Four Forest Restoration Initative

**From:** Tom Bondell
**Sent:** Tuesday, January 25, 2011 5:26 PM
**To:** 4FRI_comments@fs.fed.us
**Subject:** Fw: Comment: Four Forest Restoration Initative

**From:** Tom Bondell
**Sent:** Tuesday, January 25, 2011 3:47 PM
**To:** 4RI_comments@fs.fed.us
**Subject:** Comment: Four Forest Restoration Initative

AIR QUALITY: Of course it is of great importance to make our forests less prone to wildfires. I am a strong advocate for that. However, I live at the base of Oak Creek Canyon in "uptown Sedona"
and I can tell you that since these controlled burns have begun, it has dramatically affected my quality of life and my health. At night the smoke anywhere near the canyon drops down into it and hangs there till the next day when it is warm enough for it to lift. I am not exaggerating this point: it truly is miserable here and these controlled burns happen frequently in the area. And now
the proposal is for another 10 years of them. To me it sounds like another 10 years of suffering.

As far as the forest service is concerned, is there any merit to factoring in the quality of life and health vs constant controlled burns? Are there other methods for disposing the material, rather than
burning it? Are there areas where this material could be transported to and then burned where it would have little if any impact on people?

Tom Bondell
Sedona

02
2011-01-29

4 Forest Restoration Initiative Web-Comment Portal

January 29, 2011

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/29/2011 16:49:17 | No, already on mailing list | N/A | Unaffiliated individual | Ed Nelson | Nelson2215@msn.com | PO Box 2215 | Sedona | AZ | ? | E-Mail | There should be an overriding principle: minimize human contact. That means more wilderness area designation,few if any land trades, off road vehicle restrictions. |

2011-01-29 - 2

2011-02-02 - #3

Four Forest Restoration Initative
Coconino and Kaibab National Forest

# Comment Sheet

**Did you attend a meeting/workshop?** _____ **Yes** __X__ **No**

**If yes, what date(s)?** _____

Please check the area related to your comments, **using a separate comment form for <u>each</u> area.**

____Coconino Forest-Wide
____Flagstaff District – North of I-40
____Flagstaff District – South of I-40
____Red Rocks/Sedona
____Verde Valley
____Mogollon Rim

____Kaibab Forest-Wide

____Tusayan District
____Williams District

**Comment Topic**

____Purpose and Need
____Vegetation/Silviculture
____Wildlife – Big Game
____Wildlife – T&E
____Wildlife – Sensitive Species
____Wildlife – Birds
____Wildlife – Aquatic
____Wildlife – Other
____Fuels and Fire Behavior
____Soils and Watershed
____Air Quality
____Transportation
____Cultural Resources
____Comment Applies to All
____Other

____ Recreation Special Uses
____ Developed Recreation
____ Dispersed Recreation
____ Scenery/Visuals
____ Special Areas/Designations

**Comment:**

KEEP UP THE GOOD WORK!

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

Four Forest Restoration Initative
Coconino and Kaibab National Forest

***Please Tell Us Your Preference for Receiving Documents including the Scoping Letter, DEIS, FEIS/ROD*** *(we would like to keep printing costs down and send documents via e-mail or share by posting to our website):*

X I prefer to receive documents by e-mail which is: BOWEN841@AOL.COM

___I prefer to view documents on the forest web-site

___I would like to receive a CD copy of the DEIS and FEIS/ROD (*Note: Scoping letter will not be available via CD)*

___I would like to receive documents in hard-copy form (***please make sure you have provided your address)***

***Has Your Address Changed? Please provide your new address:***

_____

_____

_____

**Please submit all comments no later than March 14, 2010.** This will allow the 4 FRI team sufficient time to consider your comments in order to identify issues, alternatives, mitigation and monitoring options.

**Web Site:** http://www.fs.usda.gov/goto/kaibab/4fri

**Email Address:** 4FRI_comments@fs.fed.us Please note: there is an underscore "_" between the words "4FRI" and "comments" (4FRI_comments)

**US Mail:** Coconino National Forest, 1824 South Thompson St., Flagstaff, AZ 86001, *Attn*: 4FRI

**PLEASE NOTE: General comments will always be accepted and considered in subsequent steps of the 4 FRI NEPA process.**

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

2011-02-04

4 Forest Restoration Initiative Web-Comment Portal

February 2, 2011

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/2/2011 9:07:36 | Yes | N/A | Business | Bob Lee & Sons Tree Service Debbie Manelli | debbie@bobleetreeservice.com | PO Box 339 | Payson | AZ | 85547 | E-Mail | Is this a project that we as a business can bid on? |

2011-02-04

2011-02-04 - 5



**Steven Edward Sesnie**
**<Steven.Sesnie@nau.edu>**
02/04/2011 10:48 AM

To Henry Provencio <hprovencio@fs.fed.us>, Bill O Noble <bnoble@fs.fed.us>, "Mary Lata (mlata@fs.fed.us)" <mlata@fs.fed.us>, Paula Cote <pcote@fs.fed.us>, Neil
cc
bcc
Subject Wood Supply Paper

History: This message has been forwarded.

Hi folks,
I thought it would be a good to share this paper on the small-diameter wood supply assessment that was recently published. I am amazed to see how this work has evolved into the 4FRI project and others. Congratulations! Consider forwarding a copy to the Chief and Sec. of Ag, to give them an idea of where this started and that you guys are really doing it!

Ariel and Valerie,
Page 23 gives an example of the data development methods that were used, that are now being greatly refined for our Kaibab Monitoring Project and assistance with Forest Plan Revisions/monitoring process. I will likely bring this up at the meeting next week.

Best to all of you!
Steve

Steven Sesnie, Ph.D.
Assistant Research Professor/Remote Sensing
School of Earth Sciences and Environmental Sustainability
Northern Arizona University Flagstaff AZ 86011-5694
Tel 928.523.7889; Fax 928.523.7423
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Hampton et al. 2011.pdf

# Estimating Regional Wood Supply Based on Stakeholder Consensus for Forest Restoration in Northern Arizona

**Haydee M. Hampton, Steven E. Sesnie, John D. Bailey, and Gary B. Snider**

ABSTRACT

Thinning treatments focused on small-diameter trees have been designed to restore fire-adapted ponderosa pine ecosystems. Estimating the volume of wood byproducts derived from treatments can assist with agency planning of multiyear thinning contracts that sustain existing and attract new wood product businesses. Agency, local government, industry, and environmental representatives were engaged to assess the level of agreement on restoration treatments in northern Arizona. Participants unanimously agreed on appropriate management across two-thirds of the 2.4 million ac analysis area and defined desired posttreatment conditions using forest structure information derived from remotely sensed data. Results indicate that an estimated 850 million $ft^3$ of stem volume and 8.0 million green tn of tree crown biomass could be generated from tree thinning to reestablish fire-adapted conditions and stimulate new economic opportunities while meeting social and environmental criteria. Wood supply defined by stakeholders exceeded current utilization levels by 88% when extrapolated over the next 10 years.

**Keywords:** restoration treatments, wood supply, stakeholder agreement, ponderosa pine

Agreement exists among stakeholders that ponderosa pine (*Pinus ponderosa*) forest ecosystems in the southwestern United States are in urgent need of restoration to conditions supporting frequent and low-intensity fire regimes (Allen et al. 2002). Forest structural changes in these systems, such as increased surface fuel loading, crown contiguity, and ladder fuels known to bolster the size and intensity of crown fires, have been attributed to over 100 years of fire suppression, livestock grazing, human development, selective harvesting of large trees, predator control, and other human activities (Covington and Moore 1994, Mast et al. 1999, Swetnam et al. 1999). A subsequent increase in small-diameter trees and hazardous fuels conditions has precipitated severe fire behavior at an unprecedented scale, such as the 2002 Rodeo-Chediski fire, Arizona's largest wildfire in recorded history (467,066 ac). This and other recent severe wildfire events, which compromise watershed, wildlife, and aesthetic values, have galvanized public support for active and broad-scale forest restoration activities. Reductions in overall forest structural heterogeneity and understory species composition are also of concern in terms of diminished biodiversity levels (Allen et al. 2002, Chambers and Germaine 2003).

Mechanical tree thinning and prescribed burning are recommended to aid in restoring ponderosa pine forests throughout the Southwest (Fulé et al. 2001a, Pollet and Omi 2002, Graham et al. 2004, Schoenna-

Received April 21, 2009; accepted January 20, 2010.

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**Table 1. List of wood supply working group members and affiliations.**

| Name | Position | Affiliation |
|---|---|---|
| Ethan Aumack | Director of Restoration Programs | Grand Canyon Trust |
| Pascal Berlioux | President and Chief Executive Officer | Arizona Forest Restoration Products Inc. |
| Kim Newbauer | Timber Sales Contracting Officer | Coconino National Forest |
| **Rob Davis** | **President/Owner** | **Forest Energy/Future Forests** |
| Paul DeClay Jr.[a] | Tribal Forest Manager | White Mountain Apache Tribal Forestry |
| Jerry Drury | Timber Staff Officer | Kaibab National Forest |
| **Steve Gatewood** | **Owner/Consultant** | **WildWood Consulting, LLC, representing Greater Flagstaff Forests Partnership** |
| Bill Greenwood | City Manager | Town of Eagar |
| Shaula Hedwall | Senior Fish and Wildlife Biologist | US Fish and Wildlife Service |
| Scott Higginson | Executive Vice-President | NZ Legacy, LLC/Snowflake White Mountain Power/ Renegy, LLC |
| Herb Hopper[b] | Community-based forest and wood products advocate | Little Colorado Plateau Resource, Conservation and Development |
| Robert LaCapa | Forest Manager | Fort Apache Agency, Branch of Forestry, Bureau of Indian Affairs, Department of the Interior |
| Sarah (Lantz) Reif | Urban Wildlife Planner | Arizona Game and Fish Department, Region II, Flagstaff Office |
| Lisa McNeilly | Northern Arizona Program Director | The Nature Conservancy |
| Keith Pajkos | Timber Staff Officer | Arizona State Lands Department, Forestry Division |
| Chuck Peone Jr. | Tribal Forester | Fort Apache Timber Company |
| Molly Pitts[b] | Community-based forest and wood products advocate/ Consulting forester | Northern Arizona Wood Products Association |
| **Todd Schulke** | **Forest Programs Director** | **Center for Biological Diversity** |
| Larry Stephenson | Executive Director | Eastern Arizona Counties/Economic Environmental Counties Organization |
| **Diane Vosick** | **Associate Director** | **Ecological Restoration Institute** |
| **Elaine Zieroth[c]** | **Forest Supervisor** | **Apache-Sitgreaves National Forests** |

Steering committee member information is shown in bold type.
[a] The authors were honored by Paul DeClay Jr.'s presence before his passing in November 2007. They recognize the helpful participation of Mary Stuever, White Mountain Apache Tribe Forestry, who served as an alternate representative for the tribe at project workshops.
[b] Invited to alternate attendance occupying one shared seat to better accommodate their schedules.
[c] Retired in December 2007 and replaced by Robert Taylor, Supervisory Natural Resource Specialist, Apache-Sitgreaves National Forests.

gel et al. 2004). However, broad stakeholder agreement on acceptable treatment levels at the regional scale is needed to improve forest health conditions over extensive areas of the inland West. Because forest restoration has not kept pace with hazardous fuels accumulation (Stephens and Ruth 2005, Hjerpe and Kim 2008), efforts are underway in many western states to develop private wood products businesses that could purchase restoration byproducts. Restoration projects implemented through US Forest Service thinning contracts that guarantee supply over several years will help forest restoration–based industries attract investors and meet lending requirements and provide a cost-effective mechanism to restore fire-adapted conditions over large areas (US Public Law 108-7 2003). By reaching agreement across large areas, stakeholders gain assurance that industry will be "appropriately scaled" (i.e., the need to improve forest health will drive utilization opportunities) and individual project decisions will be designed within a framework of acceptable thinning levels. Significant administrative cost savings will likely stem from this approach, e.g., as increased trust and understanding translates into reductions in controversy over proposed forest management actions on public land.

In northern Arizona, agency representatives and stakeholder groups believe that forest restoration can lead to the creation of new utilization opportunities while existing industries can continue to help achieve landscape-level restoration goals. In 2006, an ad hoc group of forest restoration professionals from agencies, environmental organizations, community forest partnerships, and academia in Arizona and New Mexico convened to determine the steps needed to accomplish these objectives. At a meeting of the ad hoc group, five members volunteered to form a steering committee designed to represent a diversity of backgrounds and stakeholder interests (Table 1) to act as advisors in the collaborative process, public outreach, and other aspects of the project described here. Concurrent with this process, Arizona's governor-appointed Forest Health Council developed a Statewide Strategy for Restoring Arizona's Forests outlining similar recommendations and action items (Governor's Forest Health Councils 2007). The two priority information needs emerging from these efforts were (1) an estimate of restoration treatment levels that could be considered ecologically appropriate and broadly accepted by stakeholders and (2) an estimate of the potential wood volume from large-scale forest restoration treatments that could supply existing and proposed wood utilization facilities. To perform these analyses, an assessment of existing forest structural conditions and potential wood supply derived from forest thinning was needed across multiple land-management jurisdictions and locations where up-to-date forest inventory data is typically lacking.

We present a case study that focused on filling the aforementioned information gaps and advancing Arizona's newly crafted state restoration strategy. Case studies are useful tools to establish innovative and creative problem-solving mechanisms for mediating contemporary land-management issues. To accomplish this, and with substantial guidance from the steering committee, we

- Organized a series of highly focused stakeholder workshops to identify acceptable locations and restoration treatment levels and consequent wood supply.
- Developed new data resources using US Forest Service Forest Inventory and

**Designing successful collaborations.**

The importance of obtaining broad stakeholder acceptance of land-management practices has increased since 1970, when the first US Forest Service land-management decision was overturned in court (Coggins et al. 2001). In a study of over 700 final case outcomes between 1989 and 2002, Keele et al. (2006) found litigants won or obtained settlements in approximately 40% of cases brought against the US Forest Service. In an effort to avoid high litigation costs and adversarial interactions, most state, federal, and regional policies over the last 6 years call for the use of collaboration in land-management decisionmaking (Vosick et al. 2007). To be truly collaborative, a process needs to involve more than gathering and summarizing input from stakeholders, such as accomplished in open houses, public hearings, and comment periods typical of most NEPA processes. To make informed recommendations, our project steering committee sought a higher level of participation including access to planning and assessment tools. With their guidance, we performed a process encompassing the following major factors correlated with successful collaboration (Cestero 1999; Moote and Lowe 2008):

- Involve recognized authorities having
  - —Broad representation
  - —Formal recognition by government units
  - —Ability and willingness to work together
- Secure adequate resources
- Follow existing regulations
- Provide common factual basis
- Develop and adhere to agreed on and achievable goals while maintaining flexibility
- Maintain a fair, open, and effective process




**Figure 1. Map detailing the 2.4 million–ac wood supply analysis area in northern Arizona. The study area includes ponderosa pine and pine–oak vegetation (shown in green) south of the Grand Canyon and across the Mogollon Plateau to the border of Arizona and New Mexico within the proclamation boundaries of the Kaibab (South of Grand Canyon), Coconino, and Apache-Sitgreaves National Forests, and the Payson and Pleasant Valley Ranger Districts of the Tonto National Forest (outlined in black).**

Analysis (FIA) plot data combined with remote-sensing techniques to estimate existing wood volume and potential supply across Arizona's most contiguous forest type (ponderosa pine).

The principal objective of this study was to determine a socially and environmentally credible region-scale wood supply estimate based on thinning levels and locations required to accomplish forest restoration and improve forest health. Laird (1993) argues that the economic and social implications of technological and environmental issues create a normative requirement that they be subject to democratic scrutiny. This study integrates the idea of "discursive democracy" or public input in decisionmaking intrinsic to the democratic process (Dryzek 1990) and encouraging "participatory science" or public participation in science (Fischer 2000). The stated intent of the US Forest Service was to use the supply estimate as a tool for developing long-term thinning contracts and to inform local planning. The estimate would also serve to foster expanded and appropriately scaled restoration-based wood products businesses.

## Analysis Area

The steering committee selected a 2.4 million ac analysis area in northern Arizona (Figure 1). The analysis area was selected because it comprises the largest contiguous ponderosa pine forest in Arizona. Recent wildfire activity has shown to pose an extreme threat to human communities and multiple ecosystem values for this area. The area included the White Mountain Stewardship project designed to thin approximately 150,000 ac of forest in the wildland–urban interface (WUI; Neary and Zieroth 2007, Fleeger 2008). The analysis area did not include extensive ponderosa pine forests on White Mountain Apache tribal lands, which could potentially contribute to regional wood supply. Ninety-five percent of the analysis area includes US Forest Service lands. Decisions on these lands must be consistent with the National Forest Management Act, National Environmental Policy Act (NEPA), and other laws and regulations.

## Method for Building Agreement on Selection of Treatment Area Location and Type

To build agreement among stakeholders in the region on the location and type of restoration treatments, we worked with the

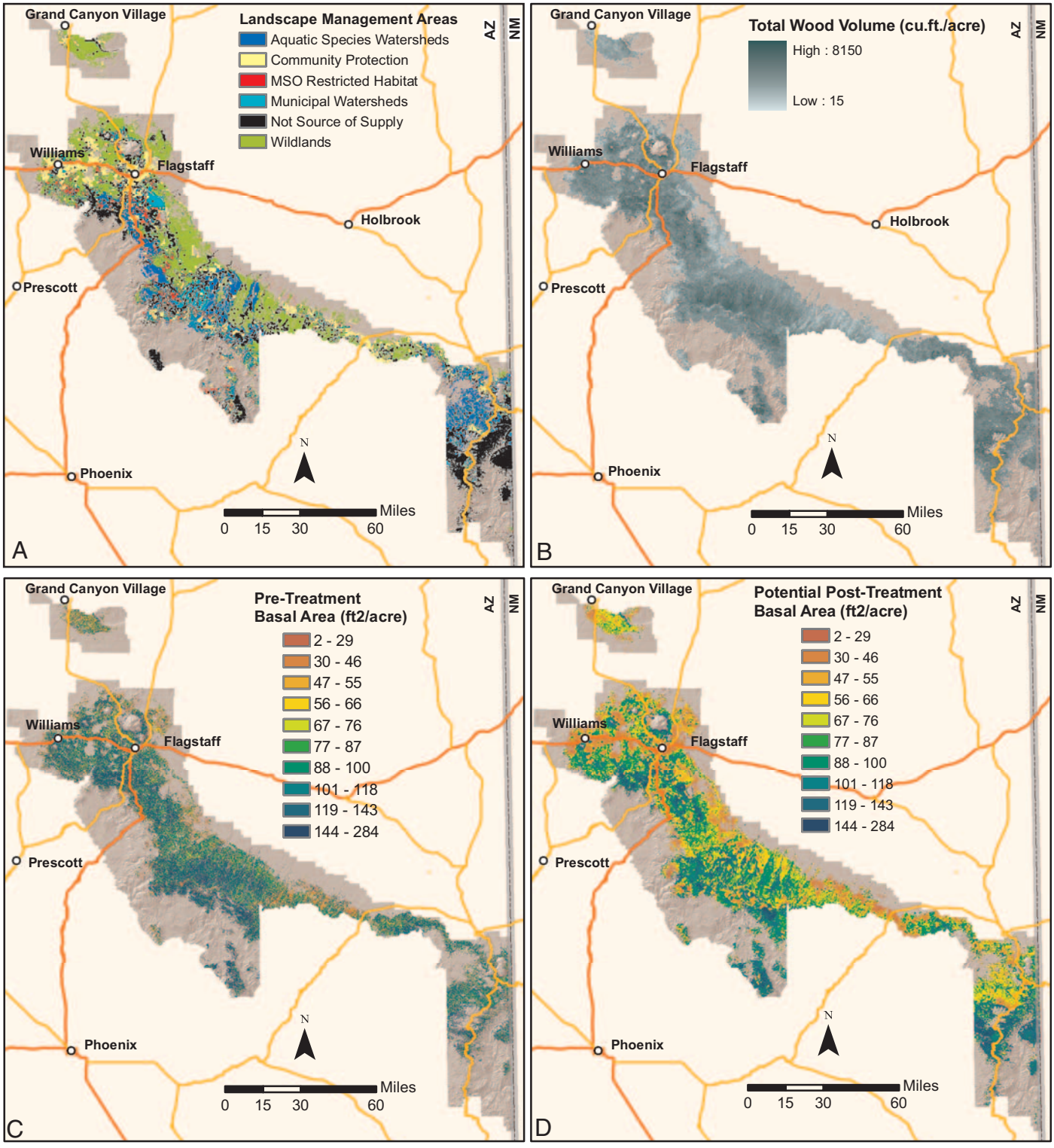



**Figure 2. (A) Areas not considered a source of wood supply from mechanical thinning treatments (black) and landscape management areas (various colors) used to define desired posttreatment conditions in working group treatment scenarios. (B) Estimated ponderosa pine bole volume for 2006 across the analysis area. (C) Estimated ponderosa pine basal area in 2006. (D) Estimated ponderosa pine basal area following potential treatments defined in the majority scenario. Spatial data sources include the National Elevation Dataset (USGS), Arizona Land and Resource Information System roads and private lands, The Nature Conservancy Arizona native fish species richness data, National Resources Conservation Service sixth-level watershed boundaries, LANDFIRE existing vegetation data, and US Forest Service data on streams, soils, roads, MSO protected activity centers, and goshawk nests.**

steering committee to form a 20-member working group representing a diversity of public and private land values (Table 1). Members of the steering committee were also integrated as stakeholders and all participants were included in a series of workshops

**Table 2. Areas not considered a source of wood byproducts from mechanical restoration thinning treatments.**

| Landscape feature | Acres |
|---|---|
| MSO protected activity centers | 182,000 |
| Specially designated areas[a] | 177,000 |
| Steep slopes (>40%) | 147,000 |
| Forest thinned within 10 yr | 113,000 |
| Northern goshawk nest areas | 63,000 |
| Soil types restricted from mechanized treatment | 126,000 |
| Streamside management zones[b] | 52,000 |
| Total (excluding overlap between layers) | 638,000 |

[a] Specially designated areas in the study area include wilderness areas, national game preserves, research natural areas, primitive areas, and inventoried roadless areas.
[b] Streamside management zones were defined as areas within 100 ft of perennial and intermittent streams.

that used a participatory geographic information system (GIS) process (Hampton et al. 2006, Sisk et al. 2006). This process involves the display and analysis of map layers portraying wildlife, watershed, and other criteria for use in developing land-management scenarios. The steering committee identified potential group members and came to full agreement on group membership by discussing the pros and cons of the participation of each individual or organization. Factors used to select a diverse group of stakeholders to participate were (1) area of expertise, (2) representation from a variety of organizations, (3) geographic purview, and (4) availability. The working group had representatives from environmental nongovernmental organizations, private forest industries, local government, the Ecological Restoration Institute at Northern Arizona University, and state and federal land and resource management agencies. We sent letters to each potential working group member or point of contact selected by the steering committee inviting the participation of an individual or organization. The composition of the group changed twice over the 6-month workshop period when a member retired and another passed away.

Seven full-day workshops were held monthly from June through November 2007. Workshops were open to the public and rotated between three locations spread throughout the analysis area to facilitate attendance. We used a "fish bowl" process at each workshop, in which members of the public were welcome to attend the entire workshop and could ask questions or provide comments during a scheduled period. Public attendance varied from 1 or 2 individuals to upward of 10. The majority were industry, local government, and agency representatives (e.g., Bureau of Land Management). We distributed agendas and detailed workshop summaries to hundreds of stakeholders via e-mail and made handouts, slides, and other materials available on a project website. The public were also encouraged to provide comments via voice mail, e-mail, or US Postal Service, which were discussed at the following workshop. To keep elected officials and other key players in the region informed, the steering committee developed a list of contacts who received periodic updates on project progress. Maintaining a transparent and open process was a key element of the project.

A professional facilitator provided guidance to maximize participation and to define a consensus-based decisionmaking approach, which was refined and agreed on by the working group. Consensus was reached when each individual or organization fully agreed with a choice or at least found it acceptable, recognizing that compromises were necessary. If a group member disagreed on an issue, it was up to them to suggest alternatives. The dialogue then continued until everyone either agreed or decided they could live with the decision. Many issues took multiple workshops to resolve, especially if the group requested additional analyses or expertise from outside the group. The consensus process succeeded because each member of the group actively worked toward reaching agreement.

Topical experts from academia, research institutes, and land-management agencies augmented the working groups' significant level of expertise in forest restoration management by providing specialized information on wildlife issues, treatment impacts on soils, hydrologic considerations, conditions favorable to fire-only restoration treatments, and pre-European settlement and posttreatment forest conditions. Throughout the process, additional specialized topics arose. Subcommittees of working group members and invited experts worked between full group workshops to study these issues and draft spatial data products to assist the working group in their collective decisionmaking.

At the initial group workshop, we provided background and foundational information to the group. Each steering committee member commented on wood supply and utilization issues related to their respective organization and described how they hoped this analysis would aid in these issues. The US Forest Service Director of Forestry and Forest Health for the Southwestern Region described the importance of the study and how the US Forest Service intended to use project results. Agency experts provided information on how treatments might be constrained or influenced by regulations and guidelines related to wildlife, soils, and hydrologic factors. We summarized the importance of landscape-scale forest restoration assessments and reviewed the main task of developing one or more treatment scenarios that was the focus of the working group.

**Table 3. Wood volume estimates summarized by total volume and three diameter classes for 2006,[a] The total wood volume layer was used to summarize cubic foot volume for the ponderosa pine type and each landscape management area in the study area.**

| Wood volume category | Total volume (million ft$^3$)[b] | Percent of total volume | Acres (millions) |
|---|---|---|---|
| Total volume in analysis area | 4,561 | 100 | 2.4 |
| Volume not considered in supply | 1,302 | 28 | 0.6 |
| Volume in management areas by dbh class | | | |
| <5 in. | 79 | 2 | |
| 5- to 16-in. dbh | 1,394 | 43 | |
| >16-in. dbh | 1,764 | 55 | |
| Total volume in management areas | 3,238 | | |
| Volume by landscape management area | | | |
| Community protection | 643 | 14 | 0.35 |
| MSO restricted habitat | 504 | 11 | 0.24 |
| Municipal watersheds | 128 | 3 | 0.06 |
| Aquatic species watersheds | 668 | 15 | 0.31 |
| Wildlands | 1,317 | 30 | 0.79 |

[a] Total cubic volume estimates for the ponderosa pine type are from a single data layer and volume by diameter class is from three separate data layers. Discrepancies between estimates derived from the total volume layer those summed over diameter classes is a primarily result of lower computation accuracy in the <5-in. dbh volume layer.
[b] Tree bole cubic foot volume includes the entire length of the tree, with no deduction from the main stem for stumps or tops at specified diameter.

At the subsequent workshops, we provided detailed information on how other collaborative groups had built scenarios for previous landscape assessments and on the availability of spatial data on forest structure and other conditions. Methods to characterize and strategically place treatments across the landscape were presented to the working group. Building on the presentations by agency experts at the initial meeting, we presented maps depicting technical methods to incorporate treatment guidelines and regulations relevant to siting treatments. For selected landscape conditions (e.g., steep slopes and northern goshawk nest areas) we reviewed data layers and estimates describing how each factor might influence a treatment scenario. The group found this map-based presentation of various options useful and requested that we continue depicting progress in this manner.

Based on this input, the working group developed an overall goal for its scenario to restore fire-adapted (ponderosa pine) ecosystems and protect communities from destructive fires, while mitigating adverse impacts of treatments on soils, surface water, and wildlife. To accomplish this goal, the group divided the landscape into areas where restoration byproducts (i.e., wood supply) were or were not potentially available from mechanical tree thinning (Figure 2A). Potential wood supply areas were further divided into five types of landscape management areas (see section "Areas Appropriate for Mechanical Thinning"), each with management objectives including desired posttreatment conditions, based on the informed judgment of experienced restoration practitioners from land-management agencies and other organizations within the working group. Prescribed burning was generally assumed to follow thinning treatments. Posttreatment conditions were designed to put these ecosystems on a trajectory toward restored conditions supporting frequent low-intensity fire regimes and increased forest structural heterogeneity.

## Areas Not Appropriate for Mechanical Thinning

The working group agreed that areas within the analysis area associated with seven landscape features would not be considered a source of restoration byproducts (i.e., wood supply) for the purposes of this study (Table 2; black areas in Figure 2A). These areas are typically not mechanically thinned because of steepness, sensitive soils, proximity to streams, recent tree harvesting, land-use restrictions, or wildlife regulations. Participants acknowledged that Mexican spotted owl (MSO) protected activity centers and other sensitive species habitats might be thinned lightly from below in some cases, resulting in minimal thinning byproducts. No changes were made numerically to wood supply estimates based on road access; however, the group expressed that they had low confidence that areas farther than ¼ mi from existing roads (constituting 241,000 ac) would be a source of thinning byproducts in the near term, because of increased costs, limits in harvesting technologies common in the region, and concerns over environmental impacts associated with new road construction and improvements.

Areas found that were not a potential source of wood supply made up 26% of the analysis area, less than the average value we observed in 27 NEPA-approved restoration projects (37%; US Forest Service 2002–2007). It was reasoned that the value derived via spatial analysis (26%) is conservative because several site-scale factors that limit mechanical thinning were not accounted for, such as archeological sites, historical sites, wildlife movement corridors, and areas with insufficient road access.

Toward identifying areas that would be excluded from mechanical thinning treatments, a subcommittee explored where prescribed and/or wildland fire use (WFU) could or should be used as an initial treatment option. At the group's request, we performed various GIS analyses to define possible fire-only treatment areas including (1) identifying areas below a specified basal area derived from either pre-European settlement conditions or expert opinion on expected surface-fire conditions, (2) assuming status quo planning levels for fire-only treatments based on the average in 27 NEPA planning areas (33%; US Forest Service 2002–2007), and (3) fire behavior model predictions under various weather scenarios. A complicating factor threaded throughout group discussions was the applicability, acceptability, and predictable effects of fire and smoke. Concerns were raised that adverse health effects of smoke and exceeding air quality threshold limits prescribed burning activities, and, furthermore, that locating potential fire-only areas was not relevant to the wood supply analysis and outside the scope of the project. Given these uncertainties and lack of time to arrive at a mutually agreeable modeling method within the 6-month workshop period, the subcommittee decided not to recommend a specific approach and advocated instead that there are areas of the landscape where fire only will continue to be the preferred treatment over mechanical thinning and that wood supply estimates needed to be adjusted downward correspondingly.

## Areas Appropriate for Mechanical Thinning

The working group divided and ranked lands for receiving mechanical thinning treatments, which were considered a potential source of wood supply (colored areas in Figure 2A). Selected areas were categorized as five landscape management areas with different restoration objectives. Community protection management areas (CPMA) received the highest ranking for tree thinning, meaning that management objectives for CPMAs took precedence wherever they overlapped with another management area. The group struggled with how to geographically represent areas identified in community wildfire protection plans because the different plans used inconsistent approaches and delineations. Ultimately, the group created a new designation. The group defined CPMAs by assigning a ¼-mi protection buffer around all private lands, with ½- to 1½-mi buffers around "high priority" private lands identified in community wildfire protection plans—the default WUI definition of the Healthy Forests Restoration Act of 2003. MSO restricted habitat management areas (rank 2) were defined as lands with pine-oak vegetation and used in tandem with the group's basal area management objectives designed to follow MSO Recovery Plan guidelines (US Department of the Interior Fish and Wildlife Service 1995) at a regional scale. Municipal watersheds management areas (rank 3) contained sixth-level watersheds with community surface water supplies. The working group defined aquatic species watersheds management areas (rank 4) as sixth-level watersheds in which native fish presence has been documented. The wildlands management area (rank 5) was a catchall for areas not defined by the other four (Table 3).

For each landscape management area, the working group specified a posttreatment basal area probability distribution appropriate for the area's management objectives

(Figure 3). For example, the proposed thinning for the CPMAs, where tolerance for fire is low, is more aggressive than the thinning goals in wildland areas, while desired posttreatment distributions in MSO restricted habitat allow for denser conditions to promote MSO target/threshold habitat. Reductions in basal area over initial conditions determined thinning intensity. Posttreatment basal area distributions follow a beta-distribution function in which minimum, maximum, and mode were used rather than a target basal area (average) to maintain landscape heterogeneity as described in early studies of ponderosa pine (Pearson 1950).

Basal area distributions within a particular management area were developed with the aid of experts and include forest management regulations and provisions for critical wildlife species habitat. For example, the MSO restricted habitat posttreatment distribution of 45–190 $ft^2$/ac (mode, 100 $ft^2$/ac) was designed to implement current (1996) National Forest Plans and the 1995 MSO Recovery Plan. The curve for MSO restricted habitat retained 10% of this management area with basal area of >150 $ft^2$/ac to meet US Fish and Wildlife Service guidelines for maintaining critical habitat. The relatively low posttreatment basal area range of 30–60 $ft^2$/ac (mode, 40 $ft^2$/ac) for CPMAs was chosen to reduce fire risk significantly (e.g., Fiedler 2002, Fulé et al. 2002a, 2002b). Curves are based on forest thinning regimes that are presently being applied in the southwest (e.g., US Forest Service 2002–2007) and all basal area ranges are more heavily weighted to lower values with distribution tails tapering off more gradually to the right (skewed to the right).

The distributions are not precise determinations or silvicultural prescriptions; rather, they are realistic assumptions that allow for the estimation of wood supply at the regional scale. The group endeavored to balance key land-management issues that included the desire to (1) reduce the threat of uncharacteristically intense fire to human communities, wildlife habitat, and other ecosystem components; (2) minimize potential negative impacts of treatments (Allen et al. 2002, Chambers and Germaine 2003); (3) restore forests to a more naturally heterogeneous structural condition (Pearson 1950, Savage 1991, Covington and Moore 1994); and (4) recognize that changes in the last 100 years, such as global warming, the spread of invasive species, and anthropogenic edge effects and fragmentation, have provided novel conditions that may result in unexpected ecosystem trajectories (Beier and Maschinski 2003). For example, the desired posttreatment basal area distribution outside of CPMAs included areas of higher tree densities to provide a variety of habitat conditions for wildlife including threatened, endangered, and sensitive species that may specialize in habitats "atypical" of those described by current reconstructions of pre-European settlement forest conditions (Beier and Maschinski 2003).

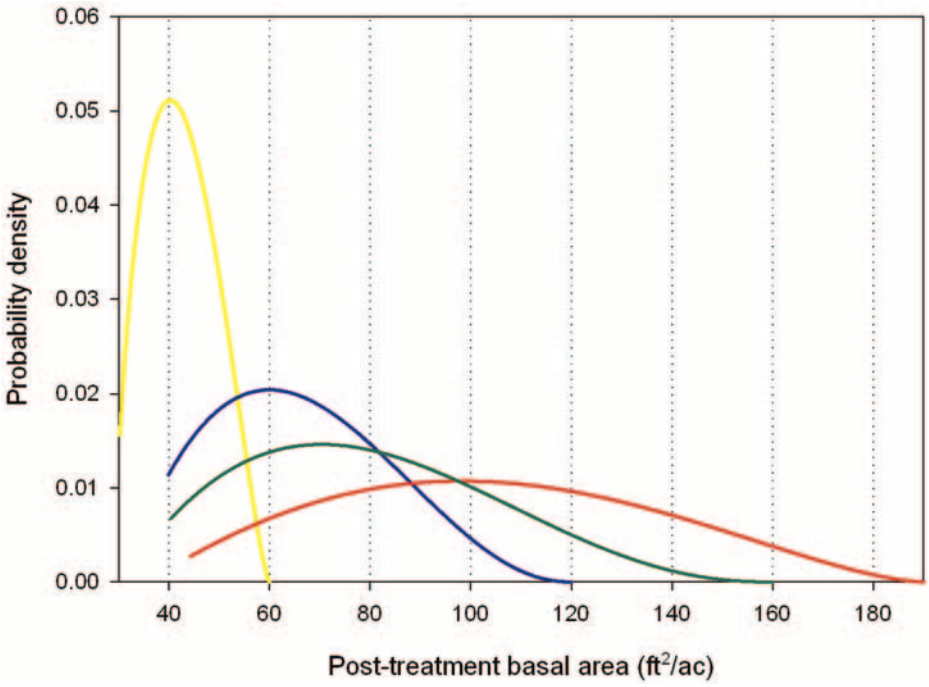



**Figure 3. Continuous probability distributions of desired posttreatment ponderosa pine basal area for each landscape management area used in consensus and majority scenarios. Locations with pretreatment basal areas lower than levels described by these curves were not decreased after potential treatments. CPMAs (yellow), aquatic and municipal watersheds (blue), MSO restricted habitat (red), and wildlands (green).**

## Consensus Reached

The group reached full agreement that 26% of the 2.4 million–ac analysis area should not be considered a source of wood supply and that 41% should be considered a potential source of byproducts generated by mechanical harvesting as part of restoration or fuel reduction treatment (Figure 4). The 41% is an analysis area average, with higher percentages applied to community protection areas and lower elsewhere, as described in the next paragraph. In addition, a majority of working group members believed that some portion of the remaining 33% of the landscape (up to a total of 74% of the analysis area) should be considered for mechanical thinning. The strategy underlying the consensus scenario was to apply nonmechanical restoration options where feasible in the remaining 33% of areas, including fire-only treatments and WFU to minimize

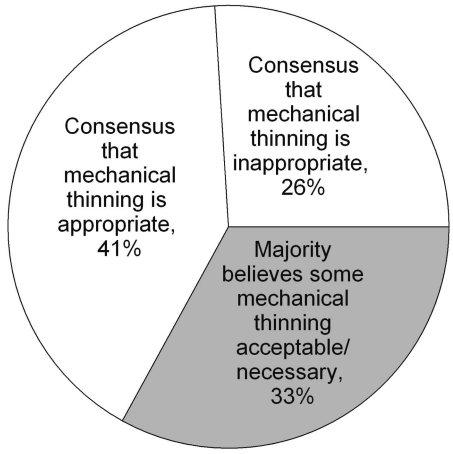



**Figure 4. Pie chart representing the level of agreement among stakeholders as a percentage of the entire analysis area. Areas in white represent full agreement over a total of 67% of the landscape. Areas in gray represent the remaining 33% of the landscape where there is a lack of consensus, but for which the majority of working group members believed some mechanical thinning would be acceptable and/or necessary.**

**Table 4. Wood supply estimates derived from the "consensus" and "majority" treatment scenarios (see text for explanation) as of 2006.[a] Potential treatments occur in the ponderosa pine type on 41% of the total analysis area acres for the consensus scenario and on 74% of the area for the majority scenario. The majority scenario was applied to all 74% of the area considered for restoration treatments; however, 5% was below a minimum amount of basal area and did not have thinning treatments.**

| Management area | Percent of management area | Wood volume[b] ($ft^3$) | Crown weight[c] (green tn) | Acres treated[d] | Percent area treated | Ave harvested[e] ($ft^3$/ac) |
|---|---|---|---|---|---|---|
| Consensus scenario | | | | | | |
| Community protection | 70% | 368,975,519 | 3,479,963 | 314,017 | 32% | 1,175 |
| MSO restricted habitat | 30% | 56,832,525 | 536,384 | 113,076 | 11% | 503 |
| Municipal watersheds | 40% | 37,448,212 | 355,581 | 34,471 | 3% | 1,086 |
| Aquatic species watersheds | 35% | 189,626,094 | 1,788,160 | 187,157 | 19% | 1,013 |
| Wildlands | 35% | 194,426,007 | 1,831,347 | 338,486 | 34% | 574 |
| Total | | 847,308,357 | 7,991,436 | 987,206 | 100% | 858 |
| Majority scenario | | | | | | |
| Community protection | 74% | 371,401,419 | 3,503,137 | 335,206 | 20% | 1,108 |
| MSO restricted habitat | 74% | 83,647,154 | 789,558 | 225,773 | 14% | 370 |
| Municipal watersheds | 74% | 47,206,561 | 448,773 | 58,031 | 3% | 813 |
| Aquatic species watersheds | 74% | 242,247,408 | 2,284,993 | 323,531 | 19% | 749 |
| Wildlands | 74% | 270,810,528 | 2,550,706 | 718,927 | 43% | 377 |
| Total | | 1,015,313,070 | 9,577,167 | 1,661,467 | 100% | 611 |

[a] Wood supply estimates are from 2006 data and have not been projected forward with forest growth information.
[b] Tree bole cubic foot volume includes the entire length of the tree, with no deduction from the main stem for stumps or tops at specified diameter.
[c] Crown weights from restoration byproducts include all tree foliage, limbs, and bark from limbs.
[d] Percent of total area potentially treated in each scenario located in each landscape management area. For example, 32% of the potentially treated areas in the consensus scenario are located in the community protection management areas.
[e] Average volume of bole and crown material per acre for differ between consensus and majority scenarios because the majority scenario covers an additional 34% of the landscape with generally lower pretreatment basal area.

potential negative impacts of mechanical treatments, whereas the majority scenario intends to provide a higher level of control and precision by using mechanical thinning to reduce the threat of uncharacteristic crown fire and achieve the group's desired conditions in these areas.

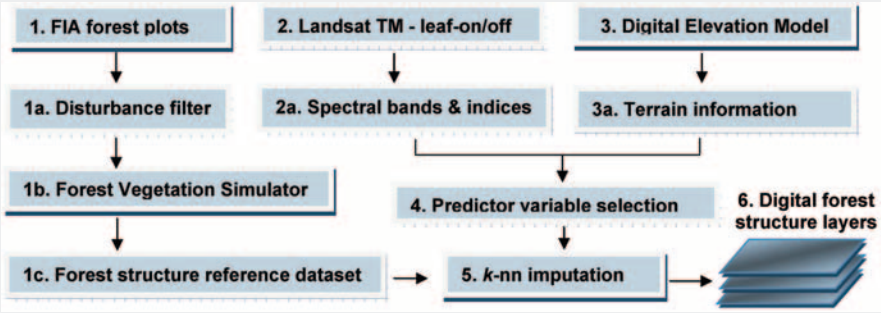
The working group partitioned the area to be restored using mechanized thinning for the consensus and majority scenarios into various proportions of each landscape management area (column 2, Table 4). The proportional breakdowns for the consensus scenario were based on informed judgment and were part of a three-tiered landscape restoration strategy in which (1) intensive mechanical thinning treatments are placed across all the CPMAs where thinning would be feasible, (2) additional mechanical thinning treatments are placed strategically across 30–40% of each of the remaining landscape management areas to significantly reduce uncharacteristic fire behavior (e.g., Finney 2006 and Finney et al. 2007), and (3) other restoration options are used where feasible and needed in the remaining areas, including prescribed burn-only treatments, WFU, and noncommercial thinning (or thinning that would not add to wood supply). The 74% for the majority scenario was based on the portion of the analysis area remaining after areas deemed not appropriate for mechanical treatments were removed from consideration.

## Assessment of Current Forest Conditions

Calculations of existing ponderosa pine wood volume and basal area per acre were a priority for estimating the potential wood supply from forest restoration treatments. Because up-to-date forest inventory data were lacking for the study area, we developed an integrated forest mapping system (IFMS) to map forest structural characteristics by combining US Forest Service National FIA plots with multidate Landsat Thematic Mapper (TM) imagery (Box 1). FIA plots provided a large-scale, consistent and systematic measurement (4.8 × 4.8-km sample grid) of forest conditions that is periodically updated (Hicke et al. 2007). Landsat TM data provided a recent (2006), low-cost multispectral and multitemporal platform for mapping ponderosa pine structural characteristics across all management jurisdictions in the study area. The integration of these data sources allowed statistical imputation using *k*-nearest neighbor (*k*-nn) algorithms to map forest structural condition for the ponderosa pine type (Box 1). The *k*-nn methods are increasingly used to map forest structure over large areas from inventory and remotely sensed data for a variety of forest types (Ohmann and Gregory 2002, Tomppo et al. 2008).

Digital forest structural layers resulting from IFMS were systematically evaluated for accuracy by comparing *k*-nn predictions of the value of each plot from all other FIA plots in the reference data set. Total forest volume estimates (Figure 2B) from digital grids resulted in an $R^2 = 0.78$ and mean and median residual error of $\pm 228/\pm 195$ $ft^3$/ac by comparing the imputed value to that observed from corresponding FIA plots. The mean residual error was influenced by plot locations with high volume and was lower ($\pm 189$ $ft^3$/ac) for comparisons using 80% of the FIA plot data for validation. Total basal area estimates (Figure 2C) showed an $R^2 = 0.72$ with a mean and median residual error of $\pm 15/\pm 11$ $ft^2$/ac in ponderosa pine forest. Summarized data from the digital volume layer resulted in a total of 4.56 billion $ft^3$ for ponderosa pine forest in the study area (Table 3). The total volume estimate was also compared with other recent regional and state wood volume assessments. Bailey and Ide (2001) calculated that 4.1 billion $ft^3$ of ponderosa pine volume existed within the four counties overlapping much of the wood supply study area, which include most of state's ponderosa pine forest, and O'Brien (1999) estimated that 5.4 billion $ft^3$ existed statewide. Although the spatial location of prior volume estimates do not overlap entirely with the wood supply study area, wood volume calculated using *k*-nn imputation for ponderosa pine forest in the study area compared well with previous estimates. Recent disturbances from large forest fires be-

**Integrated Forest Mapping System for combining US Forest Service FIA and remotely sensed data to model and map ponderosa pine forest structural characteristics across the study area.**




1. **FIA forest plots**—Georeferenced FIA forest inventory plots on National US Forest Service lands and live tree measurements (trees of ≥1-in. dbh) from years 1996 to 2005 were used to develop a region-scale ground reference data set for mapping ponderosa pine forest structure.
   a. **Disturbance filter**—FIA plots were selected by using remote sensing change detection techniques to identify plots without severe wildfire, timber harvest, and other disturbance events since the date of establishment.
   b. **Forest Vegetation Simulator (FVS)**[1]—Selected FIA forest plots representative of the ponderosa pine forest type ($n$ = 420) were grown forward in time to match the Landsat TM image year (2006). The Central Rockies Variant of FVS provided species-specific growth models for the southwestern United States (Dixon 2002) to estimate tree basal area and cubic foot volume per acre. Plots were established between years 1996 and 2005 (i.e., <10 years of simulated growth).
   c. **Forest structure reference data set**—Plot basal area and volume were used to model forest structural conditions from sampled to unsampled locations using a set of predictor variables and *k*-nn imputation methods discussed next.
2. **Landsat TM data**—Twelve Landsat TM scenes from 2006 (6 leaf-on and 6 leaf-off for deciduous tree species) were assembled to cover ponderosa pine forest type in the study area.
   a. **Spectral bands and indices**—Spectral bands and indices were derived from leaf-on and leaf-off TM images including TM bands 1–5 and 7, normalized difference vegetation index (NDVI) and derivatives such as corrected NDVI (NDVIc; Pocewicz et al. 2004) and NDVI ratio (leaf-on/-off), bands from a tasseled cap transformation (i.e., wetness, greenness, and brightness), and minimum noise fraction bands 1–3. These variables were initially selected because of their potential usefulness for predicting forest structural parameters (e.g., Cohen et al. 1995, Moisen and Frescino 2002, Tomppo et al. 2008).
3. **Digital Elevation Model (DEM)**—A 30-m DEM was used to derive four variables related to the biophysical environment that were likely to be important predictors of forest structure.
   a. **Terrain information**—Terrain variables included percent slope, elevation, surface roughness, and aspect. Aspect was cosine transformed for use as a continuous index of solar radiation related to site moisture conditions (Moisen and Frescino 2002).
4. **Predictor variable selection**—All spectral and terrain predictor variables (grids) were resampled to a 90-m grid cell size and used to attribute each reference plot for developing models and digital data layers. As part of statistical imputation (below), we used the random forest regression tree algorithm (Breiman 2001) to estimate variable importance. Therefore, a reduced subset of the best predictor variables was selected for use in a final model predicting each structural variable (see also Cutler et al. 2007, Sesnie et al. 2008a, 2008b, Evans and Cushman 2009). Predictor variable importance indicated that minimum noise fraction band 1 (leaf-on), NDVIc, and NDVI ratio in addition to TM bands 1–5, 7 from both leaf-on and leaf-off TM images, were necessary for generating accurate basal area and wood volume estimates. Elevation and roughness (elevation SD in a 3 × 3 pixel window) variables taken from a DEM were also important and used in forest structure imputations.
5. **The *k*-nn imputation**—Statistical imputation has become increasingly important for mapping forest characteristics across large areas from existing forest inventories and remotely sensed data. The *k*-nn imputation techniques used for the wood supply assessment accessed a set of reference data ($y$ = forest structural variable on FIA plots) attributed by predictor variables ($x$ = spectral and terrain predictors) to estimate $y$ for many unsampled locations (pixels) with $x$ variables only. The yaImpute package in R statistical software (The R Foundation for Statistical Computing 2007) was used to implement the random forest regression tree algorithm (Breiman 2001) for *k*-nn imputation for deriving forest structural layers (see also Crookston and Finely 2007).
6. **Digital forest structure layers**—The IFMS produced digital data layers of ponderosa pine basal area and volume (Figure 2, B and C) that were passed to a GIS for the wood supply assessment. Forest restoration treatments were applied as reductions in basal area to estimate wood supply.

[1]We used USDA FIA forest inventory plots for study on national forests in the FVS file format (US Forest Service 2007). Georeferenced FIA plot locations on National Forestland were obtained under a written agreement with the USFS Forest Inventory and Analysis program office. Ogden, UT and the USFS Southwestern Regional office in Albuquerque, NM.

fore 2006 and corresponding decreases in wood volume were also well represented in digital forest volume and basal area layers (Figure 2).

A central objective of the wood supply estimate was to determine the amount of wood supply from thinning small-diameter trees. For the purposes of this study, the group selected a 16-in. dbh threshold because of its common use within the analysis area as a break differentiating "small"- and "large"-diameter trees in the ponderosa pine forest type. To examine the amount of land area and volume where thinning could meet posttreatment conditions by harvesting small-diameter trees (i.e., trees of <16-in. dbh), three additional basal area layers were derived with the IFMS for three diameter classes of <5-in. dbh ($R^2$ = 0.45), 5- to 16-in. dbh ($R^2$ = 0.51), and >16-in. dbh ($R^2$ = 0.50). We assumed that 10 and 20% of the basal area per acre must be retained after thinning from trees of <5-in. dbh and 5- to 16-in. dbh, respectively, to promote tree age and size class diversity. Wood supply estimated from thinning treatment scenarios in the following section were used to assess the amount of volume and proportion of analysis area that would meet posttreatment basal area conditions by thinning small-diameter trees.

## Potential Wood Supply from Restoration Treatments

Based on the working group's specifications for percent area treated and desired posttreatment conditions within five landscape management categories, we estimated potential wood supply generated from the consensus and majority treatment scenarios. It was acknowledged that treatments should focus on removing small-diameter trees as the central objective, but no fixed diameter limitation was placed on restoration scenarios or supply calculations. For example, there was no concurrence within the group that trees over 16 in. should be cut and removed from areas outside the CPMAs.

We first needed to identify prethinning forest characteristics from IFMS data layers and estimate thinning levels to achieve desired posttreatment conditions. We fit the pretreatment basal area distribution for each landscape management area to the desired posttreatment probability distributions defined by the working group, while maintaining the original order of low to high basal area conditions. For example, the pretreat-

ment basal areas in CPMAs were reduced to a minimum basal area of 30 $ft^2$/ac and a maximum of 60 $ft^2$/ac, with the mode set at 40 $ft^2$/ac (Figure 3). The pretreatment basal area was reduced unless it was below a minimum desired condition (e.g., $<$40 $ft^2$/ac in wildlands) in which case the values were left unchanged. The difference between pre- and posttreatment basal area represented thinning intensity. The dominant thinning level ranged from heavy in the CPMAs, which were designed to buffer communities from severe wildlife behavior, to light in MSO restricted habitat, reflecting a preference for denser conditions. The modeled treatments, especially the high-intensity treatments in the CPMAs, interspersed with areas not thinned, created a heterogeneous pattern of potential posttreatment basal area across the landscape (Figure 2D).

To obtain estimates of wood volume harvested as a byproduct of treatments, nonlinear regression was used to determine the cubic foot volume from the amount of basal area removed. To establish these relationships, we used basal area and log transformed total wood volume from FIA plots in the reference data set ($n$ = 420). A final model showed a good fit to the data ($R^2$ = 0.81; $P < 0.0001$). A range of wood supply volumes was estimated for each management area, integrating the two working group scenarios and thinning levels (Table 4). In the consensus scenario, the highest basal area locations were thinned in each landscape management area up to the percent areas specified by the working group. This was not necessary in the majority scenario because each entire landscape management area was available for treatment.

Thinning treatments considered under the majority scenario produced 17% more wood supply (1.015 billion $ft^3$) than that of the consensus scenario (0.847 billion $ft^3$). The greater number of acres treated with the majority scenario included locations with lower basal area, which reduced the average volume harvested. Average supply volumes ranged from 611 $ft^3$/ac (majority) to 858 $ft^3$/ac (consensus), which closely matched the amount of harvest volume estimated from US Forest Service timber cruise data and recent thinning treatments within the study area (White Mountain Stewardship contract, 2008, US Forest Service, unpublished data). Differences between pre- and posttreatment landscape conditions (basal area) for the majority scenario indicate the locations treated, which cover a total of 69% of the study area where minimum basal area conditions were met (Figure 2, C and D).

From our analysis of wood supply generated from small-diameter trees we found that 1.44 million ac (81% of the area treated) had sufficient basal area from trees of $<$16-in. dbh, meaning that only small trees would be harvested. This accounted for 90% of the total wood supply volume (917 million $ft^3$) in the majority scenario. High-intensity treatments in CPMAs were the principal locations where thinning larger trees would be necessary to meet desired posttreatment conditions. The consensus scenario, which was comprised of areas having the highest initial basal area over 41% of the analysis area, resulted in similar outcomes.

In addition to stem volume, forest biomass removed by treatments was also estimated because potential wood products may be derived from residual materials. To estimate crown biomass (limbs, bark, and foliage) that is in addition to wood supply from tree boles, a relationship between bole and crown weights from FIA plots was developed via nonlinear regression. Stem weight was generally three times greater than biomass comprised of crown material. Estimates of crown biomass for the consensus and majority scenarios ranged from 8.0 to 9.6 million green tn, respectively (Table 4). Per acre volume and biomass estimates were similar to harvest volumes taken from existing forest restoration activities (White Mountain Stewardship contract, 2008, US Forest Service, unpublished data).

Harvesters removed a total of 319,800 tn of nonresidues and 12,900 tn of residues from the Kaibab, Coconino, and Apache-Sitgreaves National Forests in 2006 (unpublished data provided by the four National Forests) equivalent to 1.2% of the total bole biomass and 0.2% of the total crown biomass that would potentially be generated from treatments in the consensus scenario. A simple linear extrapolation of year 2006 harvest levels over 10 years would result in 3,198,000 and 129,000 green tn, which is 12 and 1.6% of the respective bole and crown biomass from the consensus scenario. Therefore, wood supply defined by stakeholders exceeded current utilization levels by $>$88% when extrapolated over the next 10 years.

Wood supply estimates based on the working group scenarios represent a snapshot in time. Forest growth will likely add to potential wood supply, averaging about 40 $ft^3$/ac per year including self-thinning mortality. Simple volume multipliers can be used to adjust these published values. However, increasing frequency and severity of western wildfires (Westerling et al. 2006), expected continued drying of the southwestern climate (Seager et al. 2007), and associated insect outbreaks and tree mortality (van Mantgem et al. 2009) could drive down biomass stocks and growth rates.

## Conclusions

A primary goal of this case study was to build agreement on the location and type of ecologically appropriate forest restoration treatments that could supply wood byproducts to new and existing businesses and markets. Maintaining forest structural heterogeneity across the landscape and restoring fire-adapted conditions were the two guiding principles used to design broad-scale thinning treatments. The working group reached full consensus across 67% of the landscape (26% not appropriate for mechanical thinning and 41% appropriate), which is a remarkable achievement considering such diverse stakeholder interests. In addition, a majority of working group members believed that some portion of the remaining 33% of the landscape (up to a total of 74%) should be considered for mechanical thinning. The entire group also agreed on the intensity of mechanical treatments that could be applied within five landscape management categories. Where a difference of opinion occurred for 33% of the analysis area, the estimated bole volume of restoration byproducts potentially available differed by 17% (ranging from 847 to 1,015 million $ft^3$).

Lessons learned include the importance of involving participants with broad representation among stakeholder groups and close contact with decisionmakers in their organizations. In addition, to ensure that the process and methods used to reach project objectives make sense to participants, time should be allocated up front to involve participants in their development. Finally, facilitation techniques that encourage contribution from each participant and minimize dominance by one or several groups are essential for permitting critical issues to surface.

The consensus scenario produced estimates of potential wood byproducts from restoration treatments that greatly exceed current thinning levels. The outcome of the study catalyzed new forest restoration initi-

atives and planning mechanisms to achieve the intent of the wood supply analysis. On Nov. 13, 2008, Janet Napolitano, then Governor of Arizona, endorsed accelerated restoration across northern Arizona in a letter to the Regional Forester, asking that the consensus reached in this study be institutionalized. On Mar. 2, 2009, US Representative Ann Kirkpatrick requested the US Forest Service work with stakeholders toward releasing a request for proposals to accelerate treatments. In a Mar. 6, 2009, letter, the Regional Forester announced the intent of four Forest Supervisors with management authority for lands in the wood supply analysis area to develop a strategy to substantially accelerate the rate of restoration treatments across 750,000 ac of the analysis area, followed by a "Sources Sought" notice released by the Southwestern Region of the US Forest Service on April 23rd to gather information to design contract options for the "Four Forest Restoration Initiative Project." In a letter dated May 6, 2009, Arizona Governor Janice Brewer asked the Regional Forester to work with the Governor's Forest Health Council, (6 of the 20 council members were working group members on this study), to implement the restoration goals of the consensus scenario. On June 26, 2009, Arizona Senate and House of Representatives requested that the Director of the US Forest Service and the Governor "… clearly identify additional federal appropriations needed to support acceleration of consensus-supported and scientifically informed forest restoration treatments." Challenges remain, such as, securing funding, designing effective contracts, and stepping region-scale analyses down to project level prescriptions; however, based on the unprecedented alignment of stakeholder and policymaking interests, the success of achieving landscape-scale restoration in northern Arizona's ponderosa pine forests looks promising.

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2011-02-05

4 Forest Restoration Initiative Web-Comment Portal

February 5, 2011

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 2/5/2011 13:05:41 | Yes | N/A | Unaffiliated individual | Bruce Rogers | brogers@adr.com | 4808 W. Desert Hills Drive | Glendale | AZ | 85304 | E-Mail |

2011-0205-6

**Sharon Galbreath**
**<sharoneg@q.com>**

02/03/2011 05:17 PM

To hprovencio@fs.fed.us

cc

Subject 4FRI & Comments

Dear Henry,

Attached is a short section of comments that the Sierra Club submitted to the Kaibab National Forest related to Forest Service management proposals for Ponderosa pine. Would something along these lines fulfill what you need to move 4FRI along or is it too specific. I believe a coalition of environmental groups submitted more of a straight DFC document to the Coconino Forest during the early rounds of forest planning. I could probably hunt that down.

I thought you all did a very good job of pulling together a huge amount of data. I found it very interesting. It was clear the group was interested and wanted to know more, which is always better than the reverse. I don't think you need to start over, you just need to simplify and add definitions.

I participated in the first round of forest planning in the mid-1980s. I covered the Coconino and the Kaibab for the Sierra Club. The new technology is of course fabulous, but sometimes It feels like layers of data have replaced the time we used to all spend out on the ground. Regardless of the technology used, the real struggle is to find a common language, so we all hear roughly the same thing.

Good Luck getting ready for next week.

Sincerely,
Sharon Galbreath



Kaibab Forest Plan Management_11-22-2010.pdf

**Management Recommendations for the Kaibab National Forest**
**Submitted by: The Grand Canyon Chapter of the Sierra Club**
**November 22, 2010**

The Kaibab National Forest provides a unique opportunity to restore the historic old growth forests of the Southwest, on a landscape scale. The Kaibab Plateau, a part of which is on the North Kaibab Ranger District, contains the highest remaining density of the ancient pines that once dominated the largest contiguous ponderosa pine forest in the country.

Old Growth is essential to many species inhabiting the Kaibab National Forest because it provides habitat attributes not found in younger forests. These include large, old trees, large standing dead trees, vertical and horizontal structural diversity, nesting cavities, broken tops, and fire resistant "plated" bark structure. In addition to these important habitat characteristics, old growth provides a host of ecological services including overall watershed function, clean water, soil retention, and storage of greenhouse gasses.

The Sierra Club is proposing a conservative approach to restoration, implementing treatments that preserve the greatest amount of present biological diversity while seeking to reintroduce the natural processes necessary to allow forests to restore ecosystem integrity.

**Management Recommendations for Ponderosa Pine**

**Objectives:**
**Manage Old Growth at the individual, group, and landscape scale.**
The only way to restore and develop old growth as a natural process at the landscape scale is to preserve the old growth components that currently exist. This can best be accomplished by retaining old growth components such as yellow pines and large trees at the individual and group levels while identifying stands that as a whole generally exhibit old growth characteristics. The goal is to provide as much old growth as can be sustained in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time.

While old growth is a term generally used to describe ecosystem function, it is also increasingly used by the public, academics and even some land managers to describe individual trees with the characteristics described below in "A."

> A. Retain old growth trees regardless of size, as old growth is a function of age, not size. Old growth is not a definitive age. Ponderosa pines begin to develop the thick yellow bark characteristic of an old growth tree between 120 and 150 years of age. As they age, the yellow-red bark also develops wide, large plates. In addition to bark characteristics, an old growth ponderosa pine tree typically exhibits complex structural attributes such as full crowns, flattened tops and large limbs. These trees are sometimes referred to as yellow pines, presettlement trees or mature trees. (Note that "The Path Forward" dated March 19, 2010, a document guiding the Four Forests Restoration Initiative uses the following language: "**8.No old growth trees (predating Euro-American settlement)**

**shall be cut.")**

B. Protect old growth trees by removing excess competition from small, young trees. Initially, removal should focus on, but not be restricted to, trees 12 inches in diameter and smaller. Such a focus is warranted given the high density and high percentage of the forest landscape these trees occupy. According to the USDA, more than 82 percent of ponderosa pine trees in Region Three are smaller than 11 inches in diameter. (USDA, 1999 & 2007) Thinning should occur within groups, as well as in identified openings between groups.

C. Reduce the fire risk to old growth trees by removing small, younger trees, as well as some mid-aged trees, (VSS 4: 12 to 18 dbh) from within the drip lines of individual trees. Given the lack of trees larger than 15 inches in diameter, thinning should focus on trees smaller than 15 inches in diameter. Approximately 96 percent of the trees in Region Three are smaller than 15 inches in diameter (USDA, 1999 & 2007). This would reduce ladder fuels, lowering the potential for crown fires. It would also encourage the growth of an understory community.

D. Larger diameter trees, in VSS 4, 5 and 6 should be retained to replace the structure and function of old growth trees that were removed by logging.

E. Within old growth stands, retain groups of young and mid-aged trees to provide for multiple age classes and enhance structural diversity. Thin variably within retained groups, removing ladder fuels and avoiding even spacing.

F. Identify and retain areas that would be best left unthinned as wildlife cover and for travel corridors.

G. Preserve all snags. Downed logs with a diameter greater than 10" will be preserved.

H. Use prescribed fire to reduce ground fuels and to reintroduce fire to the ecosystem.

I. Defer Livestock grazing, after the initial fire treatment to allow for understory recovery and change grazing management to allow for function of natural processes.

J. Decrease road densities to enhance stand integrity by reclaiming old skid trails and log landings.

K. Openings within and between groups that were created by the logging of presettlement trees, or larger trees established close to disruption of the natural fire regime should not be considered openings to be maintained over time. Given the high number of these openings created by logging, their impacts should be considered when proposing the creation of new openings. This should apply to all spatial scales.

L. Meadow Restoration is appropriate only in those areas that were previously meadows. Differentiate these sites from those that previously contained largely open forest structure with dispersed trees, but have been cut. Similarly, differentiate these sites from areas opened by past treatments. Retain all old growth and large trees that existed previous to the exclusion of fire within the meadows.

**Ponderosa Pine Restoration Management Objectives:**

The Sierra Club's goal is to restore the forest's ecological integrity, which would include composition, structure and function. We are seeking to restore the natural range of variability with a distribution of tree ages, sizes and spatial structures, but not precise structural conditions that existed at some designated point in time. Reconstructed historic reference conditions should be used as general guides, rather than rigid restoration prescriptions. The Sierra Club supports a conservative approach, which seeks to determine the minimum amount of mechanical intervention and structural manipulation necessary to restore natural processes such as fire. Restoration is not a single event, but a process that occurs over time.

Ponderosa pine forests historically contained a percentage of trees that were saplings, poles, and blackjack sized trees. To account for this, a diversity of tree sizes will be retained both within tree groups as well as across the restoration treatment area. Removing all of the smaller trees would result in oversimplification of the forest's structure and distribution of trees by age class.

A. Identify groups and openings using crown development, canopy continuity, and stem densities to identify groups and openings between groups.

B. Utilize and enhance existing forest structure by retaining the largest trees and groups of larger trees with interlocking crowns. Retain co-dominants in the larger diameter groups present on a site to maintain greater canopy retention with the goal of creating groups that function more like pre-disturbance groups. The diameter range of the largest trees existing on a site will vary with past treatments, site location and site productivity.

C. Larger diameter trees, in VSS 4, 5, and 6 should be retained to replace the structure and function of old growth trees that were removed by logging. This would also apply to the larger trees in smaller structural stages. According to the USDA, trees larger than 16 inches in diameter comprise approximately 3 percent of live trees in Region Three (FIA Data, USDA, 1999 & 2007).

D. Reduce the fire risk to mid-aged and mature trees by focusing on the removal of small, young trees (12" dbh) from the spaces and openings between groups. According to the USDA, more than 82 percent of ponderosa pine trees in Region Three are smaller than 11 inches in diameter. (USDA, 1999 & 2007) This would reduce ladder fuels, lowering the potential for crown fires. It would also encourage the growth of an understory community.

E. Retain the largest and healthiest young and mid-aged trees within each group and

stand to provide for multiple age classes and enhance structural diversity. Thin variably within retained groups, removing ladder fuels and avoiding even spacing. The goal is to emulate old growth group structure.

F. Openings within and between groups that were created by the logging of presettlement trees, or larger trees established close to disruption of the natural fire regime should not be considered openings to be maintained over time. However, given the high number of these logging created openings, their impacts should be considered when evaluating the creation of new openings. This should apply to all spatial scales.

G. Identify and retain areas that would be best left unthinned as wildlife cover areas and for travel corridors.

H. Preserve all snags. Downed logs with a diameter greater than 10" will be preserved.

I. Use prescribed fire to reduce ground fuels and to reintroduce fire to the ecosystem.

J. Defer Livestock grazing after the initial fire treatment to allow for understory recovery and change grazing management to allow for function of natural processes.

K. Decrease road densities to enhance stand integrity by reclaiming old skid trails and log landings.

L. Meadow Restoration is appropriate only in those areas that were previously meadows. Differentiate these sites from those that previously contained largely open forest structure with dispersed trees, but have been cut. Similarly, differentiate these sites from areas opened by past treatments. Retain all old growth and large trees that existed previous to the exclusion of fire within the meadows.

**Mixed-Conifer**

In addition to comments made in the ponderosa pine section, management should focus on retaining and restoring the pine component as well as mature Douglas-fir trees. Significant losses have occurred due to past logging practices, large wildfires and encroachment of smaller trees.

**Aspen within Ponderosa Pine Stands**

The Desired Condition states that, "Coniferous species comprise less than 10% of the overstory." The Sierra Club is concerned that this target does not take into account the amount of aspen regeneration that has taken place (primarily on the North Kaibab) due to unnatural disturbances such as logging, logging skid trails and landings. In many areas aspen regeneration is outcompeting pine. We are concerned that type conversion on a large scale could take place.

2011-02-10 - 8

"Steve Gatewood"
<wildwoodvb@earthlink.net>

02/10/2011 09:00 PM

Please respond to
"Steve Gatewood"
<wildwoodvb@earthlink.net>

To "Paula Cote" <pcote@fs.fed.us>, "Henry Provencio" <hprovencio@fs.fed.us>
cc "Taylor McKinnon" <tmckinnon@biologicaldiversity.org>, "Shaula Hedwall" <Shaula_Hedwall@fws.gov>, "Sarah Reif" <SReif@azgfd.gov>, "Marcus Selig"
bcc
Subject Fw: Firescape Document

Greetings Henry & Paula:
On behalf of the LSWG, we am forwarding a revised Firescape 3 report.
Let me know if this covers the issues you had or if we need additional modifications.
Cheers,
Steve Gatewood & Diane Vosick
4FRI Steering Committee Co-Chairs

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Steve Gatewood
Wildwood Consulting, LLC
wildwoodvb@earthlink.net
928/600-3858

----- Original Message -----
**From:** marcus selig
**To:** Steve Gatewood
**Cc:** Windy Greer ; Rod Ross ; Pam Fisher ; Tommie Martin ; Taylor McKinnon ; Todd Schulke ; Pascal Berlioux ; Molly Pitts ; Ethan Aumack ; Ed Smith ; Dennis Bowker ; David Tenney ; Diane Jayne Vosick ; Alan Kaufmann ; Henry Provencio ; Sarah Reif ; Shaula Hedwall ; Hunter Moore ; marcus.selig
**Sent:** Tuesday, February 08, 2011 9:07 AM
**Subject:** Re: Firescape Document

Steering Committee and others,

Attached are our "recommendations" for Firescape 3. Please let me know if any additional changes to the document are needed.

Marcus



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# MANAGEMENT GUIDANCE RECOMMENDATIONS FOR FIRESCAPE 3

of the First Analysis Area

**REPORT**

**FROM THE FOUR FOREST RESTORATION INITIATIVE**

**STAKEHOLDER GROUP TO THE USFS 4FRI PLANNING TEAM**

**January 31, 2011**

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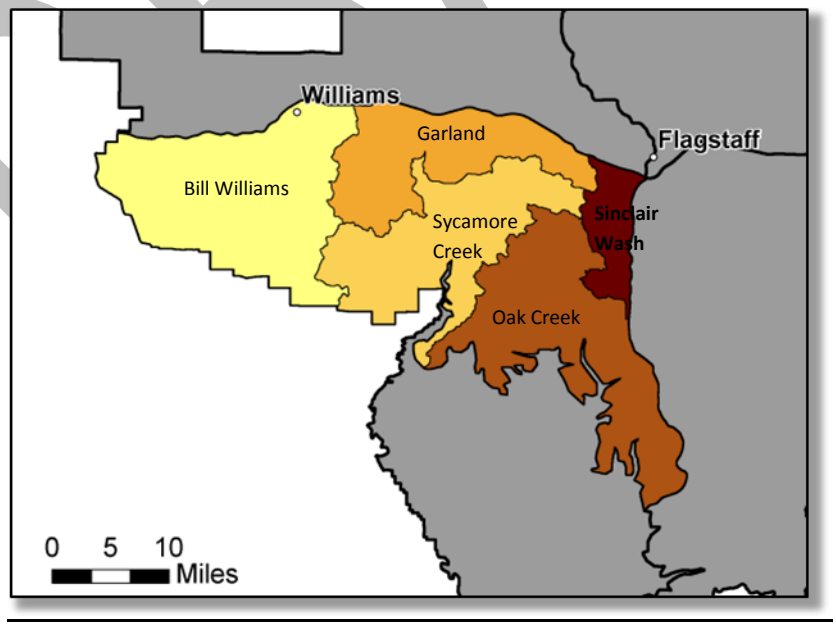
*IMPORTANT NOTICE: This document is a work in progress from the **Landscape Strategy Working Group** of the Four Forest Restoration Initiative (4FRI), and is in DRAFT form until approved by the 4FRI Stakeholder Group. Therefore, this information is subject to change and does not necessarily represent final language, a formal position, or a statement of policy from 4FRI. Comments and suggestions are welcome; please submit any comments to: **Marcus Selig (mselig@grandcanyontrust.org) or Sarah Reif (sreif@azgfd.gov ).***

## FIRESCAPE 3 MANAGEMENT GUIDANCE RECOMMENDATIONS

This document contains general management guidance recommendations for Firescape 3 of the Four Forest Restoration Initiative ("4FRI") area and, when appropriate, more specific guidance recommendations for the treatment areas located within Firescape 3. All management guidance provided in this document is intended to help the Forest Service plan, design, and implement treatments that will achieve the firescape-scale Desired Future Conditions ("DFCs") identified in the Landscape Restoration Strategy for the First Analysis Area Report ("LRS Report"). Therefore, all management guidance in this document is tiered under the firescape-scale DFCs previously identified in the LRS Report.

To facilitate Forest Service planning, the management guidance provided in this document has been grouped into ~~five~~ six different categories: (1) mechanical thinning treatments, (2) fire management, (3) wildlife habitat, (4) multiple-use management, (5) watershed management, and (6) invasive species management and other restoration activities.

Although many of the guidance recommendations provided in this document can be used by the Forest Service to design treatments under the Proposed Action for 4FRI's first analysis area, some management guidance will be beyond the scope of the Forest Service's Proposed Action. The 4FRI collaborative hopes that the Forest Service, stakeholders, and other partners will use this guidance to plan, design, and implement additional activities that will help achieve comprehensive restoration within the 4FRI area.




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**Figure 1.** Firescape 3 is located southwest of Flagstaff and consists of five treatment areas: Bill Williams, Garland, Sycamore Creek, Oak Creek, and Sinclair Wash Treatment Areas.

## MECHANICAL THINNING TREATMENT GUIDANCE

***FIRESCAPE DFC:*** **Mechanical thinning treatments result in forests that trend toward natural variability, self-regulation, and are better positioned to adapt to climate change without large, rapid, type shifts.**

### FIRESCAPE GUIDANCE

- Use site-specific biotic and abiotic factors to design mechanical treatments that result in the full range of variability of forest structural parameters (e.g., basal area, canopy cover, group size, density, etc.). Historically, site-specific prescriptions have generally targeted only the mean or minimum of the range of variability; instead, we desire a full range of prescriptions that create a heterogeneous forest structure across the landscape.

***FIRESCAPE DFC:*** **Mechanical thinning treatments allow natural disturbance processes (e.g., fire, endemic pests and pathogens) to occur at a range of endemic levels.**

### FIRESCAPE GUIDANCE

- Mechanical treatment design should consider natural rates of mortality associated with endemic levels of natural disturbances as an additional mechanism for achieving the natural range of variability. Endemic levels of ~~N~~natural disturbance events can and should be used as a means for achieving restoration goals.
- Mechanical treatments should not be designed to eradicate or sanitize the occurrence of endemic levels of natural disturbance processes (*e.g.*, dwarf mistletoe, tornado damage, etc.).
- When designing mechanical thinning treatments in areas containing dwarf mistletoe, treatment activities should be consistent with guidance identified in the "4FRI Large Tree Retention Plan" ("LTRP") and "Dwarf Mistletoes and their Management in the Southwest" (Conklin and Fairweather 2010).
- Salvage logging projects should be individually assessed, weighing planning and administrative costs, restoration opportunity costs, wildlife habitat values, fire hazard reduction value, and the use of areas as natural fire breaks. Salvage logging is not ecological restoration (Noss et al. 2006).

### TREATMENT AREA-SPECIFIC GUIDANCE

- **Garland Treatment Area-Specific Guidance**
  - In tornado damaged areas, salvage logging projects should be individually assessed within a landscape context, weighing planning and administrative costs, restoration opportunity costs, wildlife habitat values, fire hazard reduction value, and the use of areas as natural fire breaks.

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- The prioritization of treatment of tornado damaged areas should be integrated with other thinning and burning activities.

❖ **Sycamore Creek Treatment Area-Specific Guidance**

- In tornado damaged areas, salvage logging projects should be individually assessed within a landscape context, weighing planning and administrative costs, restoration opportunity costs, wildlife habitat values, fire hazard reduction value, and the use of areas as natural fire breaks.
- The prioritization of treatment of tornado damaged areas should be integrated with other thinning and burning activities.

❖ **Oak Creek Treatment Area-Specific Guidance**

- In tornado damaged areas, salvage logging projects should be individually assessed within a landscape context, weighing planning and administrative costs, restoration opportunity costs, wildlife habitat values, fire hazard reduction value, and the use of areas as natural fire breaks.
- The prioritization of treatment of tornado damaged areas should be integrated with other thinning and burning activities.

***FIRESCAPE DFC:*** **Following mechanical thinning treatments, there is low potential for unnaturally severe fire[1] to spread across the Firescape.**

**FIRESCAPE GUIDANCE**

- ~~We~~ The Stakeholder Group would like to go through an iterative modeling process and fire simulations with the Forest Service and Forest ERA to help the Forest Service determine what portion of a firescape must be treated to prevent the spread of unnaturally severe fire.
  - *EXAMPLE RESULT OF MODELING PROCESS* -- Treat x% of areas exhibiting the potential for active crown fire under 97th percentile conditions, as described in the LRS Report, with strategically placed mechanical thinning to preclude crown fires larger than [##-##] contiguous acres.
- Treatment design should build on the objectives of the Community Wildfire Protection Plans for Flagstaff and Williams.

[1] Examples of "unnaturally severe" fires may include fires of extreme size or intensity, such as the Hochderffer-Horseshoe Fire (1996), Pumpkin Fire (2000), Rodeo-Chedeski Fire (2002), Warm Fire (2006), Woody Fire (2006), Hardy Fire (2010), and Shultz Fire (2010).

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***FIRESCAPE DFC:*** **Strategically placed mechanical thinning treatments allow fire managers to safely manage prescribed fires and naturally ignited fires in a way that benefits and enhances the resilience of forest ecosystems.**

**TREATMENT AREA-SPECIFIC GUIDANCE**

- **Bill Williams Treatment Area-Specific Guidance**
  - In addition to implementing treatments in the NEPA-completed areas within the Treatment Area, mechanical thinning treatments should be implemented in the Sycamore Canyon priority area identified in the Kaibab Forest Health Focus and the LRS Report.
- **Garland Treatment Area-Specific Guidance**
  - Some portion of all candidate areas within the Treatment Area should receive treatment (thinning, burning, or both); however, there are three goshawk nest cores that overlap with candidate treatment areas. These will require additional evaluation to determine appropriate treatment.
  - In the southwestern portion of the Treatment Area, mechanical thinning treatments should focus on protecting the headwaters of Sycamore Canyon from unnaturally severe fire (and allow for safe management of fire around Sycamore Canyon).
  - Coordinate with Camp Navajo to focus on protecting the headwaters of Volunteer Canyon from unnaturally severe fire.
  - In the southwestern portion of the Treatment Area, mechanical thinning treatments should retain larger tree groups that are oriented with their long axis perpendicular to the prevailing winds in order to maintain and enhance existing wildlife corridors and meet fire management objectives (i.e., management of fire at larger than current scales).
- **Sycamore Creek Treatment Area-Specific Guidance**
  - Mechanical thinning treatments should be concentrated in areas with predicted active crown fire under 97$^{th}$ percentile conditions, as described in the LRS Report.
  - Mechanical thinning treatment intensity should vary based on topography. Higher intensity treatments (i.e., treatments resulting in lower density, crown cover, and basal area) should be implemented in flatter areas (e.g., meadows and swales), with lower intensity treatments occurring on steeper slopes of isolated hills and knobs.
- **Oak Creek Treatment Area-Specific Guidance**
  - Mechanical thinning treatments should be prioritized in areas adjacent to canyon rims and Wilderness, even if not identified as "candidate areas," to facilitate the use of natural fire in unthinnable areas (e.g., steep slopes and Wilderness) while protecting wildlife habitat and other resources outside canyons from the spread of fire out of the canyon.
  - Areas with predicted crown fire under 97$^{th}$ percentile conditions, as described in the LRS Report, should be treated with mechanical thinning~~,~~. Note, however, that areas of predicted active crown fire south of Woods Canyon ~~are~~ may not be regarded as priority areas for treatment, as ~~we~~ several Stakeholders believe there is a possibility that the model is being exaggerated by the presence of piñon-juniper forest type.

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- Other candidate areas in this Treatment Area may or may not require mechanical thinning treatments.

❖ **Sinclair Wash Treatment Area-Specific Guidance**

- Due to previously implemented treatments and already planned projects, this Treatment Area ~~does~~ may not contain high priority areas for additional mechanical thinning. The need for additional mechanical treatments in this Treatment Area will be dependent upon an assessment of the intensity and completion of ongoing projects in the Treatment Area.

***FIRESCAPE DFC:*** **Strategically placed mechanical thinning treatments maintain and enhance, but do not degrade habitat for listed, rare, and sensitive species.**

**FIRESCAPE GUIDANCE**

- For general wildlife habitat recommendations, we recommend consideration of the AGFD-USFWS-ERI draft publication "Desired Forest Conditions for Wildlife in Arizona's Ponderosa Pine Forests."
- For each treatment area, we provide occurrence and locality information for special status plants and animals (see Appendix). The following management recommendations should be used to guide restoration activities in treatment areas to provide for a variety of special status species.
  - Retain snags during mechanical treatments.
  - Retain large trees and snags near water sources (e.g., tanks, drinkers, wetlands, lakes), consistent with the LTRP.
  - Follow Forest Plan direction for implementing the Northern Goshawk Management Recommendations.
  - Implement the Recovery Plan for the Mexican spotted owl.
  - Emphasize retention of large trees and snags on north-facing slopes near highways, lakes, and wetlands for bald eagles.
  - Avoid creating landings on or skid trails across forest openings and meadows.
  - Retain coarse and fine woody debris where possible.
- For rare and sensitive plants:
  - Conduct surveys for rare and sensitive plant species.
  - In areas where rare and sensitive plant species are known to occur, avoid disturbance and trampling.
- Reduce road density by obliterating roads identified in the Travel Management Rule ("TMR").

**TREATMENT AREA-SPECIFIC GUIDANCE**

❖ **Bill Williams Treatment Area-Specific Guidance**

- Treatments in pine-oak forest types should be implemented in a manner consistent with the Recovery Plan for the Mexican spotted owl.

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- See Appendix for Heritage Data Management System special status species localities.

❖ **Garland Treatment Area-Specific Guidance**

- See Appendix for Heritage Data Management System special status species localities.
- There are at least two fairly new and mostly undescribed species (*Potentilla arizonica* and another possible hybrid or subspecies that hasn't been named) that are endemic to the Garland Prairie and Centennial Forest area. Because they are basically undescribed, they are not currently protected by any laws; however, monitoring should still be established for these species.

❖ **Sycamore Creek Treatment Area-Specific Guidance**

- Treatments in pine-oak forest types should be implemented in a manner consistent with the Recovery Plan for the Mexican spotted owl.
- See Appendix for Heritage Data Management System special status species localities.

❖ **Oak Creek Treatment Area-Specific Guidance**

- See Appendix for Heritage Data Management System special status species localities.

❖ **Sinclair Wash Treatment Area-Specific Guidance**

- See Appendix for Heritage Data Management System special status species localities.

***FIRESCAPE DFC:*** **Invasive non-native species are rare or absent and do not create novel ecological communities following implementation of mechanical thinning treatments.**

**FIRESCAPE GUIDANCE**

- Implement the Three Forest Weed EIS.
- Where possible, avoid implementing mechanical thinning treatments in areas where current conditions are identified as "at risk" of invasion or expansion of exotic species. When possible, ~~I~~implementation of mechanical thinning treatments should be postponed for "at risk" areas until actions have been taken to reduce the risk of invasion or expansion of exotic species, creating ~~in these areas should not occur until invasive species management creates~~ a more favorable environment for treatment implementation.
- Expand and test the predictive models for cheatgrass from the North Kaibab Ranger District to encompass the 4FRI area.
- When implementing mechanical treatments that buffer Wilderness and canyons, sequence treatments to reduce the likelihood of spread of invasive species into Wilderness and canyons (i.e., treat areas adjacent to unaffected areas where exotic species occurrence is low first to reduce chances of spread through treatments).

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***FIRESCAPE DFC:*** **Old-growth forest structure[2] is protected[3] from damage when implementing mechanical thinning treatments.**

**FIRESCAPE GUIDANCE**

- In accordance with the LTRP, do not remove old-growth trees for any reason.
- Manage identified target/threshold habitats (based on Recovery Plan for the Mexican spotted owl) to allow for future recruitment of old-growth forest structure.

**TREATMENT AREA-SPECIFIC GUIDANCE**

- **Oak Creek Treatment Area-Specific Guidance**
  - Create buffer to protect old-growth forest structure and research plots on private land near Barney Springs.
- **Sinclair Wash Treatment Area-Specific Guidance**
  - Old-growth forest structure near Pumphouse Wash, Kelly Canyon, Fry Canyon and James Canyon should be protected.
  - Old-growth trees near Dry Lakes, Woody Mountain, and Woody Ridge should be protected for recruitment of old growth forest structure.

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[2] Old-growth forest structure is defined as trees, snags, and coarse woody debris originating from trees present before settlement, circa 1880.

[3] Old-growth forest structure protection may be accomplished by strategically placing mechanical thinning treatments adjacent to old-growth forest structure to help manage or control the spread of fire into old-growth forest structure, or by (1) carefully locating skid trails to avoid old-growth trees, (2) raking fuels from around the base of old-growth forest structure, (3) using wet-lining or applying foam retardant to retard burning, or (4) burning in the spring before the base of snags and large coarse woody debris has dried out sufficiently to burn. These protection measures should be tested during the adaptive management process. The Stakeholders acknowledge that old-growth forest structure protection measures often require intensive resources; therefore, the use of the most costly implementation measures (i.e., raking and wet-lining or foam retardants) should primarily be used in targeted, high-priority areas.

## FIRE MANAGEMENT GUIDANCE

***FIRESCAPE DFC:*** **Where possible, natural fire regimes regulate forest structure and composition and align forest changes with climate change.**

### FIRESCAPE GUIDANCE

- Use site-specific biotic and abiotic factors to design burning activities that result in the full range of variability of forest structural parameters (e.g., basal area, canopy cover, group size, density, etc.).
- Coordinate with ~~counties~~ local governments to implement Firewise guidance in county, regional, and small community plans.

### TREATMENT AREA-SPECIFIC GUIDANCE

❖ **Bill Williams Treatment Area-Specific Guidance**

- After completion of mechanical thinning treatments, this Treatment Area, with the exception of the northeast corner, could be managed using fire at larger than current scales.

❖ **Garland Treatment Area-Specific Guidance**

- In the eastern portion of the Treatment Area, private lands and other constraints require that fire be managed at current scales.
- In the western portion of the Treatment Area, treatments should be implemented to facilitate management of fire at larger than current scales.
- Cooperation with Camp Navajo, Camp Raymond, State Forestry~~, and local fire districts~~ is essential to increasing the scale at which fire can be managed.
- The Forest Service and Stakeholders should coordinate with local fire districts (i.e., Ponderosa Fire) to help educate and involve private landowners in efforts to increase the scale at which fire can be managed.

❖ **Sycamore Creek Treatment Area-Specific Guidance**

- Following mechanical thinning of areas with predicted active crown fire under 97$^{th}$ percentile conditions, as described in the LRS Report, the area west of Sycamore Canyon could be managed with fire at larger than current scales.
- The occurrence of State lands, including Centennial Forest, and private lands east of Sycamore Canyon will require a high degree of cooperation to increase the scale at which planned and unplanned fire can be managed within this treatment area.

❖ **Oak Creek Treatment Area-Specific Guidance**

- In the northern portion of the treatment area, the use of fire at larger than current scales may be restricted by smoke impacts on the 365 kV 230-2 transmission line transecting the treatment area.
- The high occurrence of State lands, including Centennial Forest, will require a high degree of cooperation to increase the scale at which fire can be managed. This is the priority area for the Arizona State Land Department to focus their fuel reduction and forest management efforts in accordance with the Statewide Strategy for Restoring Arizona's Forests.

❖ **Sinclair Wash Treatment Area-Specific Guidance**

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- Managed fire at current scales should be used to enhance the forest structure established by previously implemented mechanical thinning and burning treatments.

***FIRESCAPE DFC:*** **Natural and prescribed fires maintain and enhance, but do not degrade habitat for listed, rare, and sensitive species.**

**FIRESCAPE GUIDANCE**

- For each treatment area, we provide occurrence and locality information for special status plants and animals. The following management recommendations should be used to guide restoration activities in treatment areas. See Appendix for special status species locality information by Treatment Area.
  - Prep snags >24" dbh (Rabe et al. 1998) prior to fire treatments by raking duff away from the base (Fowler et al. 2010).
  - Avoid smoke inundation of known raptor breeding areas during the breeding seasons
  - Follow Forest Plan direction for implementing the Northern Goshawk Management Recommendations.
  - Implement the Recovery Plan for the Mexican spotted owl.
  - Identify sensitive or rare plants within the burn area and consider individual species' response to fire prior to treating area.
  - Manage the seasonality of planned fires in large meadow systems to promote a diversity of warm- and cool-season grasses.

***FIRESCAPE DFC:*** **Natural and prescribed fires support diverse native plant communities and their associated biodiversity.**

**FIRESCAPE GUIDANCE**

- Understory vegetation must be managed to allow for the accumulation of fuels that can sufficiently restore a frequent fire regime.
- Livestock grazing and ungulates should be managed to allow for the generation of a sufficient accumulation of understory fuels.

**TREATMENT AREA-SPECIFIC GUIDANCE**

❖ **Bill Williams Treatment Area-Specific Guidance**
  - Where fire spread across adjacent lands is appropriately buffered, fire should be used to recruit and restore aspen stands.

❖ **Garland Treatment Area-Specific Guidance**
  - Efforts should be initially concentrated at Garland prairie, McDougal flat, and other grasslands and meadows (e.g., the area southeast of Spring Canyon).
  - Additional treatment efforts should focus on treatment of areas with predicted surface fire larger than 500 acres.

❖ **Sycamore Creek Treatment Area-Specific Guidance**

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- There is a high occurrence of areas with diverse understory communities in this Treatment Area. Efforts should be made to survey and identify specific areas containing rare and sensitive species.
- Treatments should be initially concentrated at Roger's Lake, Volunteer Canyon, and Sycamore Canyon to promote and protect rare and sensitive species in these areas.

❖ **Oak Creek Treatment Area-Specific Guidance**

- Efforts should be initially concentrated at Clay Park, Fry Park, Mill Park, and other grasslands and areas with uncommon understory species (e.g., blue spruce and big-tooth maple cohorts in Fry Canyon).

❖ **Sinclair Wash Treatment Area-Specific Guidance**

- Efforts should be concentrated at Dry Lakes, Pumphouse Wash, Sinclair Wash, Kelly Canyon, Fry Canyon, James Canyon, Woody Spring, Garden Spring, Griffith Spring, Kelly Seep, Mortgage Spring, Wilson Seep, and Scott Spring.

***FIRESCAPE DFC:*** **Exotic non-native species are rare or absent and do not create novel ecological communities following natural and prescribed fires.**

**FIRESCAPE GUIDANCE**

- Explore expanding and testing the predictive models for cheatgrass from the North Kaibab Ranger District to encompass the 4FRI area.
- Where possible avoid implementing burning treatments in areas where current conditions are identified as "at risk" of invasion or expansion of exotic species, including cheatgrass. Implementation of burning treatments in these areas should not occur until invasive species management creates a favorable environment for treatment implementation.

**TREATMENT AREA-SPECIFIC GUIDANCE**

❖ **Garland Treatment Area-Specific Guidance**

- The cheatgrass infestation of the greater Woody Mountain area is of particular concern and should be considered when planning and managing fire in this area.

❖ **Sycamore Creek Treatment Area-Specific Guidance**

- When conducting burning activities adjacent to Roger's Lake, Wilderness, and canyons, sequence treatments to prevent the spread of invasive species.
- The cheatgrass infestation of the greater Woody Mountain area should be considered when planning and managing fire in this area.

❖ **Oak Creek Treatment Area-Specific Guidance**

- When conducting burning activities that buffer Wilderness and canyons, sequence treatments to prevent the spread of spotted knapweed into Wilderness and canyons.
- The cheatgrass infestation of the greater Woody Mountain area should be considered when planning and managing fire in this area.

❖ **Sinclair Wash Treatment Area-Specific Guidance**

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- The cheatgrass infestation of the greater Woody Mountain area should be considered when planning and managing fire in this area.

***FIRESCAPE DFC:*** **Old-growth forest structure is protected during prescribed burns and naturally ignited fires.**

**TREATMENT AREA-SPECIFIC GUIDANCE**

- **Oak Creek Treatment Area-Specific Guidance**
  - Create buffer to protect old-growth forest structure and research plots on private land near Barney Springs.
- **Sinclair Wash Treatment Area-Specific Guidance**
  - Old-growth forest structure near Pumphouse Wash, Kelly Canyon, Fry Canyon and James Canyon should be protected.
  - Old-growth trees near Dry Lakes, Woody Mountain, and Woody Ridge should be protected for recruitment of old growth forest structure.

***FIRESCAPE DFC:*** **Fire managers manage planned and unplanned fires in locations, seasons and conditions that maximize smoke dispersion and minimize smoke impacts.**

**FIRESCAPE GUIDANCE**

- This Firescape's proximity to the Mogollon Rim and the likelihood of smoke concentration necessitates additional outreach to residents of the Verde Valley.
- Additional attention should be paid to implementing Emission Reduction Techniques for prescribed burns conducted in this Firescape.

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## WILDLIFE HABITAT GUIDANCE

***FIRESCAPE DFC:*** **Habitat management is contributing to the recovery of listed, rare, and sensitive species.**

### TREATMENT AREA-SPECIFIC GUIDANCE

- **Bill Williams Treatment Area-Specific Guidance**
  - Potential restoration of northern leopard frogs at Coleman Lake and vicinity (e.g., Metate Tank)
    - Assess bullfrog distribution within 5 mile radius; eradicate if possible
    - Maintain exclosure fence, deepen perennial pools
- **Garland Treatment Area-Specific Guidance**
  - Build roost platforms for double-crested cormorants and osprey at Scholz Lake (in addition to retention of large trees and snags)
- **Sycamore Creek Treatment Area-Specific Guidance**
  - Potential restoration of northern leopard frogs west of Sycamore Canyon
    - Assess bullfrog distribution; eradicate if possible
    - Fence several waters (to be identified in collaboration with AGFD and USFWS) for livestock exclusion and clean them out
    - Prioritize northern leopard frog reintroduction in the Deadman Pocket area
  - Construct osprey platforms (in addition to retention of large trees and snags) at White Horse Lake and JD Dam Lake
  - Increase the open water to wetland vegetation ratio at Rankin Tank to enhance habitat for marsh birds
- **Sinclair Wash Treatment Area-Specific Guidance**
  - Explore potential for northern leopard frog reintroduction at Griffiths Spring and tank
  - Reduce impacts of dispersed recreation along the western boundary of Rogers Lake

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## MULITPLE-USE MANAGEMENT GUIDANCE

***FIRESCAPE DFC:*** **Livestock grazing is compatible with and does not compromise native plant and wildlife biodiversity.**

### FIRESCAPE GUIDANCE

- Livestock grazing is managed to minimize its inhibition of native understory composition, productivity, and biodiversity.
- Livestock grazing is managed to reestablish the competition-fire filter (herbaceous vegetation outcompetes pine regeneration and is sufficient to carry fire that reduces regeneration when it occurs).
- Livestock grazing is managed to allow for the accumulation of fuels that are sufficient to carry fire.
- Allotment management plans should be consistent with forest restoration objectives as expressed in the LRS Report (and consistent with Forest Plans).
- Management recommendations identified in the Apache-Sitgreaves Burned Area Restocking Guidelines are implemented across the 4FRI Project Area.

***FIRESCAPE DFC:*** **Off-road vehicle use is compatible with and does not compromise native biodiversity.**

### FIRESCAPE GUIDANCE

- The TMR is implemented and enforced.
- Mechanical thinning treatment task orders should include road obliteration activities identified in the TMR.
- The off-road vehicle policy is enforced to ensure that Gambel oak stands that are visible post-thinning are protected from unauthorized fuelwood harvest.

### TREATMENT AREA-SPECIFIC GUIDANCE

- **Garland Treatment Area-Specific Guidance**
  - Continue managing vehicular access to lakes and tanks.
- **Oak Creek Treatment Area-Specific Guidance**
  - Prioritize implementation of the TMR to restrict cross country travel in the Treatment Area's numerous parks and riparian areas.
- **Sinclair Wash Treatment Area-Specific Guidance**
  - This is a high priority area for implementing and enforcing the TMR.

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***FIRESCAPE DFC:*** **Recreational use is compatible with and does not compromise native biodiversity.**

**FIRESCAPE GUIDANCE**

- Rehabilitation efforts are focused on restoring degraded areas and protecting existing biodiversity in areas receiving heavy recreational use.
- Work cooperatively with recreation interest groups and coordinate rehabilitation efforts to take place in concert with nearby mechanical thinning and fire treatments.
- Do not create new roads or access to Wilderness areas when conducting treatment activities.

**TREATMENT AREA-SPECIFIC GUIDANCE**

❖ **Garland Treatment Area-Specific Guidance**
  - Reduce social trails into Paradise Forks climbing area.
  - Use byproducts of small diameter thinning to provide firewood to campers at White Horse Lake and other high-use camping areas to discourage fuel-wood harvest.

o **Sycamore Creek Treatment Area-Specific Guidance**
  - Use byproducts of small diameter thinning to provide firewood to campers at JD Draw and White Horse Lake and other high-use camping areas to discourage fuel-wood harvest.
  - Work with Coconino County to develop an interpretive trail at Rogers Lake that also connects to Fort Tuthill.

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## WATERSHED MANAGEMENT GUIDANCE

***FIRESCAPE DFC:*** **Stable, restored forested ecosystems foster watersheds that yield enhanced water quantity and quality and are resilient to climatic variability.**

### FIRESCAPE GUIDANCE

- This Firescape contains a portion of the headwaters of the Verde River and Little Colorado River.
- Regional groundwater recharge and streamflow are greatly affected by hydrologic processes in the Ponderosa pine forest. Natural and human systems rely on these water resources.
- Prioritize grassland and meadow restoration in this Firescape.
- Integrate mechanical thinning and prescribed burning treatments with other comprehensive restoration activities.
- Prioritize road obliteration on roads that contribute to watershed degradation.
- Engineer road system placement and drainage to reduce erosion potential.
- Consider maximizing snow accumulation potential, in conjunction with other values, when designing mechanical thinning prescriptions. Utilize forest openings shaded by clumps and groups of trees to promote snow accumulation and retention.
- In conjunction with management for other resource values, plan for use of prescribed fire at appropriate intervals to reduce evapotranspiration and enhance groundwater recharge and surface water discharge.

### TREATMENT AREA-SPECIFIC GUIDANCE

- **Garland Treatment Area-Specific Guidance**
  - As part of the Sycamore Canyon watershed, treatments that benefit water quality, groundwater recharge and water yield are desirable for this treatment area.
- **Sycamore Creek Treatment Area-Specific Guidance**
  - As part of the Sycamore Canyon watershed, treatments that benefit water quality, groundwater recharge and water yield are desirable for this treatment area.
  - Install a streamflow gauge in Sycamore Creek to monitor flow. Partnerships may be developed with the U.S. Geological Survey, Salt River Project and/or the Yavapai County Flood Control District to fund installation and operation of the gauge.

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## INVASIVE SPECIES MANAGEMENT AND OTHER RESTORATION ACTIVITIES GUIDANCE

***FIRESCAPE DFC:*** **Exotic species are rare or absent and do not create novel ecological communities following disturbance.**

### FIRESCAPE GUIDANCE

- Implement the Three Forest Weed EIS.
- Coordinate invasive species treatments to occur concurrently with mechanical thinning and fire treatments.
- Work cooperatively with Weed Management Areas and volunteer groups to provide follow-up surveys and treatment following mechanical thinning and fire.

### TREATMENT AREA-SPECIFIC GUIDANCE

❖ **Garland Treatment Area-Specific Guidance**
- o Identify waters supporting invasive bullfrogs and crayfish and develop plan for reduction and/or removal of these species.
- o Sherwood Forest – Knapweed concern

❖ **Sycamore Creek Treatment Area-Specific Guidance**
- o Prioritize implementation of the Three Forest Weed EIS in areas buffering wilderness and canyons.
- o Identify waters supporting invasive bullfrogs and crayfish and develop plan for reduction and/or removal of these species.

❖ **Oak Creek Treatment Area-Specific Guidance**
- o Prioritize implementation of the Three Forest Weed EIS in areas adjacent to wilderness and canyons.

❖ **Sinclair Wash Treatment Area-Specific Guidance**
- o This Treatment Area is a priority area for implementing the Three Forest Weed EIS.

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# ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Janice K. Brewer
Governor

Henry R. Darwin
Acting Director


February 2, 2011

Mr. Earl Stewart, Coconino Forest Supervisor
U.S. Department of Agriculture
Coconino National Forest
1824 South Thompson Street
Flagstaff, AZ 86001-2529

Re: Coconino County: Coconino and Kaibab National Forests Restoration Initiative (4FRI)
(File Code: 1950)

Dear Mr. Stewart:

The ADEQ Air Quality Division has reviewed your letter, dated January 21, 2011, regarding the Coconino and Kaibab Four Forest Restoration Initiative. The project is located in an attainment area for 10-micron particulate matter (PM10) air pollution and, as described, may have a de minimis impact on air quality. However, there will be some particulate disturbance and open burning during project activities and, considering the prevailing winds, to comply with other applicable air pollution control requirements and minimize adverse impacts on public health and welfare, the following information is provided for consideration:

REDUCE DISTURBANCE of PARTICULATE MATTER during CONSTRUCTION

This action, plan or activity may temporarily increase ambient particulate matter (dust) levels. Particulate matter 10 microns in size and smaller can penetrate the lungs of human beings and animals and is subject to a National Ambient Air Quality Standard (NAAQS) to protect public health and welfare. Particulate matter 2.5 microns in size and smaller is difficult for lungs to expel and has been linked to increases in death rates; heart attacks by disturbing heart rhythms and increasing plaque and clotting; respiratory infections; asthma attacks and cardiopulmonary obstructive disease (COPD) aggravation. It is also subject to a NAAQS.

The following measures are recommended to reduce disturbance of particulate matter, including emissions caused by strong winds as well as machinery and trucks tracking soil off the construction site:

I. Site Preparation and Construction
   A. Minimize land disturbance;
   B. Suppress dust on traveled paths which are not paved through wetting, use of watering trucks, chemical dust suppressants, or other reasonable precautions to prevent dust entering ambient air
   C. Cover trucks when hauling soil;
   D. Minimize soil track-out by washing or cleaning truck wheels before leaving construction site;
   E. Stabilize the surface of soil piles; and

F. Create windbreaks

II. Site Restoration
A. Revegetate any disturbed land not used;
B. Remove unused material; and
C. Remove soil piles via covered trucks.

The following rules applicable to reducing dust during construction, demolition and earth moving activities are enclosed:

2
- Arizona Administrative Code R18-2-604 through -607
- Arizona Administrative Code R18-2-804

REDUCE REGIONAL HAZE

3 Particulate Matter contributes to Regional Haze that impairs visibility at national parks and monuments (Federal Class I areas), including Grand Canyon National Park on the Colorado Plateau. Although no specific Regional Haze reduction measures are in effect in the proposed project area at this time, measures that reduce disturbance of Particulate Matter also reduce Regional Haze.

PRESCRIBED FIRE ACTIVITIES

4 Fire creates smoke that includes a complex mix of air pollutants. Prescribed fire planning should minimize the effects of smoke on public health, public nuisance, and visibility in Federal Class I Areas. Prescribed fire activities must also comply with the requirements of Title 18, Chapter 2, Article 15 of the Arizona Administrative Code entitled "Forest and Range Management Burns." For further information regarding requirements for prescribed burns, please contact the Environmental Program Specialist at (602) 771-2363.

Should you have any further questions, please contact me at (602) 771-2375 or David Biddle, of the Planning Section Staff, at (602) 771-2376.

Very truly yours,

Diane L Arnst, Manager
Air Quality Planning Section

Enclosures

Cc: Bret Parke, EV Administrative Counsel
David Biddle, EV Program Specialist
File No. 252703

c. If the burning would occur at a solid waste facility in violation of 40 CFR 258.24 and the Director has not issued a variance under A.R.S. § 49-763.01.

E. Open outdoor fires of dangerous material. A fire set for the disposal of a dangerous material is allowed by the provisions of this Section, when the material is too dangerous to store and transport, and the Director has issued a permit for the fire. A permit issued under this subsection shall contain all provisions in subsection (D)(3) except for subsections (D)(3)(e) and (D)(3)(f). The Director shall permit fires for the disposal of dangerous materials only when no safe alternative method of disposal exists, and burning the materials does not result in the emission of hazardous or toxic substances either directly or as a product of combustion in amounts that will endanger health or safety.

F. Open outdoor fires of household waste. An open outdoor fire for the disposal of household waste is allowed by provisions of this Section when permitted in writing by the Director or a delegated authority. A permit issued under this subsection shall contain all provisions in subsection (D)(3) except for subsections (D)(3)(e) and (D)(3)(f). The permittee shall conduct open outdoor fires of household waste in an approved waste burner and shall either:

1. Burn household waste generated on-site on farms or ranches of 40 acres or more where no household waste collection or disposal service is available; or
2. Burn household waste generated on-site where no household waste collection and disposal service is available and where the nearest other dwelling unit is at least 500 feet away.

G. Permits issued by a delegated authority. The Director may delegate authority for the issuance of open burning permits to a county, city, town, air pollution control district, or fire district. A delegated authority may not issue a permit for its own open burning activity. The Director shall not delegate authority to issue permits to burn dangerous material under subsection (E). A county, city, town, air pollution control district, or fire district with delegated authority from the Director may assign that authority to one or more private fire protection service providers that perform fire protection services within the county, city, town, air pollution control district, or fire district. A private fire protection provider shall not directly or indirectly condition the issuance of open burning permits on the applicant being a customer. Permits issued under this subsection shall comply with the requirements in subsection (D)(3) and be in a format prescribed by the Director. Each delegated authority shall:

1. Maintain a copy of each permit issued for the previous five years available for inspection by the Director;
2. For each permit currently issued, have a means of contacting the person authorized by the permit to set an open fire if an order to extinguish open burning is issued; and
3. Annually submit to the Director by May 15 a record of daily burn activity, excluding household waste burn permits, on a form provided by the Director for the previous calendar year containing the information required in subsections (D)(3)(e) and (D)(3)(f).

H. The Director shall hold an annual public meeting for interested parties to review operations of the open outdoor fire program and discuss emission reduction techniques.

I. Nothing in this Section is intended to permit any practice that is a violation of any statute, ordinance, rule, or regulation.

**Historical Note**

Adopted effective May 14, 1979 (Supp. 79-1). Amended effective October 2, 1979 (Supp. 79-5). Correction, subsection (C) repealed effective October 2, 1979, not shown (Supp. 80-1). Former Section R9-3-602 renumbered without change as Section R18-2-602 (Supp. 87-3). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-602 renumbered to R18-2-802, new Section R18-2-602 renumbered from R18-2-401 effective November 15, 1993 (Supp. 93-4). Amended by final rulemaking at 10 A.A.R. 388, effective March 16, 2004 (Supp. 04-1).

**R18-2-603. Repealed**

**Historical Note**

Adopted effective May 14, 1979 (Supp. 79-1). Former Section R9-3-603 renumbered without change as Section R18-2-603 (Supp. 87-3). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-603 renumbered to R18-2-803, new Section R18-2-603 renumbered from R18-2-403 effective November 15, 1993 (Supp. 93-4). Repealed effective October 8, 1996 (Supp. 96-4).

**R18-2-604. Open Areas, Dry Washes, or Riverbeds**

A. No person shall cause, suffer, allow, or permit a building or its appurtenances, or a building or subdivision site, or a driveway, or a parking area, or a vacant lot or sales lot, or an urban or suburban open area to be constructed, used, altered, repaired, demolished, cleared, or leveled, or the earth to be moved or excavated, without taking reasonable precautions to limit excessive amounts of particulate matter from becoming airborne. Dust and other types of air contaminants shall be kept to a minimum by good modern practices such as using an approved dust suppressant or adhesive soil stabilizer, paving, covering, landscaping, continuous wetting, detouring, barring access, or other acceptable means.

B. No person shall cause, suffer, allow, or permit a vacant lot, or an urban or suburban open area, to be driven over or used by motor vehicles, trucks, cars, cycles, bikes, or buggies, or by animals such as horses, without taking reasonable precautions to limit excessive amounts of particulates from becoming airborne. Dust shall be kept to a minimum by using an approved dust suppressant, or adhesive soil stabilizer, or by paving, or by barring access to the property, or by other acceptable means.

C. No person shall operate a motor vehicle for recreational purposes in a dry wash, riverbed or open area in such a way as to cause or contribute to visible dust emissions which then cross property lines into a residential, recreational, institutional, educational, retail sales, hotel or business premises. For purposes of this subsection "motor vehicles" shall include, but not be limited to trucks, cars, cycles, bikes, buggies and 3-wheelers. Any person who violates the provisions of this subsection shall be subject to prosecution under A.R.S. § 49-463.

**Historical Note**

Adopted effective May 14, 1979 (Supp. 79-1). Former Section R9-3-604 renumbered without change as Section R18-2-604 (Supp. 87-3). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-604 renumbered to R18-2-804, new Section R18-2-604 renumbered from R18-2-404 and amended effective November 15, 1993 (Supp. 93-4).

R18-2-605. Roadways and Streets

A. No person shall cause, suffer, allow or permit the use, repair, construction or reconstruction of a roadway or alley without taking reasonable precautions to prevent excessive amounts of particulate matter from becoming airborne. Dust and other particulates shall be kept to a minimum by employing temporary paving, dust suppressants, wetting down, detouring or by other reasonable means.

B. No person shall cause, suffer, allow or permit transportation of materials likely to give rise to airborne dust without taking reasonable precautions, such as wetting, applying dust suppressants, or covering the load, to prevent particulate matter from becoming airborne. Earth or other material that is deposited by trucking or earth moving equipment shall be removed from paved streets by the person responsible for such deposits.

Historical Note

Adopted effective May 14, 1979 (Supp. 79-1). Former Section R9-3-605 renumbered without change as Section R18-2-605 (Supp. 87-3). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-605 renumbered to R18-2-805, new Section R18-2-605 renumbered from R18-2-405 effective November 15, 1993 (Supp. 93-4).

R18-2-606. Material Handling

No person shall cause, suffer, allow or permit crushing, screening, handling, transporting or conveying of materials or other operations likely to result in significant amounts of airborne dust without taking reasonable precautions, such as the use of spray bars, wetting agents, dust suppressants, covering the load, and hoods to prevent excessive amounts of particulate matter from becoming airborne.

Historical Note

Section R18-2-606 renumbered from R18-2-406 effective November 15, 1993 (Supp. 93-4).

R18-2-607. Storage Piles

A. No person shall cause, suffer, allow, or permit organic or inorganic dust producing material to be stacked, piled, or otherwise stored without taking reasonable precautions such as chemical stabilization, wetting, or covering to prevent excessive amounts of particulate matter from becoming airborne.

B. Stacking and reclaiming machinery utilized at storage piles shall be operated at all times with a minimum fall of material and in such manner, or with the use of spray bars and wetting agents, as to prevent excessive amounts of particulate matter from becoming airborne.

Historical Note

Section R18-2-607 renumbered from R18-2-407 effective November 15, 1993 (Supp. 93-4).

R18-2-608. Mineral Tailings

No person shall cause, suffer, allow, or permit construction of mineral tailing piles without taking reasonable precautions to prevent excessive amounts of particulate matter from becoming airborne. Reasonable precautions shall mean wetting, chemical stabilization, revegetation or such other measures as are approved by the Director.

Historical Note

Section R18-2-608 renumbered from R18-2-408, new Section R18-2-408 adopted effective November 15, 1993 (Supp. 93-4).

R18-2-609. Agricultural Practices

A person shall not cause, suffer, allow, or permit the performance of agricultural practices outside the Phoenix and Yuma planning areas, as defined in 40 CFR 81.303, which is incorporated by reference in R18-2-210, including tilling of land and application of fertilizers without taking reasonable precautions to prevent excessive amounts of particulate matter from becoming airborne.

Historical Note

Section R18-2-609 renumbered from R18-2-409 effective November 15, 1993 (Supp. 93-4). Amended by final rulemaking at 6 A.A.R. 2009, effective May 12, 2000 (Supp. 00-2). Amended by final rulemaking at 11 A.A.R. 2210, effective July 18, 2005 (Supp. 05-2).

R18-2-610. Definitions for R18-2-611

The definitions in Article 1 of this Chapter and the following definitions apply to R18-2-611:

1. "Access restriction" means restricting or eliminating public access to noncropland with signs or physical obstruction.
2. "Aggregate cover" means gravel, concrete, recycled road base, caliche, or other similar material applied to noncropland.
3. "Artificial wind barrier" means a physical barrier to the wind.
4. "Best management practice" means a technique verified by scientific research, that on a case-by-case basis is practical, economically feasible, and effective in reducing $PM_{10}$ emissions from a regulated agricultural activity.
5. "Chemical irrigation" means applying a fertilizer, pesticide, or other agricultural chemical to cropland through an irrigation system.
6. "Combining tractor operations" means performing two or more tillage, cultivation, planting, or harvesting operations with a single tractor or harvester pass.
7. "Commercial farm" means 10 or more contiguous acres of land used for agricultural purposes within the boundary of the Maricopa $PM_{10}$ nonattainment area.
8. "Commercial farmer" means an individual, entity, or joint operation in general control of a commercial farm.
9. "Committee" means the Governor's Agricultural Best Management Practices Committee.
10. "Cover crop" means plants or a green manure crop grown for seasonal soil protection or soil improvement.
11. "Critical area planting" means using trees, shrubs, vines, grasses, or other vegetative cover on noncropland.
12. "Cropland" means land on a commercial farm that:
    a. Is within the time-frame of final harvest to plant emergence;
    b. Has been tilled in a prior year and is suitable for crop production, but is currently fallow; or
    c. Is a turn-row.

ARTICLE 8. EMISSIONS FROM MOBILE SOURCES (NEW AND EXISTING)

**R18-2-801. Classification of Mobile Sources**

A. This Article is applicable to mobile sources which either move while emitting air contaminants or are frequently moved during the course of their utilization but are not classified as motor vehicles, agricultural vehicles, or agricultural equipment used in normal farm operations.

B. Unless otherwise specified, no mobile source shall emit smoke or dust the opacity of which exceeds 40%.

**Historical Note**

Adopted effective February 26, 1988 (Supp. 88-1). Amended effective September 26, 1990 (Supp. 90-3). Amended effective February 3, 1993 (Supp. 93-1). Former Section R18-2-801 renumbered to Section R18-2-901, new Section R18-2-801 renumbered from R18-2-601 effective November 15, 1993 (Supp. 93-4).

**R18-2-802. Off-road Machinery**

A. No person shall cause, allow or permit to be emitted into the atmosphere from any off-road machinery, smoke for any period greater than 10 consecutive seconds, the opacity of which exceeds 40%. Visible emissions when starting cold equipment shall be exempt from this requirement for the first 10 minutes.

B. Off-road machinery shall include trucks, graders, scrapers, rollers, locomotives and other construction and mining machinery not normally driven on a completed public roadway.

**Historical Note**

Adopted effective February 26, 1988 (Supp. 88-1). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-802 renumbered to Section R18-2-902, new Section R18-2-802 renumbered from R18-2-602 effective November 15, 1993 (Supp. 93-4).

**R18-2-803. Heater-planer Units**

No person shall cause, allow or permit to be emitted into the atmosphere from any heater-planer operated for the purpose of reconstructing asphalt pavements smoke the opacity of which exceeds 20%. However three minutes' upset time in any one hour shall not constitute a violation of this Section.

**Historical Note**

Adopted effective February 26, 1988 (Supp. 88-1). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-803 renumbered to Section R18-2-903, new Section R18-2-803 renumbered from R18-2-603 effective November 15, 1993 (Supp. 93-4).

**R18-2-804. Roadway and Site Cleaning Machinery**

A. No person shall cause, allow or permit to be emitted into the atmosphere from any roadway and site cleaning machinery smoke or dust for any period greater than 10 consecutive seconds, the opacity of which exceeds 40%. Visible emissions when starting cold equipment shall be exempt from this requirement for the first 10 minutes.

B. In addition to complying with subsection (A), no person shall cause, allow or permit the cleaning of any site, roadway, or alley without taking reasonable precautions to prevent particulate matter from becoming airborne. Reasonable precautions may include applying dust suppressants. Earth or other material shall be removed from paved streets onto which earth or other material has been transported by trucking or earth moving equipment, erosion by water or by other means.

**Historical Note**

Adopted effective February 26, 1988 (Supp. 88-1). Amended effective September 26, 1990 (Supp. 90-3). Amended effective February 3, 1993 (Supp. 93-1). Former Section R18-2-804 renumbered to Section R18-2-904, new Section R18-2-804 renumbered from R18-2-604 effective November 15, 1993 (Supp. 93-4).

**R18-2-805. Asphalt or Tar Kettles**

A. No person shall cause, allow or permit to be emitted into the atmosphere from any asphalt or tar kettle smoke for any period greater than 10 consecutive seconds, the opacity of which exceeds 40%.

B. In addition to complying with subsection (A), no person shall cause, allow or permit the operation of an asphalt or tar kettle without minimizing air contaminant emissions by utilizing all of the following control measures:

1. The control of temperature recommended by the asphalt or tar manufacturer;
2. The operation of the kettle with lid closed except when charging;
3. The pumping of asphalt from the kettle or the drawing of asphalt through cocks with no dipping;
4. The dipping of tar in an approved manner;
5. The maintaining of the kettle in clean, properly adjusted, and good operating condition;
6. The firing of the kettle with liquid petroleum gas or other fuels acceptable to the Director.

**Historical Note**

Adopted effective February 26, 1988 (Supp. 88-1). Amended effective September 26, 1990 (Supp. 90-3). Former Section R18-2-805 renumbered to Section R18-2-905, new Section R18-2-805 renumbered from R18-2-605 effective November 15, 1993 (Supp. 93-4).

2011-02-16-#10

# What We Heard by Firescape and Treatment Area (TA) - at the February 2nd, 9th and February 16th 4FRI Scoping Workshops

## Firescape 1, Treatment Area 1

### General Discussion/Notes

Minimal treatments are needed in this firescape due to past and on-going projects that have been conducted. Assumption: past projects will not be analyzed in this EIS if they had a restoration intent (achieved a restoration objective)

### Treatment Priorities/Recommendations:

1. Currently areas proposed for treatment on the southeastern border of Firescape 1 (vicinity of Walnut Canyon) may be dropped– is primarily pinyon-juniper with some ponderosa pine

    - **Action Item:** Determine if these areas are to be added - determine if there is potential for fire only (no mechanical RX)

2. Vegetation and fire treatments need to be considered in the airport area

    - **Action Item**: Evaluate adding this (what/where/why) in refined PA

3. Fire layer – Anderson Mesa shows up as having crown fire attributes because it is a grassland/shrub model. The vegetation layer shows treatment in this area – needs to be corrected – is already being addressed with past/on-going projects

    - **Action Item**: Remove vegetation treatments, pull out the grassland/shrub fuel model – updated data will be reflected in refined PA
    - **Action Item:** Define what projects are past/on-going (and answer what/how much, where, when, how, why)

## Firescape 1, Treatment Area 2

### General Discussion/Notes

- Many burned areas are within this TA – some pine stringers that would have once needed treatment no longer exist, example is Yellow Jacket Spring
- Al's Lake – pine transition zone (Anderson Mesa)
- Candidate Treatment layer includes ¼ mile recreation site buffers, what does this mean? Indicates that treatment is desired to protect infrastructure from fire.

- In Inventoried Roadless Areas (IRA), no treatment or prescribed burning is included in the PA (treatment would need Secretary of Agriculture approval and IRA has already been burned – no need for change)

**Treatment Priorities/Recommendations**

1. Include ponderosa pine that was part of the Mint project (analysis that encompasses parts of TA 1-4 and 1-5) completed about 15 years ago – restoration was not a theme for this project – is located in the general vicinity is the very southern tip of the TA and 125 Road, below and east of Mormon Lake

    - **Action Item:** Evaluate potential for treatment in this area – is still being implemented, about 1,000 acres were recently successfully burned – check with district

2. Candidate Treatment layers shows the AZ Trail buffer but does not show much vegetation in the very southern tip of the TA (south of 124, 125 Road), fire layer shows need in this location – may need mechanical treatment

    - **Action Item:** Evaluate potential for treatment in this area

## Firescape 1, Treatment Area 3

**General Discussion/Notes**

- Many areas do not show up as needing treatment, why? Upper left portion of the TA is Mountainaire and Elk Park – already treated
- Difference in FS data and Candidate RX Layer: Eastern Boundary – Lake Mary Watershed – FS fire layer shows crown fire and high intensity surface fire risk – candidate treatment layer does not show fire because it is smoothed to 50 acre and 97$^{th}$ percentile – Mary Lata did confirm fire potential with district fire professionals – agree with data because of steep slopes and ridge tops
- For MSO, USFWS and FS are deciding what treatments are needed for 117 PACs – about 11 PACS are scheduled to be treated in other projects - if habitat cannot be improved – no treatment would be proposed
- Regarding treating around PACs to decrease risk from fire – if habitat is suitable, may not want to treat in order to expand owl's ability to move into these new areas
- Firescape 1, Treatment Area 3 – high priority for treatment

**Treatment Priorities/Recommendations**

1. Northern goshawk PFA has not been excluded in FS layer – we can treat PFAs –but if already too open – no RX would be proposed – candidate treatment layer excluded mechanic al but would be ok with hand thinning nest stand

    - **Action Item**: Final RX needed for refined PA

2. Portions of Lake Mary Watershed has severe headcutting in many drainages – FS has (Coconino) forest-wide map of headcuts that has been gathered by district hydrologists. Kaibab is requesting information from soils and watershed specialists.

    - **Action Item**: Use data for refined PA – Objective for Lake Mary Watershed – restore to historical condition as reasonable/practicable: (1) Treat to reduce the potential for increased sedimentation from crown and high intensity surface fire (note: any change in water yield would be described/projected in the soils and watershed effects analysis); (2) Use design criteria, BMPs to mitigate noxious weeds, non-native invasive species, use weeds database

3. Newman Park – proposed vegetation RX would be savannah, grassland and IT (intermediate thin). In addition to vegetation RX, area has headcuts that should be restored. Note: Is part of the Lake Mary Allotment (is a grass bank) that could be used by the Walnut Allotment but not before infrastructure and fencing needs are addressed

    - **Action Item:** Include headcut restoration treatments specific to Newman Park

4. There are springs that need restoration: Babbitt – needs fencing and pipe reconstruction, Clarks Spring is within a PAC. Restoration has been proposed in the Elk Park project, Hoxsworth – treated in several projects

    - **Action Item**: Review Babbitt for inclusion into the PA, confirm other analyses have sufficiently addressed Clarks and Hoxsworth

5. In this TA (1-3) also include restoration/treatment around springs, seeps, meadows and dry ephemerals to reduce sedimentation potential – use treatments similar to Hoxsworth treatments
    - **Action Item**: Review areas for restoration in refined PA

## Firescape 1, Treatment Area 4

### General Notes

- Eastern half of TA is very open
- Western ½ - only treatments on the Candidate Layer Map is buffers along roads, whereas FS shows much treatment
- FS fire layer show crown fire potential from shrub and ponderosa pine fuels
- This treatment area has many PACs and the presence of mixed conifer in vicinity of Hutch Mtn. limits treatment opportunities. We would not want to increase the potential for off-road vehicle use in and around PACs and extensive work on powerline (which occurs in PACs) has already occurred.

### Treatment Priorities/Recommendations

What analysis was completed for the 365 KV line? **Action Item:** Locate

## Firescape 1, Treatment Area 5

### General Notes

- High number of PACs – Mormon Mountain, Bar M – mostly pine-oak
- Per wildlife –promote oak – however, where the PAC productivity is high, mechanical treatment would not be considered
- 1,000 acres of leafy spurge has been treated (at 40 acre size) using biological control and herbicides in this TA
- Bottom ½ of 1-5 is covered by Mormon Lake Basin, Munds and Upper Beaver Creek projects
- Not many opportunities to protect MSO PACS
- Lee Butte is a PAC – open pipo and oak – large threat of fire but drainage bottoms are generally open (with some encroachment)

### Treatment Priorities/Recommendations

1. Treat between the highways (east of I-17 in the Rocky Park area) and PAC boundaries to reduce fire risk. Note: There was an older fuels project that occurred west of I-17 in very rocky terrain.
    - **Action Item**: Evaluate risk to PACs and inclusion into revised PA
2. Treat transition areas both east and west of the PACs (would include TA 1-4 and TA 1-5) – Taylor Area and Lake Mary Road

- **Action Item:** Evaluate risk to PACs and inclusion into revised PA

3. In Bar M Watershed – recommend 5 acre (large) clusters of groups for wildlife – smaller openings would be consistent with proposed treatments as shown on map

    - **Action Item**: Evaluate for inclusion into refined PA

4. Since there are limited opportunities to protect MSO PAC s, there is a need to reduce the potential of fire from the south-southwest – use presence of I-17. May be fire only due to terrain limitations.

    - **Action Item**: Evaluate for inclusion into refined PA

5. Treatment between LM Road and TA 1-4 is a high priority as there is high fire potential in a few areas around the PACs. See Map - below the label 1-5 is habitat where owls can expand – good example of where treatment would not be desirable. Use treatment optimization model to assist in mitigating risk.

    - **Action Item**: Evaluate for applicability to refined PA

6. **Summary of Priorities**: (1) Treat east and west of I-17 in TA 3-5 to protect PACs, old growth, turkeys, etc. (2) Treat between PACs – wildlife input needed on habitat type, input needed on non-native invasive potential, (3) Model to address issues in 1-5, south ½ of Firescape 3-5 (SPOTS) in vicinity of Rocky Park, Willard Springs, Sheep Springs, (4) Model between 2 large PACs

7. Evaluate which springs could be covered in this analysis
    - **Action Item** – Review any other on-going analysis with spring restoration, evaluate for applicability to refined PA

## Firescape 1, Treatment Area 6

### General Notes

- P/J dominated
- Some treatment is proposed along the Rim – the northeast side is covered by the Upper Beaver Creek analysis
- Treatment would address presence of old plantations – small trees
- Candidate layer includes road buffers and buffer around Apache Maid
- This is transition country – may provide opportunities for future hand thinning

**Treatment Priorities/Recommendations**

1. Clear for treating ponderosa pine within the TA but considered low priority – by the time the forest is ready to treat, may need a Chapter 18 review

    - **Action Item**: Evaluate for applicability to refined PA

## Firescape 2

**General Discussion/Notes**

- Candidate areas layer addresses road buffers
- Rarick Canyon Area – not likely to have treatment due to terrain and no fire potential
- Oak Creek Canyon – addressed in other analyses

**Treatment Priorities/Recommendations**

1. Drop any treatments in this unit

    - **Action Item:** For cumulative effects, get other Oak Creek Canyon analyses, evaluate applicability of treatment to the refined PA

## Firescape 3, Treatment Area 1

**General Discussion/Notes**

- 3-1 includes an exclusion area due to the Bill Williams NEPA analysis that is underway
- Candidate layer displays buffers around roads, recreation sites, communities
- Western side of the TA is pinyon/juniper
- Dutch Kid Knoll Area – pronghorn migration area to Garland Prairie
- For clarification on potential treatment in transition areas, in areas where pine stringers of ponderosa pine are present, treatment would be proposed if the area is large enough. No other transition areas (mechanical treatments in p/j) are proposed.

**Treatment Priorities/Recommendations**

1. Even though pinyon juniper is prevalent, include areas of ponderosa pine in this analysis so it is cleared for treatment. For clarification, no treatments in transition zones (p/j) are being proposed – vegetation has to be ponderosa pine-dominated.

2. Leave more cover on knolls, slopes below the map label "3-1" – can leave areas more open elsewhere (related to wildlife corridors).

3. Use prioritization, treatment optimization and strategic placement methods to address timing and sequencing

4. Use a strategy that places/prioritizes additional treatments using criteria that includes proximity to roads (¼ mile from roads) upwind, downwind

    - **Action Item**: Evaluate for applicability to refined PA

## Firescape 3, Treatment Area 2

### General Notes

- This TA includes a proposed RNA and Camp Navajo
- Project underway are likely to be rolled into 4FRI
- See area below 3-2 label by Garland Prairie → East of Camp Navajo – why are there so many different prescriptions? Needs a closer look – is coming from mountainous terrain to flats – different treatments reflect variations in slope, aspect, aspen island

### Treatment Priorities/Recommendations

1. In the large exclusion area there are timber sales that were never implemented, reconsider and make part of this analysis

2. In the southwest corner (Elk Lee) below 3-2 is part of the Sycamore Watershed – watershed restoration which includes an objective of increased water yield should be part of the proposal – in this area there should be larger tree group and breaks for wildlife. Elk Lee area may be designated as MSO target threshold habitat.

    - **Action Item**– Consider suggestions/comments in refined PA, gather AZDGF wildlife corridor information, take closer look at area around Garland Prairie and Camp Navajo. Ask district for updated information.

    - **Action Item**: West side of 3-2 (and west side of 3-3) needs treatment designed for increased water yield. This area is likely excluded due to four projects that are underway (already in contracting)

## Firescape 3, Treatment Area 3

### General Discussion/Notes

- TA has Sycamore Canyon, checkerboard of private ownership, wilderness, grasslands
- TA 3-2 and 3-3 has some of the highest percent of crown fire and high intensity surface fire risk
- Proposed FS treatments line up well with candidate treatment layer

- There are no MSO PACs
- The southwest corner – northern goshawk PFA – the edges need treatment

**Treatment Priorities/Recommendations**

- **Action Item:** Needs treatment to reduce fire risk, Treat edges of PFA, West side of 3-2 (and west side of 3-3) needs treatment designed for increased water yield

## Firescape 3, Treatment Area 4

**General Discussion/Notes**

- Per Mary, crown fire as displayed on map is under-representing risk
- Likely to be MSO target threshold managed for larger trees and hard to treat as there are no roads
- There are many PACs (and many occupied), data goes back to the early 1990's – whether attributes are still in place needs to be determined

**Treatment Priorities/Recommendations**

1. Exclude Woody and Kachina treatments and treat what is left
2. Treat area above Munds Park
3. On W. Fork of Oak Creek – strategically place treatments around this area to protect
4. Do areas around lower 89 and west of 89 need treatments?

- **Action Item**– Consider suggestions/comments in refined PA

## Firescape 3, Treatment Area 5

**General Discussion/Notes**

**Treatment Priorities/Recommendations**

1. Treat with fire west of I-17 to the Rim – terrain limitations

- **Action Item**– Consider suggestions/comments in refined PA

## Firescape 4, Treatment Area 1

**General Discussion/Notes**

- No uranium mining occurs in this unit
- Candidate layer displays buffering roads

**Treatment Priorities/Recommendations**

No recommendations provided

## Firescape 4, Treatment Area 2

**General Discussion/Notes**

- City project north of I-40 is being implemented
- Layer displays 4 contiguous crown fire and high intensity surface fire north of infrastructure

**Treatment Priorities/Recommendations**

No recommendations provided

## Firescape 4, Treatment Area 3

**General Notes**

- Sitgreaves Mtn area
- Eagle Rock Fire
- Much of the treatments are for grassland restoration
- Candidate area displays treating/buffering Sitgreaves Mtn
- Connects with Garland Prairie – savannah and grassland treatments would overlap with pronghorn corridor
- Potential impacts include aesthetics/visuals – private land owners
- There is a lot of ponderosa pine that is in good condition or is heavily infected with mistletoe in this unit
- For clarification, bigger gaps = less productive site

**Treatment Priorities/Recommendations**

No recommendations provided

## Firescape 4, Treatment Area 4

**General Discussion/Notes**

- Candidate area displays treating/buffering roads, mtns
- For clarification, an Intermediate Thin with 10-25% gaps is displayed in the analysis as X acres of IT within a firescape
- Canopy cover (applies to VSS 4-6) is met at the group level – applied to the group of trees post treatment

- For clarification, the potential treatment layer as shown during the workshops does NOT mean that treatment would occur as currently displayed – still need to apply other resource filters and comply with the forest plan

**Treatment Priorities/Recommendations**

No recommendations provided

## Firescape 4, Treatment Area 5

**General Notes**

- Not much treatment displayed
- For clarification, heterogeneity is built into the PA in two ways: (1) variation between each treatment type (10% to 25% gaps = heterogeneity), (2) Actual prescription – on ground implementation
- Most of this TA is in private ownership

**Treatment Priorities/Recommendations**

1. Check on projects that have not made it through scoping (Wing) – 4 FRI could use the stand exam, survey and roll the project into this analysis.

2. What about A-1? Treatment will be needed in 10 years.

    - **Action Item for 1 -2** – Consider suggestions/comments in refined PA

## Firescape 5, Treatment Area 1

**General Discussion/Notes**

Rio de Flagstaff is crucial for North Flagstaff protection (FS 5-1)

- **Action Item**: Treat slopes around city boundaries (avoid Shultz post-fire conditions), treat north of the Water Museum

## Firescape 5, Treatment Area 2

**General Discussion/Notes**

- In FS 5-2, there should be special attention paid to soil moisture retention; non-native invasive species; San Francisco Peaks weed management area, and; the relative low benefit to cost ratio
- In FS 5-2, Fort Valley, there are important wildlife migration corridors (ex. bear) that may need special attention, and should not be excluded
- For clarification, in the Cinders area, moisture retention is not likely due to porous soils

**Treatment Priorities/Recommendations**

- **Action Item** - Consider suggestions/comments in refined PA
- **Action Item** – Get clarification on exactly what treatment is being proposed

## Firescape 6

**General Discussion/Notes**

- Smoothing crown fire model data to 50 acre pixels may give a larger scale view, but would have some drawbacks
- Treating nearby areas may help lower threats to sensitive areas
- Economics may make mechanical treatments difficult in FS 6, unless a local use can be designated
- There should be a clear description of Desired Future Conditions for FS 6 due to special habitats (such as sage)
- Swatch Canyon smoke impacts have been severe at times, so some other method of disposing of slash needs to be considered.
- The rim in FS 6 may be a recharge area for canyon springs (6-4 – Upper Basin Area)
- All of Firescape 6 is under revision by silviculture – more detailed data is being used

## Where is Firescape 6, Treatment Area 1

**General Discussion/Notes**

- Excluded - not ponderosa pine
- Concern – too much past/ongoing treatment in this TA
- Tier to the Kaibab Forest Health Focus

## Firescape 6, Treatment Area 2

- There are elk present in FS 6-2, as well as spring recharge areas
- This FS analysis would benefit from more fire path runs
- Many treatments would be developed to achieve appropriate patterns and composition of stands

- Non-commercial and pre-commercial thinning can be used to alter structure and composition
- Field check the fire model assumptions for FS 6-2 and 6-3

## Firescape 6, Treatment Area 3

- Field check the fire model assumptions for FS 6-2 and 6-3
- See general discussion

## Firescape 6, Treatment Area 4

- FS 6-4 does have some access to the northern section
- See general discussion

## General Comments and Questions (Note: 4FRI IDT will answer these questions and post on web)

- Forest ERA data is valuable at the mid scale, FS data is valuable at the smaller scale
- Note: currently the PA has no correlation to treatment areas or firescapes –will be addressed in refined PA
- Note: Firescape 1, Anderson Mesa – may be suitable for future restoration actions that stakeholders are developing
- How will headcuts be treated?
- What past actions caused/affected head-cuts?
- On roads to be decommissioned and on unauthorized routes (user-created routes) that are to be obliterated, if thinning occurs where these features are located, would they be used for project implementation? They would be used as needed and restored after treatment.
- 4FRI is providing an opportunity to implement travel management
- Is hand thinning being proposed on slopes greater than 40%?
- Provide information on various silvicultural treatments and what area could look like pre and post treatment.
- Please put January 20, 2011 power-point presentations on the website.
- Please clarify terms such as site class, Stand Density Index and explain how SDI is measured for ponderosa pine (what is the maximum, what SDI indicates a healthy forest, what SDI indicates there is a problem).
- Provide additional information on different treatment proposals including photos of before and after and how treatment helps achieve desired condition. What would an uneven-aged treatment that resulted in various percentages of openings look like? Please provide this for all potential treatments and for each desired condition (reduced stand density, movement towards having all age classes represented).

- Where did the definition of firescape come from? Will treatment areas be aggregated by firescape?
- What is the exact acreage within the analysis area? Do proposed treatments adequately address reduced fire risk in the urban interface?
- In areas where intermediate thinning and extreme fire behavior overlaps, would treatments resolve fire behavior?
- Are the more intensive treatments lining up with fire risk reduction? Is potential tree mortality from prescribed fire being calculated? Is the Fort Valley mortality projection paper being used? Can natural fire ignitions be broken out from all ignitions?
- Can the analysis differentiate the risk of fire within grasslands and tree/shrubs?
- Have roads from other NEPA analyses been included in the proposed action? How (and when) would these roads be decommissioned if they are part of other on-going projects?
- How will decommission methods improve soils and watershed if only the first ¼ mile of road is obliterated? What if the entire length needed to be obliterated to remedy resource impacts?
- What would happen to those roads that need decommission but are not located in an area where treatment is proposed
- Would user-created routes be part of the proposed action?
- Does the group and gap strategy in savannah create new/additional/more grasslands than reference condition? Large, severe fires have created new grasslands. There should be no net loss of forest.
- What is the average estimate for wood products?
- What data was used in determining forest productiveness? Is it equivalent to regeneration potential?
- Is target stand density index uniform across the analysis area?
- What is the existing basal area?
- Was Stand Density Index (SDI) used for openings?
- What process is being used to accommodate small multiple sites (less than 100 acres) at the larger scale?
- It is important to correlate the % openings with canopy cover with remaining trees and groups.
- Will proposed treatments protect Mexican spotted owl Protected Activity Areas (PACs) in Firescape 1, Treatment Area 3 where there are many PACs?
- Provide additional information on science used in identifying mollisol and mollic-integrade soils – post on web.
- If no regeneration is planned in areas with mistletoe, what is the long term plan?
- What if more acres are cleared than can be treated? How would timing and sequencing be addressed if only 50,000 blocks are to be treated?
- Areas of pinyon-juniper transition are of concern versus interior ponderosa pine.
- For areas showing up on the map layers as being "cleared through other processes", are they being re-considered?
- Has the objective of providing for greater heterogeneity been met in the proposed action?
- Where are the true grasslands and what forested areas are functioning within the grasslands?

- Note – on candidate treatment layer, upwind buffers only occur where they coincide with the CWPP. Are private land buffers adequate?
- What are the scales of analysis?
- When will maps be ready for wetlands and aspen?
- How many alternatives will be evaluated?
- Did Coconino fire review the PA firescape?
- What are the Goshawk dispersal aims?
- How do you define "young" trees?
- Why the difference in TA's between Firescapes 4 and 5?
- What is the relationship of canopy density and percent openings?
- How will you keep VSS guidelines with areas of large gaps
- Will the specifics of each TA be descriptive of canopy closure?
- Can you provide some communication relative to the relationship (or lack thereof) between percent opening and canopy closure?
- How will details be developed for VSS per polygon in the firescape?
- How is canopy cover calculated for Savannah? There will need to be consistency of descriptions re VSS and canopy closure.
- At what scale are treatments described?
- Will the need for VSS1 mean removal of VSS5+ trees?
- How will canopy closure be monitored?
- What is the ultimate spatial scale for adaptive management?
- Can some areas be designated VSS1 as is?
- When and where will detailed implementation strategies be available?
- Will transition areas be dropped from the analysis?
- Should treatments take place outside of fire areas
- Is there coordination with the National Park Service management objectives re FS 6?
- Road drainage assessments should be done with ephemeral channel restorations
- Draft Forest Plans provide useful descriptions
- There is an overall desire to retain old growth trees and stands
- This EIS may not be specific enough
- It would be useful to have definitions by TA, with emphasis explained
- Smoke is a big concern, and should be carefully mitigated

2011-02-17-11

**City of Flagstaff**
**211 W. Aspen**
**Flagstaff AZ 86001**

**928-779-7685**
**http://az-flagstaff.civicplus.com**

Feb 15, 2011

Henry Provencio
Four Forests Restoration Initiative Team Leader
Coconino National Forest
1824 S. Thompson Street
Flagstaff, AZ 86001

SUBJECT: Lake Mary Watershed - Firescape #3

Dear Henry:

The City of Flagstaff is appreciative of the discussion that occurred at the public meeting in Williams on Feb 8, 2011 to include the Lake Mary Watershed (LMW) in 4FRI's first forest treatment area: This has long been a goal of ours. We strongly support this position, robustly advocate for its inclusion, and pledge our active engagement toward successful implementation.

The LMW provides approximately 50% of the City's water supply on an annual basis. The devastating Schultz Fire and subsequent flooding destroyed our Inner Basin water pipeline, creating a major supply challenge and resulted in transport and treatment cost increases. While the pipeline is repairable - at major expense - it clearly exposes the vulnerable position we are in as a result of unhealthy forests.

To be clear, our interest with the LMW is not one of additional water production: rather, it is focused on overall watershed restoration and protection. Our primary concern is that a severe wildfire in the LMW, in addition to loss of forest cover and associated values, would likely result in a spike in sediment transport and deposition into either of the two lakes (thus reducing storage capacity) and a degradation of water quality due to ash and other debris flow. This would truly impact our community in a way not easily addressed after-the-fact. Any additional water production that would result would be a welcome secondary benefit, and would even provide additional supplemental downstream flow into Walnut Canyon.

To further support our interest in this area, the Greater Flagstaff Area Community Wildfire Protection Plan (GFA-CWPP), authorized by the Healthy Forest Restoration Act of 2003, was completed in 2004. It was subsequently adopted by both the Flagstaff City Council and Coconino County Board of Supervisors in 2004, and approved by the AZ State Forestry Division in 2005. It clearly identifies the LMW as a priority area for future forest treatments. It is noteworthy that the GFA-CWPP was the result of an eight-month public process spearheaded by the Greater Flagstaff Forests Partnership (GFFP) and the Ponderosa Fire Advisory Council (PFAC) and relied heavily upon data provided by Northern Arizona University's Forest Ecosystem Restoration Analysis (Forest ERA) team.

Finally, in closing, we respect the 4FRI stakeholder group and the energy and skills both they and the USFS 4FRI Team bring to this collective effort. As a founding member of GFFP, we recognize the tremendous benefit of a community-based regional collaborative and we fully intend to continue our support within this framework. We trust that all recognize that inclusion of the LMW in 4FRI's first treatment area is vitally important to both ecosystem health and our community's long-term well-being. We look forward to working with all on this effort.

Sincerely,

Sara Presler
Mayor, City of Flagstaff

CC: Congressman Paul Gosar
Forest Supervisors - Coconino, Kaibab, Tonto, and Apache-Sitgreaves National Forests
Flagstaff City Council members
Kevin Burke - Flagstaff City Manager
Coconino County Board of Supervisors
Steve Peru - Coconino County Manager
4FRI Stakeholder group

2011-02-17 -12



"Sarah Reif"
<SReif@azgfd.gov>
02/17/2011 12:46 PM

To <hprovencio@fs.fed.us>, "Neil McCusker" <NMcCusker@fs.fed.us>, "Bill O Noble" <bnoble@fs.fed.us>, "Mary Lata" <mlata@fs.fed.us>,
cc "Bill Noble " <bnoble@fs.fed.us>, "Bruce Greco" <Bruce.Greco@nau.edu>, "Daniel Laughlin" <Daniel.Laughlin@nau.edu>, "Dave Dorum"
bcc

Subject FW: aspen restoration

FYI – thought this might be a useful resource for 4FRI… It reminds me that we haven't talked about potential aspen treatments in the proposed action?

*Sarah Reif*
Habitat Program Manager
Arizona Game and Fish Department
928-214-1253

**From:** Andi Rogers
**Sent:** Thursday, February 17, 2011 10:50 AM
**To:** Ron Sieg; Carl Lutch; Tom McCall; Susan MacVean; Stephen Cassady; Mark Ogonowski; Jessica Gist; Larry Phoenix
**Cc:** Sarah Reif
**Subject:**

Just out.. thought they might be of interest..

ANDI ROGERS, HABITAT SPECIALIST, REGION II
*Arizona Game and Fish Department*
*3500 S. Lake Mary Road*
*Flagstaff, AZ 86001*
*Phone (928) 214-1251*
*Fax (928) 779-1825*

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*http://www.azgfd.gov/eservices/subscribe.shtml*



UTAspenRestoration.pdf

2011-02-17 -13

++++++++++++++++++++++++++++++++++
Craig J. Johnson, M.A.
Tribal Relations Specialist / Archaeologist
Coconino National Forest Supervisor's Office
1824 South Thompson Street
Flagstaff, Arizona 86001
desk; (928) 527-3475
cell: (928) 525-6578
fax: (928) 527-3620
email: cjjohnson@fs.fed.us
++++++++++++++++++++++++++++++++++

----- Forwarded by Craig J Johnson/R3/USDAFS on 02/17/2011 08:03 AM -----



**<markaltaha@wmat.us>**
02/17/2011 07:59 AM

To "Craig J Johnson" <cjjohnson@fs.fed.us>
cc "Chris Coder" <ccoder@yan-tribe.org>
Subject RE: 4-FRI letter to White Mountain Apache

Craig,

My apology for the delayed response to this consultation effort. Considering that the project area is pretty far north we've determined it is not necessary for White Mountain Apache tribe to be a part of the proposed project, however, we'd like to defer all consultation efforts to the Yavapai Apache Nation. See attached letter.

Again, we appreciate your continued consultation efforts in the preservation and protection of sensitive cultural heritage resources.

***Mark T. Altaha***
***White Mountain Apache Tribe***
***Historic Preservation Office***

-------- Original Message --------
Subject: 4-FRI letter to White Mountain Apache
From: Craig J Johnson <cjjohnson@fs.fed.us>
Date: Fri, January 28, 2011 10:59 am
To: markaltaha@wmat.us, rxrapache@yahoo.com

This letter went out today to Tribal Chair.

2011-02-18 -14



lboussard@q.com
02/18/2011 08:59 AM

To 4FRI_comments@fs.fed.us
cc
bcc
Subject Document preference

Although I don't have any comments at this time, please change the manner in which I receive info about the initiative. I am currently on the mailing list and would like to change that to email in order to save printing and mailing costs.

My email address is: lboussard@q.com
Address: 6755 E Eagle Crest Dr, Flagstaff, AZ 86004

Thank you,
Liz Boussard

2011-02-20 - #15



"Pat"
<azpatty@commspeed.net>
02/20/2011 09:47 AM

To <4FRI_comments@fs.fed.us>
cc
bcc
Subject 10 Year Restoration Activities

We believe my proper falls in the Flagstaff Ranger District. I am a firm supporter of restoration but also are concerned regarding methods. It would appreciated if updates in your processes and activities in the Flagstff Ranger District could be e-mailed to us – save the trees.

Pat and Jack Williamson

2011-02-22 -16

Four Forest Restoration Initative
Coconino and Kaibab National Forest

# Comment Sheet

**Did you attend a meeting/workshop?** ____ **Yes** ✓ **No**

**If yes, what date(s)?** _____

Please check the area related to your comments, **using a separate comment form for each area.**

- ✓ Coconino Forest-Wide
- ____ Flagstaff District – North of I-40
- ____ Flagstaff District – South of I-40
- ____ Red Rocks/Sedona
- ✓ Verde Valley
- ✓ Mogollon Rim
- ✓ Kaibab Forest-Wide
- ____ Tusayan District
- ____ Williams District

**Comment Topic**

- ____ Purpose and Need
- ____ Vegetation/Silviculture
- ✓ Wildlife – Big Game
- ____ Wildlife – T&E
- ____ Wildlife – Sensitive Species
- ____ Wildlife – Birds
- ____ Wildlife – Aquatic
- ____ Wildlife – Other
- ____ Fuels and Fire Behavior
- ____ Soils and Watershed
- ____ Air Quality
- ____ Transportation
- ____ Cultural Resources
- ✓ Comment Applies to All
- ____ Other
- ✓ Recreation Special Uses
- ✓ Developed Recreation
- ✓ Dispersed Recreation
- ____ Scenery/Visuals
- ____ Special Areas/Designations

**Comment:**

FIRST AND FOREMOST I WOULD LIKE TO THANK ALL THE MEN AND WOMEN WHO HAVE PUT GREAT DETAIL IN TO MANAGING OUR FOREST IN AZ. A HEALTHY FOREST IS THE ONLY FOREST THAT WE ALL CAN APPRECIATE.

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

Four Forest Restoration Initative
Coconino and Kaibab National Forest

My Concern has been for the Recreational opportunity the Forest has provide. I am in favor of a healthy Forest and the

**Comment Continued:**

need to conduct the plan's that have been established. I hope that best practiced procedure will be used. Please keep the Forest open for us to utilize in the time that is need for the restoration to occur.

Cooperation is needed and I believe is best for the Forest health and continued use.

Thank you. for keeping me Informed


Name: Robert Brito

Address: 9029 W. Mackenzie Dr
Phoenix, Az 85037

rabjabrito@cox.net


Please note: Names and addresses submitted in response to any request for comments are considered part of the public record for this project and may be released to the public if requested under the Freedom of Information Act. Providing contact information is optional.

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

Four Forest Restoration Initative
Coconino and Kaibab National Forest

***Please Tell Us Your Preference for Receiving Documents including the Scoping Letter, DEIS, FEIS/ROD*** *(we would like to keep printing costs down and send documents via e-mail or share by posting to our website):*

✓ I prefer to receive documents by e-mail which is: ~~ebr~~ rabjabrito@cox.net

___I prefer to view documents on the forest web-site

___I would like to receive a CD copy of the DEIS and FEIS/ROD (*Note: Scoping letter will not be available via CD)*

___I would like to receive documents in hard-copy form (***please make sure you have provided your address)***

***Has Your Address Changed? Please provide your new address:***

_____

_____

_____

**Please submit all comments no later than March 14, 2010.** This will allow the 4 FRI team sufficient time to consider your comments in order to identify issues, alternatives, mitigation and monitoring options.

**Web Site:** http://www.fs.usda.gov/goto/kaibab/4fri

**Email Address:** 4FRI_comments@fs.fed.us Please note: there is an underscore "_" between the words "4FRI" and "comments" (4FRI_comments)

**US Mail:** Coconino National Forest, 1824 South Thompson St., Flagstaff, AZ 86001, *Attn*: 4FRI

**PLEASE NOTE: General comments will always be accepted and considered in subsequent steps of the 4 FRI NEPA process.**

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

2011-02-22 -17

GREATER FLAGSTAFF FORESTS PARTNERSHIP

**1300 S. Milton, #209**
**Flagstaff AZ 86001**

**www.gffp.org**

Feb 16, 2011

Henry Provencio
Four Forests Restoration Initiative Team Leader
Coconino National Forest
1824 S. Thompson Street
Flagstaff, AZ 86001

SUBJECT: Lake Mary Watershed - Firescape #3

Dear Henry:

The Greater Flagstaff Forests Partnership (GFFP) heartedly gives our support to the recent discussion to include the Lake Mary Watershed (LMW) in 4FRI's first forest treatment area. Doing so makes sense from both an ecological and social standpoint.

1 The health and resiliency of watersheds is critical to our forests and their sustainability. The LMW is especially important to the greater Flagstaff community as it is a major source of drinking water, provides critical wildlife habitat, and is a major recreation venue. All of these have a direct bearing on overall quality-of-life for residents and visitors alike.

↓ We do not need to belabor the point that an unhealthy forest is prone to loss, not only of forest cover but also of those values and benefits we cherish and enjoy. Recent wildfires, the 1 secondary affects that occur from those fires, insect infestations, and other disturbances dramatically point-out that our forests, in their current condition, are vulnerable.

Our primary focus within the LMW is one of restoration and protection, not additional water production. We are concerned that an intense damaging wildfire could easily result in an increase in sediment transport and deposition into either of the two lakes and an overall 2 degradation of water quality. Any additional water production that would result would be a welcome secondary benefit, especially if it would result in supplemental downstream flow into Walnut Canyon.

In 2004, we were one-of-two entities (the other being the Ponderosa Fire Advisory Council) which spearheaded the development and adoption of the Greater Flagstaff Area Community Wildfire Protection Plan (GFA-CWPP). It was subsequently adopted by both the Flagstaff City Council and Coconino County Board of Supervisors, and approved by the AZ State Forestry Division.

general

Our CWPP (*http://www.gffp.org/PDF_Pages/CWPP_Report.htm*) developed over an eight-month period in a public forum, and incorporating data provided by Northern Arizona University's Forest Ecosystem Restoration Analysis (Forest ERA) team, clearly identifies the LMW as a priority area for future forest treatments.

Since adoption of the CWPP, we have held periodic discussions on moving forward on this issue, and members have provided information to Congressional delegations on the subject. The recent Schultz wildfire and subsequent flooding adds urgency to the matter. With the on-going planning efforts, highlighted by the recent Firescape discussions, among 4FRI members, it now seems like the ideal time to move forward in a collaborative fashion on this landscape.

We recognize that differences exist between the *Interface Zone* of the CWPP and the *Community Protection Management Areas* as defined in the Wood Supply Study and utilized in the Landscape Restoration Strategy. In the simplest explanation, the former were identified using a matrix of six overlapping criteria and the former to determine potential wood volumes; the former were adopted by the community at-large with a goal of protection, while the later was done so by a stakeholder group focused on a larger landscape and for a different purpose. Regardless, our joint focus should be toward the watershed as a whole - its protection, enhancement, and resiliency.

In closing, we appreciate the opportunity to provide comment, and look forward to working with both the Stakeholder group and the USFS on this effort.

Sincerely,

Paul Summerfelt
President, Board of Directors

CC: Congressman Paul Gosar
Forest Supervisors - Coconino, Kaibab, Tonto, and Apache-Sitgreaves National Forests
Flagstaff City Council and City Manager
Coconino County Board of Supervisors and County Manager
4FRI Stakeholder group
GFFP Partnership Advisory Board members

# COMMUNITY WILDFIRE PROTECTION PLAN

*for*
*Flagstaff and Surrounding Communities*
*in the Coconino and Kaibab National Forests*
*of Coconino County, Arizona*

**January 2005**

---

A collaborative planning and implementation effort coordinated by:

*Greater Flagstaff Forests Partnership*
*&*
*Ponderosa Fire Advisory Council*






Community Wildfire Protection Plan for Flagstaff and Surrounding Communities in the Coconino and Kaibab National Forests of Coconino County, Arizona

# TABLE OF CONTENTS


**Signature Page**
**Introduction**
Context . . . . . 1
Goal . . . . . 1
Partners . . . . . 2
Principles . . . . . 3
Process . . . . . 4
Relationship to Other Plans . . . . . 5
For More Information . . . . . 6
**Community Identification and Description**
Analysis Area . . . . . 7
Wildland/Urban Interface Zone . . . . . 15
**Community Assessment**
Fuel Hazard . . . . . 19
Risk of Ignition & Occurrence. . . . . 24
Community Values-At-Risk . . . . . 27
Community Preparedness & Protection Capability . . . 28
**Community Mitigation Plan**
Fuel Hazard Reduction . . . . . 30
Desired Future Conditions . . . . . 30
Treatment Guidelines . . . . . 31
Wildfire Prevention and Fire Loss Mitigation . . . . 37
Improved Protection Capabilities . . . . . 40
**Implementation and Monitoring**
Community Mitigation Treatments . . . . . 44
Priority Areas and Treatment Costs . . . . 45
Predicted Treatment Effects . . . . . 50
Monitoring and Assessment Plan . . . . . 50
Roles & Responsibilities of Stakeholders . . . . 56
**Assistance** . . . . . 58
**Glossary** . . . . . 60
**Appendices:**
Appendix 1 – GFFP and PFAC Membership . . . . . 63
Appendix 2 – Guiding Principles for Forest Restoration and Community Protection. . . . . 65
Appendix 3 - Attributes utilized to develop Threat Map . . . 74
Appendix 4 – PFAC Operating Plan . . . . . 80
Appendix 5 – PFAC Smoke Management Plan . . . . 89
Appendix 6 – Utilization: Vision, Accomplishments, Plan . . . 93
Appendix 7 – Coconino National Forest Prevention Plan . . . 100
Appendix 8 – After the Fire . . . . . 108
Appendix 9 – GFFP Monitoring & Research Team Adaptive Management Framework . . . . . 116

# LIST OF FIGURES


Photo 1 - Volunteers preparing a future prescribed fire site . . . 2
Photo 2 - A treated forest . . . . . 2
Photo 3 - A FireWise Home . . . . . 2
Map 1 - Analysis Area, Communities . . . . . 8
Map 2 - Analysis Area, Land Ownership . . . . . 9
Map 3 - Analysis Area, Predicted Fire Behavior, Current Conditions . 12
Map 4 - Analysis Area, Threat Level . . . . . 14
Map 5 - Wildland/Urban Interface . . . . . 17
Photo 4 - A common scene in today's forest . . . . . 19
Map 6 - Analysis Area, Dominant Overstory Vegetation . . . 20
Map 7 - Analysis Area, Tree Density . . . . . 21
Map 8 - Completed Treatments, City of Flagstaff – July 2004 . . 24
Map 9 - Analysis Area, Fire Risk . . . . . 26
Map 10 - Rodeo/Chedeski Fire Boundary Overlay on Flagstaff Area . 28
Photo 5 - "Traditional" harvesting operation . . . . . 34
Photo 6 - "Micro" harvesting: cutting with a small shear . . . 34
Photo 7 - "Micro" harvesting: Skidding wood with an ATV . . . 34
Photo 8 - Pile burn operation . . . . . 35
Photo 9 - Broadcast burning . . . . . 35
Photo 10 - Public involvement is critical to success . . . . 37
Map 11A - Wildland/Urban Interface, Potential Treatment Type . . 47
Map 11B - Analysis Area, Potential Treatment Type. . . . . 48
Map 12A - Wildland/Urban Interface, Predicted Post-Treatment Effects
On Fire Behavior . . . . . 51
Map 12B - Analysis Area, Predicted Post-Treatment Effects
On Fire Behavior . . . . . 52
Map 13 - Comparison of Pre and Post-Treatment Fire Behavior . . 54


# LIST OF TABLES


Table 1 - Ownership/Jurisdiction – Analysis Area . . . . 7
Table 2 - Threat Matrix . . . . . 10
Table 3 - Predicted Pre-Treatment Fire Behavior, Analysis Area . . 11
Table 4 - Threat Level, Analysis Area . . . . . 13
Table 5 - Threat Level by Ownership/Jurisdiction, Analysis Area . . 15
Table 6 - Ownership/Jurisdiction, Wildland/Urban Interface zone . . 18
Table 7 - Principles of Fire Resistant Forests . . . . 31
Table 8 - Acreage & Estimated *Initial* Treatment Costs . . . 49
Table 9 - Post Treatment Predicted Fire Behavior . . . . 53
Table 10 - Roles and Responsibilities of Key Stakeholders . . . 57

# SIGNATURE PAGE

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# INTRODUCTION

## CONTEXT

Wildfire is a natural event within the southwestern ponderosa pine forest. Its very occurrence is a necessary ingredient to a healthy ecosystem. However, historic fires were predominantly frequent surface fires of low intensity that thinned the forest of fuel accumulations, with occasional intense stand replacement fires occurring in patchy areas or under extreme fire conditions. Due to past societal demands and land-management practices, natural fuel accumulations have been increasing for decades, resulting in an escalating trend in uncharacteristic, danger-ous, destructive, and costly wildfires.

When a forest is "healthy" it would support low intensity, ground fires every 2-20 years across the landscape. Every year hundreds of thousands of acres of surface fuels would burn through natural ignitions or ignitions by native (pre-European) peoples. Thus, one of the best defenses against "catastrophic crown fires" is to live with and adapt to the type of fire that is natural to the system. As one of the goals of the national fire plan states, a "Community-based approach to wildland fire issues combines cost-effective fire prepared-ness and suppression to protect communities and the environment with a proactive approach that recognizes fire as part of a healthy, sustainable ecosystem."

The 1996 fire season in our area clearly focused public attention on the plight of our forests and the risk posed by catastrophic wildfire. The result was an energized community committed to action, the founding of the Greater Flagstaff Forests Partnership (GFFP), and the increased involvement of the Ponderosa Fire Advisory Council (PFAC). Since that time, continued wildfire activity and on-going education and mitigation efforts have resulted in widespread public support of and an expectation for forest treatments. In addition, as we become more effective with our treatments, land managers will be able to make greater use of characteristic, low intensity fires through prescribed burns, appropriate wildland fires for resource benefit and containment of wildland fires as more effective, cost efficient strategies – a true measure of living with and adapting to a fire-dependent ecosystem.

Community protection and preparedness is a critical step toward mitigating immediate fire hazards and restoring adjacent wildlands. A combination of fuel management, FireWise standards, and appropriate fire-use and/or suppression response across ownerships within-and-adjacent to at-risk communities will reduce threats to life and property, protect values-at-risk, and create a safe context for the use of fire in subsequent forest ecosystem:
restoration efforts. This plan outlines actions needed to prepare and equip the greater Flagstaff community to live and thrive within our fire-adapted ponderosa pine forests.

## GOAL

To protect Flagstaff and surrounding communities, and associated values and infrastructure, from catastrophic wildfire by means of:

a) An educated and involved public,
b) Implementation of forest treatment pro-jects designed to reduce wildfire threat and improve long-term forest health, in a progressive and prioritized manner, and
c) Utilization of FireWise building techniques and principles.

The Community Wildfire Protection Plan (CWPP), authorized by the Healthy Forests Restoration Act of 2003, is a strategic plan as well

as an action plan: it provides a broad operating framework for all agencies and ownerships – private, city, county, state, and federal – within the area, while identifying community protection priorities. Site specific planning and implementation remains the responsibility of each owner/jurisdictional agency, acting in concert with the guidelines expressed within this plan.



Photo 1: Volunteers preparing a future prescribed fire site



Photo 2: A treated forest

Fuel management treatments designed to reduce the threat of catastrophic wildfire and protect communities incorporate the principles of ecological restoration. Practices designed to reduce excessive numbers of smaller trees, retain large trees, and accept natural fire (or apply prescribed fire to mimic the natural event) are key to reducing the wildfire threat in our area. These treatments, along with other practices over a period of time, are required to create the conditions necessary for an improvement in overall forest ecosystem health.



Photo 3: A FireWise Home

## PARTNERS:

PFAC is a 16 member group of local emergency and prevention fire agencies; GFFP is a 27 member group committed to ecological forest restoration and community wildfire protection. Membership for each organization is included in Appendix 1. Both groups have partnered to coordinate development of this plan. Staff of the Coconino National Forest (USFS), which is a member of PFAC and operates under a Memorandum of Understanding with GFFP, have been consulted throughout this process as well.

Both PFAC and GFFP, in concert with strong citizen support, have been collaborating for years to reduce the risk of wildfire. Traditionally, PFAC has focused on response to fire events and public education designed to lessen the risk, while GFFP has designed forest restoration and community protection projects in 10,000-acre blocks around the greater Flagstaff area.

Signed by President Bush in December 2003,

the Healthy Forest Restoration Act (HFRA) requires development and approval of a CWPP by communities who wish to receive priority funding for implementation of forest treatments designed to reduce wildfire risks to their respective community.

The GFFP and PFAC have identified five mutual objectives: though not all are specifically referenced or included in the CWPP, they nonetheless influenced plan development. They are:

- Create a healthy and sustainable forest and protect communities by implementing forest treatments designed to reduce the threat of catastrophic wildfire.
- Engage the public by providing opportunities in both preparedness and mitigation efforts.
- Support efforts to establish effective and sustainable methods to utilize small-diameter wood and other forest biomass.
- Promote FireWise building materials and construction techniques, as well as creation and maintenance of defensible properties and neighborhoods.
- Attract necessary funding (appropriations, contracts, donations, grants, etc.) to successfully reduce fire threat.

Both groups take seriously their respective responsibility to resolve the issues we – as a greater community – now face. Together, we are committed to action that will reduce wildfire threat across jurisdictions and within our mutual area-of-interest.

The Northern Arizona University Forest Ecosystem Restoration Analysis (ForestERA) project was engaged to provide baseline data and analysis to assess the impacts of ponderosa pine restoration and fuel-reduction treatments. Using the latest available data (2001 satellite imagery), spatial analysis tools in an ArcGIS environment were used to:

- Identify areas for management focus,
- Provide baseline data on current condi-tions (vegetation, canopy closure, etc.),
- Design treatment scenarios and test and compare the cumulative effects of these modeled treatments on fire behavior, and
- Predict fire hazard and behavior across the entire *Analysis Area.*[+]

It is recognized this is a "coarse-filter" approach restricted to ponderosa pine forest ecosystems that does not exactly match what various agencies would utilize to plan and implement site-specific treatments. Therefore, information presented throughout this plan can and should be augmented by the Jurisdiction-Having-Authority (JHA) with site-specific data during project planning efforts. This may result in adjustments of priorities, locations, and treatments.

The inclusion, application and analysis of ForestERA data is intended to provide a framework for discussion and illustrate both the threat and potential impacts of a range of treatments that could be applied throughout both the *Wildland/Urban Interface* zone and the entire *Analysis Area.*

## PRINCIPLES:

Development of the CWPP has been guided by the following framework:

- ***Fuel Management:*** Reduction of target hazardous fuels is based upon known fire risk, fire behavior, and threats to values-at-risk.
- ***Social and Political.*** Social and political concerns play a major part in defining treatments and their locations.
- ***Operational:*** Due to financial, infra-structure, and personnel constraints, emphasis must be placed on strategically located fuel treatments designed to protect key values-at-risk, and that can serve as anchor points for larger,

[+] NOTE: Interested parties are invited to visit the ForestERA website (www.forestera.nau.edu) for a more detailed discussion of available data and their modeling process.

landscape-scale treatments.

- ***Ecosystem:*** Reduction of hazardous fuels should be integrated with overall ecosystem conservation, restoration and management goals.
- ***Economic:*** Implementation and main-tenance of fuel treatment benefits greatly outweigh their costs
  - They save money by avoiding suppression expenditures, rehabil-itation costs, and compensation for property damage
  - They are an investment in protect-ing firefighter and civilian lives
  - They present new opportunities for rural economic development
  - They may help address issues related to the availability of homeowner's insurance in fire prone forest ecosystems

***Ethical:*** The continuing decline in forest health and the increasing probability of catastrophic fires, and their potential impact on the greater Flagstaff region, is a reality. The need to act now to restore forest health and reverse this dangerous downward spiral is of utmost importance.

In addition, the Arizona Governor's Forest Health Advisory Council developed a set of *"Guiding Principles for Forest Restoration and Community Protection"* through collaboration by a wide variety of forest professionals to help communities think through how to articulate a plan of action for restoring their forests, and for protecting their communities. Those Principles are included as Appendix 2 and were used during development of this plan and in the design of actions to achieve our goal.

## PROCESS:

Development of the CWPP incorporated the eight steps outlined in *"Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities"* (March 2004).

These steps are:
**Step One:** Convene decision makers.
**Step Two:** Involve federal agencies.
**Step Three:** Engage interested parties.
**Step Four:** Establish a community base map.
**Step Five:** Develop a community risk assess-ment
**Step Six**: Establish community hazard re-duction priorities and recommendations to reduce structural ignitability.
**Step Seven:** Develop an action plan and assessment strategy.
**Step Eight:** Finalize the Community Wildfire Protection Plan.

In addition, we endeavored to reflect the standard themes of any emergency plan – Prevention, Mitigation, Response, and Recovery – where appropriate in the plan.

To facilitate development of the CWPP, both PFAC and GFFP, operating together, initiated the following:

1. Issued a press release outlining the effort and offering the public opportunities to become involved and offer comment (CWPP Project Record).
2. Split development of the five sections into separate work groups, with on-going consultation with the USFS.
3. Conducted regular outreach to the community via:
   A. Posting of Development Team meetings in the *AZ Daily Sun*
   B. Informational insert in the July 4th and July 11th edition of the *AZ Daily Sun* – 13,000 copies each day
   C. Article in the summer edition of *CityScape* – 34,000 copies
   D. Article in newsletters.
      1) Summit Fire District – 3,200 copies
      2) Continental Home Owner Asso-ciation (HOA) – 2,400 copies
   E. E-Mail posting to employees –

announcement of CWPP planning effort:
1) City of Flagstaff – 600 addresses
2) Coconino County – 750 addresses

F. Meetings/Programs/Presentations:
1) GFFP *Community Forest Forum* – June 1
2) Flagstaff Mayor's Community Leadership Group – June 15
3) Community Open-House (Flagstaff) – June 16
4) Coconino County Board of Supervisors (Flagstaff) – July 13
5) Power-point overview provided to all City of Flagstaff employees – July
6) Sedona Fire District Board of Directors (Sedona) – July 27
7) Highlands Fire District Board of Directors (Kachina Village) – August 11
8) Pinewood Fire District Open House (Munds Park) – August 21
9) Joint session Flagstaff City Council and Coconino County Board of Supervisors – September 13
10) Kachina Village Open Space event – September 25
11) Parks-Bellemont Fire District Public Meeting (Parks) – September 30

G. Periodic updates in City of Flagstaff Weekly Report.

4. Met with 20 members of the *Communities Committee* (developers of *"Preparing a Community Wildfire Protection Plan*") on April 30th.
5. Drafts of individual sections were reviewed, edited, and compiled into a working draft CWPP document.
6. Monthly status updates were provided at both the PFAC and GFFP Partnership Advisory Board meetings.
7. All members of PFAC and GFFP, along with the public, were afforded an opportunity to provide comment on the working draft.
8. A Final Draft was then prepared and distributed, followed by a formal 45-day public comment period. Nine formal comments were received, with most items incorporated into the Final Plan.
9. Finally, the CWPP:
   A. Received **Concurrence** by the GFFP, PFAC, the Coconino National Forest and the National Park Service.
   B. Was **Approved** by the Coconino County Board of Supervisors, Flagstaff City Council, local Fire Departments and Fire Districts, and the AZ State Land Department – Fire Management Division.

Coordination occurred with both the Kaibab National Forest and the Williams Interagency Fire Advisory Council regarding areas both west and northwest of this CWPP area, and will continue as they work toward development of a CWPP in their area. Other adjacent areas, such as the Blue Ridge area, will be monitored and coordination will occur as they begin development of CWPPs or are added to this plan by amendment. In addition, the CWPP for Flagstaff and surrounding communities will be reviewed in six months and then annually by a CWPP Review Team consisting of representatives of PFAC, GFFP, the USFS, local governments, environmental groups and citizens. If substantive changes are required, it will be submitted to the appropriate authorities for review and approval.

## Relationship To Other Plans

In March 2000, the then Grand Canyon Forests Partnership (GCFP), later renamed the GFFP, in partnership with PFAC, developed a "*Flagstaff Area Wildfire Risk Assessment"* report. That report detailed wildfire risk in the greater Flagstaff area generally based upon a half to 1 mile set-distance from selected communities within the boundaries of the GCFP. This CWPP supercedes that earlier document: we have expanded the analysis area, incorporated additional communities, and utilized data not

available at the time of the earlier report to develop a more realistic picture of both threat and need.

This plan is compatible with and inclusive of on-going planning and implementation efforts of various agencies and jurisdictions engaged in its development. In addition, this plan is designed to compliment both existing and developing emergency/disaster management plans and Homeland Security related efforts.

## For More Information

This plan is posted on the GFFP website at www.gffp.org. Individuals interested in learning more are encouraged to contact either PFAC or GFFP via email at:

fuelmanagement@ci.flagstaff.az.us

or:

info@gffp.org, respectively.

# COMMUNITY IDENTIFICATION AND DESCRIPTION

## ANALYSIS AREA

Map 1 depicts Flagstaff and surrounding communities at-risk included in the CWPP *Analysis Area*. The *Analysis Area* includes portions of two counties (primarily Coconino, with a very small part of Yavapai), two cities and their associated adjacent areas (Flagstaff and Sedona), several unincorporated communities (Munds Park, Mormon Lake, Parks/Bellemont, Cosnino/Winona), the greater Flagstaff Metropolitan Planning Organization area (joint County-City of Flagstaff planning effort), two National Forests (primarily the Coconino, with a small part of the Kaibab), and the Flagstaff-area National Monuments.

Map 2 depicts ownership within the plan boundary. Acreage breakouts for the *Analysis Area* are shown below:

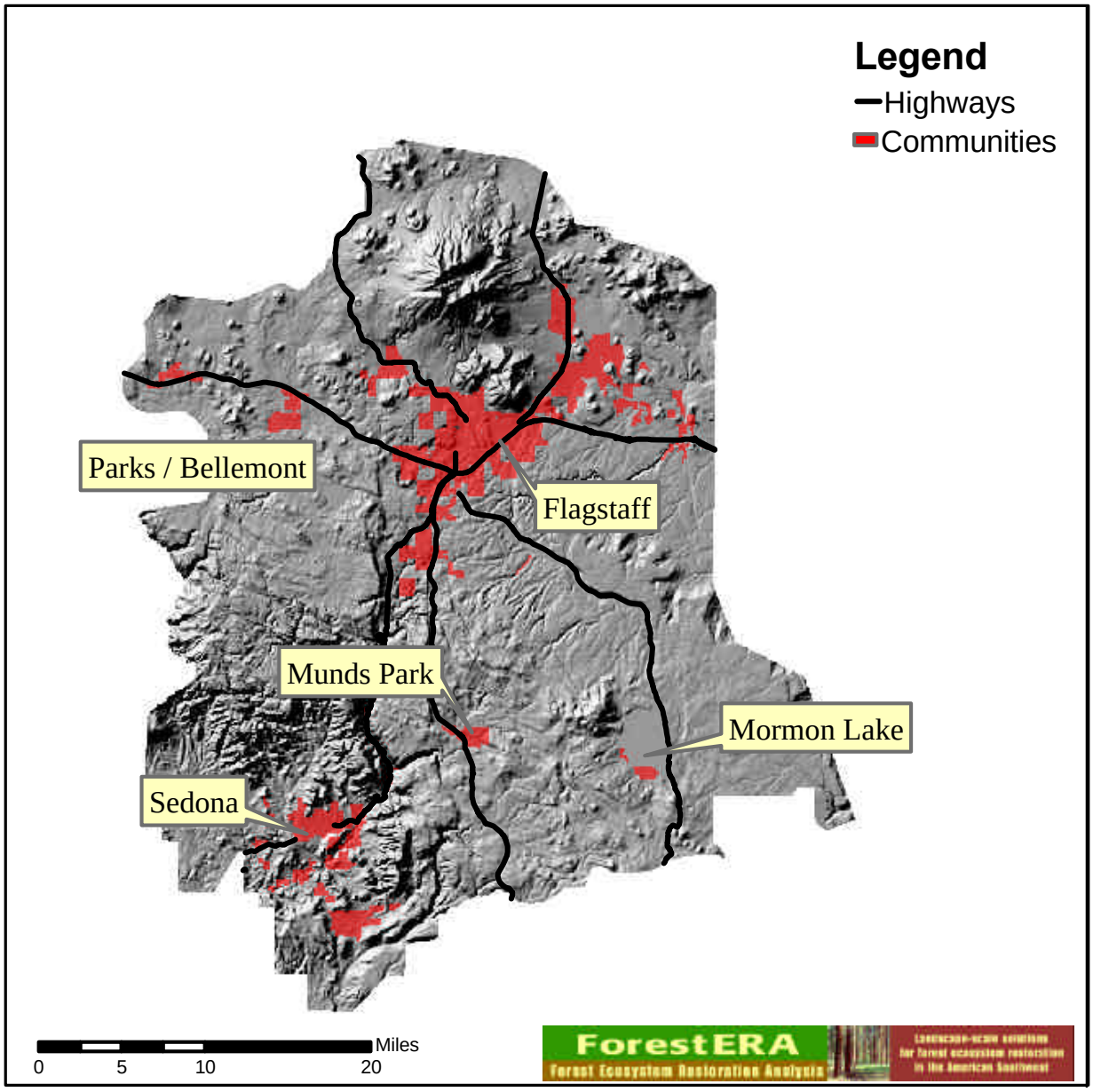
**Table 1**

**Ownership/Jurisdiction – *Analysis Area***

| Ownership/Jurisdiction | Acres | % of Total |
|---|---|---|
| Federal: | | |
| Flagstaff Monuments | 4,832 | 5% |
| Coconino National Forest | 763,064 | 81.0% |
| Kaibab National Forest | 28,619 | 3.0% |
| State: | | |
| Land Department | 34,575 | 3.5% |
| Camp Navajo (Division of Military & Emergency Affairs) | 26,371 | 3.0% |
| **Private/Other** (includes local government) | 82,275 | 9.0% |
| **TOTAL** | **939,736** | **100%** |

The roughly 1,465-square mile *Analysis Area* stretches from the San Francisco Peaks to below the Mogollon Rim, and is in the midst of the largest continuous ponderosa pine forest in the world. The full-time population of the area is approximately 75,000, with another 20,000+/- visitors in the area on any given day.

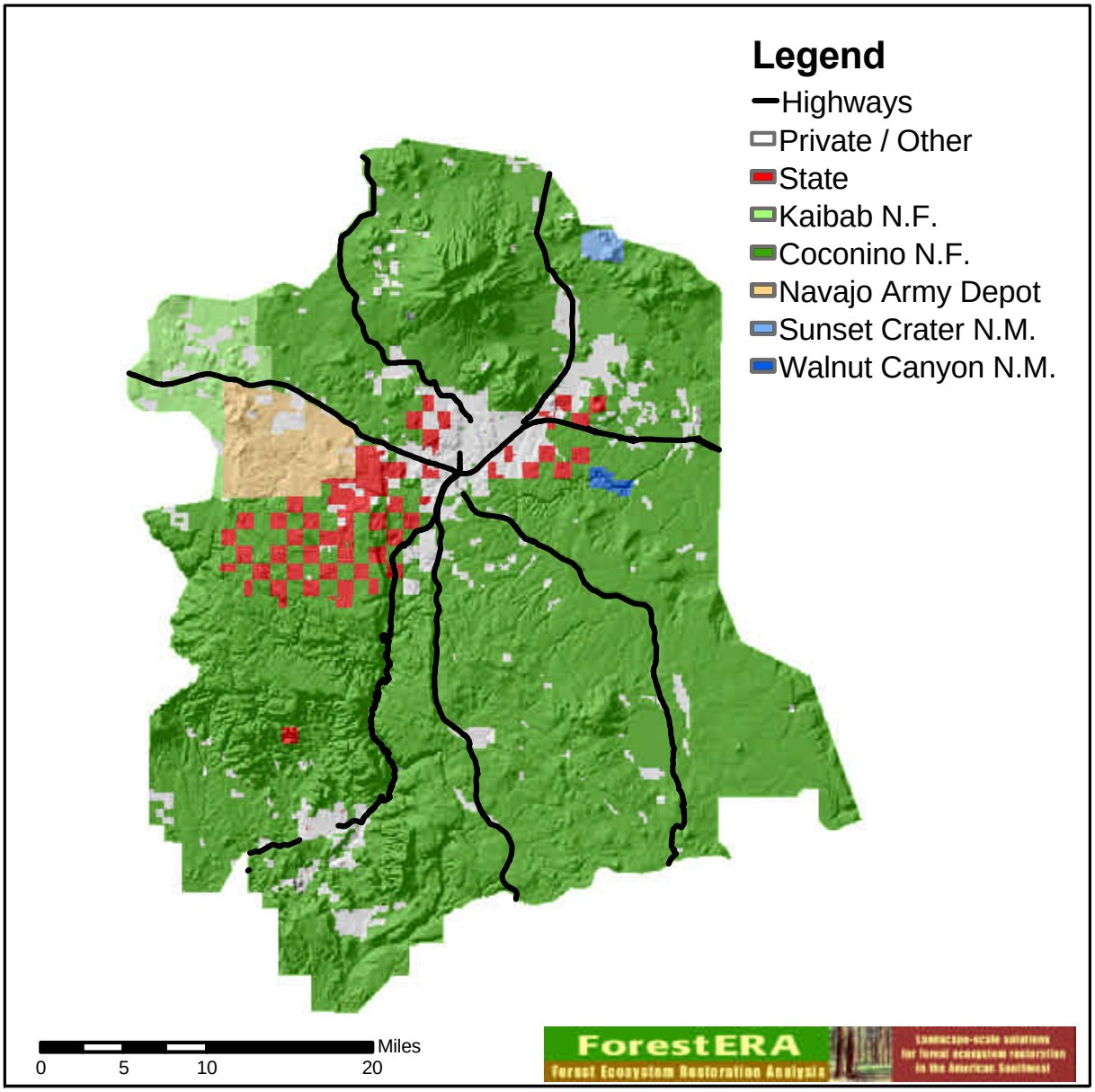
**MAP 1**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – COMMUNITIES***

**MAP 2**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – LAND OWNERSHIP***

In addition, the plan encompasses an area that includes two Interstate Highways (I-17 and I-40), two Arizona Department of Transportation designated scenic byways (Hwy 89A and Hwy 180), a major east-west railroad line (Burlington Northern Santa Fe), a regional airport, a state university and community college, two world-class observatories (three sites), numerous cultural attractions, archaeological treasures, and recreational sites, three critical community watersheds (Flagstaff – Rio de Flag and Lake Mary; Sedona – Oak Creek), and the San Francisco Peaks, the highest mountains in Arizona and a backdrop for the area recognized as a significant site for several Native American tribes.

Headquarters of the Coconino National Forest, the area also serves as the gateway to Grand Canyon National Park. Finally the area is bounded on the west by Camp Navajo, a weapons storage site and AZ Army National Guard training facility, and on the northeast and east by the Flagstaff Area National Monuments (Wupatki, Sunset Crater, and Walnut Canyon).

To facilitate establishment of the *Wildland/Urban Interface*, a Threat Matrix utilizing ForestERA data for the entire *Analysis Area* was developed. Multiple parameters were examined both separately and in combination with others. Those selected to include in the final analysis were as follows:

**Table 2**

**Threat Matrix**

| | |
|---|---|
| **VALUES** | 1. Communities<br>2. Municipal watersheds (Lake Mary) |
| **RISK** | 3. Fire behavior (predicted active and passive crown fire, surface fire)<br>4. Post-fire flooding potential (Rio de Flag and Oak Creek) |
| **OTHER** | 5. Areas upwind (six-mile distance) from at-risk communities |

Items which influenced the selection of these five parameters included:

1. Homes and businesses are the basis of the CWPP. We chose a minimum "buffer" value of 1½ miles around at-risk communities. (Infrastructure was considered separately – see p. 21)
2. The Lake Mary watershed provides approximately 30% of the water supply for the Flagstaff area (since 1949).
3. Predicted fire behavior (Table 3 and Map 3) can be modeled based upon vegetation, slope, weather and other factors.
4. Both the Rio de Flag and Oak Creek have a high potential for flooding (with associated erosion and sedimentation) following a severe wildfire, with significant impacts to Flagstaff and Sedona, respectively.
5. Large fires are typically associated with wind events: it is not uncommon for long-distance spread of several miles to occur in a relatively short period (4-6 hours).

**Table 3**

**Predicted Pre-Treatment Fire Behavior**

***Analysis Area***

| Type Fire Behavior | Acres | % of Total |
|---|---|---|
| Active | 219,181 | 23.5% |
| Passive | 420,282 | 43.5% |
| Surface | 99,207 | 10.5% |
| No Prediction | 201,066 | 21.5% |
| **TOTAL** | **939,736** | **100%** |

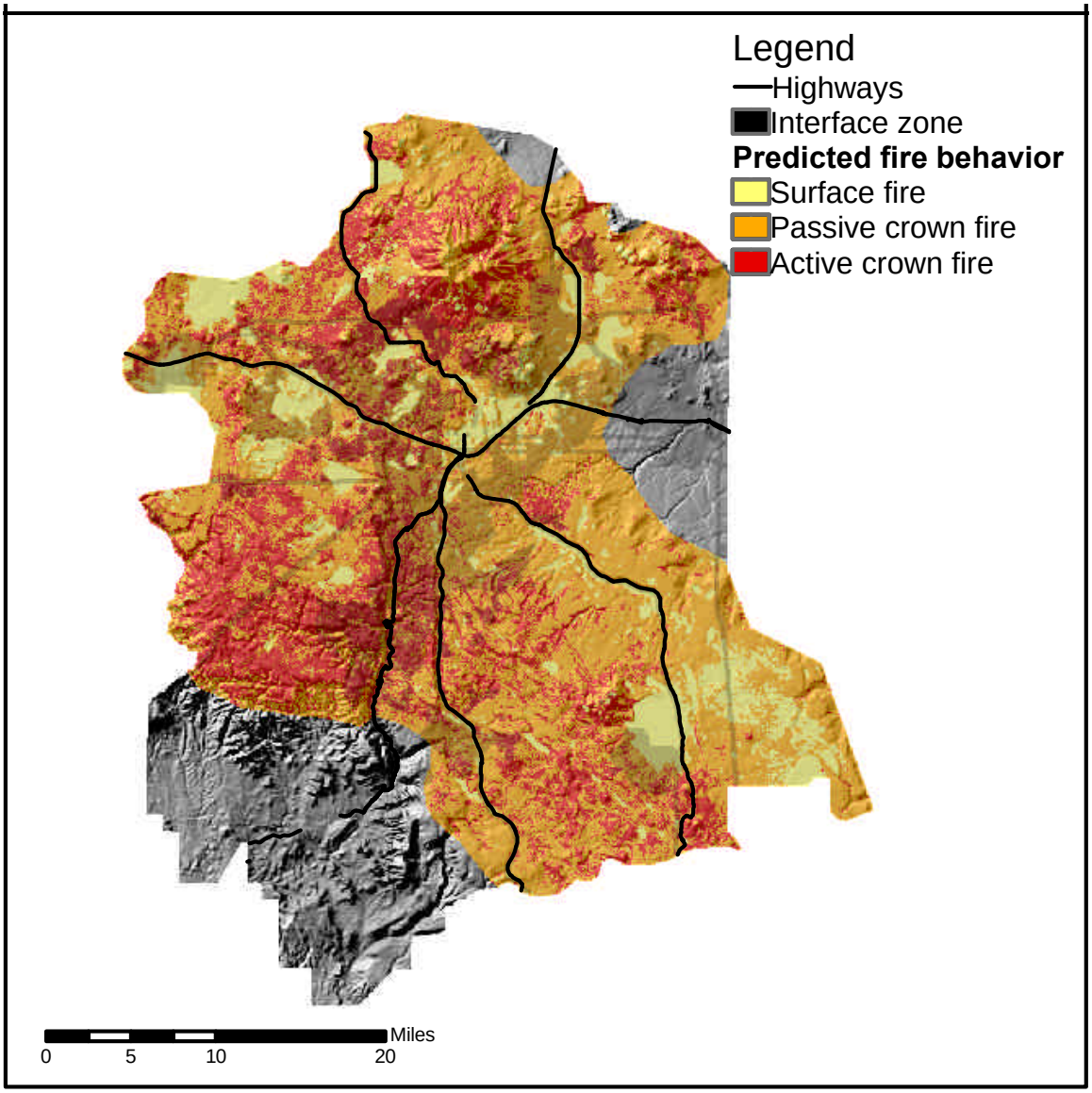
Active Fire Behavior = Fires readily transition into tree crowns and actively moves through the canopy, with large group tree torching common: associated long-range (≥ .5 mile) spotting is common.

Passive Fire Behavior = Fires will transition into tree crowns, but does not move through the canopy and only small-group or individual tree torching common: associated long-range spotting (≥ .5 miles) can occur.

Surface Fire Behavior = Fires stay on the ground, with little tendency to transition into tree crowns except in isolated cases: short-range spotting (≤ ¼ mile) can occur.

No Prediction = No data were available in the ForestERA format that allowed a fire behavior prediction to be made

**MAP 3**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - PREDICTED FIRE BEHAVIOR, CURRENT CONDITIONS***

As depicted in Tables 4 and 5, and Map 4, the Threat Level was divided into three categories: High, Moderate, and Low. Three important items to understand in reviewing this Map are:

1. Based upon this analysis, an indication of High Threat did not appear around the communities of Parks or Mormon Lake. However, a ground assessment of the site reveals that a High Threat does indeed exist. (This reinforces the concept that the ForestERA approach requires site-specific evaluation prior to implementation of any recommended treatment.) To ensure inclusion of protection for all communities, a 1½ mile buffer on the upwind side of communities and a ½ mile buffer on the downwind side was included.
2. Oak Creek Canyon is a "corridor" which links the Sedona area with both the Munds Park and greater Flagstaff areas. Topography and other resource issues may restrict the ability to conduct large-scale treatments in this corridor, but reinforces the need to implement effective FireWise building standards on private property, and to conduct treatments downwind, where fire will exit the canyon and threaten either Munds Park or Flagstaff.
3. This analysis is based upon a landscape-scale study: threats to some areas (Sedona, Winona, City of Flagstaff) are not clearly depicted but all threat levels are known to exist. Site-specific interpretation is required by local experts, owners, and jurisdictional agencies.

Appendix 3 contains a complete set of the five separate maps listed above (Values, Risk, Other) that were utilized to conduct this analysis.

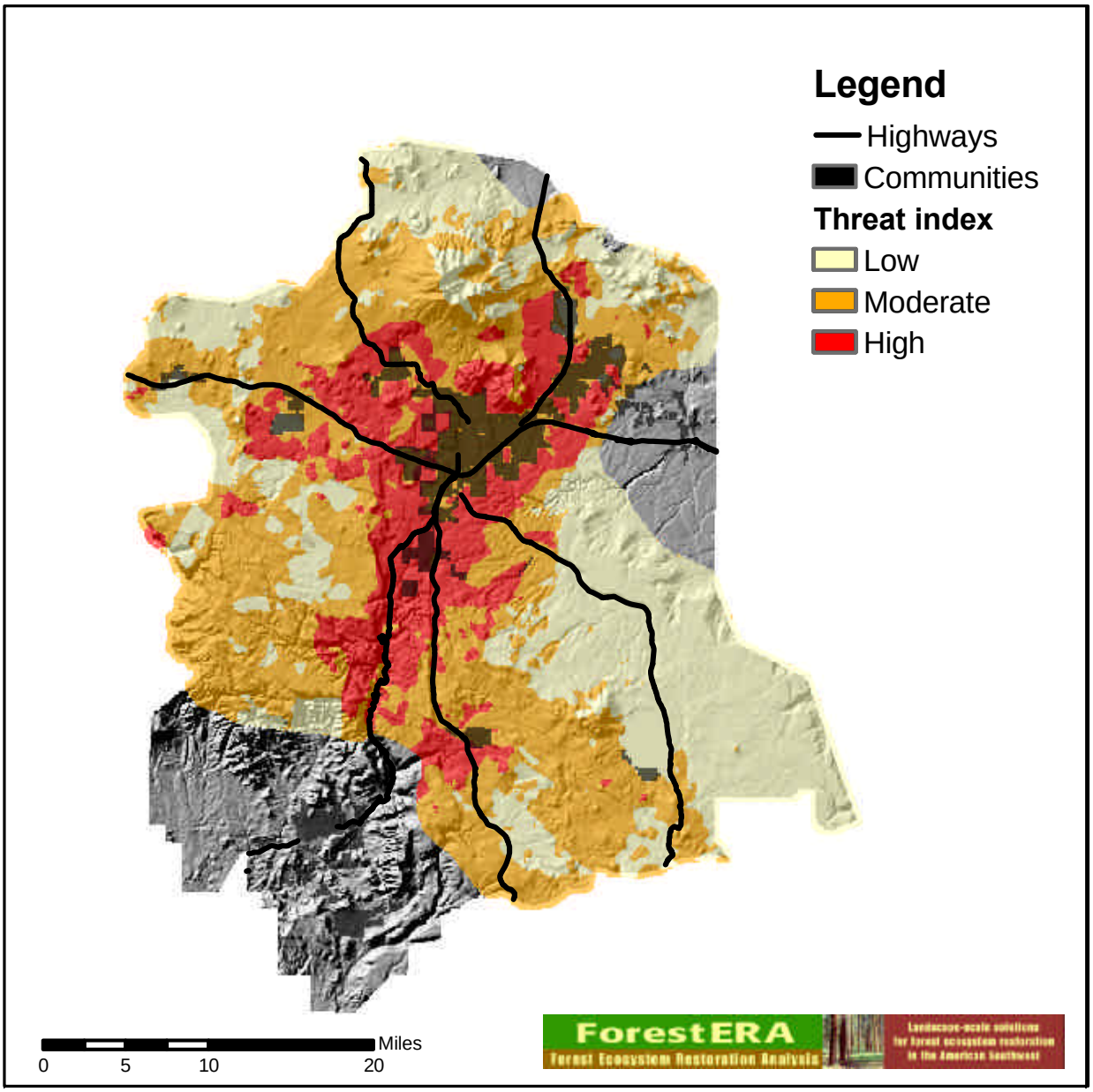
**Table 4**

**Threat Level Acreage**

***Analysis Area***

| Threat Level | Acres | % of Total |
|---|---|---|
| High | 135,041 | 14.5% |
| Moderate | 355,192 | 38.0% |
| Low | 279,243 | 30.0% |
| Data Unavailable | 170,260 | 17.5% |
| **TOTAL** | **939,736** | **100%** |

**MAP 4**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - THREAT LEVEL***

Acreage for each Threat Level by Ownership/Jurisdiction within the entire *Analysis Area* is shown below:

**Table 5**

**Threat Level Acreage by Ownership/Jurisdiction**

***Analysis Area***

| | THREAT LEVEL | | | |
|---|---|---|---|---|
| **Ownership/Jurisdiction** | **High** | **Moderate** | **Low** | **TOTAL** |
| Federal: | | | | |
| Flagstaff area Monuments (NPS) | 0 | 94 | 3,888 | 3,982 |
| Coconino National Forest | 109,652 | 274,701 | 235,401 | 619,754 |
| Kaibab National Forest | 355 | 13,657 | 14,559 | 28,571 |
| **State:** | | | | |
| Land Department | 6,687 | 13,933 | 6,687 | 27,307 |
| Camp Navajo (Division of Military and Emergency Affairs) | 8,523 | 11,391 | 6,346 | 26,260 |
| **Private/Other** (includes local government) | 9,824 | 41,416 | 12,362 | 63,602 |
| **TOTAL** | **135,041** | **355,192** | **279,243** | **769,476** |

## WILDLAND/URBAN INTERFACE

The *Wildland/Urban Interface* for Flagstaff and surrounding communities at-risk encompasses multiple jurisdictions and ownerships within a relatively large geographical area. It extends for some distance outside the City of Flagstaff corporate boundaries, the largest metropolitan community in Northern Arizona. Areas within unincorporated Coconino County include the communities of Munds Park, Kachina Village, Mountainaire, Forest Highlands, Mormon Lake, Bellemont, Timberline-Fernwood, Doney Park, Lower Lake Mary, Flagstaff Ranch, Baderville-Ft. Valley, Mt Elden, Westwood, and Pine Dell Fire Districts (contract entities served by the Flagstaff Fire Department), Cosnino, Winona, Upper Oak Creek Canyon, and Sedona, as well as substantial state and federal land. Overall, this plan incorporates these at-risk communities and their associated infrastructure sites into a single regional CWPP, rather than separate plans for each.

The "interface" is often defined as an easily identified geographic area where structures directly abut wildland fuels. In this perspective, the "interface" is confined to a relatively narrow area a set-distance from neighborhoods or communities. Some view it strictly as the "Home Ignition Zone", a distance of roughly 100-200 ft. from a structure. Others view it in a somewhat larger context: the Healthy Forests Restoration Act (HFRA) identifies it, in the absence of a CWPP, as a distance of a half mile or 1½ miles from an at-risk community, depending on local conditions.

Limiting treatments to a pre-set distance from

structures, while important to individual structure and/or infrastructure protection, does not recognize that a community is more than a collection of structures, and fails to understand the dynamic nature of fire behavior. Further, a strict distance definition does not adequately address the ecological needs of an area.

The *Wildland/Urban Interface* for Flagstaff and surrounding communities, as allowed by the HFRA, is identified as an area where public safety is the over-riding goal: it is sufficiently large to:

1. Reduce the potential of a high intensity fire from entering the community,
2. Create an area whereby fire suppression efforts will be successful,
3. Limit large amounts of wind-driven embers or "fire brands" from settling on the community, and
4. Protect critical infrastructure.

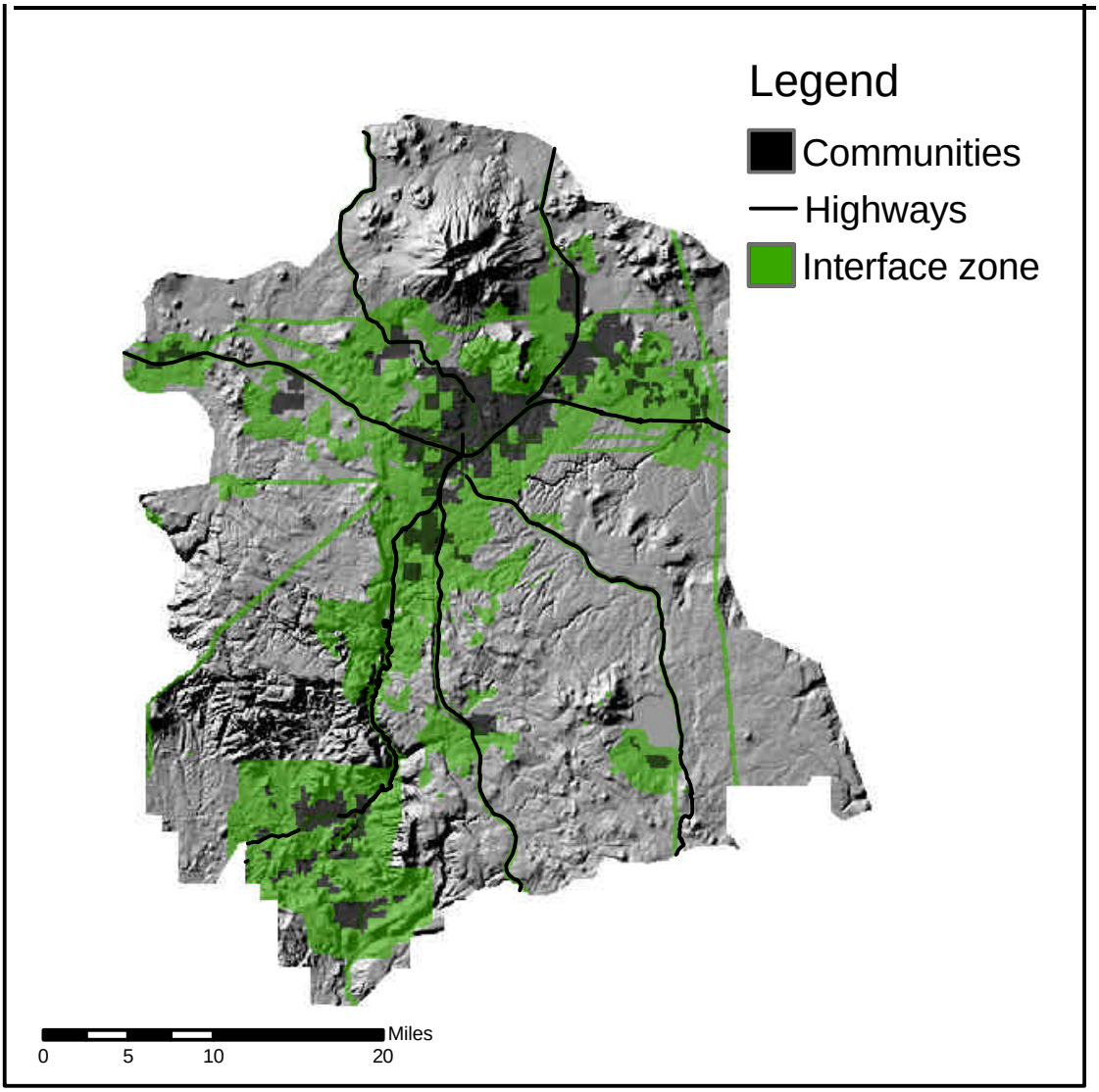
Infrastructure outside of identified at-risk communities was also incorporated into the *Wildland/Urban Interface* zone. We chose to buffer infrastructure, such as is listed below, by a quarter mile treatment zone (1/8 mile either side):

- NOPI Research Facility – Anderson Mesa
- Utilities:
  - High voltage overhead powerlines
  - El Paso Natural Gas aboveground stations
- Transportation:
  - Burlington Northern
  - Santa Fe Railroad
  - Interstate 17 and 40
  - State Highways 3, 89A, and 180
- Communication:
  - Cell Phone Towers
  - Mt. Elden Tower Sites
  - Mormon Mountain Tower Sites
  - Schnebly Hill Tower Sites

In addition, ForestERA data does not exist for the Sedona and Cosnino/Winona areas. We have therefore chosen to include a 1½ mile buffer on the upwind side of each community and a half mile buffer on the downwind side.

When the Threat Map (Map 4) and community and infrastructure buffers were combined, the *Wildland/Urban Interface* for this CWPP was established as depicted on Map 5, with acreage breakouts shown in Table 6.

**MAP 5**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE ZONE***

**Table 6**

**Ownership/Jurisdiction – *Wildland/Urban Interface* zone**

| Ownership/Jurisdiction | Acres | % of Total |
|---|---|---|
| **Federal:** | | |
| Flagstaff Monuments | 146 | .1% |
| Coconino National Forest | 215,166 | 76.7% |
| Kaibab National Forest | 8,633 | 3.1% |
| **State:** | | |
| Land Department | 15,665 | 5.6% |
| Camp Navajo (Division of Military & Emergency Affairs) | 8,963 | 3.0% |
| **Private/Other** (includes local government) | 32,082 | 11.5% |
| **TOTAL** | **280,655** | **100%** |

We recognize that several smaller clusters of homes exist outside the identified at-risk communities and designated *Wildland/Urban Interface* zone but within the overall *Analysis Area.* Their exclusion in no way diminishes the need for those owners to undertake appropriate mitigation efforts or cooperative ventures between themselves and the adjacent landowner and/or jurisdictional authority. However, to include every parcel of private land within the *Wildland/Urban Interface* is to enlarge it beyond realistic treatment capabilities.

# COMMUNITY ASSESSMENT

## FUEL HAZARD

Prior to European settlement in the 1860's, the forest around Flagstaff was comprised of relatively open stands of large-diameter ponderosa pine with scattered oaks, aspen, and other species, and intermingled with denser forests in canyons and on steep slopes, and with open meadows and grasslands common. Tree numbers averaged 30-50 per acre, with these trees arranged in small groups. While some young thickets and open meadows were undoubtedly present, a savanna community structure dominated the landscape. Fires were frequent, returning every 2-7 years, and were relatively low-intensity in nature

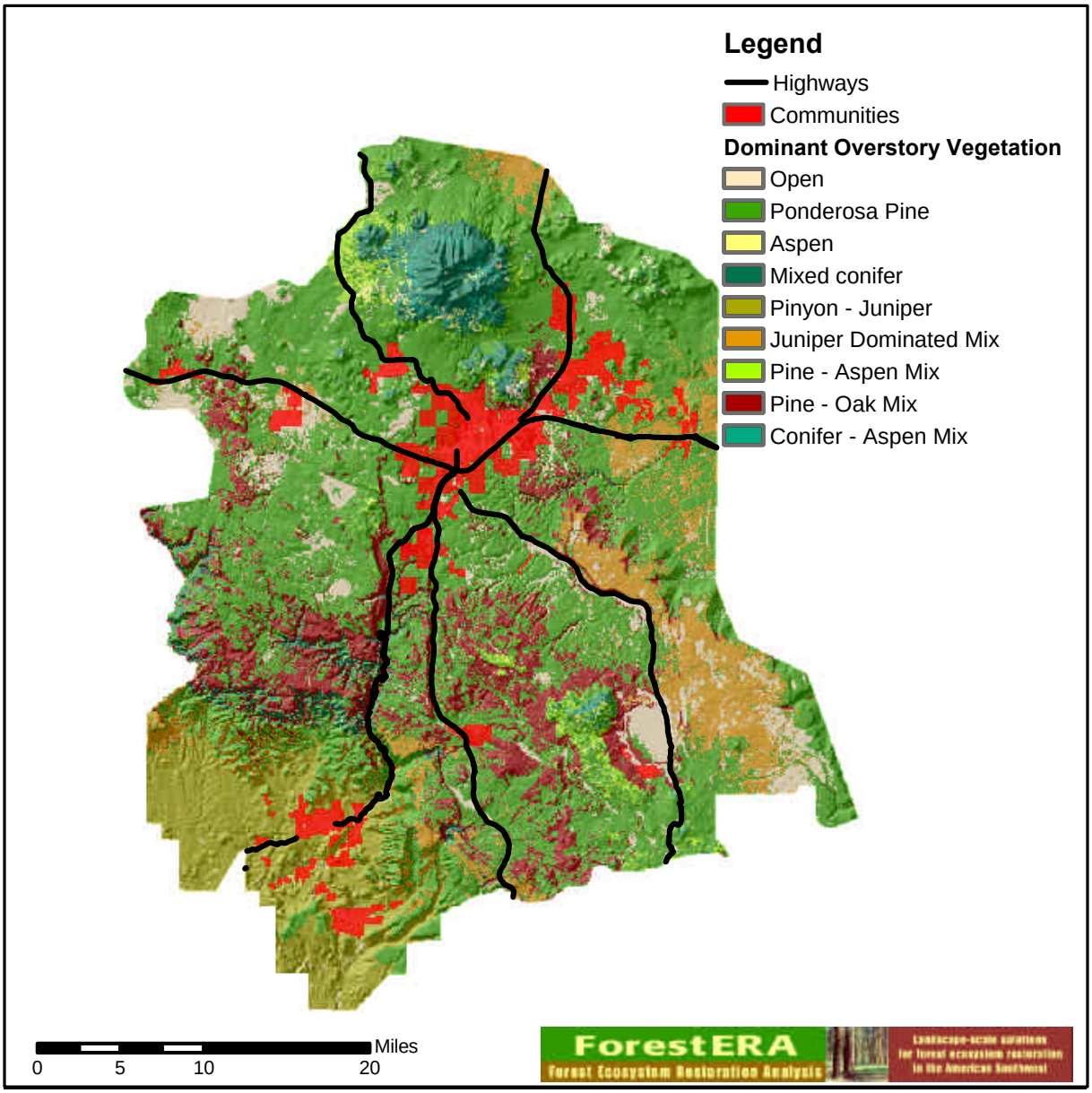
Beginning in the 1880's, and extending until fairly recently, area forests were subjected to societal demands that resulted in intense livestock grazing, harvesting of large-diameter trees, and a policy of fire suppression that embraced fire exclusion. These actions led to profound changes within the forest and set-the-stage for the intense wildfires common today.

From 1917-1920, a period of relatively wet weather, in combination with the exceptional 1919 cone crop, resulted in the establishment of millions of new seedlings. These trees are the very fuels which stoke the wildfires common today.



Photo 4: A common scene in today's forest

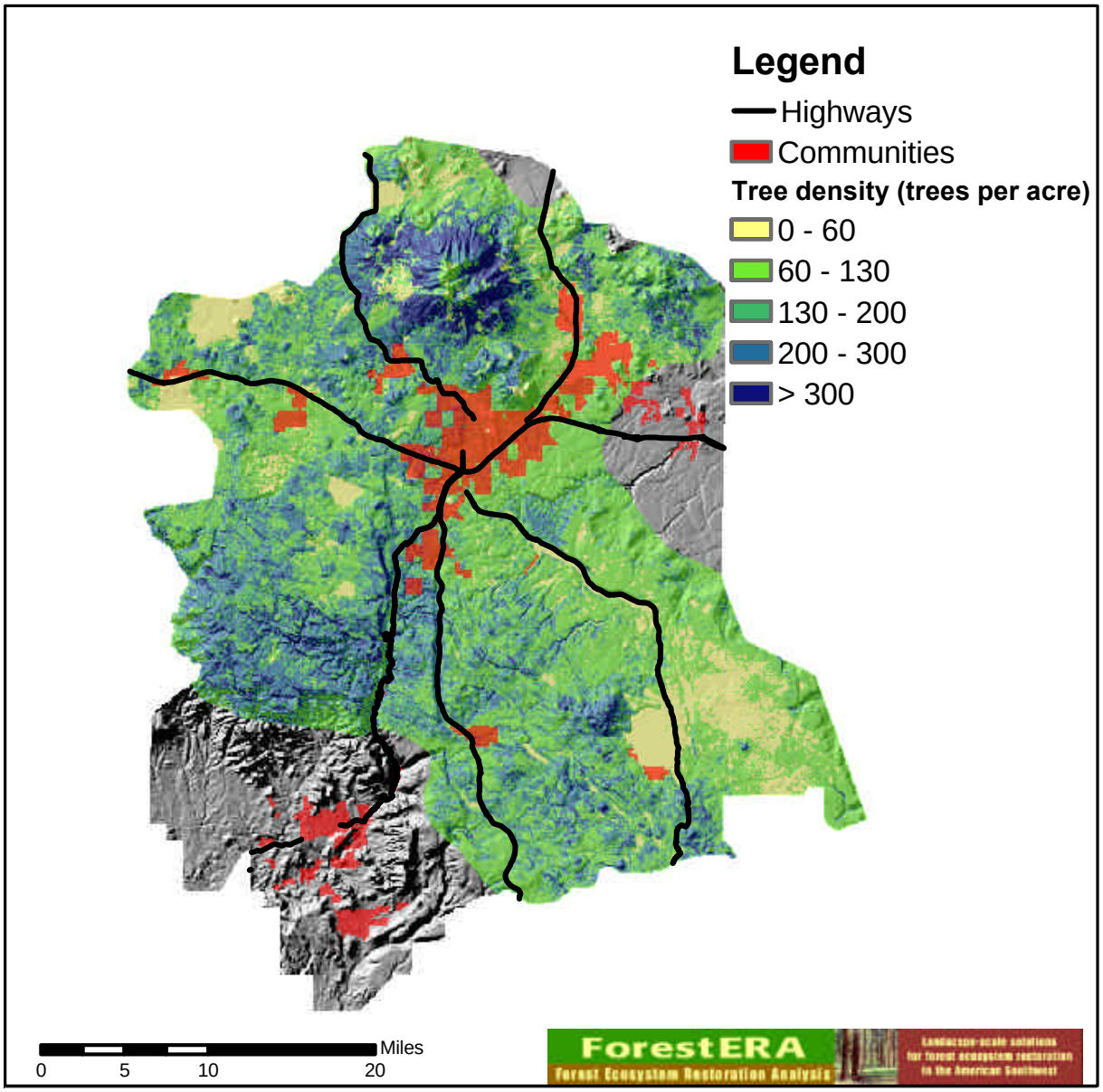
**MAP 6**




## CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

## *ANALYSIS AREA - DOMINANT OVERSTORY VEGETATION*

**MAP 7**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - TREE DENSITY***

As a result, many pine stands are presently overstocked with small and mid-sized second-growth trees. Basal areas commonly range from 150 to well over 200 and tree density from several hundred to over a thousand per acre. Canopy closure typically varies from 50% to 70% but often approaches 100%. An occasional juniper, pinyon pine, Douglas fir, white fir, Gambel oak, limber pine or aspen occurs among the pine stands. Insect and disease problems in these stands include dwarf mistletoe and periodic episodes of various bark beetles and other insects and disease.

Ponderosa pine sites, the overwhelming majority of the entire area, are best represented by Fire Behavior Prediction System (FBPS) Fuel Model #9 - closed-canopy pine stand with needle understory. In the few open areas, ground cover is a mix of grasses and forbs. Logging residue from the early 1900's such as pitchy high stumps and remaining cull trees contribute to the fire hazard and fuel laddering potential.

Fires are natural events, have been present since before humans occupied this area, and will continue to occur. What has changed, however, is the severity of fires we now experience. Our ponderosa pine ecosystem did not evolve with the fire intensity of today's fires, whether natural or human caused.

Three factors influence the spread of wildfire: fuel, weather, and topography. Of these, we can only manage fuel to reduce the intensity and spread of wildfire.

***Fuel*** – The area around Flagstaff is part of the largest continuous ponderosa pine forest in the world. Natural fuel amounts have increased dramatically in the past 80 years. Homes and flameable structures are simply another source of fuel.

***Weather*** – Historically, due to prevailing wind pattern, our local fire spread pattern is from the southwest to northeast. We also experience two other fire weather factors on a fairly routine basis that, like wind, are beyond our ability to control: low relative humidity and high temperature. The southwest is also in the midst of a persistent drought that has greatly increased vegetation mortality, thus increasing fire potential.

***Topography*** – Fires burn faster upslope than down. Canyons, ridges, and drainages funnel wind. South facing slopes dry quicker and burn more readily. Steep slopes present challenges for treating hazardous fuels, thus reinforcing the need to treat adjacent, more easily accessible areas, in a more intensive manner and at a greater scale.

Wildfires teach valuable lessons:

1. They occur in any season of the year. Although the primary concern (both in number and severity) is during the April - July timeframe, fire agencies in the area respond to wildfires virtually year-round when appropriate weather conditions exist.
2. They can be any size. Both small and large fires can be destructive.
3. They occur in any fuel type. Timber fires have the biggest flames, and offer the most resistance to control, but grass fires can be just as frightening to residents, and result in significant damage/loss to homes and infrastructure.
4. They can burn with incredible speed. Most damage within developed areas occurs within a relatively short timeframe. Once a wildfire encroaches upon a community, it is too late to implement widespread, highly effective mitigation measures.
5/ Generally, there are seldom enough resources to protect every home, structure, or improvement during a large, catastrophic wildfire. Emergency responders are often forced to decide which homes to protect and which to abandon. Mitigation actions

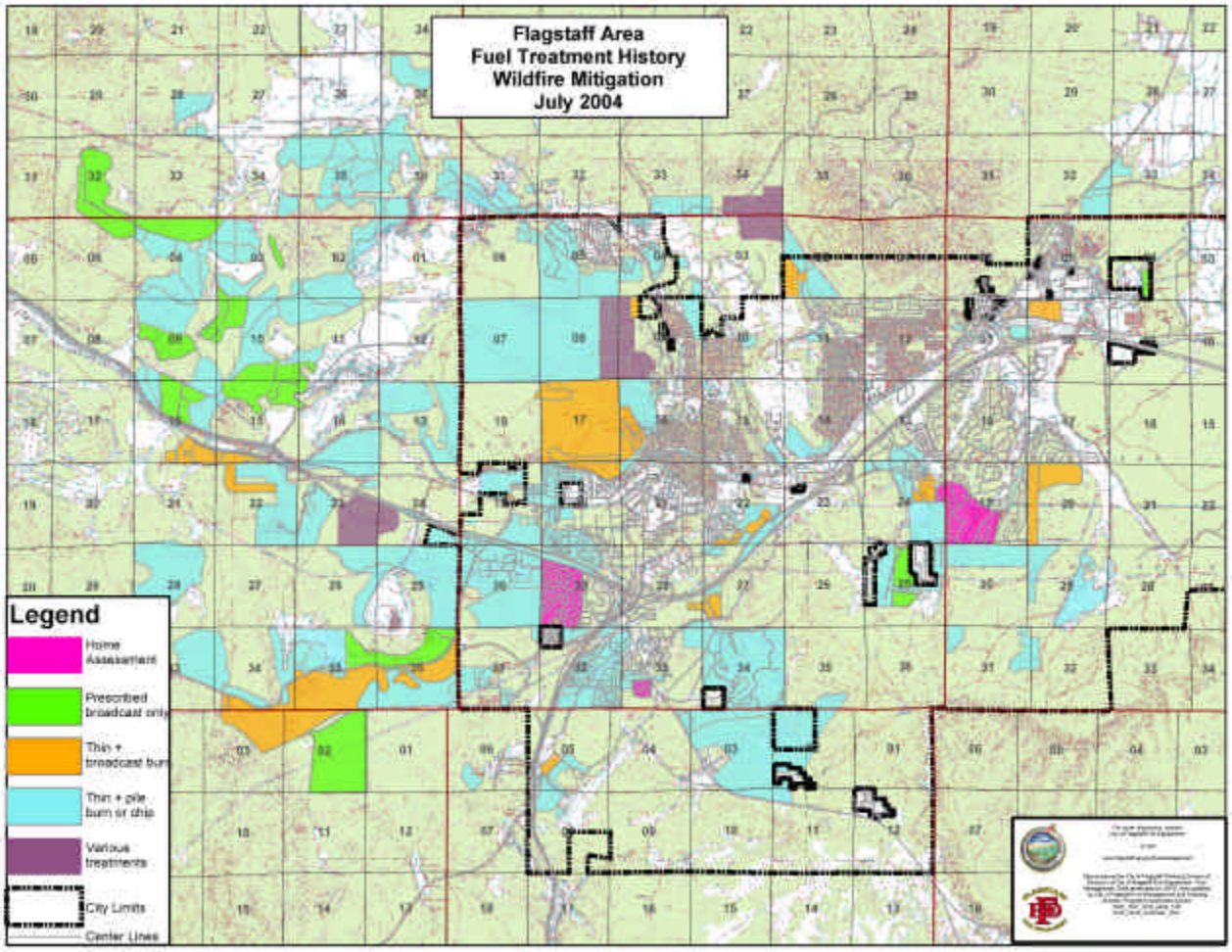
recommended and/or required and implemented now will make a tremendous difference in the survival of homes and property and the protection of community values-at-risk.

6. The trend in wildfire size and intensity, coupled with increasing awareness of other values-at-risk, is resulting in growing pressure to place firefighters in areas of greater-and-greater risk. Firefighter and public safety are the absolute first priority, but it is not uncommon for fire managers to find themselves at-odds with non-fire personnel who insist on dangerous and unsafe actions of questionable value. Responsible fire managers understand that permitting such actions violates their first priority and are obliged to refuse.
7. Wildfires do not respect boundaries or jurisdictions, and they have become increasingly destructive and expensive. A multi-agency, inter-departmental, and multi-faceted program approach is necessary to reduce risk prior to ignition; suppression actions alone are not the answer.
8. The question is not "if" a wildfire will occur, it is "when" and "where" it will happen.

To achieve ***community protection***, forest treatments and FireWise standards focused on public safety must begin in the *Wildland/Urban Interface.* First priority should be given to treating areas of dangerous fuels adjacent to communities, and then working outward in the W/UI. The overall scope-of-work is immense and the need to act quickly and decisively in this priority area is paramount. For ***community benefit,*** treatments in the *Analysis Area* focused on ecological needs and forest health, but reflecting the need to reduce fire threat, should also occur.

Important community protection and forest health restoration work has been implemented throughout the *Analysis Area* during the past several years, and plans are underway to continue treatments. As one example, treatments completed in-and-around the City of Flagstaff as of July 2004 are depicted in Map 8, which was compiled by the Flagstaff Fire Department.

**MAP 8**




CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

COMPLETED TREATMENTS - City of Flagstaff Area – July 2004

## RISK OF IGNITION AND OCCURRENCE

Wildfire is the #1 fire threat to Flagstaff and surrounding communities. The greater Flagstaff area averages around 150 ignitions per year (Map 9), while within the City of Flagstaff alone, there are roughly 60-80 wildfires each year.

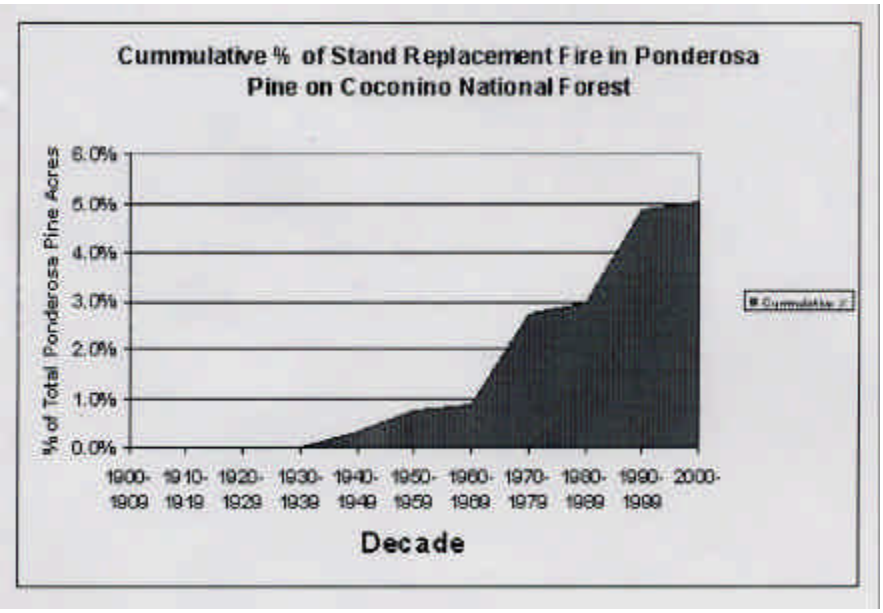
Statistics from the entire Coconino National Forest (#1- #3 below), which includes areas outside the *Analysis Area,* illustrate both risk and occurrence:

1. Total Fires - 1970 thru 2003:

| | |
|---|---|
| Lightning Fires | 10,377 |
| Human Caused Fires | 6,131 |
| Total Fires (1970-2003) | **16,508** |
| Average per year (Lightning) | 314 |
| Average per year (Human) | 185 |
| Average per year (Total) | **499** |

2. Growing trend of Stand-Replacement fires:

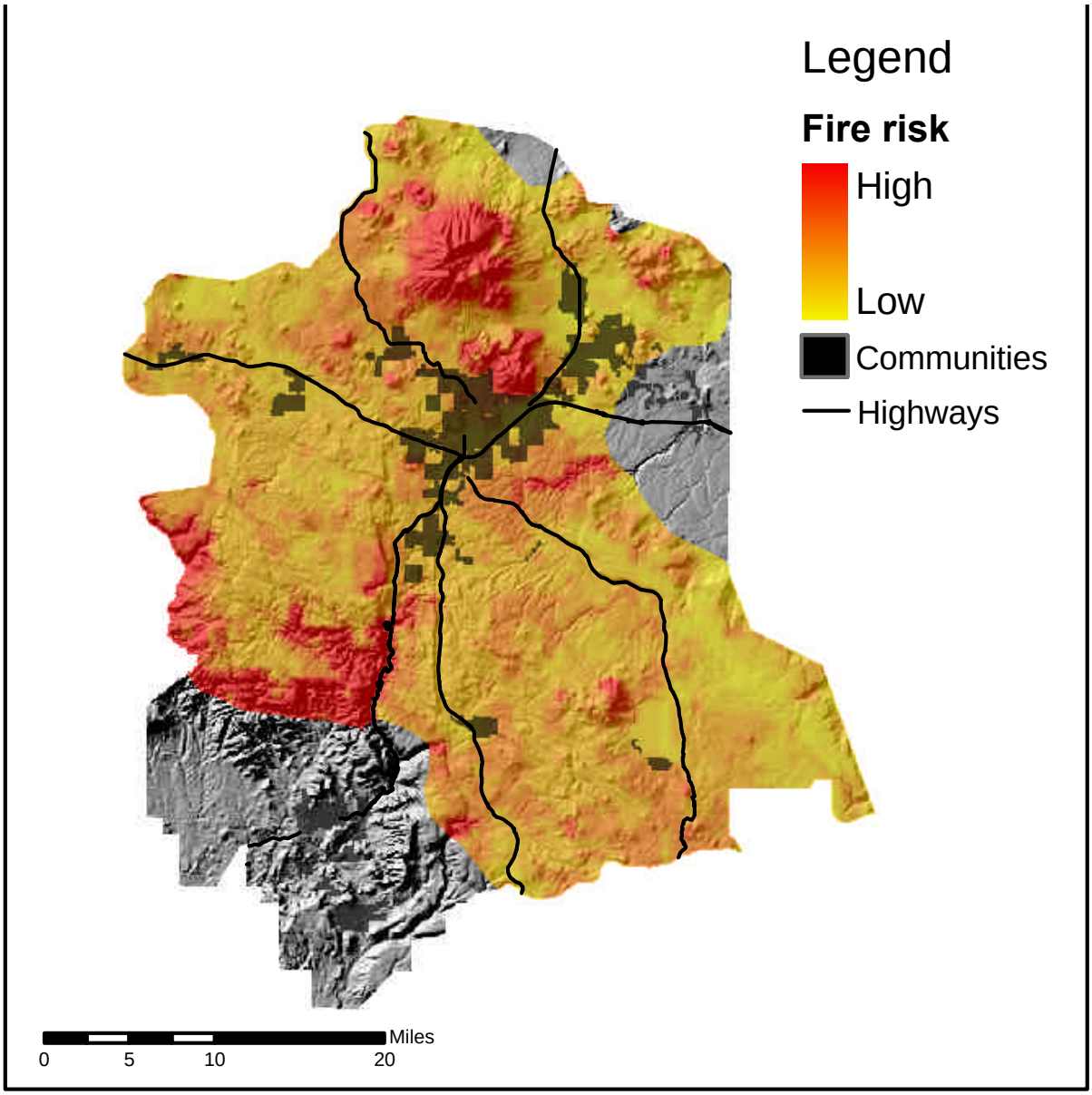
**Graph 1**




3. Closures/restrictions by lengths (based on fire danger):

| | |
|---|---|
| 1996 | 6 weeks |
| 2000 | 3 weeks |
| 2003 | 9 weeks |

**MAP 9**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – RISK OF FIRE IGNITION***

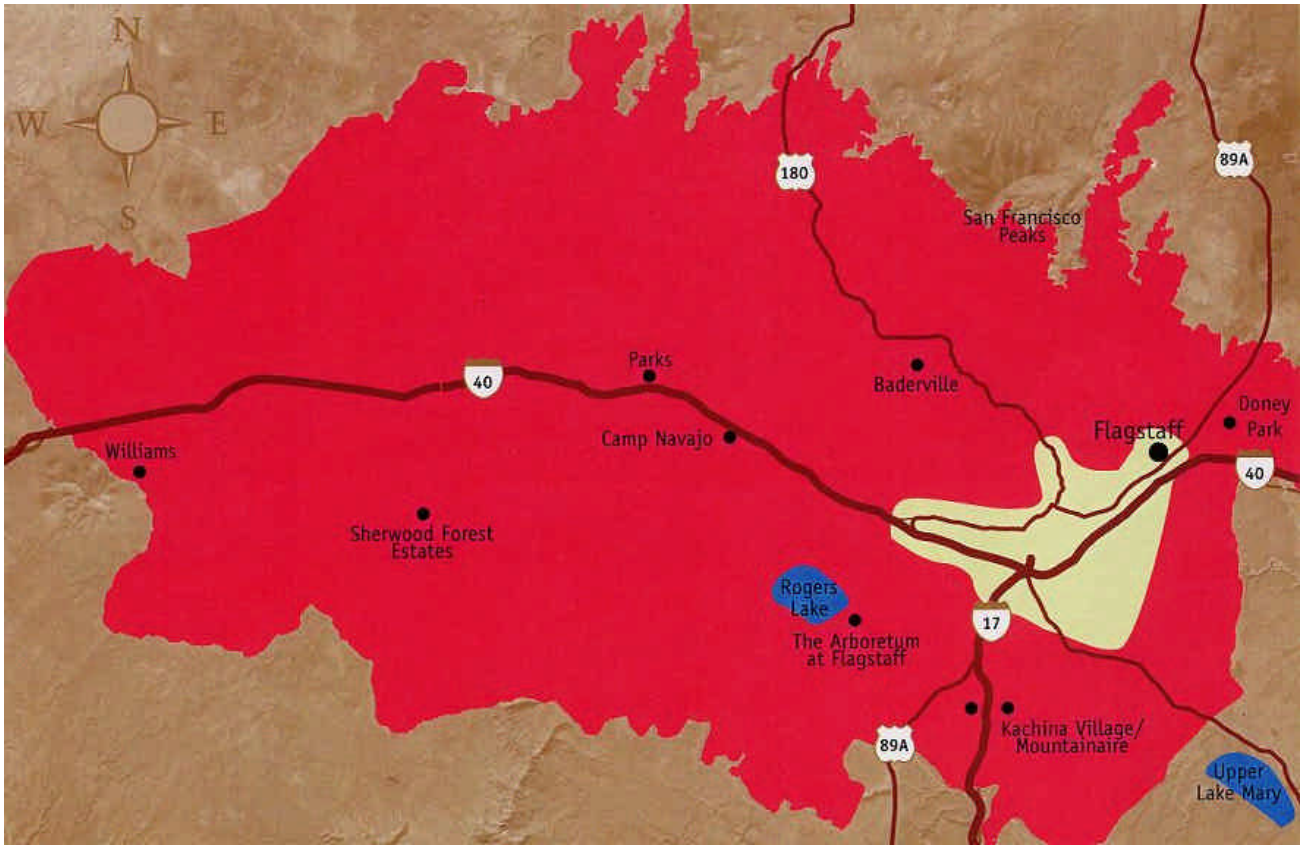
## COMMUNITY VALUES AT RISK

The greater Flagstaff area is dependent upon a healthy forest for community well being. Catastrophic wildfire, fed by excessive fuel amounts, on-going drought, and devastating insect attacks, threaten a myriad of community values. These values may include scenic vistas, emotional and spiritual attachments, cultural resources, watershed values, wildlife habitat, old-growth forests, recreational opportunities, public health, firefighter safety, structures and other infrastructure, and public confidence in government. (A description of these can be found in the article *"The Wildland Urban Interface: What's Really At Risk?"* at the following web site: www.flagstaff.az.gov/fuelmanagement.)

Two other community impacts not commonly considered include the following:

1) The economic shock of catastrophic fires to a local economy is an important, and often overlooked impact. A recent study conducted by the Flagstaff Fire Department, with information supplied by the Greater Flagstaff Economic Council, the Chamber of Commerce, and the City's Sales Tax Division, andutilizing information from other communities affected by large fires, revealed that a fire which damaged and/or destroyed 300 homes in early summer – at the onset of the tourist and visitor season – would have a first-year economic impact to the greater community in excess of $60 million.
2) The Rodeo-Chediski fire (2002) was the largest wildfire in Arizona's recorded history and was visible from Flagstaff. Even though it was more than 80 miles away, it prompted tremendous public concern as evidenced by the large increase and tone of calls into the Flagstaff 911 Emergency Dispatch Center. By overlaying the boundary and footprint of that 460,000 fire on Flagstaff and the northern area of the CWPP (Map 10), we get a dramatic illustration of the extensive impacts a large fire like this might have on our area – communities from Doney Park to Williams devastated, wildlifie habitat and critical watersheds stripped of their vegetative cover, decades to rebuild lives and centuries for ecosystem restoration. The scope of values that could be impacted is truly significant and just the potential for that type of wildifre occurrence is a primary driving force for creation of this CWPP - *to ameliorate the threat of such a fire to the Flagstaff and surrounding communities.*

**MAP 10**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***OVERLAY OF THE BOUNDARY/FOOTPRINT OF THE RODEO-CHEDISKI FIRE ON FLAGSTAFF AND THE NORTHERN CWPP ANALYSIS AREA***

## COMMUNITY PREPAREDNESS AND PROTECTION CAPABILITY

Two primary aspects of the existing readiness-level are found in the Appendices to this plan. Each has been slightly modified from their original document to better fit within the context of this plan.

Appendix 4 – Initial and Extended Attack Wildland Fire Operations Plan for the PFAC Response Area (Also known as the *"PFAC Ops Plan"*). This documents operational procedures to be utilized by all PFAC members for wildfires which do not exceed the complexity of a Type 3 incident.

Appendix 5 – Community Smoke Management Plan for the PFAC Response Area (Also known as the *"PFAC Smoke Management Plan"*). This documents actions to both minimize smoke impacts and educate the public regarding smoke from prescribed fire operations.

Each will be reviewed and revised on an annual basis by PFAC as part of that organization's annual work plan.

# COMMUNITY MITIGATION PLAN

## FUEL HAZARD REDUCTION

As indicated in the Introduction section, the CWPP is both a strategic plan and action plan: it provides a broad operating framework for all agencies and ownerships – private, city, county, state, and federal – within the area and identifies priority areas and treatments. Specific site prescription planning and implementation is the responsibility of each JHA, acting in consideration of the guidelines expressed within this plan.

Mitigation actions designed to reduce dangerous fuel accumulations within the *Analysis Area* are based, in part, on the *"Guiding Principles for Forest Ecosystem Restoration and Community Protection"* promulgated by the Governor's Arizona Forest Health Advisory Council (Appendix 2). These principles include:

1. *The overall strategy is dynamic, adaptive, and coordinated*. Given the current continuing decline in forest health, and the increasing threat of catastrophic wildfire, our actions to reverse this trend must be bold, large-scale, and undertaken immediately. All actions must be considered against the certain results of inaction, and must be continually monitored and revised as necessary.
2. *A sustainable community, with associated values-at-risk, is linked to a sustainable ecosystem.* Appropriate treatments must be based on social and ecological needs, and be geared toward reducing risk of destructive wildfire and restoring functioning ecosystems. Restoration efforts should be directed toward protecting and promoting development of old-growth and large trees, but not – if such a case should exist – at the expense of adequate fire protection to communities at-risk. Fire hazard reduction must be linked to the reintroduction of fire as a keystone ecological process. An active program of prescribed fire, including maintenance burns, and natural fire use, with implementation by land-managers on a site-specific need and basis, is essential. Vegetative treatments, and the pace of their implementation, will vary across the landscape, thereby creating an opportunity for biodiversity to exist and flourish.
3. *The immediate, but not exclusive, focus is on protecting communities.* A fire-resistive condition will be accomplished by modifying forest fuels at sufficient distances from structures and communities so as to reduce severe fire behavior, establishing defensible neighborhoods, and widespread use of fire resistant construction materials and architectural design.
4. *Necessary treatments, both-first entry efforts and maintenance activities, implemented and continued on site-specific needs, require a sustained commitment of public interest, political will, and financial investment.* Reducing wildfire risk and improving forest health is a long-term process measured in decades: because we are dealing with a living and dying ecosystem, it is one that will essentially be required forever.

## DESIRED FUTURE CONDITIONS

Actions and treatments will leave both the landscape and at-risk communities resistant to catastrophic fire. Ponderosa pine stands will generally range from 30-100 larger-diameter trees/acre and/or basal area of 40-80/acre, be found in groups in varying degrees of interlocking canopy, and be separated by openings of various sizes. This pattern of tree clumps and openings will be variable and provide for a diverse, rich,

robust and healthy ecosystem that supports a variety of butterflies, songbirds, mycorrhizae, carabib beetles, pollinators, grasses, flowers, shrubs and herbaceous plants. Further, it will avoid a homogenous, plantation appearance. Thicker groupings of trees, including all sizes, are found scattered throughout the larger area

Specific objectives related to fire behavior in ponderosa pine forest ecosystems (designed to make suppression actions easier, safer, and less costly, and to facilitate prescribed fire use), are as follows:

**Table 7**

**Principles of Fire Resistant Forests**

(Adapted from *"Forest Restoration and Fire-Principlesin the Context of Place",* R.T. Brown et al, 2002)

| Objective | Effect | Advantage | Issues |
|---|---|---|---|
| Reduce Surface Fuels | Reduces potential flame lengths | Less resistance to control | Less surface disturbance with fire than other techniques |
| Increase Canopy Base Heights | Requires longer flame lengths to produce torching | Less torching and resulting spotting | Opens understory: may allow surface winds to increase somewhat |
| Decrease Crown Density | Makes active crown fire less probable | Reduces crown fire potential | Surface wind may increase, with associated drying of fuels |
| Increase Proportion of Fire–Resistant Trees | Thicker bark, taller crowns, higher canopy base height | Increases survivability of trees | Removing smaller trees is economically less profitable |

These principles address only forested ecosystems. One quarter of the *Analysis Area*, such as areas around Sedona and Cosnino/Winona, is composed of other vegetation types, primarily pinon/juniper woodlands and chaparral. As better data becomes available on fire behavior and treatment effects in these vegetation types, this plan will be amended to address fire behavior within these habitats.

## TREATMENT GUIDELINES

This plan provides recommendations for successful outcomes, and not prescriptive options for treatment of ponderosa pine forests. The following discussion is intended to serve as a general guide and framework within which specific prescriptions should be developed. Modification of these concepts, by the JHA based upon specific conditions and objectives for that specific parcel, existing land management plans, legal requirements, and other standards, will be required and is encouraged.

*Tree Selection* - Selective thinning from below, initially focusing on over-topped pines, is a priority. If possible, "leave" trees are left in a clumped pattern rather than evenly spaced. Openings created by the clumpy leave-tree pattern allow a fire to either drop to the ground or stay on the ground permitting effective suppression action. Clumps can vary from 1/10$^{th}$ acre up to as large as 1 or more acres in size. The number of trees in a clump may range from as few as two to 15 or more, with 30 or more occurring in a limited number of clumps throughout specific project areas. Trees, including the crown area, will generally occupy areas ranging from 20-50% of the area. Openings will range from 1/10$^{th}$ to 1-2 acres in size and constitute a variable of 50-80% of the area.

In general, trees designated for removal exhibit one-or-more of the following characteristics:

1. Contributes to crown-fire behavior: ladder

effect into the overstory canopy, low crown-base heights, dense interlocking canopies, etc.

2. Are vulnerable to drought or insect infestation: suppressed, reduced vigor, etc.
3. Currently infested with insects that threaten to spread to other trees, unless the tree is to remain for other benefits.
4. Infected with dwarf mistletoe: Stands with high infestation levels of dwarf mistletoe can be thinned or pruned to reduce crown fire potential during the inevitable wildfire. Small pockets of mistletoe can be Isolated from non-infected trees by a barrier of fifty feet (to reduce further spread of the parasite), or removed.

Conversely, trees considered for retention, will be those, unless other issues or benefits prevail, which are often:

1. Clustered around evidences of historic forest structure (ex: downed logs, stumps, stump-pits, etc) or, alternatively, based on best existing forest structure.
2. The largest diameter, exhibit high crown-base heights, and are the most fire resistant:
3. Old trees exhibiting yellow bark.
4. Oaks, aspen, or other species of wildlife or ecological value

NOTE

- Some variation is needed: trees may vary in-height. Stands should include small intermediate size trees, saplings and seedlings, but none of these should threaten larger, older trees during a fire.
- In the absence of prescribed fire, clumps may be prone to loss due to high surface fuel loadings: retention of clumps requires periodic use of fire.

Removal of the larger diameter trees in a stand, including standing dead snags, is to be avoided unless cutting is required to adequately reduce fire risk, provide for public safety or protection of improvements (ex: trees leaning over home, play area, power line, road, or hiking trail), or for some other ecological benefit. (Removal of "large" trees is a significant issue for many groups and individuals. The GFFP has been discussing this issue for several years and is currently considering adoption of *"A Management Policy for Ponderosa Pine Forest Structure in the Flagstaff Wildland/Urban Interface"*. Such a policy, when adopted, should be incorporated into revisions of this CWPP to address this issue.)

When designating trees for removal, personnel must be aware of fire behavior alignments such as prevailing wind direction, shading, slope, fuel arrangement and continuity, including interlocking crowns, and potential suppression strategy and tactics best-suited to the individual site.

Wind-driven fires are not uncommon in our area. To provide optimal protection, treatments are required upwind of at-risk communities – south and west in our area – to a greater distance to provide adequate protection. Conversely, treatment distance north and east of at-risk communities can be reduced unless circumstances dictate otherwise. However, one should be mindful that plume dominated fire behavior results in extreme fire spread from spotting of several miles in all directions and should be expected.

Topographic features – such as canyons – directly influence fire behavior, but may be impractical to treat due to slope, soil sensitivity, safety, expense, and other values such as critical wildlife habitat. This lends emphasis to enlarging treatments where fire is expected to emerge from a canyon and where firefighting forces have the best opportunity for control

Overall, this approach is considered to be an intermediate-intense modification of most existing stands, involving removal of 50-75% of the

existing trees. Experience has shown that over the entire area, many, but not all, of the trees to be removed will be smaller diameter.

*Cutting Techniques* - The type of mechanized operation is obviously important when conducting treatments. A traditional harvesting operation may be the preferred method in some areas, while in others it may not. For the later, a "micro" harvesting approach may be required: trees are cut either using hand-crews with power saws or by a small shear, and wood can be moved by an All-Terrain-Vehicle (ATV) with a trailer or some other small-equipment approach. Such an approach, however, will likely lengthen the time required to treat the parcel, and may result in higher costs and pose an increased risk to the operator.

Restricting hours of operation in response to local conditions and neighborhood concerns may be warranted. For example, if an operation is immediately adjacent to homes or a neighborhood, activity may need to be restricted to normal working hours within a reasonable distance to lessen the impact to residents. However, doing so should be done with the realization the operation will extend further into the future.

Stumps should be cut as low to the ground and as level as possible. This not only improves post-treatment visual quality, but permits easy access for wood removal and other subsequent land management needs. However, potential adverse impacts from unrestricted post-treatment access (ex: soil compaction, erosion, etc) should be addressed in the planning phase of a project, and subsequently managed.

*Utilization* - The majority of material available for wood production from the greater Flagstaff area will be small diameter ponderosa pine. Opportunities for using this material are constrained by a number of factors including high harvesting costs, structural properties associated with juvenile wood, and a lack of consistent markets and processing facilities. Harvesting costs associated with forest restoration and community wildfire protection, including transportation and handling of raw material, are often quite high even where larger, high-value trees can be harvested. These costs can be prohibitive for smaller businesses.

The difficulty in finding suitable markets for this small diameter material is magnified by poor mechanical properties that make it unsuitable for all but the least demanding structural uses. It is characterized by suppressed growth with low tension and strength due to a high ratio of juvenile wood and difficulty in product drying. Finding suitable markets is further complicated by the fact that currently there are virtually no outlets for the types of timber that will be harvested. New processing facilities will have to match the types of wood material available with the use of contemporary utilization techniques.

Northern Arizona and Flagstaff is uniquely situated to capitalize on contemporary opportunities for solid wood and biomass utilization. (See Appendix 6 for a complete description of this topic.) Solid wood applications in which businesses are actively exploring or have already invested in the Flagstaff area, include roundwood construction, composite products like oriented strand board (OSB) and wood/plastic materials, and engineered lumber like glu-laminate beams and finger-jointed lumber. Biomass applications include wood chips for baseload energy production, densified fuel pellets for heating, and biochemical extractives. Other products for which small diameter pine is currently being used in the region include firewood, posts and poles, landscaping timbers, ground covers or mulch, pallet manufacturing, and crafts.

*Slash Treatment* – Four general slash-disposal methods exist and each may be utilized under the appropriate circumstances. Regardless of the method chosen, the required work (such as piling) should be completed as soon as possible after it is generated.

- Hand Piles: This is a common practice of

handling slash. Hand piles should be a minimum of six feet tall and six feet wide. Piles should be located in openings to minimize scorching leave trees when the piles are later burned. Likewise, placing piles on top of old stumps or logs should be avoided to reduce both the amount of smoke and the chance for "creep" when the piles are later burned.

- Machine Piles: This method is feasible and widely utilized. It is particularly appropriate on larger projects and in more open areas. Piles are typically much larger than those created by hand-piling. Whole tree skidding may also be used with the piles created at the landings. Windrows may also built using dozers: this technique has been successfully utilized in the area.
- Chip or Grind: Although occasionally used, this technique is comparatively expensive and chips decompose slowly in our area. If future under-burning is anticipated for the site, chips may add to smoke management problems. The material can, however, be used for mulch or decorative landscaping. Hauling chips to a disposal site is expensive.
- Lop-and-Scatter: This method, where material is cut so it is less than 12-24 inches above ground-level and then left on-site, should be carefully considered on sites immediately adjacent to structures. If the amount of slash is light and the manager can complete a broadcast burn as soon as the material has dried, it may be effective. However, due to the increased fire hazard, as well as visual concerns, this method is not as common as it once was, and adjacent to homes, it should never be left in-place for an extended period.

*Pile Burning* - Piles should be burned only when consumption will be greater than 90%. All pile burns should be conducted under conditions intended to minimize scorch and smoke impacts.



Photo 5 – "Traditional" harvesting operation




Photo 6 – "Micro" harvesting: cutting with a small shear



Photo 7 – "Micro" harvesting: Skidding wood with an ATV (Roll-over protection recommended for this type operation)

Because the ultimate intent for many treatment sites is to conduct a broadcast burn, some existing dead-and-downed material can be piled during the thinning operation. These piles could then be burned alongside thinning-material slash piles. Although there are financial costs of doing so, which may be prohibitive depending upon the site, removing these materials during the pile burn phase does result in decreased smoke emissions during the subsequent broadcast burn.

Hand Piles: As a standard practice, these piles are burned either when snow cover exists or during an extended wet weather episode. Once ignited and as they burn-down, the piles can be periodically consolidated to ensure complete and timely consumption. Ignited piles should, if at all possible, burn-down by nightfall to minimize smoke impacts to area residents.

Machine Piles: Like pile burns, this type operation requires either snow or an extended wet weather episode. These type piles typically are larger than hand-piles, and will therefore burn longer once ignited. The advantage is that there are fewer piles per acre and they can often be burned under wetter conditions than possible for hand-pile burning.



Photo 8: Pile burn operation

*Broadcast Burning-* Treating ground fuels is a critical component of any effort designed to reduce fire threat, and it has added ecological benefits, such as recycling nutrients. Once an area has been thinned and the slash has been treated, or where a burn only treatment is designated, the site can be broadcast burned. Firelines are usually constructed by hand or with a drag pulled by an ATV, or the burn crew can use natural breaks or roads/trails as a containment line.

Where site objectives dictate that standing dead trees and large downed woody material need to be protected, they can be either hand lined or otherwise excluded from the burn block. Extra protection measures may not be necessary for many fire-tolerant cultural or archaeological sites: treating these areas with prescribed fire has the advantage of protecting them from emergency suppression activities during a wildfire..



Photo 9: Broadcast burning can be successfully implanted both in the forest and adjacent to homes

Deep duff and needle accumulation at the base of the larger older trees will often smolder for days. This essentially bakes the cambium layer and can lead to tree death 1-2 years, or more, after the burn. To avoid this potential loss, the site should be evaluated prior to ignition. If necessary, duff and needle material can be raked-away from high-risk trees: usually raking to a distance of one foot from the bole is sufficient.

Historically, large-scale broadcast burning has occurred in the fall, and to a lesser extent, during breaks in the summer monsoon season. Within the past few years, however, in response to smoke management objectives, burning is also occurring in the spring. As the demands to boost

prescribed fire use increase, one option to enlarge the burn "window" is to shift more burns into the spring and summer months to recreate the historical fire regime. This, however, is a more challenging time to use prescribed fire and will depend on the availability and preparedness of appropriate resources at the local, regional and national levels. Summer burning should become easier, from a fire behavior standpoint, once a site has been previously burned and excessive accumulations of fuel are removed.

Under-burning in pine stands generally calls for target flame lengths of 1 to 3 ft, although some sites require a "hotter" burn to achieve resource objectives.

Ignition by hand with drip torches or with ATV-mounted torches is preferred. Burn operations usually begun by mid-morning following the break-up of the night time temperature inversion and the establishment of the day time wind pattern. Completion of ignition should be targeted early enough to ensure adequate smoke dispersal prior to the onset of cooler nighttime temperatures.

Every burn is to have a completed burn plan. Among many items in this plan are specific objectives for the burn. These may include, but are not limited to, such items as:

1. Fuel Reduction (fuel size classes, percentages, etc)
2. Tree Mortality
3. Scorch

Extensive public notification is an essential element of the program. This can be achieved by posting signs in the area announcing the proposed burn, news releases, and in many cases, door to door contact throughout the nearby neighborhood(s). A continuing education program through talks to civic groups, service clubs, and others to inform the community of the importance and benefits of the program are important as they generate understanding and support for the effort.

Local experience has shown that a previously notified neighborhood is willing to tolerate smoke for a day, but after 2-3 days, patience wears thin. If a particular log, stump, or site within a burn unit becomes a major concern to nearby resident(s), the responsible fire manager may decide to extinguish it the first night.

Burn units should be designed so they can be dispersed throughout the area so as to not constantly impact the same neighborhood(s). Neighborhood air sheds, indicated by diurnal smoke flows, are key to managing nighttime smoke impacts.

*Maintenance:* Once thinning, slash treatment, and first under-burning have been completed, the treated area constitutes an effective fuel-break for the next several years. Follow-up thinning and maintenance burns must be scheduled as necessary to ensure the treated areas remain free of the risk of catastrophic wildfire. Adequate access must be assured, not only to conduct needed follow-up treatments, but also to permit rapid response of fire suppression forces. As part of a long-term maintenance and fire management program, fire containment and wildland fire use should be emphasized as appropriate management options for fire restoration.

*Community Involvement* - Throughout any treatment operation, the Project Manager must maintain contact with potentially affected residents. Input and concerns from such persons must be considered, and where possible, incorporated into the overall effort. Treatments bordering neighborhoods should be explained to residents: one approach would be to go door to door to each residence, explain the project, and gather first-hand comments. In particular instances, a "case-officer", assigned to a specific resident, may be desired so that one person deals with that individual throughout the life-of-the project.

*Costs* - Individual project expenses vary tremendously from site-to-site based on ownership, size, complexity, and need. It is difficult to compare one site to another, especially initial

treatment vs. maintenance requirements. Table presents "average" costs associated with CWPP treatment recommendations in order to establish a ball-park figure of what it may cost to achieve the fire behavior modifications described in this plan.



Photo 10: Public involvement is critical to success

What should also be considered is the cost of doing nothing. For our area, it is no longer a question of "if" a wildfire will occur, but "when", "where", and "how much damage" will result. Working with residents before the wildfire, not during or after it, is preferred.

*Benefits* – Experience with wildfires burning in previously treated areas demonstrates the following:

- Improved access for fire fighters and apparatus
- Increased efficiency when locating and constructing firelines
- Easier detection and suppression of spot fires
- Decreased mop up time and effort
- Reduced fire intensity, torching and mortality
- Improved public safety
- Reduction of loss
- Reduction of air emissions

Another benefit, particularly in interface areas, is reduced trash accumulation through elimination of hiding cover necessary for transient camps and party spots.

*Recommendations and Guidelines* – Experience with *Interface Zone* treatments has led to development of the following procedures:

1. Involve those potentially impacted or affected from the very beginning.
2. Once the project is started, commit to complete it in a timely manner.
3. Use signs, news releases, and other appropriate methods to update people on the status of the project.
4. When mistakes occur, which can and will happen, immediately notify adjacent residents, explain what happened and why, and advise them of what is being done to correct the situation. Assume full-responsibility: allow on-site personnel to make commitments to address a problem.
5. Document and follow-up special concerns or small details that may be important to a concerned individual. Personal "client" service is an absolute necessity. All involved must always strive to establish and maintain professionalism, integrity and credibility.
6. Project staff must stay focused on the ultimate goal. Reduction of fire risk requires the active and on-going involvement of all.
7. Success leads to success. Recent history has demonstrated that many landowners throughout the community have seen ongoing and completed treatments and have implemented similar treatments on their own land.

## Wildfire Prevention and Fire Loss Mitigation

Two documents and one area-of-emphasis contribute greatly to community protection. They include:

**Coconino NF Prevention Management Plan** – See Appendix 7. Only a few pages of the plan are included to demonstrate the ongoing prevention

efforts of the USFS. For detailed annual activities under the plan, visit their web site at: www.fs.fed.us/r3/coconino.

**Volunteer Agreement** – Within the past month, an agreement between the USFS and various fire departments and districts, has been finalized. A long-sought objective of PFAC, the agreement allows fire departments and districts to volunteer personnel and equipment to USFS prescribed burn operations. This promises to permit effective hands-on training and greater treatment accomplishment than previously possible.

**Structure Ignitability** – Implementation of measures to reduce fire risk and improve community protection are not restricted to federal, state, county, or city lands: they must also occur on private property. The interested reader is encouraged to visit www.firewise.org for additional details, or contact either the State Land Department or the appropriate fire department or district (see Section 5).

Wildfire suppression will always be needed, but preparing and equipping homes and neighborhoods to live in a fire-environment is just as critical. Developers and property owners can greatly enhance protection of their investments by establishing a FireWise property and neighborhood. This is done by:

*A. Development Standards* – Working with both Planning Departments and developers and property owners to incorporate FireWise techniques prior to construction can significantly reduce fire threat and improve public safety. Efforts undertaken with a single owner prior to individual lot development is very efficient and greatly preferred. Fire Departments and Districts can provide fuel reduction, access, water source, and street width and slope standards, along with bridge load limits and other fire protection needs/requirements during the planning stage, prior to actual development.

*B. Hazard Fuel Reduction* – Treatment of an entire property, rather than a narrow strip or portion of a site, is the recommended and preferred method. Doing less simply creates the illusion of home or neighborhood protection.

Treatments include selective thinning, brush disposal, and prescribed fire. Varied levels of treatment can occur on the property based on density and species of vegetation present, and location in relation to topography (ridge top, slope, aspect, presence of steep drainages, etc).

The goal is to keep fire intensity low, keep the fire on the ground, and limit flame exposure to structures. This can be accomplished as follows:

1. Thin to reduce crown density with canopy breaks to eliminate crown fire spread,
2. Eliminate low-hanging branches and other material which allows a ground fire to climb into trees (ie - ladder fuels), and
3. Reduce excess fuel accumulations through removal or prescribed fire.

Depending upon the property, these actions can generate large amounts of material that require disposal. Methods utilized are often dependent upon such factors as amount produced, property location, and any restrictions currently in-effect. Techniques include burning, bulk curbside pick-up, transport to a waste management facility, or transformation into a useful product: examples of the later approach include removal for firewood or chipping for landscape use.

*C. Fire Resistive Materials and Construction Techniques* – Incorporation of these items into the design and construction phases of a building project directly contribute to structure survivability. Examples include:

1. Non-combustible roof material: Minimum of Class B or better.
2. Limited combustible siding: large logs, stucco, rock, etc.
3. Enclosed soffits
4. Screened roof and crawl space vents: minimum of ¼ inch wire screen.
5. Limited combustible decking material: to

further promote FireWise efforts, enclose and/or keep areas underneath clear of debris.

6. Double paned windows.
7. Glass skylights (rather than plastic).
8. Home suppression systems: several types are now entering the marketplace. Activated in advance of an approaching wildfire, they are a viable form of home defense. However, they do not replace the need to create a FireWise home environment utilizing all the techniques described in this section of the plan.

*D. Landscaping* – Outdoor plantings are an important component of our community. They add shade and beauty, buffer noise, provide privacy and inspiration, and supply habitat for wildlife. Proper selection, placement, and maintenance of landscape plants can provide the desired benefits and not increase the risk to home and property. However, improper selection, poor placement, or deficient maintenance of plantings can directly contribute to the destruction of a home during a wildfire event. PFAC has produced a brochure on FireWise landscaping – consult their web site for details.

There are four attributes of vegetation that should be considered when purchasing, planting, or conducting maintenance:

1. Location: Vegetation can be close or even adjacent to a home, provided it is of the right kind and not part of a continuous "fuel-bed" leading up to the house. Adjacent to a home, "specimen" type shrub and tree plantings should be considered. These plantings should be isolated from others through both horizontal and vertical separation: grass, flowers, cinders, or mulch can be used to fill-in the gaps.
2. Type: Highly flammable plants high in oils or resins should not be planted close to structures. These plants will ignite easier and burn hotter than other types of vegetation. If such plants are already in-place, consider removal. If unable to do so, separate them from other existing vegetation by removal of adjacent plants. Favor plants which naturally have a high moisture content as evidence by leaves which are often thick, soft, and pliable. Ignition can still occur, but it will take longer and they will not burn as hot.
3. Amount and Arrangement: Large plants are acceptable, provided they are not crowded together in a continuous planting. Tree branches should not interlock and form a closed, continuous canopy overhead. Such an arrangement allows heat and fire to be easily transmitted from one plant to another. Shorter plants should not be placed where their presence could provide a "ladder" for a ground fire to climb higher into adjacent vegetation, thus endangering the home. Consider plants that are low growing: If ignited, there will be less material to burn. Be sure to inspect these plants regularly and remove any fallen leaves and needles that might collect in or under them. In addition, dead material in plants should be removed during routine maintenance. Weeds and grass should be routinely mowed to a height of two inches or less.
4. Vigor: Healthy plants are better able to withstand the challenges of our environment. Plants should be watered as required. Consider use of native plants, many of which require less water than exotics. Mulch should also be utilized to reduce watering needs: wood chips are OK provided they are placed so not to form a continuous fuel bed leading directly to the house.

*E. Annual Maintenance* – Maintaining a FireWise property will decrease yearly fuel accumulations and limit potential ignition sources that could cause structures to ignite. These include:

1. Eliminate readily-combustible materials (ex: needles, hay bales, firewood, etc) to a distance at least 30 feet from structures.
2. Clean needles, leaves, or any other

combustibles from roofs, raingutters, and under decks.

3. Remove tree limbs which overhang fireplace chimneys.
4. Clear vegetation around propane tanks.
5. Remove dead vegetation.
6. Mow weeds and grass to less than 2 inches in height.
7. Remove branches and limbs that are within six feet of the ground.

*F. Home Assessments* – Fire departments and districts will conduct a free home/property assessment, upon request, to educate owners about fire threat and provide recommended mitigation methods.

*G. Neighborhood Coordination* – Individual home protection is a necessary first step, but to achieve community protection, defensible neighborhoods are critical. Recent fires have conclusively demonstrated that an approaching wildfire can ignite individual structures, triggering a neighborhood conflagration beyond the response capability of firefighters. Interested individuals, home owner associations and others, such as Block-Watch or Woods-Watch groups, can be the needed catalyst to spur neighborhood action to reduce fire threat.

## IMPROVED PROTECTION CAPABILITIES

Several potential activities and efforts should be initiated or further developed, thereby increasing community protection. These include, but are by no means limited to, the following:

1. *Survey existing neighborhoods.* Identify, map, and prioritize neighborhoods for neighborhood-wide home ignitibility reduction.
2. *Establishment of a regional fuels crew.* This would involve many different partners and require sufficient funding. Principle among the partners would be PFAC members, but it could also involve NAU-ERI and GFFP as well. The consolidated crew, larger than current separate efforts, would be under single leadership with standardized training, equipment, and treatments standards. In addition to mitigation and prevention efforts, the crew could be available within the local area for fire suppression needs throughout the year
3. *Increased public education activities: Utilization of new outreach methods to prepare the community to receive fire.* Currently, there are a number of education initiatives and outreach methods underway by area partners. These include public meetings, presentations to service clubs, civic organizations and homeowner associations, media notices, periodic workshops and symposia, development/distribution of material, and participation in community events such as the Forest Festival, Science In-The-Park, and the County Fair. Future activities might include involvement in the Northern Arizona Home Show, public service announcements, airing of informational videos on Public Access TV and public service announcements on commercial TV, recognition of FireWise communities by the national FireWise program, and development and maintenance of a joint-agency website devoted to this issue.
4. *Develop/adopt/implement Legislation & Appropriations (State/Federal)* – Adequately fund and/or support, with sufficient oversight to ensure proper and timely application. Items of current interest include:

   Federal:

   **National Fire Plan** (particularly those areas having to do with assistance to local government via the State Fire Assistance grants and other mechanisms),

   **Healthy Forests Restoration Act** (chiefly to ensure professional planning and an increased level of forest treatment implementation, tied to appropriate plans),

   **Forest Landowner Enhancement Program** (a highly effective forest

treatment cost-share program for private landowners).

**Ecological Restoration Institute of Northern Arizona University** (provides the scientific foundation and academic credibility to our efforts, as well as a source of student interns and seasonal employees), and

**Local Community Partnerships/ Collaboratives** (provide interface for federal agencies to address community needs)

State:

**Implementation of HB 2549**, comprised of the following five actions:

Healthy Forest Enterprise Assistance Program (Incentives for wood-based businesses)

- State Forester (establishes office w/associated duties)
- Biomass Energy (Directs State to purchase)
- Urban-Wildland Fire Safety Committee (establishes 12-member committee w/associated duties)
- Interface Code (Permits adoption of code, per Wildland Fire Safety Committee)

**Adopt the remainder of the Governor's Arizona Forest Health Advisory & Oversight Councils recommendations**, provided spring 2004. Among others:

- Increase local planning & zoning authority
- Require real estate disclosure

**Revise the current Environmental Portfolio Standard** (AZ Corporation Commission) to eliminate the expiration date, include a larger total percentage of renewable energy, and emphasize use of biomass energy production.

4. *Recruitment of small-diameter, sustainable wood-based industry.* Utilization of the large amounts of biomass that must be removed from area forests is critical to success. This issue is covered elsewhere in this Section (See Utilization.)
5. *Fire district formation.* Some outlying homes within the CWPP are outside existing fire districts. Owners within these areas should seriously consider formation of Fire Districts – via the County – to facilitate emergency response, prevention, and mitigation efforts.
6. *Compatible data-layers for the Sedona and Winona area to facilitate analysis of the entire CWPP area.* Key information used in the development of this plan is lacking for the Sedona and Winona areas and/or not in the same format as that for the remainder of the area. This somewhat complicated our use of the work of the NAU-ForestERA project. Comparable data for areas with gaps should be developed to make future revision of this plan easier.
7. *Develop a standardized Neighborhood Wildfire Assessment format.* The City of Flagstaff has recently received a donation from Allstate Insurance Foundation for just such an effort. Once developed, it can be readily transferred to other jurisdictions within the CWPP area. The information derived from this effort can augment the threat matrix data contained in this plan, as well as become an educational outreach tool to residents.
8. *Incorporation of CWPP into on-going activities and established land-management and agency plans*. Both PFAC and the GFFP intend to utilize this document to prioritize actions, secure funding, coordinate activities, implement treatments, and monitor desired outcomes. The CWPP also provides guidance to private citizens in their effort to reduce their exposure to wildfire.
9. *Identification of additional resource and equipment need.* Individual agencies are responsible to provide appropriate

administration and planning for their respective organization. In addition, and to facilitate joint discussion and interoperability, PFAC, on an annual basis and with any needed assistance from GFFP, will host a multi-party discussion of current fire response capability within the CWPP area. Centered on the goal of reviewing and revising the PFAC Operations Plan (Appendix 4), the discussion will include all facets of fire management resources and other topics that may be appropriate.

10. *Funding.* This plan, and implementation of the identified activities, is intended to demonstrate our intent to implement and provide general information to appointed and elected officials and grant-funding organizations and agencies. Our coordinated effort to protect the greater Flagstaff community is a key ingredient to attracting additional funding to further implementation efforts.
11. *Wood distribution networks.* Establishment of on-going relationships with individuals and organizations on both the Hopi and Navajo Reservations, as well as with large charity organizations with interest and capability in wood delivery/distribution efforts, is an important utilization initiative. There is tremendous need for wood products – primarily firewood and posts-and-poles throughout both areas. It is estimated that over 75% of all homes on the Reservations have no electricity and require wood for heating and cooking. Creation of a steady "wood-pipeline" will not only benefit those who receive the wood, but also assist in reducing fire threat in our area by removal/utilization of excess small-diameter trees.
12. *Statewide mapping effort.* The "Arizona Fuels, Information, Restoration, and Education Mapping and Assessment Program" or ARIZONA FIRE MAP, is designed to establish and maintain a GIS-based mapping system that will document forest treatments, CWPP status, grant receipts, etc. Forest treatments within the Flagstaff area have been used to develop a prototype map. Involvement with this effort, as it develops, will ensure our area remains at the forefront of statewide activities.
13. *Coordination with adjacent areas during development of their respective CWPP.* Two adjacent areas where future plans may be developed are Sedona/Verde Valley and Williams/Parks-Bellemont. Both Sedona and Parks-Bellemont are included in this plan: inclusion in another plan is encouraged, but synchronization will be required to ensure management conflicts do not occur.
14. *Adoption/implementation of the Coconino County Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) and the Coconino County Emergency Management Plan (EMP).* Wildfire has been identified as one-of-five priority hazards within the County. The MJHMP, upon approval by the Federal Emergency Management Agency (FEMA) opens-the-door for pre-disaster mitigation funding and facilitates post-disaster mitigation and recovery efforts. The all-risk EMP, currently under development, will ensure consistency in emergency prevention, mitigation, response (including evacuation protocols), and recovery efforts throughout the entire county.
15. *PFAC Operations and Smoke Management Plans* – On an annual basis, a review and revision of each plan will occur.
16. *Development of a PFAC Prevention Plan.* On an annual basis, a comprehensive prevention plan, using and incorporating the existing Coconino National Forest plan as a template (see Appendix 7), will be developed to coordinate activities, messages, etc.
17. *Adoption and enforcement of appropriate codes throughout the Greater Flagstaff Area.* Such action will ensure consistency on fire

resistive construction, access, water, and addressing requirements, hazard fuel mitigation efforts, etc. (The adoption of the remainder of the Governor's "Arizona Forest Health Advisory & Oversight Councils" recommendations, identified in this plan, will assist with this need.)

18. *Implement an appropriate monitoring program.* Designed to track both accomplishments and effects of treatments, this will lend credibility to the effort and provide information necessary for the adaptive management of the plan. Perhaps this could be a project for an interested student or volunteer.
19. *Support the USFS in: a) Encouraging development/use of a Wildland Fire Use Plan for application in appropriate wildland areas, b) Application of the Appropriate Management Response for area wildfires, c) Planning, preparation, and implementation of prescribed fire projects*

Both GFFP and PFAC can provide leadership and assist with public educational needs to ensure community support of these two items.

# IMPLEMENTATION AND MONITORING

## COMMUNITY MITIGATION TREATMENTS

The combined effects of fuel reduction treatments implemented through past projects with proposed treatments identified and prioritized in this plan will not create a completely "Fire Safe" community, nor eliminate the need for suppression operations. Due to conditions outside our control, such as drought or extreme weather conditions, no one can guarantee total safety from wildfire. However, this plan is based upon both science and experience, and implementation will greatly reduce fire threat and create a FireWise environment.

Rather than recommending specific treatments, we have chosen to present, as found in Section 3, Desired Future Conditions and general Treatment Guidelines. Variations of these guidelines have been successfully utilized by property owners and land managers in the area for a number of years.

In this section, we have also chosen to present Treatment-Types utilizing the "coarse-filter" approach and vocabulary available with ForestERA data: We recognize that site-specific planning will need to occur prior to implementation of any treatment, and that the application of tree cutting, prescribed fire, etc, may differ somewhat from that described herein and must reflect silviculturally-accurate methodology and terminology. Factors considered in defining these potential Treatment Types included (see "Treatment Types" in Glossary for definitions of terms):

1. Overall reduction of predicted fire behavior from *Active Crown Fire* to *Passive Crown Fire.* It is extremely difficult to move predicted fire behavior to Surface Fire with just initial treatment unless significant tree removal and pruning, along with surface fuel removal, occurs: even then, individual and small groups of trees may ignite.
2. Treatment action in areas currently rated as Surface Fire will be as follows:
   A. Within the *Interface Zone* → Low Thinning Intensity, (if needed), followed byLight Prescribed Burn (Maintenance).
   B. Outside the *Interface Zone,* but within the *Analysis Area* → Light Prescribed Burn only, unless other factors or objectives dictate the need for Low Intensity Thinning.
3. Protection of wildlife habitat (such as Mexican Spotted Owl and Northern Goshawk), municipal or other critical watersheds (such as Lake Mary and Rio de Flag), and specially designated areas (such as Kachina and Red Rock Secret Mountain Wilderness Areas and San Francisco Peaks and Oak Creek Canyon Research Natural Areas) were considered and included in the analysis.

The exact location of the various potential Treatment Types may need to be slightly adjusted to take advantage of topographic or access features in order to facilitate effective and safe suppression actions when a major fire threatens the area. Adaptive management requires adjustment and refinement as the effort moves forward, and we encourage treatments that have as their goal the reduction of fire risk and the improvement of overall forest ecosystem health.

Five treatment types are recommended - three utilizing mechanical removal of trees followed by prescribed (broadcast) burning, and two burn-only treatments. They include:

Mechanical Thinning Followed by Prescribed Burn

**Low Intensity** = Light thinning followed by prescribed fire; representative of a maintenance

fuel reduction or light restoration.

**Intermediate Intensity** = Moderate thinning followed by prescribed fire; representative of a moderate fuels reduction or moderate restoration.

**High Intensity** = Heavy thinning followed by prescribed fire; representative of a heavy fuels reduction or full restoration.

Prescribed Fire Only:

**Light Burn** = No mechanical thinning (not required); maintenance burn (one goal is low tree mortality) on sites with light fuels.

**Heavy Burn** = No mechanical thinning (restricted or impractical); thin with fire (one goal is higher tree mortality) on sites with heavy fuels.

For additional discussion of these fuel treatments and how they were used in the analysis to modify predicted fire behavior, visit the ForestERA web site.

In addition to vegetation treatments, FireWise building techniques and standards are required. The Uniform Fire Code (UFC) and various Wildland Interface Fire Codes all provide the necessary framework, but not all areas can now adopt such codes based upon population, statutory authority, etc. (This issue is addressed in Section 3 - Improved Protection Capabilities, p. 52.) Currently, within the CWPP area, only the City of Flagstaff has requirements that all new developments implement a Fuel Management program prior to construction and that use of limited-combustible building material is mandatory in selected areas.

## Priority Areas and Treatment Costs

The priority area for implementation of appropriate vegetative treatments is the entire *Wildland/Urban Interface* zone (Map 5). Achieving public safety and community protection through treatment of the most severe fuel accumulations nearest communities are the over-riding objectives. Therefore, within the W/UI priority zone, emphasis should be placed on treating areas of predicted active crown fire behavior adjacent to communities or infrastructure. In addition, anywhere surface fire behavior is predicted, these areas can be treated more quickly and at much lower cost with prescribed fire and may also be emphasized.

Over the long term, treatment of the remaining acreage within the *Analysis Zone* will need to be implemented. However, sites within this area should reflect other values: public safety may not be the over-riding emphasis, and treatments must reflect those other values and resource management objectives. Opportunities may arise where appropriate treatments within this area are desirable prior to treatments in the *Wildland/Urban Interface*: if this occurs, and the work will not jeopardize priority projects within the W/UI, the opportunity should not be missed. Work in this area will require the JHA to review and refine any treatments in close collaboration with various stakeholders.

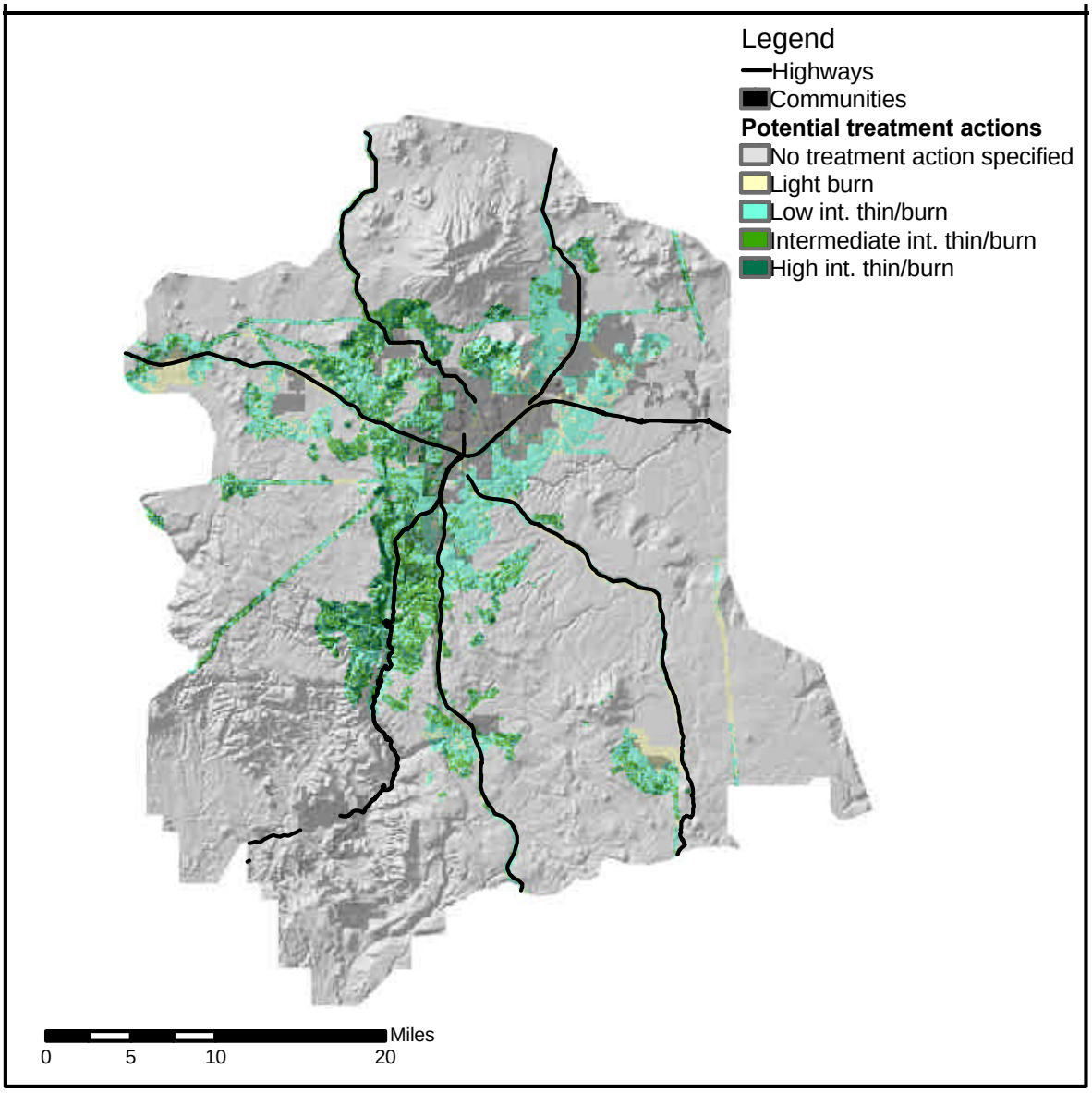
Maps 11A (*Wildland/Urban Interface*) and 11B (*Analysis Area*), depict recommended locations of where the treatments should be located. As indicated earlier, development of detailed prescriptions will be the responsibility of the JHA, and must be consistent with statutory authority and applicable land and resource management plans, be based on detailed knowledge of site conditions, and address specific resource management objectives.

Table 8 identifies the acreage of each treatment type within the *Wildland/Urban Interface* and the remaining *Analysis Area* excluding the W/UI. The table also provides an estimate of potential costs associated with applying the recommended treatments to the appropriate acres. Based on best estimates of typical costs associated with planning and implementation of the five treatments in earlier projects, an “average” per/acre cost was determined and applied. This data dramatically illustrates the financial commitment required to treat the recommended

acres. This cost demonstrates that from a strategic perspective, small-diameter wood-based enterprise development (including infrastructure development, wood utilization technology, sustained supply, and sufficient capital for business establishment and operating), all geared toward the establishment of a sustainable and effective industry that can offset some of the costs associated with hazardous fuel treatment, is critical if we are to succeed.

Needed capital can take many different forms: subsides, low-interest loans, cost-share, profit-sharing ventures, and direct payments. Funding sources may include numerous federal, state, local government, and private corporation ventures, and should include the entire gamut: planning, design, implementation, and monitoring.

**MAP 11A**

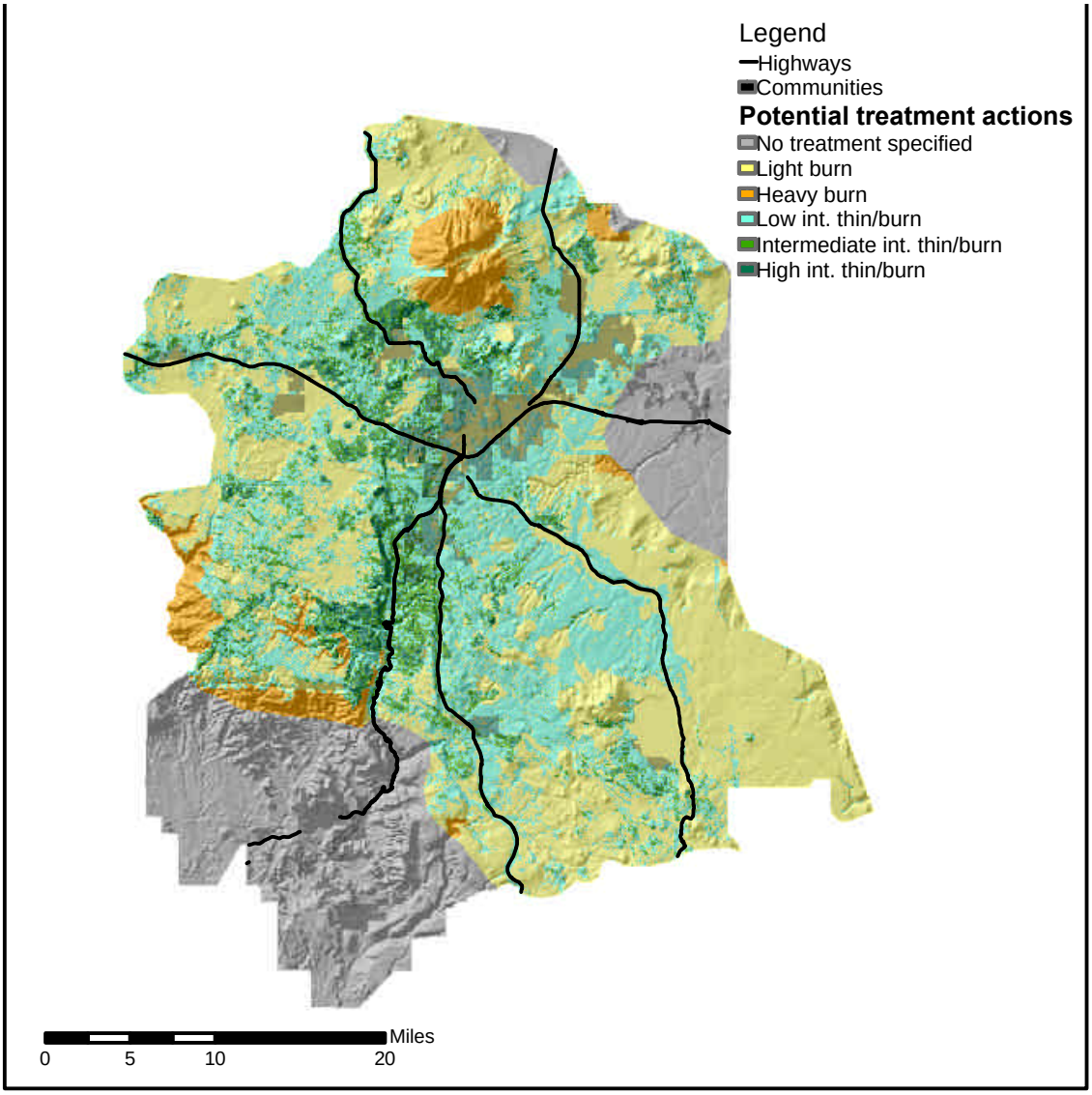



**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE - POTENTIAL TREATMENT TYPE***

**(Requires Site-Specific Analysis and Refinement)**

**MAP 11B**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - POTENTIAL TREATMENT TYPE***

**(Requires Site-Specific Analysis and Refinement)**

## Table 8

## Acreage & Estimated *Initial* Treatment Costs

**POTENTIAL TREATMENT TYPE**

| LOCATION | Low Intensity Thin | Intermediate Intensity Thin | High Intensity Thin | Light Burn | Heavy Burn | TOTAL |
|---|---|---|---|---|---|---|
| **Wildland/Urban Interface** | | | | | | |
| Acres | 97,693 | 45,930 | 21,191 | 32,519 | 0 | 197,333 |
| *Cost ($)* | $63.5 M | $36.7 M | $21.2 M | $2.4 M | 0 | $123.8 M |
| **Analysis Area Less W/UI** | | | | | | |
| Acres | 164,420 | 15,979 | 104 | 318,030 | 43,429 | 541,962 |
| *Cost ($)* | $106.9 M | $12.8 M | $0.1 M | $23.4 M | $5.4 M | $148.6 M |
| **ACRES *** | **262,113** | **61,909** | **21,295** | **350,549** | **43,429** | **739,295** |
| **COST ($)** | **$170.4 M** | **$49.5 M** | **$21.3 M** | **$25.8 M** | **$5.4 M** | **$272.4 M** |

***** No treatment specified on 200,441 acres of Analysis Area due to lack of data

**Estimated Treatment Types Costs:**

Thinning Intensity:

Low = $650/acre
Intermediate = $800/acre
High = $1000/acre

Prescribed Burn:

Light = $75/acre
Heavy = $200/acre

**NOTES:**

1) Costs shown above are **for initial treatment only** an annual maintenance budget will be required.
2) Estimates include planning costs.
3) Total **Acres** and **Cost ($)** are low as the above figures do not reflect areas (200,441 acres) where ForestERA data does not exist (ex: Sedona, Cosnino/Winona).

## PREDICTED TREATMENT EFFECTS

When proposed treatments are applied to the appropriate acres as recommended in this plan, the ForestERA model is capable of predicting and displaying potential effects on fire behavior resulting from treatment. Maps 12A and 12B depict the response of fire behavior to implementing the recommended treatments in the *Wildland/Urban Interface* and in the entire *Analysis Area*. Although these are predicted effects, it does serve to illustrate the potential impacts of fuel reduction treatments on one of the parameters of most concern in protecting communities from catastrophic wildfire. For comparison purposes, Map 13 presents three maps side by side: predicted fire behavior under current conditions, predicted fire behavior after all recommended treatments are implemented in the *W/UI*, and predicted post-treatment fire behavior in entire A*nalysis Area*. Table 9 provides acreage and percent change in predicted fire behavior based on these maps.

## MONITORING AND ASSESSMENT PLAN

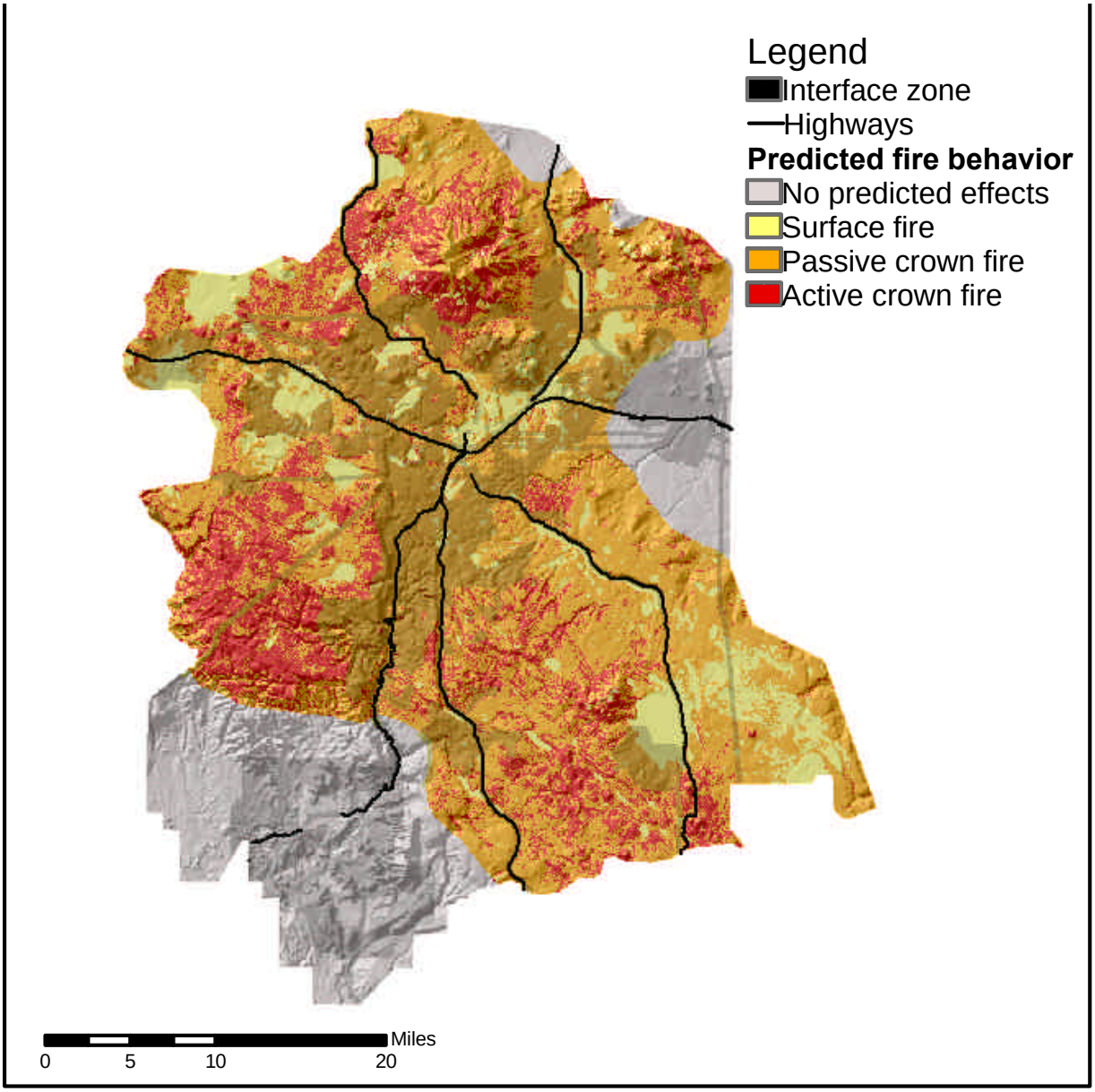
In our efforts to reduce the threat of uncharacteristic wildfire to communities and restore fire to fire adapted ecosystems, we recognize that we do not fully understand the consequences of all management options. Similarly, we do not yet fully realize or appreciate the consequences of traditional treatment options in all areas or ecosystems. In the face of uncertainty regarding the social, ecological, economic, and actual fire behavior changes as a result of fuels reduction efforts, and the concomitant potential "slowing down" of projects due to stakeholders' concerns, appeals, and lawsuits, it is imperative that a targeted, efficient and effective monitoring program be integrated into land management actions. However, to best use the information gathered by such monitoring efforts, it is also imperative that we, as stewards of the land, use a decision making process that is adaptive, or able to alter the course of actions based on the best available information. This is what is intended by the process of *adaptive management*.

To coordinate tracking and monitoring of the implementation of this CWPP, a Review Team should be established to include, at a minimum, representatives from GFFP, PFAC, Forest ERA, the USFS, local government, the environmental community, and citizens at large. Initiating activities right after formal approval of the CWPP and utilizing input from various sources, the Review Team should evaluate and report on the accomplishments and challenges in meeting the overall goal of this plan:

To protect Flagstaff and surrounding communities, and associated values and infrastructure, from catastrophic wildfire by means of:

1. An educated and involved public,
2, Implementation of forest treatment projects designed to reduce wildfire threat and improve long-term forest health, in a progressive and prioritized manner, and
3. Utilization of FireWise building techniques and principles.

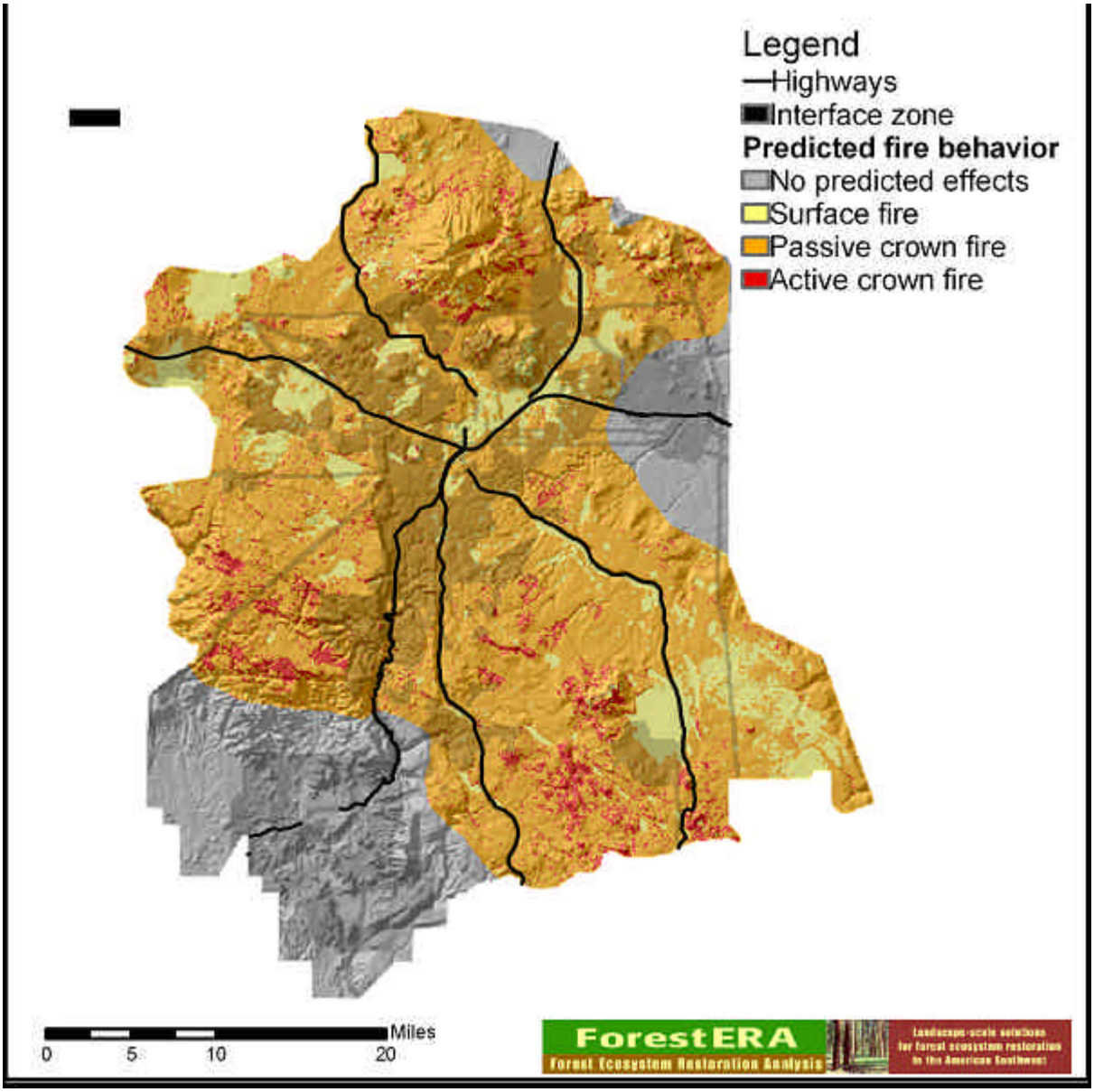
**MAP 12A**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE – PREDICTED POST-TREATMENT EFFECTS ON FIRE BEHAVIOR***

**MAP 12B**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

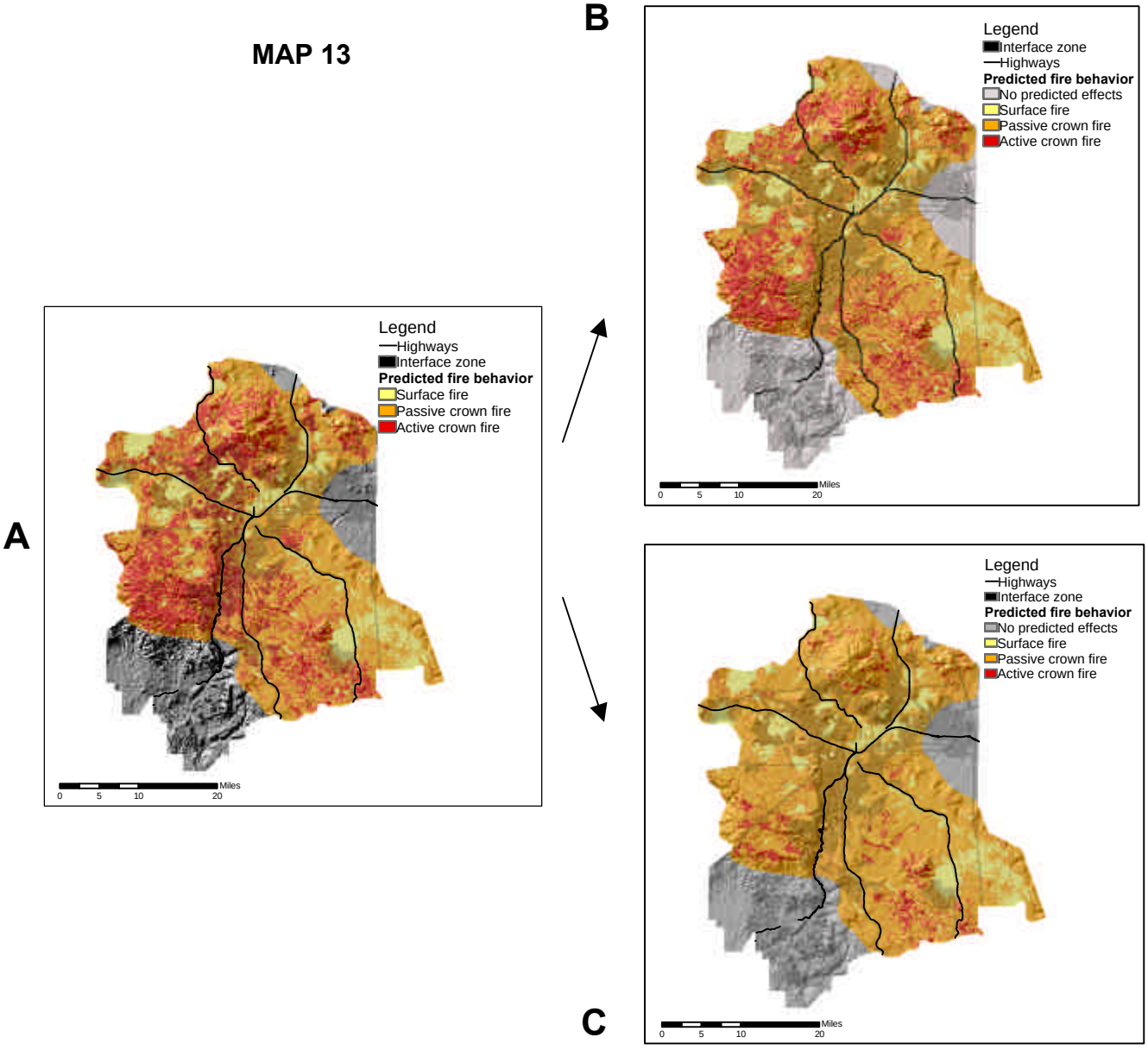
***ANALYSIS AREA – PREDICTED POST-TREATMENT EFFECTS ON FIRE BEHAVIOR***

**Table 9**

**Post Treatment Predicted Fire Behavior**

| Location | Fire Behavior | Pre Treatment Acres | Post Treatment Acres | % Change of Total |
|---|---|---|---|---|
| **W/UI** | Active | 68,248 | 3,606 | - 94% |
| | Passive | 105,353 | 169,834 | + 61% |
| | Surface | 23,757 | 25,765 | + 8% |
| | No Prediction | 0 | 0 | 0% |
| **Analysis Area** | Active | 150,933 | 47,610 | - 69% |
| (Less W/UI) | Passive | 314,929 | 416,405 | + 32% |
| | Surface | 75,450 | 75,450 | 0% |
| | No Prediction | 201,066 | 201,066 | 0% |
| **TOTAL ACRES** | | **939,736** | **939,736** | |

**MAP 13**




## CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

## COMPARISON OF PRE-TREATMENT AND POST-TREATMENT FIRE BEHAVIOR

**Map A shows predicted fire behavior under current conditions. Map B shows predicted fire behavior if all potential treatment actions were to be implemented within the *Wildland/Urban Interface* zone. Map C shows predicted fire behavior if all potential treatment actions were to be implemented within the *Analysis Area*.**

It is proposed that the Review Team also be tasked with designing and coordinating implementation of a multi-party monitoring program to acquire real data with which to accomplish their evaluation and reporting activities and implement adaptive management. The monitoring program will need to address diverse areas such as fuel reduction and fire behavior, ecosystem restoration, ecological impacts, and social and economic issues, and should be based on existing monitoring protocols. A framework of goals, objectives, and measurement methods, such as the *"GFFP Monitoring & Research Teams Adaptive Management Framework"* and which is included as Appendix 9, should be considered for inclusion in CWPP projects, based on the management objectives and potential impacts of each project. Not every project will have the same degree of uncertainty, and not every project has the same number of factors that are potentially impacted. The Review Team (or other appropriate body) may need to assess each project, and decide the level of monitoring that should be accomplished based on site-specific details, management objectives specific to existing conditions, desired future conditions, and the management options available to accomplish those objectives.

All CWPP projects must allocate funds to accomplish monitoring (approximately 5-10% of project costs is a target), and establish a formal process for integrating the results of that monitoring through time back into the land management decision-making process. One of the major benefits of monitoring projects and the cumulative effects of projects at the landscape level is that the process serves as a tremendous tool for public education and involvement, and as we learn from our failures and successes, there is greater agreement about how to proceed into the future.

At a minimum, each of the three items in the goal above will be evaluated based upon the four criteria described below. Not all may be applicable for each item, and additional criteria may be added. They include:

1. Implementation – A crucial aspect of measuring success will be actual implementation of needed treatments: Did they occur and in what locations? Treatment Maps (For example: Map 8) will be updated annually and shared with the community and all responsible parties.
2. Effectiveness – Of equal importance is the question of how effective are the various treatments: have they done what was anticipated in terms of fire risk reduction? Where possible, pre-and-post treatment fuel transects will be inventoried to determine actual change in fuel amounts. Fire affects from subsequent wildfires will be evaluated to refine future treatments and the results shared with the community.
3. better understanding of how fuels reduction and forest restoration actions affect the plants, animals, soils, watersheds, and ecosystems within project areas. If we are to be successful in *restoring* forests, we must understand the ecological effects of our various restoration strategies and actions, both at the project scale, and at the landscape scale.
4. Social Monitoring – Public attitudes toward both on-going and proposed treatments, and the agencies/organizations promoting and implementing them, is critical to success. Assessment of these attitudes will be on-going, and will include review of the following indicators:
   - *Editorials and other media coverage*
   - *Letters to editor*
   - *Requests for assistance*

   At some point, it may be beneficial to engage the Behavioral Sciences Lab at Northern

Arizona University (or another source) to conduct a scientific poll or survey to further refine treatments and guide education and planning efforts.

5. Economic Impacts - If we are to achieve success, a sustainable utilization component is essential. Of importance will be the success in attracting viable small diameter wood-based businesses into the area and evaluating their resulting economic impact. Once in place, evaluation of this aspect will be coordinated with the Greater Flagstaff Economic Council.

The Review Team should hold their initial meeting as soon as the CWPP is approved and establish a process to help facilitate implementation of the plan among the various land management agencies and to design and implement the monitoring program. A formal convening of the Team should also be scheduled for six months after adoption of the CWPP to complete a comprehensive review of the Plan and develop any recommended revisions. Thereafter, the Team should meet at least annually to review progress and make recommendations for appropriate revisions to the document.

## Roles and Responsibilities of Stakeholders

As depicted on Table 10, successful implementation of the CWPP cannot be done without major cooperation from all. Without continued collaboration and mutual assistance, this plan will only provide a false sense of security. Wildfire does not recognize property boundaries, and neither can we.

## Table 10

## Roles and Responsibilities of Key Stakeholders

| Stakeholder | Planning Design Implementation | Education Information Transfer | Advisory | Regulatory Permitting |
|---|---|---|---|---|
| **Private:** | | | | |
| Citizens | X | X | | |
| Businesses | X | X | X | |
| Service Clubs | X | X | | |
| Homeowner Groups | X | X | | X |
| **City:** | | | | |
| Officials/Departments | X | X | X | X |
| Fire Departments | X | X | X | X |
| **County:** | | | | |
| Officials/Departments | X | X | X | X |
| Fire Districts | X | X | X | X |
| Rural Environmental Conservation Corps | X | X | | |
| **State:** | | | | |
| Dept of Emergency & Military Affairs (Camp Navajo) | X | X | X | |
| Land Dept – Fire Management | X | X | X | |
| Dept of Transportation | X | | | |
| Dept of Corrections | X | | | |
| Game & Fish Dept | X | X | X | X |
| Dept of Environmental Quality | | X | X | X |
| Cooperative Extension Service | X | X | X | |
| Northern AZ University: | | | | |
| Ecological Restoration Institute | X | X | X | |
| School of Forestry | | X | X | |
| Forest ERA | X | X | X | |
| Centennial Forest | X | X | | |
| **Federal:** | | | | |
| Naval Observatory | X | | | |
| Forest Service | X | X | X | X |
| Fish & Wildlife Service | X | X | X | X |
| National Park Service | X | X | X | |
| **Other:** | | | | |
| Utilities – | | | | |
| El Paso Natural Gas | | X | X | |
| AZ Public Service | X | X | X | |
| Greater Flagstaff Forests Partnership | X | X | X | |
| Ponderosa Fire Advisory Council | X | X | X | |

# ASSISTANCE

Development of the CWPP is a new initiative established under the HFRA of 2003. Since very few communities have completed plans – per guidelines set forth by the National Association of State Foresters, Communities Committee of the Seventh Forest Congress, Society of American Foresters, National Association of Counties, and Western Governors' Association – reference material from other communities or groups regarding both specific plan content and process was limited. Nonetheless, we believe we have developed a community supported CWPP that meets the intent of the HFRA.

Important documents utilized during development of this plan include:

"*Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities*" (www.safnet.org/policyandpress/cwpp.cfm)
"*Federal Agency Implementation Guidance for the Healthy Forest Initiative and the Healthy Forests Restoration Act*" (www.fs.fed.us/projects/hfi/field-guide)
"*Field Guidance for Identifying and Prioritizing Communities at Risk*" www.stateforests.org/reports/COMMUNITIESATRISK.pdf)
Several websites also provided valuable information. They include:
Arizona Cooperative Extension Service (http://ag.arizona.edu/extesion/fh/)
Arizona Fire Management Division (www.azstatefire.org)
Arizona FireWise Communities (www.cals.arizona.edu/firewise)
Arizona Forest Health Council (www.governor.state.az.us/FHC/)
Forest Ecosystem Restoration Analysis Project (ForestERA) (www.forestera.nau.edu)
Flagstaff Fire Department (www.flagstaff.az.gov/fuelmanagement)
Fire Safe Council (www.firesafecouncil.org)
Grants: Foundation (www.fdncenter.org)
Federal (www.grants.gov)
Greater Flagstaff Forests Partnership (www.gffp.org)
Northern Arizona University Forest Health (www.forestfire.nau.edu/)
Southwest Area Fire & Drought (www.swstrategy.org/fire.html)
The National Fire Plan (www.fireplan.gov)
Western Governor's Association (www.westgov.org)
For recommendations regarding treatments and/or site-specific FireWise information, contact:

| | | |
|---|---|---|
| AZ State Land Department | - | 928-774-1425 |
| Flagstaff Fire Department | - | 928-779-7688 |
| Highlands Fire District | - | 928-525-1717 |
| Mormon Lake Fire District | - | 928- |
| Parks-Bellemont Fire District | - | 928-635-5311 |

| | | |
|---|---|---|
| Pinewood Fire District | - | 928-286-9885 |
| Sedona Fire District | - | 928- |
| Summit Fire District | - | 928-526-9537 |

For information regarding specifics of this plan, contact either of the following:


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steveg@gffp.org

# GLOSSARY

Glossary terms come from several sources including:

Arizona Forest Health Advisory Council. 2003. *Guiding Principles for Forest Ecosystem Restoration and Community Protection*. September 2003.

Ecological Research Institute. 2004. *Western Mogollon Plateau Adaptive Landscape Assessment Draft Report on Initial Workshop Outcomes*. June 2004

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Basal Area (BA): The area of the cross-section of a tree trunk near its base, usually 4½ feet above the ground. Basal area is a way to measure how much of a site is occupied by trees. The term basal area is often used to describe the collective basal area of trees per acre.

Biodiversity (biological diversity): The variety of life and its process, including the variety in genes, species, ecosystems, and the ecological processes that connect everything in the ecosystem.

Coarse-filter analysis: An analysis of aggregates of elements such as cover type or plant community.

Community protection: Actions or programs undertaken for the purpose of protecting human lives, property, and infrastructure.

Conservation: The careful protection, utilization and planned management of living organisms and their vital processes to prevent their depletion, exploitation, destruction, or waste.

Critical habitat: According to Federal Law, the ecosystem upon which endangered and threatened species depend.

Crown fire: This is a fire that travels from one crown (or tree top) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns,

Defensible space: This is the area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to the surrounding forest. Defensible space provides room for the firefighters to do their jobs. Many communities are taking a more holistic approach of creating defensible neighborhoods rather than jus individual properties.

Disturbance: A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.

Ecosystem: Living organisms interacting with each other and with their physical environment, usually described as an area for which it is meaningful to address these interrelationships.

Ecological restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Fire Behavior: As utilized throughout this plan -

*Active Fire Behavior* = Fires readily transition into tree crowns, with large group tree torching

common: associated long-range (≥ .5 mile) spotting is common

*Passive Fire Behavior* = Fires will transition into tree crowns, but only small-group or individual tree torching common: associated long-range spotting (≥ .5 miles) can occur

*Surface Fire Behavior* = Fires stay on the ground, with little tendency to transition into tree crowns except in isolated cases: short-range spotting (≤ ¼ mile) can occur

Fire Frequency (Fire Return Interval): How often fire burns a given area; often expressed in terms of fire return intervals (e.g., fire returns to a site every 5-15 years). (see also Fire Regime Group).

Forest ecosystem health: A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, allowing goals for uses, values, and services of the ecosystem to be met.

Forest ecosystem restoration: Holistic actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes. Generally refers to the process of enabling the system to resume acting, or continue to act, following the effects of a disturbance. Restoration management activities can be active (such as control of invasive species, thinning of over-dense tree stands, or redistributing roads) or more passive (more restrictive, hands-off management direction that is primarily conservation oriented). Frequently, a combination or number of actions is used sequentially to achieve restoration goals.

Hazard: To place something of value in a risky or dangerous situation

Hazardous fuel: Excessive live and dead trees and other vegetation and organic debris that increase the potential for uncharacteristically intense wildland fire and decrease the capability to protect life, property, and natural resources.

Healthy ecosystem: An ecosystem in which structure and functions allow the maintenance of the desired condition of biological diversity, biotic integrity, and ecological processes over time.

Old growth tree; This is an old tree, one that exhibits the complex structural characteristics associated with the oldest age class of trees in a group, clump or stand. In today's forests, an old growth tree in one that has been present since before the onset of commercial logging and fire exclusion. These trees are sometimes referred to as pre-settlement trees. These trees typically have orange or yellow platy bark.

Prescribed fire: A management fire ignited to meet specific fuel reduction or other resource objectives. All prescribed fires are conducted in accordance with prescribed fire plans.

Risk to communities: The risk associated with adverse impacts to communities resulting from unwanted wildfire.

Reference conditions: Conditions characterizing ecosystems composition, structure, and their variability.

Restoration: Actions taken to modify an ecosystem in whole or in part to achieve a desired condition.

Surface fire: A fire that burns over the forest floor, consuming litter, killing aboveground parts of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees.

Sustainability: The ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time.

Threat: An indication that an undesirable event or catastrophe may occur. For this plan, a Threat matrix, using three items, was developed to permit focus upon the Interface Zone.

*Value* – The measure of how strongly something is desired, expressed in terms of effort, money, etc

one is willing to expend to attain or preserve it. Two issues (Communities and Infrastructure, and Municipal Watersheds) were identified in this plan.

*Risk* – The possibility of danger, injury, or loss. Two issues (Predicted Fire Behavior and Post-Fire Flooding) were identified in this plan.

*Other* – Further or additional issues. One item (Areas upwind from at-risk communities (permitting fire spread into at-risk communities) was identified in this plan.

Treatment Types (potential): These are general descriptor terms only, not silvilcultural terms-

*Thinning Intensity*:

*Low* = Simple thinning, w/prescribed fire

*Intermediate* = Moderate thinning, w/prescribed fire

*High* = Heavy thinning w/prescribed fire

*Prescribed Fire only (Rx):*

*Light* = No mechanical thinning: maintenance burn (one goal is lower tree mortality) or sites w/light fuels (less intense fire)

*Heavy* = No mechanical thinning (required or practical): thin with fire (one goal is higher tree mortality) or sites w/heavy fuels (more intense fire

Watershed: An area of land with a characteristic drainage network that contributes surface or ground water to the flow at that point: a basin or a major subdivision of a drainage basin.

Wildland fire use: The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined in Fire Management Plans.

# Appendix 1

## GFFP and PFAC Membership

**GFFP PARTNERSHIP ADVISORY BOARD MEMBERS** – September 2004

Arizona Game & Fish
Arizona Public Service
Arizona State Land Department – Fire Management Division
City of Flagstaff – Fire Department
Coconino County – Community Development Department
Coconino County Farm Bureau / Cattle Growers Association
Coconino Natural Resource Conservation District
Coconino Rural Environment Corps
Cocopai Resource Conservation & Development District
Ecological Restoration Institute at Northern Arizona University
Flagstaff Chamber of Commerce
Flagstaff Native Plant & Seed
Grand Canyon Trust
Greater Flagstaff Economic Council
H & K Consulting
Highlands Fire District (Communities of Kachina Village, Forest Highlands and Mountainaire)
Indigenous Community Enterprises
Northern Arizona University - College of Engineering
Northern Arizona University - School of Forestry
Perkins Timber Harvesting
Ponderosa Fire Advisory Council
Practical Mycology
Southwest Environmental Consultants
Society of American Foresters - Northern Arizona Chapter
The Arboretum at Flagstaff
The Nature Conservancy
US Fish and Wildlife Service

**Cooperators**

USDA Coconino National Forest
USDA Rocky Mountain, Pacific NW and Southern Research Stations
USDA Forest Products Lab

**PONDEROSA FIRE ADVISORY COUNCIL MEMBERS** – September 2004

Arizona State Land Department
Camp Navajo Fire Department
Coconino County Emergency Services
Coconino National Forest
Coconino Sheriff Department
Flagstaff Fire Department
Flagstaff Police Department
Flagstaff Ranch Fire Department
Highlands Fire Department
Kaibab National Forest
Mormon Lake Fire Department
Parks/Bellemont Fire Department
Pinewood Fire Department
Sedona Fire Department
Summit Fire Department
Walnut Canyon-Wapatki-Sunset Crater National Monuments

# Appendix 2

## Guiding Principles for Forest Restoration and Community Protection

# GUIDING PRINCIPLES FOR FOREST ECOSYSTEM RESTORATION AND COMMUNITY PROTECTION

**Arizona Forest Health Advisory Council**
**September 2003**

Steve Campbell ~ Navajo County Cooperative Extension
Dr. Wally Covington ~ Northern Arizona University Ecological Restoration Institute
Dr. Carl Edminster ~ USDA Forest Service Rocky Mountain Research Station
Lori Faeth ~ State of Arizona
Don Falk ~ University of Arizona Laboratory of Tree-Ring Research
Deb Hill ~ Coconino County
John Kennedy ~ Arizona Game and Fish Department
Robert Lacapa ~ Bureau of Indian Affairs
Taylor McKinnon ~ Grand Canyon Trust
Dr. Marty Moore ~ Eastern Arizona Counties Organization
Brian Nowicki ~ Center for Biological Diversity
Kirk Rowdabaugh ~ Arizona State Land Department
Karl Siderits ~ USDA Forest Service Tonto National Forest
Ed Smith ~ The Nature Conservancy
Dr. Tom Swetnam ~ University of Arizona Laboratory of Tree-Ring Research
Richard Van Demark ~ Southwest Forestry
Beth Zimmerman ~ Arizona Division of Emergency Management

## Preamble to the Guiding Principles

*Arizona's high country is home to magnificent forests harboring a diversity of biological, cultural, and economic values. Yet many of Arizona's forests—especially Arizona's extensive ponderosa forests—have undergone a dramatic transformation during the past century due to land use, climate, and other factors. These changes have increased insect and disease outbreaks, abnormally severe fires, and adversely affected biological, cultural, and economic values. The unacceptable risk posed by these conditions requires immediate and strategic action.*

*Recognizing these factors, Arizona Governor Janet Napolitano convened a Governor's Conference on Forest Health and Safety in March 2003. Findings from this conference led to the development of an Action Plan for Arizona, and a call for the creation of a broad, science-based Forest Health Advisory Council to provide recommendations on how to improve the health of Arizona's forests.*

*The Arizona Forest Health Advisory Council has developed these Guiding Principles to provide an overall framework for planning and implementing forest ecosystem restoration and community protection projects statewide. In presenting these Guiding Principles, the Council emphasizes the following:*

*Different forest types have different natural disturbance regimes. For example, where crown fire is unnatural, thinning and prescribed burning may be needed to safely reestablish more natural surface fire regimes. But in forest types where crown fire is natural, such treatments may not be needed, at least from an ecological standpoint.*

*Understanding these differences is fundamental to restoring more natural disturbance regimes in our forests.*

*Community stakeholders must take the lead to implement these principles and make the decisions for their communities at risk. The Council stresses the immediate and urgent need to adequately reduce the risk to communities. This will require a comprehensive effort to reduce hazardous fuels in and around at-risk communities regardless of the adjacent ecosystem type. Fire research and recent fires demonstrate that fuels reduction treatments in and around communities may not prevent the loss of homes. Homeowners must do their part to create defensible space and replace or mitigate flammable building materials.*

*Although Arizona's forest and woodland ecosystems need restoration, it is important to understand that restoration is a young science whose long-term outcomes are uncertain. The Council urges employing a diversity of restoration strategies that fit local ecological, social, political, and economic circumstances. A "one size fits all" approach is not appropriate.*

*Learning about restoration should be an active and ongoing process. A serious commitment to monitoring and adaptive management is critical to understanding the ecological, social, and economic dimensions of restoration. The Guiding Principles should be viewed as dynamic and adaptable to evolving conditions and experiences.*

*The costs of restoration must be weighed against the costs of inaction. Though restoration may seem a weighty investment, it pales in comparison to the immediate and long-term costs and risks of allowing current forest conditions to persist. Restoration is a process of recovery requiring a substantial and sustained investment of funds, and political and public support.*

*The Guiding Principles urge us to think big. Arizona's forests and the ecological processes that sustain them span landscapes. Assessing needs, identifying priorities, and charting progress toward community protection and forest ecosystem restoration goals must occur within an appropriately large landscape context.*

*The Council's ultimate hope is that the Guiding Principles will help guide our movement toward sustainable and reciprocal relationships between human communities and forest ecosystems – relationships that sustain the biological, cultural, and economic values that contribute to a healthy democratic society, both now and into the future.*

# Guiding Principles

## Integration

***The overall strategy for restoring forest ecosystem health and protecting communities must be dynamic, comprehensive and integrated.*** A primary component of the overall strategy is to perform a statewide forest health evaluation to identify high-priority communities, critical infrastructure, habitats, and watersheds at risk. This evaluation can also provide the framework for monitoring individual projects and cumulative effects.

## Sustainable Communities and Economies

***Sustainable economies are linked to sustainable ecosystems.*** We should be building a sustainable future for Arizona's forests and communities

***The immediate focus should be on protecting human communities at risk, critical infrastructure, along with key watersheds and habitats.*** Distinguishing between forest ecosystem restoration and community protection, and focusing on community protection within the entire community—private, public and tribal lands and the wildland-urban interface—will improve the likelihood of success.

***Close collaboration among all stakeholders is essential to a community-based approach to forest ecosystem restoration and community protection.*** Encourage and empower community-based collaborations to demonstrate and implement effective community protection and forest ecosystem restoration. Be sensitive and responsive to the diversity of individuals and communities who value and/or depend on the forest and its resources.

***Decision-making about forest ecosystem restoration and community protection must occur with a serious commitment to rigorous adaptive management.*** Such an approach should include baseline data, short and long-term monitoring, and a transparent mechanism for tracking results, evaluating and incorporating findings into the decision-making process.

## Ecological Integrity

***Appropriate restoration methods are based on ecological need.*** These methods are further defined by the importance of the site in the watershed or landscape, and the timing, techniques and resources needed to restore ecological integrity. Restoration needs to be designed with a clear understanding of desired and ecologically appropriate future conditions.

***Effective forest ecosystem restoration should reestablish fully functioning ecosystems.*** A primary goal of forest restoration is to enhance ecological integrity, natural processes and resiliency to the greatest extent possible. Fire hazard reduction must be linked to the reintroduction of fire as a keystone ecological process. An active program of prescribed and maintenance burns and natural fire use is essential.

***Forest ecosystem restoration and community protection treatments should protect and enhance water and soil resources.*** The development and implementation of forestry best management practices will serve to protect these resources.

***Forest ecosystem restoration should protect and promote development of old-growth trees and large trees needed to restore ecosystem structure and function.***

***Landscape scale forest ecosystem restoration should maintain native plant and wildlife populations and habitat features.*** A key consideration is the need to maintain and restore movement corridors and refugia to avoid biodiversity bottlenecks.

***Project work should be based upon landscape assessments of risks to and status of aquatic and terrestrial resources and of the potential for restoration to be successful.*** The assessment is used to identify the root causes of ecosystem degradation at the eco-regional, intermediate and site level scales, determine appropriate methods for restoring degraded systems and create a spatially-explicit prioritization of restoration needs.

## Land Use and Planning

***Forest ecosystem restoration must include evaluating and changing public land use practices that are scientifically demonstrated to contribute to forest health degradation.***

***Forest ecosystem problems and solutions exist in a context of land use.*** In fire prone areas community officials must develop, adopt, and enforce comprehensive land use plans, zoning regulations and building codes for community protection, forest restoration, ecosystem health requirements and long-term fire management. Zoning and land use have a major impact on fire management, and can make a significant contribution to restoring forest health and protecting communities.

***Forest ecosystem restoration requires effective community protection to establish and maintain a fire-resistive condition for structures, improvements and vegetation.*** Methods for accomplishing this condition are based on public safety needs, fire hazard, and local capability and creativity. A fire-resistive condition will be accomplished by removing and modifying forest fuels, establishing defensible space, and use of fire-resistant construction materials and architectural design.

## Funding and Compliance

***Forest ecosystem restoration and community protection requires a sustained investment of federal, tribal, state, local and private resources.*** Restoration is a long-term process requiring a sustained commitment of funding. Adequate, sustained investment in forest ecosystem restoration and community protection is more cost effective and socially desirable than fire suppression and rehabilitation.

***Forest ecosystem restoration and community protection actions should comply with all applicable environmental laws and regulations.***

## Practices

***Forest ecosystem restoration and community protection programs should use the lowest impact techniques that will be effective and efficient.*** Explore, develop and utilize low impact technologies to sustain and enhance ecosystem integrity and productivity, and minimize negative cumulative effects.

***All forest ecosystem restoration and community protection treatments should use locally adapted native plant materials to the greatest extent possible.*** Non-invasive, non-native species may be considered for emergency rehabilitation.

# GLOSSARY

**Adaptive Management**
A type of natural resource management in which decisions are made as part of an ongoing process. Adaptive management combines planning, implementing, monitoring, research, evaluating, and incorporating new knowledge into management approaches based on scientific findings and the needs of society. Results are used to modify future management methods and policy.

**Biodiversity**
The variety of life forms and processes including complexity of species, communities, gene pools, and ecological functions.

**Biodiversity Bottleneck**
A bottleneck in this context is the assemblage of environmental and/or human-caused factors or ecological "threats" that hamper the ability of ecosystems to support biodiversity at its current level through time. The bottleneck analogy is that fewer organisms (and their genes) in the bottle (current conditions) may be able to emerge on the other side (future conditions) due to resource limitations. (Source: this council.) http://www.usembassy.it/file2001_04/alia/a1041704.htm; http://www.clat.psu.edu/biodiversity/defined/populations/populations-p04.html

**Community Protection**
Actions or programs undertaken for the purpose of protecting human lives, property, and infrastructure. (Source: this council)

**Crown fire**
This is a fire that travels from one crown (or treetop) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below the crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY. p. 282. (See also Surface Fire)

**Cumulative Effects**
Individual actions when considered alone may not have a significant impact on the quality of the human environment. Groups of actions, when added together may have collective or cumulative impacts that are significant. Cumulative effects that occur must be considered and analyzed without regard to land ownership boundaries. Consideration must be given to the incremental effects of past, present, and reasonably foreseeable related future actions of the Forest Service, as well as those of other agencies and individuals. Source: CEQ Regulations applied to US Forest Service regulations http://www.fs.fed.us/emc/nepa/includes/epp.htm#c151

**Defensible Space**
This is an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to the surrounding forest. Defensible space provides room for the firefighters to do their jobs.(New Mexico State Forestry) Many communities are taking a more holistic approach of creating defensible neighborhoods rather than just individual properties.

**Ecosystem**
A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and components of any part of the natural environment within its boundaries. An ecosystem can be of any size-a log, pond, field, forest, range or grassland, or even the earth' s biosphere. (Society of American Foresters, 1998.)

**Ecosystem Function**
The process through which the constituent living and nonliving elements of ecosystems change and interact, including biogeochemical processes and succession.

**Ecosystem/Ecological Integrity**
The completeness of an ecosystem that at multiple geographic and temporal scales maintains its characteristic diversity of biological and physical components, spatial patterns, structure, and functional processes within its approximate range of historic variability. These processes include: disturbance regimes, nutrient cycling, hydrologic functions, vegetation succession, and species adaptation and evolution. Ecosystems with integrity are resilient and sustainable.

**Ecosystem Process**
The actions or events that link organisms and their environment, such as predation, mutualism, successional development, nutrient cycling, carbon sequestration, primary productivity, and decay. Natural disturbance processes often occur with some periodicity (From Webster's dictionary, adapted to ecology).

**Ecosystem Resilience**
The ability of a system to respond to disturbances. Resiliency is one of the properties that enable the system to persist in many different states or successional stages.

**Fire Frequency (Fire Return Interval)**
How often fire burns a given area; often expressed in terms of fire return intervals (e.g., fire returns to a site every 5-15 years). (see also Fire Regime Group).

**Fire Regime Group**
A generalized description of the role fire plays in an ecosystem. It is characterized by fire frequency, predictability, seasonality, intensity, duration, and scale (patch size), as well as regularity or variability. (See also Fire Frequency)

**Forest Ecosystem Health**
A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, allowing goals for uses, values, and services of the ecosystem to be met.

**Forest Ecosystem Restoration**
Holistic actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes. Generally refers to the process of enabling the system to resume acting, or continue to act, following the effects of a disturbance. Restoration management activities can be active (such as control of invasive species, thinning of over-dense tree stands, or redistributing roads) or more passive (more restrictive, hands-off management direction that is primarily conservation oriented). Frequently, a combination or number of actions is used sequentially to achieve restoration goals.

**Hazardous Fuel**
Excessive live or dead trees and other vegetation and organic debris that increase the potential for uncharacteristically intense wildland fire and decrease the capability to protect life, property, and natural resources.

**Invasive or Noxious Weed** (also applies to animals and other organisms)
Any species of plant which is, or is liable to be, detrimental or destructive and difficult to control or eradicate and shall include any species that the director, after investigation and hearing, shall determine to be a noxious weed. Arizona Revised Statutes 3-201 http://www.azleg.state.az.us/ars/3/00201.htm

**Landscape**
An area composed of interacting and inter-connected patterns of habitats (ecosystems) that are repeated because of the geology, landform, soils, climate, biota, and human influences throughout the area. Landscape structure is formed by patches (tree stands or sites), connections (corridors and linkages), and the matrix. Landscape function is based on disturbance events, successional development of landscape structure, and flows of energy and nutrients through the structure of the landscape. A landscape is composed of watersheds and smaller ecosystems. It is the building block of biotic provinces and regions.

**Natural Disturbance Regime**
A natural disturbance (e.g. fire, insect outbreak, flood) with a characteristic frequency, intensity, size, and type that has influence on an ecosystem over evolutionary time.

**Old Growth Tree**
This is an old tree, one that exhibits the complex structural attributes associated with the oldest age class of trees in an old growth stand. In today's forests, an old-growth tree is one that has been standing since before the onset of commercial logging and fire exclusion. These trees are sometimes referred to as pre-settlement trees. Old-growth ponderosa pine trees typically have orange, platy bark. Source: Schubert, G.H. 1974. Silviculture of southwestern ponderosa pine: the status of our knowledge. USDA Forest Service General Technical Report RM , http://www.ancienttrees.org/cfoggа.php#1

**Prescribed Fire**
Any fire ignited by management actions to meet specific objectives. All prescribed fires are conducted in accordance with prescribed fire plans. (See also Wildland Fire Use)

**Risk to Communities**
The risk associated with adverse impacts to communities resulting from unwanted wildland fire.

**Surface fire**
A fire that burns over the forest floor, consuming litter, killing aboveground parts of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY p. 281 (See also Crown Fire)

**Sustainable (Sustainability)**
Meeting the needs of the current generation without compromising the ability of future generations to meet their needs. Ecological sustainability entails maintaining the composition, structure and processes of a system, as well as species diversity and ecological productivity. The core element of sustainability is that it is future-oriented. (Committee of Scientists Report, 1999.)

**Wildland Fire Use**
The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined in Fire Management Plans. (See also Prescribed Fire)

**Wildland-Urban Interface**
The area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel.

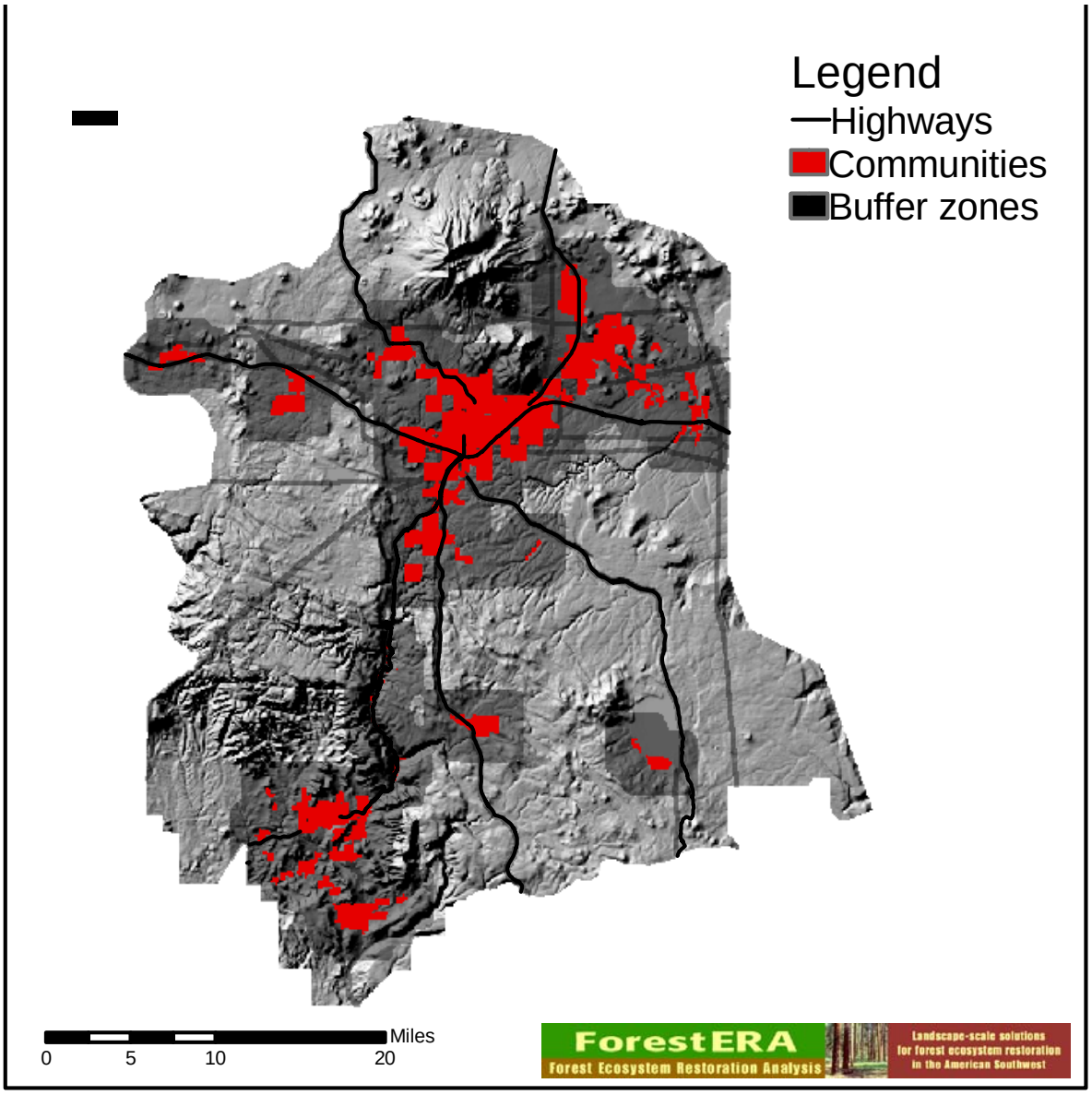
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Unless noted, all definitions come from: “RESTORING FIRE-ADAPTED ECOSYSTEMS ON FEDERAL LANDS - A COHESIVE STRATEGY FOR PROTECTING PEOPLE AND SUSTAINING NATURAL RESOURCES” USDI/USDA Draft unpublished document, pp. 74-78, 12/19/2001.
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# Appendix 3

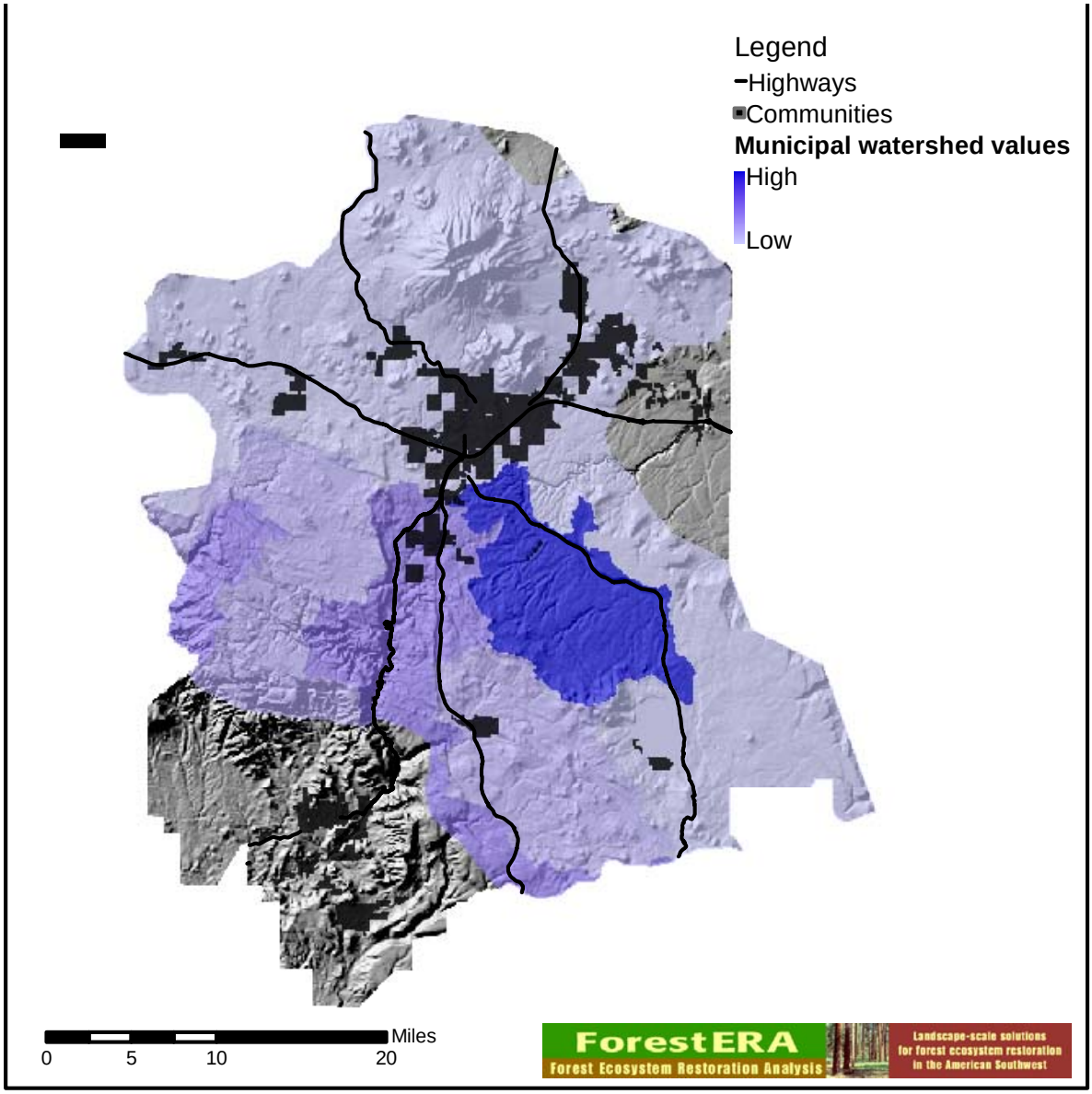
## Attributes Utilized in Development of the Threat Map

## COMMUNITY BUFFER

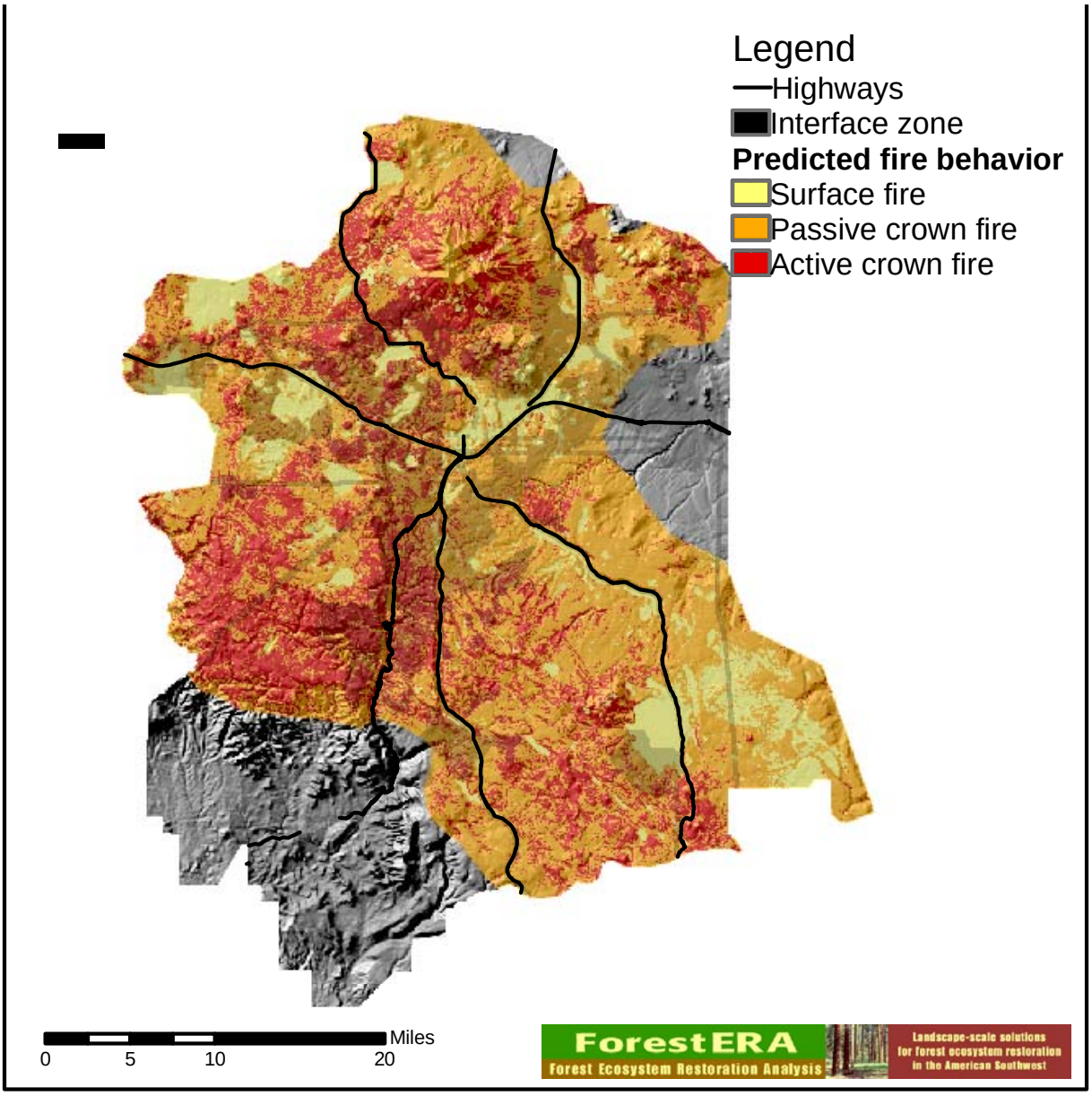



**1½ miles Around At-Risk Communities**

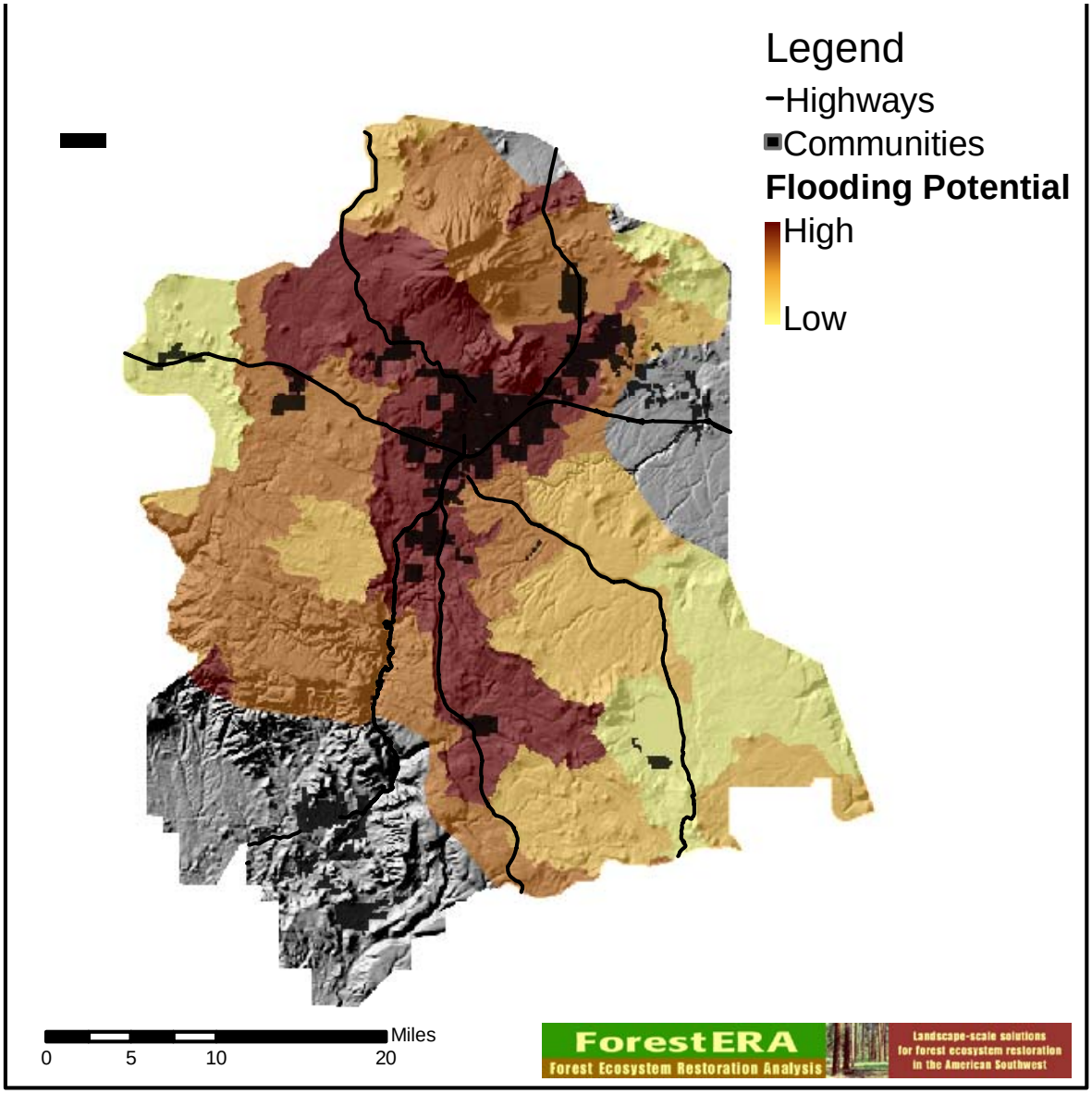
## MUNICIPAL WATERSHED



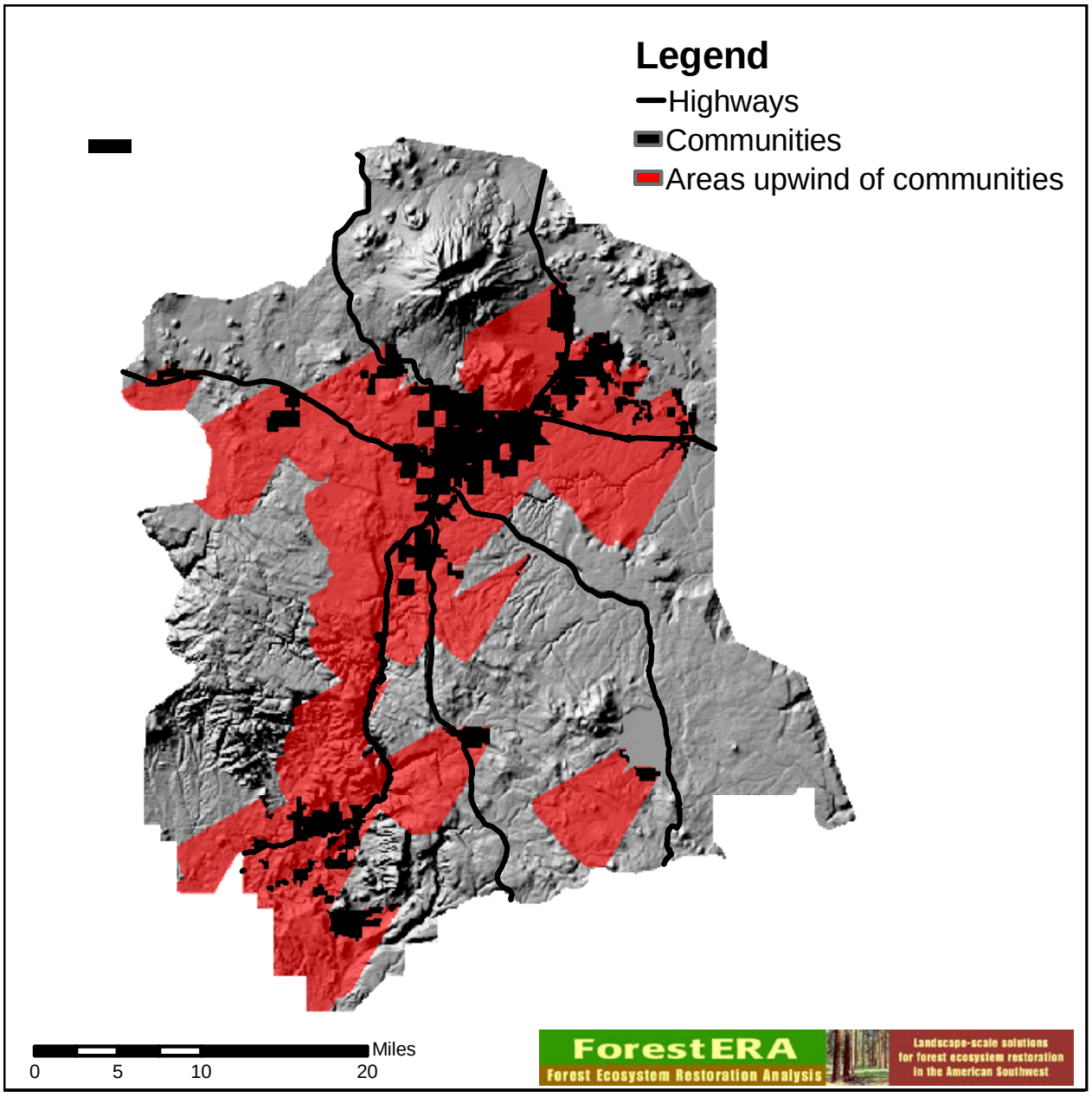
## PREDICTED FIRE BEHAVIOR



## FLOODING POTENTIAL



## AREAS UPWIND FROM AT-RISK COMMUNITIES




**Six-mile Buffer**

# Appendix 4

## PFAC Operating Plan




## A Partnership of Emergency Services In the Greater Flagstaff Area

# Initial and Extended Attack Wildland Fire Operations Plan for the PFAC Response Area

***** MODIFIED *****

**May 1, 2004**

# TABLE OF CONTENTS


I. Initial Incident Notification and Dispatch Procedures

1) Call comes into an Alarm Center

2) Call comes into Flagstaff

3) Call comes into Arizona State Land

II. Dispatch Model for Fire Danger Levels

1) Single Jurisdiction Fire

2) Multi-jurisdictional Fire

III. Emergency Scene Operational Responsibilities

1) Aviation Operations in the Urban Interface / Congested Areas

2) Temporary Flight Restrictions

IV. When Initial Attack Fire becomes an Extended Attack Fire

V. Joint Information Center

VI. Law Enforcement

1) Evacuation

2) Traffic Control

3) Security


### Purpose

The purpose of this document is to prepare an organized operations plan that will be in place in the event of any initial or extended attack fires within the PFAC response area. This area includes the cities of Flagstaff and Sedona as well as the following fire districts; Flagstaff Ranch, Highlands, Mormon Lake, Parks-Bellemont, Pinewood, Sedona and Summit Fire. This area also includes all of the State and Federal lands throughout this area. This plan is meant to deal with incidents that do not exceed the complexity level of a Type 3 incident. This plan builds on the current Mutual Aid Agreement amongst all PFAC members and will help to maximize effectiveness and efficiency in providing safe and professional responses to wildland fire incidents throughout our area.

## Initial Incident Notification and Dispatch Procedures

In order to clearly understand our dispatch procedures, please understand the distinctions between the three primary dispatch centers we will be dealing with.

**"Flagstaff"**- This dispatch center is run by the Coconino National Forest and will be the primary dispatch center for all wildland incidents. While it is not always staffed 24 hours a day, there is an answering service that will begin the activation process if any call is made to the Fire Reporting number, 526-0600.

**"Alarm" (Flagstaff/Coco Co. 911) -** This dispatch center is run by the City of Flagstaff Police Department and also dispatches for the Coconino County Sheriff's Office. "Tones" will be given by this center to initiate a wildland fire dispatch to all northern fire departments, which will then transfer to Channel 10 and have all further communications with "Flagstaff".

**"Alarm" (Sedona FD, Pinewood FD) -** This dispatch center is run by the Sedona Fire Department. "Tones" will be given by this center to initiate a wildland fire dispatch to all southern fire departments, which will then transfer to the Flagstaff Coconino 1 Channel and have all further communications with "Flagstaff".

### *1) Call comes into an Alarm Center*

Alarm locates jurisdictional responsibility and dispatches those resources. After agency notification, Alarm will immediately notify Flagstaff of the incident and which units are responding. Flagstaff will dispatch any additional or requested resources based upon the predetermined Dispatch Model for Fire Danger Levels.

### *2) Call comes into Flagstaff*

Flagstaff will immediately determine jurisdictional responsibility and dispatch closest available state or federal resources based upon the Dispatch Model for Fire Danger Levels. Flagstaff will contact an Alarm Center if the closest available resources are not state or federal units and Alarm will initiate dispatch. Initial dispatching of resources will be based upon the predetermined Dispatch Model for Fire Danger Levels.

### *3) Call comes into Arizona State Land*

In the case of Initial Attack fires, all dispatches for SLD will go through Flagstaff. Flagstaff will dispatch appropriate agencies as indicated in the Dispatch Model for Fire Danger Levels. The ASLD will provide to the responding agency or agencies the authority to make appropriate requests for resources until their arrival.

## **All dispatch duties after the initial dispatch will be done by Flagstaff.**

# Dispatch Model for Fire Danger Levels

(These are minimum dispatch levels and may be adjusted accordingly).

Flagstaff will dispatch resources based on fire danger levels. They are L=Low, M=Moderate, H=High, **VH=Very High, and E=Extreme**.

### *1) Single Jurisdiction Fire:*

L-H The agency of jurisdiction will be dispatched to this incident. Adjacent jurisdiction(s) who feel their jurisdiction could be threatened may also respond.

VH- E Flagstaff will automatically dispatch an additional two (2) engines, water tender, and two (2) overhead above the normal dispatch of resources as available. A dozer will be dispatched as requested by the IC or at the discretion of Flagstaff.

### *2. Multi-jurisdictional Fire:*

L-H Primary Jurisdiction/Closest Available Resources respond as appropriate. **(USFS & FD**) Adjacent jurisdiction(s) who feel their jurisdiction could be threatened may also respond.

VH-E Flagstaff will automatically dispatch an additional two (2) engines, water tender, and two (2) overhead above the normal dispatch of resources as available. A dozer will be dispatched as requested by the IC or at the discretion of Flagstaff.

The purpose of identifying a Dispatch Model for Fire Danger Levels, especially during Very High to Extreme conditions, is to keep small fires from getting large. We encourage fire agencies to monitor USFS Channel 1 and if a **'fire flash'** is in your jurisdiction to initiate a response. It is imperative that if a response is initiated in this manner or if a report comes directly into an agency, **contact with Flagstaff and Alarm should be done immediately.** If Flagstaff gets notification of an incident during Very High to Extreme conditions, **they will immediately dispatch closest available resources** as identified in the Fire Order Model for Dispatch.

Please note that all non-jurisdictional companies will be released as soon as possible to become available back in their home areas. Also, the response request can be denied by the requested agency if they can not meet the demands of the request.

Contact with both Flagstaff and Alarm will also be made when any agency is involved in an incident(s) that removes all of their resources from availability. If this notification is made, a time frame should be given for unavailability. When units become available, contact will be made to both Flagstaff and Alarm of their availability.

After the initial dispatch, all units will use Forest Service Channel 1 to communicate with all units responding to a wildland incident. Upon arrival at the incident, the use of a tactical channel(s) will be used as designated by the IC. The following channels will be identified as Group 2 for Initial Attack (IA) in those radios that are capable of multiple groups or are field programmable. **Please note**: The City of Flagstaff Fire Department does not have multiple group radios and use of our standard group one channels will be necessary. It is only at the request of the IC that the use of the pre-identified Group 2 frequencies will be used.

As this Operations Plan is a supplement to our existing PFAC Mutual Aid Agreement, all agencies agree to allow the use of their frequencies to other agencies while involved in the mitigation of an incident.

# Emergency Scene Operational Responsibilities

Regardless of jurisdiction, first on scene unit will assume Incident Command. IC will communicate with Flagstaff the following:

a. Initial size-up to include size, IC, fire name, etc**. (use IRPG)**
b. Location/Jurisdiction
c. Additional resource requirements
d. Immediate concerns, exposures, access, etc.

At this time, command of the incident may be transferred to the appropriate jurisdictional personnel or may be transferred due to the level of complexity of the incident.

### *2) Aviation Operations in the Urban Interface / Congested Areas*

All aircraft use will be ordered and coordinated through the Flagstaff Zone Dispatch Office in accordance with established procedures in the Southwest Area Mobilization Guide.

The following will apply to determine air-tanker use when dispatched to congested areas:

1. A Lead Plane will be ordered any time an air-tanker has been requested for use in a congested area. Air Tanker Drops may precede before the Lead Plane arrives if communications are established between the aircraft and Incident Commander, authorization is granted from the IC, and the line is cleared of personnel and equipment prior to commencing retardant operations.

2. Aerial supervision (Air Tactical Group Supervisor) is recommended when there are more that two aircraft or a mix of aircraft (fixed/rotor-wing) over the incident at the same time.
3. An Air Operations Branch Director will be ordered for any fire requiring continuous air-tanker or helicopter operations within the congested area to coordinate with the Flagstaff Airport Manager and/or Control Tower in the designing and implementation of Temporary Flight Restrictions and aviation operations. The AOBD may also assist in the establishment of dip-sites and heli-base operations.

### *3) Temporary Flight Restrictions*

When fires occur, there may be a need to request Temporary Flight Restrictions to secure airspace over the incident for aviation operations. These restrictions will be requested by the Incident Commander, Air Tactical Group Supervisor, or the Air Operations Branch Director through the Flagstaff Zone Dispatch Center. The request will be made to the Southwest Coordination Center, who will advise when the TFR goes into effect. This may take 2-4 hours. When the restriction is no longer needed, it should be rescinded as soon as possible.

The TFR will need to be configured and closely coordinated with the Flagstaff Airport Manager and Control Tower as nearly every portion of our urban interface areas have the potential to impact airport operations. A guide for Incident Commanders in determining the need for a TFR includes:

- Type and number of aircraft operating (Air Tactical, air-tanker, helicopter) within the incident and their aeronautical requirements including orbit dimensions horizontally and vertically.
- Entry and exit points and routes for incident aircraft.
- Multiple incidents in close proximity.
- When the extent and complexity of the operation creates a hazard to non-participating aircraft.
- Incident is expected to attract sight-seeing aircraft.
- Operations are being conducted near or in the dimensions of a military training areas
- Incident is being conducted in or near a Victor flyway.
- "See and Avoid" capabilities are reduced or compromised.

# When Initial Attack Fire becomes Extended Attack

When it is determined by the IC that this Initial Attack Fire has become an Extended Attack Fire, a request will be made by the IC for an activation of the Flagstaff Zone Type 3 team, or a Type 1 or Type 2 IMT based upon the Coconino National Forest's Complexity Analysis.

When the Type 3 Team is called for, Flagstaff will begin the notification process for the Type 3 Team. The County Emergency Services Coordinator and/or City Manager will be notified immediately by Flagstaff through the appropriate Alarm Center. It will be the County Emergency Coordinator or City Manager's decision to activate the EOC.

# Joint Information Center

If an EOC is established a Joint Information Center will also be established at the EOC. If an EOC is not established, the Joint Information Center will be located at the Peaks Ranger District, the Flagstaff Law Enforcement Administrative Facility (LEAF) or Sedona Fire Station #1.

# Law Enforcement

Law enforcement is recognized as a needed and essential part of any IA fire of any consequence. The appropriate LE agency having jurisdiction in the area of a fire will be notified immediately. The Law Enforcement Representative will meet with either the Liaison Officer or IC. As needed, a Law Enforcement Branch will be established.
Responsibilities for Law Enforcement will be determined by their representative and the Incident Commander.

### *1) Evacuation*

Upon determination by the Incident Commander and/or the Sheriff that evacuation procedures are warranted, the Coconino County Sheriff's Office, the City of Flagstaff Police Department, the Sedona Police Department, the Arizona Department of Public Safety, the Arizona Department of Transportation, or any other appropriate law enforcement agencies shall be responsible for implementing an appropriate evacuation. The Law Enforcement Liaison shall report evacuation progress to the Incident Commander, on a regular basis. CCEM must be notified early in this process, to provide appropriate reception areas/shelters.

### *2) Traffic Control*

The Coconino County Sheriff's Office, City of Flagstaff Police Department, and other law enforcement agencies shall be responsible for implementing a traffic control plan. Continued communication with the Liaison or the IC is essential.

It is important that a law enforcement liaison be established early in the incident (at the Command Post) in order to minimize traffic congestion and maintain safety to the public.

### *3) Security*

It shall be the responsibility of the jurisdictional law enforcement agency to establish, when appropriate, a security patrol for evacuated areas yet to be immediately threatened by fire (pre-cautionary evacuation mode), in conjunction with the law enforcement coordinator assigned to the command staff. The appropriate LE agency will assist in securing the perimeter of the incident to allow authorized persons only into and out of the area.

# Appendix 5

## PFAC Smoke Management Plan




## A Partnership of Emergency Services In the Greater Flagstaff Area

# Community Smoke Management Plan for the PFAC Response Area

***** MODIFIED *****

**May 12, 2004**

**Purpose:** Catastrophic wildfire is the #1 threat to the greater Flagstaff area. A wide range of community values – documented elsewhere – are impacted by these type wildfires. Reducing overabundant natural fuel accumulations and improving forest health within and adjacent to communities must occur.

One method to do so is the application of prescribed (Rx) fire. Rx fires reduce slash accumulations produced during fuel reduction projects, as well as forest surface fuels that have accumulated during the past decades. Restoring fire to the ecosystem improves forest health increases community protection capability.

**Background:** Smoke is a natural result of fire: the issue we must focus on is not if we should have smoke - we have no choice: it will either be wildfire or prescribed – but when, where, and under what conditions it will occur. The only way we can focus on, and manage, these issues, is with application of Rx fire and implementation of a Community Smoke Management Plan (CSMP).

**Components:** The three primary components of this plan are:

*Emission Reduction Techniques:* These include, but are no means limited to –

- Removing wood products (firewood, post-and-pole, etc)
- Allowing sufficient time for material to dry
- Avoiding stumps, downed logs, snags
- Restricting piles or acreage
- Limiting consecutive burn days in same area
- Utilizing proper ignition patterns
- Timing ignitions to coincide with favorable weather events
- Scheduling to avoid special event days or high-occupancy sites

*Public Awareness:* Three separate areas require continuing attention -

1) On-Going: Brochures, website information, special presentations, and media interviews are valuable techniques to establish the purpose of Rx fire, methodology of planning, ERT's and control efforts, future plans, agency coordination practices, and results of previous burns. Together, these will serve to reduce concerns associated with Rx fire.

2) Pre-Fire: These announcements must inform the public of project locations, dates and times of implementation, and homeowner mitigation measures they can implement to reduce impacts to their own health, property, and daily activities. They can be distributed through the media, posting specific project information on agency websites; notifying homes and neighborhoods immediately adjacent to burns as well as areas which will be significantly impacted (both day and night), and personal contacts to individuals with high health concerns. Fire managers must provide a common message including project goals and smoke mitigation efforts.

3) During Burn: Techniques during an on-going Rx fire could include empowering each person on-site to act as an Information Officer if approached by the public, placement of a designated person at a site easily accessible to the public and within site of the burn to answer questions, or leading field tours for interested people. If unexpected conditions occur during the operation, efforts to minimize impacts should be announced, what is being done to mitigate the impacts, and responsibility stated to ensure continued public acceptance of the program.

*Agency Coordination:* A culture of open-and-continuing communication and coordination between land management agencies, fire management professionals, public health organizations, and air quality regulators is critical for an efficient and effective Rx fire program. Project planning, treatment priorities, coordination with adjacent Rx fires, resource sharing, public notification, and potential smoke impacts and mitigation efforts require discussion and joint involvement.

Monitoring day and night smoke movements through personal observations, mapping, and photographs will enable local fire managers to document and share information on smoke-travel patterns, effectiveness of smoke mitigation efforts, and potential accuracy of forecasted weather information. Instrument-based air-quality monitoring, the responsibility of regulatory agencies, can help determine visual and health impacts, compliance with air quality standards, and provide information necessary to refine future Rx fire efforts. In addition, post-Rx fire reviews are beneficial so lessons can be identified and shared with others.

**Permits:** Local Fire Depts and Fire Districts are allowed, through an agreement with the AZ Dept of Environmental Quality (ADEQ), to issue permits for small debris burns within their jurisdiction. State and Federal agencies, and larger burns within the Fire Dept/Fire District jurisdictions, require a permit from ADEQ. Permit information is available at:
www.adeq.state.az.us/environ/air/assess/smp.html

**Public Notification Contacts:**

1) Contact information for PFAC agency personnel can be found in PFAC Operating Plan (Appendix 1 to the CWPP)

2) Each agency will maintain their own individual homeowner/business contact list

**Result:** Effectiveness of the CSMP will be determined by level of public awareness, including acceptance of reasonable smoke, the success of agency coordination, and the continued-and-timely application of ERT's. Efforts to further the Rx fire program will pay dividends in the future: the wise use of Rx fire will reduce fire threat, improve forest health, and protect our community.

# Appendix 6

## Utilization: GFFP UET Accomplishments & Work Plan

# *STATUS REPORT*

***Small Diameter Timber Utilization*** ***July 15, 2004***

## GREATER FLAGSTAFF FORESTS PARTNERSHIP ECONOMIC VISION

Twenty years from now, the greater Flagstaff area will be home to a small but thriving sector of businesses based on the ecologically sustainable utilization of forest products. Revenues created through the sale of these forest products will provide the economic engine for ecosystem restoration efforts in the region's forests.

Businesses will include primary producers of forest products and "value-added" processors employing technologies that maximize the value of forest products. Availability of these forest products will be based on long-term forest management planning, and healthy ecosystem functioning, seeking a sustainable and stable flow of products to users, which in turn will provide stable jobs and benefits for local workers and the community.

***PARTNERSHIP ENDORSED PROJECTS***

**The Arboretum at Flagstaff:** The Arboretum applied for and received $50,000 from the *Southwest Sustainable Forests Partnership* for the purchase and installation of a wood pellet boiler system for district heating. Preliminary engineering studies have been completed by *Forest Energy, Corp.,* and marketing and interpretation plans are being developed.

**Arizona Corporation Commission:** Consultation with the Corporation Commission regarding the inclusion of woody biomass as an energy option in the revision of the Environmental Portfolio Standard.

**Arizona Governor's Office:** Consultation with the Governor's staff and the *Greater Flagstaff Economic Council* on a pending executive order requiring consideration of wood/pellet heating in state facilities.

**Arizona Public Service:** Three locations have been identified in the Flagstaff area for the siting of biomass energy power plants. Preliminary feasibility and air quality studies have been completed by APS. Projects are on hold pending financing and final approval.

**Indigenous Community Ventures (ICV):** ICV is the recipient of $95,000 from the Partnership to purchase an LT300 Wood-Mizer to expand business operations to log home construction. ICV is currently producing log hogans in partnership with Indigenous Community Enterprises and has hired marketing consultants to expand production to off-reservation log homes.

**Northern Arizona University:** University officials are exploring the installation of a district wood pellet heating system for the central campus in conjunction with *Forest Energy, Corp*. Meetings and negotiations are on-going with project partners to initiate a feasibility study.

**Savannah Pacific Corp., LLC:** Company officials are proposing the location of a glulam plant and small diameter sawmill facility in the Flagstaff area capable of processing 25 million board feet annually. Preliminary site assessment has been completed and a conditional use permit has been approved for the glulam operation. Project is currently on hold pending financing for the Flagstaff area operation.

**Total Timber:** Total Timber is the recipient of $100,000 from the Partnership to purchase equipment and initiate business operations for a commercial firewood processing plant in Flagstaff. The business is currently in production and meeting targeted first year sales.

***PROJECT MONITORING***

**Arizona Lumber Industries, Inc.:** Proposed location of an oriented strand board (OSB) facility in the greater Flagstaff area capable of processing small diameter ponderosa pine. Project is currently in the due diligence phase.

**City of Tusayan:** The city has hired a bioenergy consultant to assess the feasibility of a fluidized bed (gasification system) for converting woody biomass and municipal solid wastes to energy.

**Forest Energy, Corp., LLC:** Proposed location of a wood pellet processing facility in the Flagstaff area to manufacture densified fuels for commercial heating systems. Project is in the due diligence phase.

**Mogollon Brewery, Co.:** Proposed location of biomass ethanol facility in Flagstaff. Project is currently in the scoping phase to assess feasibility of ethanol production.

**National Relief Charities:** The non-profit organization is developing partnerships among the *Hopi Nation, High Desert Investments,* and the *Coconino National Forest* to provide approximately 400 cords of donated firewood to tribal members over 65 years of age.

**BIOgen Power Group, LLC:** Proposed location of 10MW biomass energy plant in Prescott
**Dakota Hauling and Timber, Inc.:** Sawlog processing in Humboldt within the Prescott basin
**Fred Merritt Sawmill:** Sawlog processing in Ash Fork
**LB International, Inc.:** Heating and camping log production at *Eco-Lena, LLC* in Winslow
**Perkins Sawmill, Co.:** Sawlog and firewood processing in Williams
**Twin Mountain Ranch**: Pallet Division: Wood pallet operations in Williams
**Zellner's Firewood:** Mobile firewood operations in Williams

***PARTNERSHIP MARKETING & REPORTS***

- Small Diameter Timber Utilization & Marketing Brochure (2004)
- In-Woods MicroMill Economic Assessment (2004)
- Coordinated Resource Offering Protocol – CROP (2003)
- Enterprise Development Fund for Small Wood Utilization in the Greater Flagstaff Region (2003)
- Preliminary Feasibility Assessment for a Biomass Power Plant in Northern Arizona (2002)
- Small Log Sawmill Site Assessment Study for Northern Arizona (2002)
- Small Diameter Sawmill and Small Log Processing Mill Run (2002)
- Small Diameter Wood Utilization Strategy (2002)
- Lumber Recovery From Small Diameter Ponderosa Pine From Flagstaff, Arizona (2001)
- Log Sort Yard Model and Commentary (2001)
- Does a Log Sort Yard Make Sense for Forest Restoration? (2000)
- Market & Utilization Options for Low-Value Wood Products: Preliminary Assessment of Markets (1999)
- Southwest U.S. Regional Wood Products Industry Survey: Summary of Findings (1999)
- Northern Arizona Post and Pole Enterprise Feasibility Assessment (1999)
- Feasibility Assessment for Development of a Log Merchandising & Manufacturing Center in N. AZ (1999)
- Feasibility of Producing Commercial Products From Pinon-Juniper Woodlands (1997)
- Potential for Using Small Diameter Ponderosa Pine Resources in Arizona: A Feasibility Study (1997)

***PARTNERS IN UTILIZATION***

- Greater Flagstaff Economic Council
- Small Business Development Center
- Coconino County
- City of Flagstaff
- Coconino National Forest, USFS
- Rocky Mountain Research Station, USFS
- Pacific Northwest Research Station, USFS
- Forest Products Laboratory, USFS
- Arizona Sustainable Forests Partnership
- Southwest Sustainable Forests Partnership
- Four Corners Sustainable Forests Partnership
- Northern Arizona Forest Products Association
- AZ Dept. of Commerce, Industries of the Future
- Arizona Governor's Office

# Utilization and Economics Annual Work Plan

Guiding Principles

- Providing information and resources to existing and prospective small businesses.
- Getting small companies to relocate or expand to Flagstaff.
- Keeping the momentum going with the Utilization & Economics Team.
- Seeking expanded utilization of Pinyon-Juniper in addition to Ponderosa Pine.
- Seeking economically feasible ways to do forest thinnings.
- Seeking funding to conduct research and product development.
- Identifying and expanding markets for small diameter material.
- Finding suitable markets to reduce the costs of service contracts.
- Strengthening partnerships in light of rapidly changing regulatory situations.
- Matching of utilization options to community needs and capacities.
- Regional coordination of partners.
- Positioning partnership for national priorities in regard to utilization.

2004 UET Projects & Strategies (Proposed)

**1) Continue efforts focused on biomass and expand focus on district heating systems**

- Continuing to work with the AZ Corporation Commission on the Environmental Portfolio Standard (EPS) – write letters of support, seek expansion of EPS to include biomass from forest thinnings, seek expansion of EPS beyond 2012 deadline.
- Seek thermal credits for using wood heating.
- Conduct a feasibility or demonstration study on a wood-heating district leading to private and commercial investment.
- Continued identification of viable biomass technologies.
- Encourage local wood pellet consumption and market expansions – pursue wood pellet manufacturing in or near Flagstaff.

**2) Continue efforts focused on forest supply issues**

- Expansion of the CROP pilot project to include more suppliers, levelization of supply, and out-year planning and coordination among suppliers. Seek a 5-year funded project to coordinate local supply based on projected sustainability (GFFP-led).
- Encourage Forest Service to use stewardship authorities for levelized supply.

**3) Formalize relationships between key UET partners and establish protocols for the sharing of information – Staff & UET partners**

- Formalize relationships among key UET partners (GFFP, GFEC, SBDC, County, etc.).
- Establish protocols for sharing information sharing with similar/ related organizations.
- Provide a clearinghouse of UET-related information in coordination with the SBDC.
- Project development and management – point of contact to assist business development.
- Display and promote past accomplishments – the list of pubs in the PowerPoint posted on the web and able to download.
- Small business outreach and coordinate with Southwest Strategy (SWSFP, Region 3)

**4) Increase and expand efforts to develop grant opportunities and other means of financial support for existing and prospective businesses**

- Secure funding for continuation of the Enterprise Development Fund (EDF)
- Work closely with the GFEC and SBDC to identify and provide financial support to existing and prospective businesses.
- Establishing a revolving loan fund, perhaps with the sale of GFFP purchased stumpage.
- Host workshop(s) to assist landowners, contractors, and small businesses to better use grant opportunities (NRCS, ASLD, SBDC, etc.). Provide technical assistance to aid them in finding and applying for financial assistance.

**5) Provide market assistance to existing businesses (UET partners)**

- Provide technical assistance and counseling to businesses in identifying markets, developing marketing strategies, and understanding market drivers.
- Provide assistance to small businesses to develop effective business plans (SBDC).
- Create a database of raw material users and producers for the greater Flagstaff region.
- Develop marketing materials for prospective businesses to include existing studies, ongoing research, and other pertinent information and resources.
- Improve capacity of private sector small businesses by providing technical support.

**6) Seek GFFP staff support for UET functions**

- Hire a utilization and marketing staff person to carry out UET priorities.
- Out-source for project implementation.
- Share tasks with SWSFP on intern basis and overlap with other partner functions.
- Separate UET priorities from the work individual partners are doing. Share and elaborate that information. Identify GFFP capabilities to do remaining work.

**7) Develop political strategies for all of the above priorities**

- Track funding priorities of the Healthy Forest Act.
- Focus on locating sources of funding.
- Advocate in state, local, and federal government for support for forest restoration, development and program funding.

<u>Long-Range UET Projects & Strategies (Proposed)</u>

**8) Education of small diameter timber utilization terms and practices**

- Educate public and the GFFP partnership on local issues including technological advances in harvesting and feasibility of small diameter timber uses.
- Public awareness is high but there is deep mistrust of the wood products industry and the Forest Service relationship with private industry.
- Educate public on the ecological aspects of small diameter timber, its sustainability, and linkages to economic practices, community health, and related environmental impacts.
- Educate the public on the need to manage forests, wood products and the wood product industry as a cohesive unit with sustainability emphasized.

**9) Experiment with the GFFP purchasing stumpage from Coconino NF to sell to others.**

**10) Serve as a catalyst for a sustained yield-type unit**

**11) Continuation of Savannah-Pacific type mills – focus on economies of scale and ramping up volume processed**

**12) Develop strategies for linking healthy forests to healthy communities with appropriately scaled industries providing living wages and ecologically driven forest based products.**

- Continue community involvement in decisions regarding matching scale of restoration efforts and value-added, technically suitable utilization options with community needs.
- Can we play a role in creating the framework for ecologically and economically sustained use of our forest? We need to replace the boom-bust cycle of extractive industries.

**13) Invasive species and erosion from harvesting and wildfires**

**14) Portable, in-woods processing feasibility to reduce processing costs**

**15) Monitoring of community benefits from restoration projects and utilization**

- Social and economic impacts
- Ecological impacts of project implementation

**16) Explore green certification for local processors and National Forest lands**

**17) Create strategies to work with private landowners**

- Establish protocol to work with private landowners with less than 40 acres

**18) Seek long-term strategy to add value to small diameter timber linked to stumpage**

# Appendix 7

## Coconino National Forest Prevention Management Plan

**Only a few pages of the plan are included here. For details on compartment assessment rankings, which may change on a regular basis, please consult the USFS/Coconino NF web page:**

**www.fs.fed.us/r3/coconino**

**Coconino National Forest**
**Prevention Management Plan**




February 11, 2004

***** ABBREVIATED *****

# Contents

Introduction & Management Objectives

Fire Prevention Compartment Listing

Compartment Detail
Compartment Assessment Rankings
- Fuels Hazard
- Protection Capability
- Ignition Risk
- Fire History
- Values
- Catastrophic Fire Potential
- Composite Compartment Assessment Ranking

Prevention Responsibilities

Prevention Work
- Prevention Specific and General Actions

## Introduction

This Plan has been prepared for the Coconino National Forest using the Risk Assessment and Mitigation Strategies (RAMS) planning process. RAMS was developed for fire managers to be a holistic approach to analyzing wildland FUELS, HAZARD, RISK, VALUE, and SUPPRESSION CAPABILITY. It considers the effects of fire on unit ecosystems by taking a coordinated approach to planning at a landscape level, and allows users to develop fire prevention and/or fuels treatments programs.

The steps involved in this process included:

- Listing Management Objectives for the Coconino National Forest
- Identification of spatial Compartments for study
- Assessment of significant issues within each Compartment
- Identification of Management Objectives within each Compartment
- Identification of Fire Management Zones (FMZs) and Sub-Units
- Development of Alternative Fire Prevention Program Options
- Creation of Personnel and other Expense Prevention Budgets
- Identification of detailed Prevention Work Programs
- Development of a total Fire Prevention Program and budget

Management Objectives

The following Management Objectives are identified for the Coconino National Forest:

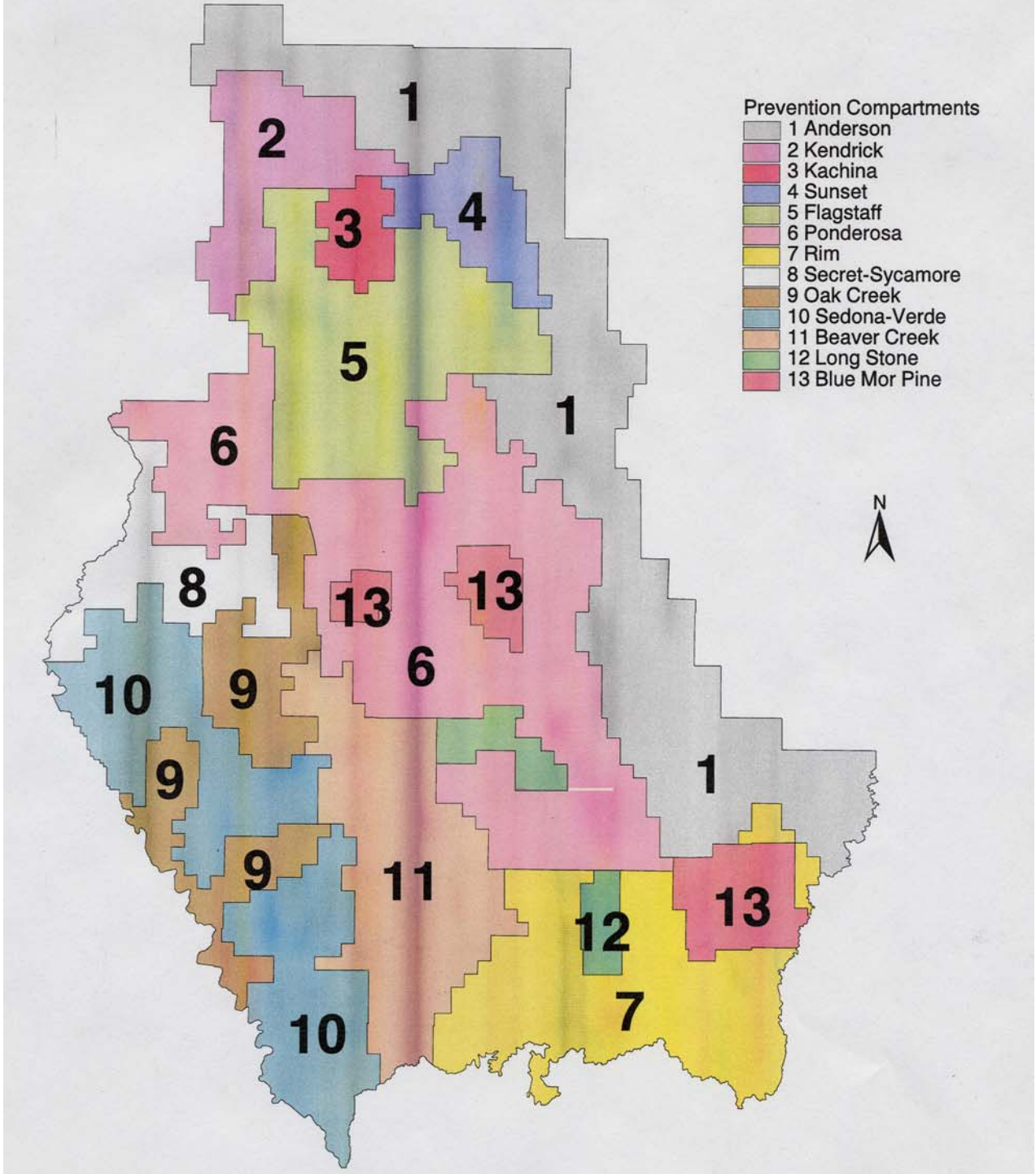
1. Maximize firefighter and public safety
2. To reduce resource loss due to human caused fires.
3. Cooperate with agencies in a combined wildfire and public fire education effort
4. Implement Fire Prevention Plan in a cost-effective manner

**Fire Prevention Compartment Listing**

| Code | Description | Code | Description |
|---|---|---|---|
| 1 | Anderson | 8 | Secret - Sycamore |
| 2 | Kendrick | 9 | Oak Creek |
| 3 | Kachina | 10 | Sedona – Verde |
| 4 | Sunset | 11 | Beaver Creek |
| 5 | Flagstaff | 12 | Long - Stone |
| 6 | Ponderosa | 13 | Blue - Mor - Pine |
| 7 | Rim | | |

# Coconino National Forest

## Fire Prevention Compartments



## ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ *EXAMPLE OF A COMPARTMENT LISTING* ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~

**Compartment 5: Flagstaff - Catastrophic Fire: Likely**

Fuels Hazard characteristics are rated:
- Fuels (flame length produced): **High**
- Crowning Potential: **Moderate**
- Slope Percent: **Moderate**
- Aspect: **High**
- Elevation: **Moderate**

Protection Capability ratings are:
- Initial Attack: 0 - 20 minutes **(Low)**
- Suppression Complexity: Complex **(High)**

Ignition Risk factors include:
- Population Density - Wildland Urban Interface
- Power Lines & Sub-station
- Maintenance/service contracts
- Active timber sale
- Construction project
- Debris/slash burning
- Off highway vehicle use
- Developed camping areas & Dispersed camping areas
- Gas pumps or storage
- Gas or oil wells/transmission
- Electronic installations
- Incendiary
- Government operations
- Woodcutting area, power equipment
- Dump
- Fireworks, children with matches
- Cultural Activities
- Shooting/target
- Railroads
- Public Access Road(s)
- County road(s)
- State/Federal highway(s)

## Compartment Assessment Ranking
## Fuels Hazard

| Rating | Compartment | | |
|---|---|---|---|
| High | 8: Secret – Sycamore | Low | 2: Kendrick |
| High | 9: Oak Creek | Low | 11: Beaver Creek |
| | | Low | 1: Anderson |
| Mod | 13: Blue - Mor – Pine | Low | 4: Sunset |
| Mod | 12: Long – Stone | | |
| Mod | 6: Ponderosa | | |
| Mod | 5: Flagstaff | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 3: Kachina | | |
| Mod | 7: Rim | | |

## Compartment Assessment Ranking
## Protection Capability

| Rating | Compartment | | |
|---|---|---|---|
| High | 8: Secret – Sycamore | Low | 9: Oak Creek |
| High | 7: Rim | Low | 5: Flagstaff |
| High | 3: Kachina | Low | 12: Long - Stone |
| High | 13: Blue - Mor - Pine | | |
| High | 1: Anderson | | |
| | | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 6: Ponderosa | | |
| Mod | 2: Kendrick | | |
| Mod | 11: Beaver Creek | | |
| Mod | 4: Sunset | | |

## Compartment Assessment Ranking
## Ignition Risk

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 2: Kendrick |
| High | 10: Sedona – Verde | Low | 3: Kachina |
| High | 13: Blue - Mor – Pine | Low | 8: Secret – Sycamore |
| High | 9: Oak Creek | | |
| | | | |
| Mod | 12: Long - Stone | | |
| Mod | 11: Beaver Creek | | |
| Mod | 4: Sunset | | |
| Mod | 7: Rim | | |

## Compartment Assessment Ranking
## Fire History

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 2: Kendrick |
| High | 4: Sunset | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 11: Beaver Creek |
| High | 7: Rim | Low | 8: Secret - Sycamore |
| High | 9: Oak Creek | | |
| | | | |
| Mod | 13: Blue - Mor – Pine | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 12: Long – Stone | Mod | 3: Kachina |

## Compartment Assessment Ranking
## Values

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 12: Long - Stone |
| High | 10: Sedona – Verde | Low | 4: Sunset |
| High | 9: Oak Creek | Low | 2: Kendrick |
| High | 7: Rim | Low | 1: Anderson |
| High | 6: Ponderosa | | |
| | | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 13: Blue - Mor - Pine | | |
| Mod | 11: Beaver Creek | | |
| Mod | 3: Kachina | | |

## Compartment Assessment Ranking
## Catastrophic Fire Potential

| Rating | Compartment | | |
|---|---|---|---|
| High | 13: Blue - Mor – Pine | Low | 2: Kendrick |
| High | 12: Long – Stone | Low | 1: Anderson |
| High | 9: Oak Creek | | |
| High | 7: Rim | | |
| High | 6: Ponderosa | | |
| High | 5: Flagstaff | | |
| | | | |
| Mod | 11: Beaver Creek | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 4: Sunset | | |
| Mod | 3: Kachina | | |

## Compartment Assessment Ranking
## Composite Compartment Assessment Rating

| Rating | Compartment | | |
|---|---|---|---|
| High | 9: Oak Creek | Low | 11: Beaver Creek |
| High | 7: Rim | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 2: Kendrick |
| High | 13: Blue - Mor - Pine | | |
| High | 5: Flagstaff | | |
| | | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 3: Kachina | | |
| Mod | 12: Long - Stone | | |
| Mod | 4: Sunset | | |

# Appendix 8

## After the Fire

# *AFTER THE FIRE…*

## Returning Resident

## Safety

## Tips

### *Ponderosa Fire Advisory Council*

### Fire Recovery Contacts

| | |
|---|---|
| American Red Cross | 928-779-4594 |
| AZ Department of Public Safety | 928–773-3600 |
| Arizona Public Service | *928-779-6911* |
| Citizen's Arizona Gas | 928 774-4592 |
| Coconino County Animal Shelter | 928-526-1076 |
| Coconino County Emergency Services | 928-526-2735 |
| Coconino County Sheriff Department | 928-774-4523 |
| Coconino National Forest | 928-527-3600 |
| FEMA Help Line | 1-800-621-FEMA |
| Flagstaff Clean & Green (Haz Waste) | 928-779-7622 |
| Flagstaff Fire Department | 928-779-7688 |
| Flagstaff Medical Center | 928-779-3366 |
| Flagstaff Police Department | 928-774-1414 |
| Flagstaff Water/Sewer | 928-779-7646 |
| Highlands Fire Department | 928-525-1717 |
| Parks-Bellemont Fire District | 928-635-5311 |
| Pinewood Fire District | 928-286-9885 |
| Summit Fire District | 928-526-9537 |
| US West (residential) | 800-244-1111 |

**Table Of Contents**

***Electrical……4***
*Electric Safety Facts*
Electric Safety Tips
Electric locations to avoid
Special Info. on Fuses and Circuit Breakers
Emergency Procedures on Electrical Fire
To Restore a fuse
To Reset a Circuit Breaker

**Drinking Water…….……..6**
Restoring Water Systems

**Solid Waste……..……6**
Removing Debris

**Heating Fuels…….…….7**
Checking Propane Tanks
Checking Home Heating Oil Tanks

**Miscellaneous Safety Awareness…….…….7**
Ash Pits
Evaluation of Trees Damaged by Fire
Residual Smoke in Fire Interior

## Fire Recovery Safety Tips

REMEMBER – *use caution and good judgment. Hazards may still exist, even though the fire is controlled.*

# ELECTRICAL

## Electrical Safety Facts

**General: An important part of the disaster recovery is hazard recognition. Should you come across damaged or fallen power poles or lines, contact your local electrical power authorities. DO NOT TOUCH THE DOWNED WIRES. In the cleanup area, be especially careful when cutting trees and operating heavy equipment around power lines. Vegetation and power poles may have lost stability due to fire damage.**

**If a power line or pole should fall next to you while working in the area, *do not walk – hop out of the area.* (Using this technique, you will be less likely to be a conductor of electricity).**

**Electricity is always trying to go somewhere. It goes easily through conductors; it does not go easily through non-conductors.**

| Conductors | Non-Conductors |
|---|---|
| Metal | Rubber |
| Water | Glass |
| Wet Things | Plastic |
| Things In Water (including animals/pets) | |

**One of the most important fixtures in the conduction of electric current are utility poles. The fire or fire suppression actions may have dislodged or broken some of these poles, causing the wires to sag or break, resulting in extremely hazardous conditions. *Do not touch anything at the scene*.**

**Trees can also be dangerous conductors of electricity. When a tree falls or grows into contact with power wires, the electric power diverts and finds a path to the ground through the branches and the trunk. Anyone who comes into contact with these trees is subject to tragic consequences, since electric power can easily jump from the tree to the person.**

## Electrical Safety Tips

- **Do not overload circuits; don't operate several large appliances at the same time on the same circuit.**
- **Do not use extension cords to plug in many items on one outlet.**
- **Turn off appliances when you finish using them. Provide adequate air circulation around all appliances to prevent over-heating. Keep appliances clean, repaired and serviced.**
- **Check wires and plugs regularly. Replace worn or frayed wires. Do not run cords under carpets or across doorways.**
- **Be careful when replacing fuses or breakers. Keep the area near the circuit box dry and turn the main switch off before changing the fuse/breaker.**
- **Temporary lines should be removed from service.**

## Electrical Locations To Avoid

- **Electrical meters and service lines coming into the home or other outbuildings.**
- **Any power supply line which appears to sag, show bare wire, or have insulation missing.**
- **Secured power sub-stations or any area identified as high voltage.**
- **Downed power lines.**

## Emergency Procedures for an Electrical Fire

- **Call the fire department.**
- **Shut off power supply at the breaker if possible.**

## Restoring Electric Power

**If, upon returning to your residence, there is no electrical power, please check to make sure the main breaker is on. If the breakers are on and power is still not present, please call to report the power outage to your local electrical power authorities. Reporting problems like a down or broken wire will speed up the process of power restoration.**

- **Stand off to one side of the breaker box when turning on the main breaker.** ***Do not stand directly in front of the box.***
- **If any smells of hot electrical insulation or sparking occurs*, turn of the breaker immediately and call an electrician.***
- **If electrical lights or appliances appear brighter than normal, turn off main breaker**. ***The service entrance needs to be checked.***

## To Change A Fuse

**Try to find the cause of the blown fuse, and correct it by disconnecting the defective appliance or appliances causing the overload or short circuit. Shut off the main power switch when you change the fuse.**

- **Do not replace fuses with a higher amp rating fuse than you removed.**
- **Turn on the main switch to restore the power.**
- **If the fuse blows again, leave it alone and contact a certified electrician. Other problems may exist and should be investigated to remove the possibility of an electrical fire.**

## To Reset A Circuit Breaker

**Try to find the cause of the overload or short circuit and correct it by disconnecting the defective appliance or appliances. Turn the switch to "on" to reset and restore power. If breaker trips again leave it alone, and contact a certified electrician. Other problems may exist and should be found to remove the possibility of an electrical fire.**

## Special Information of Fuses & Circuit Breakers

**Fuses and circuit breakers shut off the current whenever too much current tries to flow through a wire because of:**

- **A short circuit, possibly caused by a bare wire touching the ground;**
- **Overloading, possibly caused by too many lights or appliances on one circuit; or**
- **By defective parts in an appliance.**

**Know where the main circuit or fuse box is located in your house. Be sure you can locate the main switch; it controls all of the power coming into the house and is usually inside the circuit box. In some cases, however, it may be located outside of the house. Fuse or circuit boxes generally are labeled to designate which area of the house the circuits or fuses serve.**

---

# DRINKING WATER

## Restoring Water Systems

**Unless impacted by a fuel spill, the fire should not have affected wells at undamaged homes. If your house was damaged, your water system may potentially have become contaminated with bacteria due to loss of water pressure. In this case it is recommended that the well be disinfected and the water be tested before consumption. To disinfect your water system, pour ½ - 1 cup of chlorine bleach inside the**

**well casing and turn on all faucets until a chlorine scent in noticed. Allow the chlorine solution to remain in the system overnight. The following morning, open all faucets and flush the system until free of chlorine smell.**

**If you have a public use well or water system, contact the County Health Department for specifics on testing prior to consumption of any water.**

## SOLID WASTE

### Removing Debris

**Cleanup of your property can expose you to potential health problems from hazardous materials. Wet down any debris to minimize health impacts from breathing dust particles. The use of a two-strap dust particulate mask with nose clip and coveralls will provide the best minimal protection. Leather gloves should be worn to protect your hands from sharp objects while removing debris.**

**Hazardous materials such as kitchen and bathroom cleaning products, paint, batteries, contaminated fuel and damaged fuel containers must be handled properly. Contact the City of Flagstaff or Coconino County for specific handling restrictions and disposal options.**

**All hazardous materials should be labeled as to their contents if known!**

## HEATING FUELS

### Checking Propane Tanks

**Propane suppliers recommend homeowners contact them for an inspection prior to reusing their system. If the fire burned the tank, pressure relief valve probably opened and released the contents of the tank. Tanks, brass and copper fittings, and lines may be heat-damaged and unsafe. Valves should be turned off and remain closed until the propane suppliers inspect the system.**

### Checking Home Heating Oil Tanks

**Heating oil suppliers recommend homeowners contact them for an inspection prior to reusing their system. The tank may have shifted or fallen from the stand and fuel lines may have kinked or weakened. Heat from the fire may have caused the tank to warp or bulge. Non-vented tanks are more likely to bulge or show signs of stress. The fire may have loosened or damaged fittings and filters. If the tank is in tact and heating oil remains in the tank, the heating oil should still be good. If you have questions on the integrity of the tank, fuel lines, tank stand, or the fuel, or need assistance in moving the tank or returning it to service, contact your fuel supplier.**

# MISCELLANEOUS SAFETY AWARENESS

## Ash Pits

**Holes created by burned trees and stumps create ash pits, which are full of hot ashes. Mark them for your safety, as they can stay hot for many days following the fire, causing serious burns. Warn your family and neighbors, especially children. Tell them to watch for ash pits and to not put hands or feet in these holes—they are hot!**

## Evaluation of Trees Damaged by Fire

**The following information will assist you in evaluating any trees that have been scorched or burnt by the fire. Identification of the type of tree affected is important and can easily be done. Two basic types of trees exist in this area: deciduous and evergreen. Deciduous trees are broad leaf trees that lose their leaves in the fall.**

**In this area we have quaking aspen (deciduous). Evergreen trees have needles and in this area we have ponderosa pine, Douglas-fir and Rocky Mountain juniper.**

***First:*** ***visually check the tree stability.*** **Any tree weakened by fire may be a hazard. Winds are normally responsible for toppling weakened trees. The wind patterns in your area may have changed as a result of the loss of adjacent tree cover.**

**If the tree looks stable:**

- **Visually check for burnt, partially burnt or broken branches and tree tops that may fall.**

- **Check for burns on the tree trunk. If the bark on the trunk of the tree has been burned off or scorched by very high temperatures completely surround the tree's circumference, the tree will not survive. This is because the living portion of the tree (cambium) was destroyed. The bark of the tree provides protection to the tree during fire. Bark thickness varies based upon tree species: check carefully to see if the fire or heat penetrated the bark. Where fire has burnt deep into the tree trunk, the tree should be considered unstable until checked.**

- **Check for burnt roots by probing the ground with a rod around the base of the tree and out away from the base several feet. The roots are generally six to eight inches below the surface. If you find that the roots have been burned you should consider this tree very unstable; it could easily be toppled by wind.**

**If the tree is scorched**

**A scorched tree is one that has lost part or all of its needles. Leaves will be dry and curled. Needles will be a light red or straw colored. Healthy deciduous trees are resilient and may possibly produce new branches and leaves, as well as sprouts at the base of the tree. Evergreen trees, particularly long-needled trees, may survive when partially scorched. An evergreen tree that has been damaged by fire is subject to bark beetle attack. Please seek professional assistance concerning measures for protecting evergreen trees from bark beetle attack.**

***Seek professional assistance before felling trees near power lines, houses or other improvements.***

## Residual Smoke In Fire Interior

**Smoke may be present on the interior of the fire for several days following containment. This occurs as a result of stumps, roots, and other surface materials being exposed to changing temperatures and wind conditions. Smoke volume from these materials may fluctuate depending on weather conditions. This activity should not pose a risk and smoke will continue to dissipate until materials are fully consumed or extinguished by fire crews or weather.**

# Appendix 9

## GFFP Monitoring & Research Team
## Adaptive Management Framework

# GFFP Monitoring & Research Team
# Adaptive Management Framework
Discussion Draft 10/01/04

The following tables were developed by the Greater Flagstaff Forests Partnership (GFFP) Monitoring and Research Team as the initial makings of a monitoring and research plan for the 180,000 acre project area of the GFFP (see www.gffp.org). This framework could be applied to a smaller or larger landscape. The following five broad areas of concern reflect the monitoring needs categories of this partnership, and are divided into **fuels reduction, ecosystem restoration, social issues, economic health, and institutional health**. This is a very broad framework of what areas **COULD** be monitored within the larger area. The actual application of what **SHOULD** be monitored within individual projects may be a much smaller, and more focused subset of these variables. Decisions about which goals are desirable for individual projects should be decided by the actual project designers (e.g., ID team), and determined based upon very specific project objectives, the specific landscape that is affected by the project, the desired conditions for that landscape, and how those desired conditions are proposed to be achieved. Also, an explicit relationship needs to be developed between an analysis of the outcomes of the monitoring, and how those outcomes affect future management.

## GOAL: Reduce threat of uncharacteristic* fire)

| Objective | Indicator | Metric | What are known thresholds? | Frequency | Scale (spatial and temporal) | Cost<br>L - <$1000/yr<br>M - $1K-10K/yr<br>H - >$10K/yr |
|---|---|---|---|---|---|---|
| Create conditions that are conducive to the increased use of **frequent, low intensity fire*** in the fire-adapted landscape, including fires resulting from both | 1. Forest Vegetation Simulator (FVS) with Fire & Fuels Extension.<br>2. Fire model (e.g. NEXUS or FLAMMAP) runs indicate that fuels reduction treatments | Canopy cover<br>Stand height<br>Crown base height<br>Crown bulk density<br>Deadwood fuel loading<br>Litter, dead, and live fuels moisture levels. | Depends on fuel model, but thresholds exist for surface or ground fire, passive canopy fire, and active canopy fire. | Before and after treatments.<br>FVS uses stand data typically collected by USFS personnel.<br>FLAMMAP gives predictive ability; factor in continued treatment. | Project and roll up to landscape | H |

| | | | | | | |
|---|---|---|---|---|---|---|
| human and natural ignitions. | are effective in reducing the risk of active and passive canopy fire*.<br>3. Cumulative acres in characteristic and uncharacteristic fire condition<br>4. Fire Regime Condition Class<br>5. # of acres in Fire Use plans.<br>6. # of acres where "monitoring" or containment is considered an appropriate suppression tactic. | Annual reports of acres treated. ForestERA analysis process. | | | | |
| Reduce risk of **uncharacteristic*** fire for community protection and other special areas. | Ditto above | | | | | |

- For terms marked with an asterisk, please see glossary at end of document for current definitions and references, or click on hyperlink.

References: Brown 1974, Anderson 1978, Scott 1999, http://fire.org/nav.mas?pages=fire&mode=14; http://www.frcc.gov/

-

# GOAL: Restore Forest Ecosystem Health

| Objective | Indicator | Method or Metric | Frequency | Scale (spatial and temporal) | Cost |
|---|---|---|---|---|---|
| Increase use of frequent, low intensity | 1. Number of acres that will support a surface | USFS, State/Private, county, and city review | Annual & cumulative | Project & Landscape Short & Long-term | L if fuels reduction monitoring is done |

| | | | | | |
|---|---|---|---|---|---|
| fire in the landscape (or ponderosa pine and associated ecosystems). Improve fire regime*. | fire.<br>2. Number of acres burned by characteristic* surface fire (both Rx and wildfire individ. And combined).<br>3. Number of Rx fires. | of accomplishments (units in ac/ha and # of burns). List by FY and CY. | | | |
| Create conditions that are conducive to the increased use of frequent, low intensity fire in the landscape. | 1. Number of acres that will support a surface fire. | See above in **Fuels Reduction** | Annual & cumulative | | L |
| Retain, enhance, and develop old and large trees*, both living and dead, and mature ecosystems. | 1. Number of old/large trees/acre.<br>2. Number and decay class of snags & dead/down trees/acre.<br>3. Number of acres of existing and developing old growth* ecosystems. | USFS and Partner surveys of trees per acre by stand. Cumulative survey of OG areas. | Before and after projects | Project scale rolled up to landscape level. | L at project<br>H at landscape |
| Conserve and enhance native species*' populations and their habitat and reduce invasive, nonnative species*. | 1. Abundance, distribution & diversity of selected native species.<br>2. Abundance, distribution & diversity of nonnative selected species.<br>3. Number of acres of intact native habitat*. | Species transects and quadrats, point-intercept data and time-constrained sampling in selected areas and for selected species.<br><br>USFS surveys | Before and after treatment/projects, annual/seasonal. | Project scale rolled up to landscape level. | H |

| | | | | | |
|---|---|---|---|---|---|
| Conserve soil resources. | 1. Degree of erosion<br>2. Amount of bare ground. | Field surveys | Before and after projects | | M? |
| Maintain and improve watershed function. | 1. Amount of water flow, timing (hydrograph), and water quality.<br>2. Degree of erosion & sedimentation. | Stream gages, direct water sampling, geomorphology measures. | Before and after projects, Annually | | M |
| | | | | | |

*For words underlined and marked with an asterisk, please see glossary.

References: Harrington, Michael G.; Sackett, Stephen S. 1992, Coconino LMP 1987; Pellant et al. 2000, Pyke et al. 2002; Herrick et al. 2002 (Jornada experimental range); Taylor 1999, O'Dea 2003;

## GOAL: Improve Social Understanding & Acceptance of Land Management Practices

**Sub goal: MAINTAIN QUALITY OF LIFE**

| Objective | Indicator | Metric<br>*Measured as baseline data → for pre-treatment and measured at post-treatment* | Frequency | Scale<br>*Project vs. GFFP Area* | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Reduce the perceived risk of uncharacteristic (high intensity) fire.** | Perceived risk/threat of uncharacteristic (high intensity) wildfire that will directly or indirectly affect residents' quality of life. | 1. Survey residents to determine the perceived risk/threat of uncharacteristic (high intensity) fire.<br>2. Focus groups during GFFP field trips/presentations. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Increase the perceived benefits of characteristic (frequent, low-intensity) prescribed and natural fires.** | Perceived benefit of characteristic (frequent, low-intensity) prescribed and natural fires that will directly or indirectly affect residents' quality of life. | 1. Survey residents to determine the perceived benefit of characteristic (frequent, low-intensity) prescribed and natural fires.<br>2. Focus groups during GFFP field trips/presentations. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Reduce the risk of uncharacteristic (high intensity) fire.** | 1. Fire model<br>2. Defensible space. | 1. See "Fuels Reduction" metrics<br>2. Amount of defensible space around neighborhoods/homes. | Pre- and Post-treatment; Seasonally (bi-annually or quarterly) | Short term-Project<br>Long term-GFFP area | H |
| **Increase/maintain public's perception of recreational opportunities, in the context of restoration activities, in the local community.** | Public perception of access and level of use for recreational activities in the forests in and around the local community (in the context of restoration activities). | Survey residents to determine perception of recreational opportunities in the forests in and around the local community (in the context of restoration activities). | Pre- and Post-treatment surveys | Short term-Project<br>Long term-GFFP area | M |
| **Protect/promote the aesthetic value of the** | Public perception that restoration projects will/are | 1. Survey residents to determine perception of the | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |

| | | | | | |
|---|---|---|---|---|---|
| **forest.** | preserving and promoting forest aesthetics in and around their community. | effects of restoration efforts on forest aesthetics in and around their community.<br>2. Focus groups during GFFP field trips/presentations. | | | |
| **Protect/promote spiritual value of the forest.** | Public perception that restoration projects will/are preserving and promoting the spiritual value of the forest. | 1. Survey residents to determine perception of restoration efforts in protecting the spiritual value of the forest. Over sample Native American members of the community. Conduct personal interviews/focus groups with Native American members of the community. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Reduce the number of unplanned human-caused forest fires in the GFFP area.** | Number of human-caused fires in the forest in the GFFP area. | Forest Service logs of fire occurrences and the ignition sources. | Pre- and Post- program implementation | Long term-GFFP area | M |
| **Public's perception of forest closures.** | Public's knowledge of the reasons for forest closures. | Survey residents to determine knowledge of why forest closures occur; does the public link it to restoration activities? | Pre- and Post-program survey | Short term-Program<br>Long term-GFFP area | M |
| **Public's perception of forest restrictions.** | Public's knowledge of the reasons for forest restrictions. | Survey residents to determine knowledge of why forest restrictions occur; does the public link it to restoration activities? | Pre- and Post-program survey | Short term-Program<br>Long term-GFFP area | M |

**Sub Goal: INCREASE PUBLIC INVOLVEMENT IN RESTORATION EFFORTS**

| **Objective** | **Indicator** | **Metric**<br>***Measured as baseline data***<br>**→**<br>***for pre-treatment and measured at post-treatment*** | **Scale**<br>*Project vs. GFFP Area* | **Frequency** | **Cost**<br>**(H, M, L)** |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Increase the knowledge/ perception of "Fire Wise" principles/communities and implementation of defensible space.** | 1. Amount of public knowledge/perceptions of "Fire Wise" principles/communities.<br>2. Public knowledge/perceptions of implementing "defensible space" (space near and around homes). | Survey residents to determine the knowledge/perceptions of "Fire Wise" principles/communities and implementation of defensible space. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase the number of communities* that are recognized as "Fire Wise" in the GFFP area.** | Number of communities in the GFFP geographic area designated as "Fire Wise." | Determine number of communities in the GFFP region that are recognized as "Fire Wise" through certification of Firewise/Communites/USA. (Currently in AZ → Timber Ridge) | Long term-GFFP area | Pre- and Post-program implementation | H |
| **Increase the number of neighborhoods/households that are implementing "Fire Wise" principles around their homes.** | 1. Number of households that are implementing (the degree of) "Fire Wise" principles around their homes.<br>2. Number of neighborhoods that are implementing "Fire Wise" principles. | 1. Survey residents to determine their level of implementing "Fire Wise" principles around their homes.<br>2. Interview fire station personnel in neighborhood/home assessments.<br>3. Review fire station field survey logs. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase community involvement in restoration activities. Pay special attention to youth service corps programs that include middle-high school age students.** | 1. Number of GFFP sponsored workshops, field trips, etc.<br>2. Number of youth programs established by GFFP that promote involvement & education with restoration efforts.<br>3. Number of participants and/or groups attending GFFP events.<br>4. Number of service groups | 1. Review GFFP logs.<br>2. Review event coordinator logs. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |

| | | | | | |
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| | participating in GFFP events.<br>5. Attendance of GFFP meetings - public and GFFP members. | | | | |
| **Improve public access and participation in forest restoration.** | 1. Public's perception of the ability to participate in restoration activities and forest planning.<br>2. Public's access to information pertaining to restoration activities.<br>3. Media types utilized to disseminate GFFP information.<br>4. Most common media sources used by the public to access restoration information. | 1. Survey residents to assess their perceived ability to participate and obtain information regarding restoration activities and forest planning.<br>2. Review number and type of GFFP public announcements for restoration activities.<br>3. Survey public to determine most desirable media source(s) to access the information. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |

**Sub goal: INCREASE PUBLIC INFORMATION/SUPPORT FOR RESTORATION PROJECTS**

| Objective | Indicator | Metric<br>*Measured as baseline data →*<br>*for pre-treatment and measured at post-treatment* | Scale<br>*Project vs. GFFP Area* | Frequency | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Increase perceptions of "healthy forests" resulting from forest restoration activities that include characteristic wildfire, wildlife habitat and watershed function in and around communities/GFFP geographic areas.** | Public perception of restoration activities resulting in "healthy forests" in and around their community. | Survey residents to determine perceptions of restoration activities resulting in a "healthy forest." | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase awareness/support/notification for restoration projects.** | 1. Campaigns that are in place as informational tools for restoration projects.<br>2. Number of public notifications that include: prescribed burns-posting signs, new releases, door-to-door in neighborhoods, public meetings, presentations to service clubs/organizations, press releases, development and distribution of material and participation of GFFP in community events. | 1. Review number of GFFP sponsored workshop, field trips, etc.<br>2. Review of the number of community participants in the events.<br>3. Review number of public notifications for prescribed burns-posting signs, new releases, door-to-door in neighborhoods, public meetings, presentations to service clubs/organizations, press releases, development and distribution of material and participation of GFFP in community events.<br>4. Perform content analysis of campaign types and messages.<br>5. Conduct focus groups to assess perceived messages | Short term-Program<br>Long term-GFFP area | Pre- and Post-program surveys/focus groups | M |

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| | | of GFFP literature. | | | |
| **Increase awareness/support for restoration projects.** | 1. Number and content of local publications, editorials and letters to the editor regarding restoration efforts (Non-GFFP members)<br>2. Number and content of USFS public comments. | 1. Content analysis: review number and content of local publications, editorials and letters in to the editor regarding restoration efforts.<br>2. Content analysis/frequency of public comments submitted to the USFS | Short term-Program<br>Long term-GFFP area | Pre- and Post-treatment/implementation | M |
| **Increase public support for mechanical thinning, road construction, and smoke as necessary tools for ecological restoration.** | 1. Number of complaints to authorities regarding thinning, road construction and smoke resulting from a restoration project(s).<br>2. Number of complaints to authorities for faster and more efficient implementation of restoration efforts. | 1. Examine local fire department and police logs.<br>• Review type and number of complaints filed per restoration project.<br>• Review number and type of requests to initiate or complete restoration projects. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program/treatment implementation | M |
| **Improve awareness and public attitude towards partners & cooperators involved in restoration projects** (e.g., USFS, ERI, NPS, GCT, TNC, Flagstaff Fire Dept., etc.). | Public's awareness and perceptions of GFFP partners and cooperators. | 1. Survey residents to determine attitudes towards GFFP partners and cooperators in regards to their involvement in restoration efforts.<br>2. Focus groups of residents to determine attitudes towards GFFP partners and cooperators. | Long term-GFFP area | Pre- and Post-treatment surveys/focus groups | M |
| **Decrease number of appeals and lawsuits filed against GFFP projects.** | 1. Number of appeals of GFFP supported projects.<br>2. Number of lawsuits of GFFP supported projects.<br>3. Number of acres analyzed | 1. Review appeals to determine number filed against GFFP projects.<br>2. Review lawsuits to determine number filed against GFFP supported | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation or annual | M |

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|---|---|---|---|---|---|
| | and treated through the NEPA process. | projects.<br>3. Review the results of the appeal. Was it upheld?<br>4. Length of time it took the agency to process the appeal. | | | |
| **Increase public's knowledge of ecologically-based fuels reduction.** | Public's knowledge of ecologically-based fuels reduction. | 1. Survey residents to determine knowledge of ecological-based fuels reduction.<br>2. Focus groups during GFFP filed tips/presentations | Short term-Program<br>Long term-GFFP area | Pre- and Post-program surveys/focus groups | M |

# Steps in the Evaluation Process

Longitudinal Study – Process Evaluation – assess changes over time.

1. Collect baseline data-establish an understanding of what currently exists; before intervention (treatments or programs).
2. Collect data at stages as projects progress; either at regular time intervals or after major interventions.
3. What is the change from pre- to post-test? Analyze the data.
4. Answer the question – Have goals been met? Establish criteria for successful outcomes.
5. Recommendations – refine treatments and programs; guide planning and education efforts.

***A sustainable community is linked to a sustainable ecosystem.***

***Healthy forest → Community well-being.***

## Areas to explore

1. Insurance industry – current status of homeowner insurance for forest fire loss.

2. USFS and congressional representatives – determine public pressure thresholds to either suspend or omit restoration prescriptions.

# References


Greater Flagstaff Forest Partnership and The Ponderosa Fire Advisory Council. 2004. *Greater Flagstaff Community Wildfire Protection Plan.* Retrieved July 26, 2004 (http://www.gffp.org/docs/June_draft.htm).

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"Monitoring Social and Economic Effects of Forest Restoration." Handbook Five. Retrieved July 8, 2004 (http://www.fs.fed.us/r3/spf/cfrp/monitoring/index.shtml).

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## GOAL: Improve Economic Health of Community

| Objective | Indicator | Metric /Method | Scale<br>*Project vs. GFFP Area* | Frequency | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Ensure the availability of forest material at a sustainable and constant level to support <u>appropriate forest product</u> industries.** | 1) # of acres and total volume in long-term (10 years or greater) contracts in the Flagstaff region. | Annual review of acres/total volumes in long-term contracts provided by public agencies (USFS and State). | Multiple: local, GFFP, & w/in 150 miles. | Annual | L |
| **Provide employment opportunities to Flagstaff area residents in forest restoration projects & forest product or other related industries.** | 1) # of employees in forest-restoration & product related companies in Flagstaff region.<br>2) Proportion of Flagstaff area residents (as % of total) employed by forest product and restoration-related companies.<br>3) Proportion of permanent to temporary employees in …<br>4) Number of locally owned businesses. | Annual surveys/questionnaires with all forest product companies utilizing small diameter material. GFEC collected data. NAU College of Business (Bank 1 center). | GFFP area of product/material distribution | Annual | L |
| **Provide technical and professional training to Flagstaff area residents to work on forest restoration projects.** | 1) Number and duration of training events and programs per year.<br>2) # of participants in training events & programs/year.<br>3) Level of training (professional, technical, accredited, on the job). | Identify all area institutions providing professional training related to forest products and restoration. Annual survey of those institutions to count events, level of training, and participants. | GFFP area of product/material distribution. **Need help from economist on scale decision.** | | L |

| | | | | | |
|---|---|---|---|---|---|
| **Expand uses and products associated with small diameter material (SDM) and biomass.** | 1) Total number, size, and longevity of operational businesses utilizing small diameter material in Flagstaff area.<br>2) Total # of products and uses for SDM and biomass.<br>3) Total volume (cords) of small diameter material processed locally in Flagstaff area by businesses. | Annual surveys/questionnaire with all forest product companies utilizing small diameter material & biomass. GFEC, NAU, etc. | | | M |
| Flagstaff area = 150 mile radius | | | | | |
| Small diameter material = <16" **Need to define*** | | | | | |

## GOAL: Institutional Health

| Objective | Indicator | Method/Metrics | Scale *Project vs. GFFP Area* | Frequency | Cost (H, M, L) |
|---|---|---|---|---|---|
| *Increase annual budget to facilitate forest ecosystem restoration* | Annual budget of GFFP, with operations as %. | review of annual budget | All GFFP Area | Annual | L |
| | # of donors, gifts, grants & contracts awarded (public & private) reported by category. | review of development database | All GFFP Area | Annual | L |
| | # of 5-6 figure project budgets/grants by category | review of annual budget and/or development database | All GFFP Area | Annual | L |
| *Increase satisfaction among partners with GFFP operations* | partner satisfaction (strategic direction, conflict resolution, consensus building, etc) | Survey (D. Hospodarsky) | All GFFP Area | Annual | M |

| | | | | | |
|---|---|---|---|---|---|
| *Maintain & enhance collaborative effort among partners* | # of PAB members; PAB and work team participation and attendance; content analysis of meetings. | meeting minutes review | All GFFP Area | Annual | L, M |
| | # of independent projects between partners fostered by GFFP. | reports from partners | All GFFP Area | Annual | L |
| *Achieve annual objectives & develop long term strategy* | Proportion of annual goals & objectives achieved | annual objectives review and cumulative achievement of goals | All GFFP Area | Annual | L |
| | Long term strategic plan development and perception among members of its implementation. | creation of document, survey of members | All GFFP Area | Annual | M |
| *Implement MOUs developed with USFS Cooperators (RMRS PNWRS, SRS, FPL, CNF)* | % of "shalls" in MOUs followed | MOU annual reviews | All GFFP Area | Annual | L |
| *Increase communication among GFFP partners and cooperators* | Project updates are current<br><br>Minutes are shared betw/ BOD and PAB, and among work teams<br><br>Partners' perception of communication | Survey of minutes, website and partners | All GFFP Area | Annual | L<br><br>M |
| *Increase visibility of GFFP at regional & national level* | # of visits to website, project areas, media hits<br><br>requests for GFFP documents, presentations | web log, interviews, elected officials meeting, GFFP records | All GFFP Area | Annual | L |

## Partial Glossary for Greater Flagstaff Forests Partnership Research and Monitoring Team

**Characteristic & Uncharacteristic**– In ecological systems, this refers to whether or not a variable or condition of the ecosystem or its parts is included in what is known about its historic or natural range of variability, which may be specific to a given geographic area. E.g., we know from tree ring studies around Flagstaff that the historic range of variability for low intensity fires for the period of 1500 to 1872 was 2-15 years. Thus fires that currently occur within that range are characteristic in frequency (see **Fire Regime**).

**Crown Fire, Active and Passive --** This is a fire that travels from one crown (or treetop) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below the crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY. p. 282. (see also **Surface Fire**)

**Fire Regime** -- A fire regime is defined according to fire characteristics such as intensity, frequency, severity, season, extent, duration, behavior, spatial distribution, and type of fire (see **Crown Fire**).

**Fire Regime Condition Class (FRCC)--** - http://www.frcc.gov/

**Surface Fire --** A fire that burns over the forest floor, consuming litter, killing aboveground parst of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY p. 281 (se also **Crown Fire**).

**Monitoring Cost Categories**
**L – Low = $1-1,000 per year or monitoring period/effort**
**M – Medium = $1,000 – 10,000**
H – High = $10,000 - $100

2011-02-24 -18



Conservation Congress

February 24, 2011

Coconino National Forest
Attn: 4FRI
1814 S. Thompson Street
Flagstaff, AZ 86001

The Conservation Congress appreciates the opportunity to provide initial scoping comments on the draft proposed action for the 4FRI. Please incorporate them into the administrative record and consider them in any future analysis.

We have numerous concerns with the proposed action. First, the project area is enormous (750,000 acres) and we are not convinced the Forest Service can conduct an ecological/legal project at this level based on past abuses by the Forest Service in much smaller areas. Furthermore, the project will last approximately ten years. Many things can change over a decade and with climate change they likely will. In general NEPA documents over 7 years old are considered stale by the courts so we would suggest the Forest Service scale back the project and implement it over a 5 to 7 year period. 1

There are numerous contradictions in the proposed action that strongly suggests the use of Best Available Science was not used in the development of the proposed action. For example, the scoping notice states the desired condition is to move towards an uneven-aged forest structure with all size classes represented, yet the Forest Plan requires "Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape." We read this to say the desired condition is an old growth forest sustained over time across the landscape, not an area with all age classes represented. 2

The scoping notice speaks to lack of fire as causing the decline of Aspen and oak yet proposes logging to stimulate these species. Why not burn them after removing small diameter trees? 3

The scoping notice also states the desired condition in the majority of the analysis area is FRCC I but this would not be conducive to maintaining an old growth forest. Fire is natural and needed to maintain ecological diversity. Ponderosa pine adapted with fire and it should not be excluded. 4

**Post Office Box 5**
**Lewistown, MT 59457**
**406-538-4220**

The scoping notice also states the desired condition is to promote large trees and understory vegetation yet there are no diameter limits or age classes proposed. Considering these forests are at high elevation, arid, and the trees are slow growing, the project should not be cutting trees over 80 years of age. If this is a true restoration project to maintain old growth forest the project should clearly state that it is only going to thin small diameter young trees and then under-burn the area. We question the proposal to conduct intermediate thinning which is geared towards older and larger tree classes. 5

We also object to the proposal to use existing closed roads for the duration of the project (10 years) when many roads are currently producing sediment to water quality. What is the current open road density? We also object to reconstructing roads. The Forest Service has a backlog of road maintenance of around $80 billion dollars. The Forest should not be opening closed roads, reconstructing closed roads or building new roads. 6

We question the need to cut trees within selected Mexican spotted owl PACs to improve habitat unless they are 8" DBH or less. How much of the 750,000 acres is designated critical habitat? Do the four forests have an updated environmental baseline for the owl? Have the four forests conducted Section 7 consultation with the USFWS for previous fires that burned owl habitat? 7

Clearly the analysis area has current problems with water quality, soil quality, wildlife habitat, etc. Considering logging and road building contributed to all of these problems we aren't convinced that more of the same will provide for restoration. 8

We recommend the Forest Service conduct a small scale project in order to determine if the proposed treatments will actually be effective in attaining desired goals. Considering this is a pilot project we believe the Forest Service is biting off more than it can chew and mistakes made at a grand scale are far more difficult to remedy. 9

Please keep us on the mailing list for this project and forward the draft EIS to us immediately upon release. We also request that the water, soil, wildlife, MIS, BA/BE reports be included as appendices to the EIS so we can review them. 10

Sincerely,

Denise Boggs

Denise Boggs,
Executive Director

**Post Office Box 5**
**Lewistown, MT 59457**
**406-538-4220**

**Denise Boggs**

**From:** [redacted]
**Sent:** Thursday, February 24, 2011 1:07 PM
**To:** [redacted]
**Subject:** Roy Keene-- forester's prospective---Will More Logging Restore Forests?

This editorial by Roy Keene matches my own perspective on the issue of restoration forestry. As Roy says at the end if soil disturbance and site impacts are considered, not to mention the effects of new roads (temporary or not), spread of weeds, impacts on sensitive wildlife, and the impacts on watersheds, any tampering with forests is an ecologically losing proposition.

Will More Logging Restore Forests?

Beginning with Bush's 2003 Healthy Forests Restoration Act, there have been a number of politically powered, scientifically justified proposals to log more federal forests. These efforts to increase logging assert that our forests are unhealthy and, therefore, in need of "restoration".

Senator Wyden's Eastside Forest Restoration and Jobs Act, proposing to triple logging in 3 million acres of already over-logged forests, brought in a new twist: environmental organizations are working with the timber industry to promote this latest round of logging. They pushed this Trojan horse proposal last year at PIELC.

Jack Ward Thomas, ex-chief the Forest Service, a forger of the Northwest Forest Plan, publicly challenged this collaborative logging proposal. In an Oregonian op-ed, he questioned special interest groups dictating national forest policy, undercutting existing forest management laws, and expediting logging by reducing appeals and public participation. Why must existing protective laws be canceled to restore forests?

Politically and scientifically driven logging to "restore" our forests precedes Bush and Wyden efforts by 40 years. In the early 70's, massive clearcut logging, called "regeneration harvesting", was sold as a way to bring decadent ancient forests back to health. Liquidating these "overly mature" forests was supposed to create more wildlife habitat, increase water flows and salmon runs, foster more diversity, and help prevent fire. It's done just the opposite.

A Forest Service silviculturalist I worked with during that period jeopardized his career by calling "regeneration harvesting" what it really was... deforestry. Wikipedia says using buzzwords is "Stating goals with opaque words of unclear meaning; their positive connotations prevent questioning of intent." In a Register Guard Opinion, Tom Partin of the American Forest Resource Council cloaked this latest logging scam in buzzwords without ever saying the "L" word.

Fear of wildfire is heavily used to sell these political forest "restoration" schemes. Logging has not been proven, in practice, to reduce fire frequency or intensity. Historically, the largest, most destructive blazes, like the Tillamook conflagration, were caused from logging or fueled by slash. Unlogged forests, cool and shaded, are typically more fire resistant than cut over, dried-up stands choked with slash and weeds.

Large scale logging (by any name) has devalued our forests, degraded our waters, damaged soils, and endangered a wide variety of plants and animals. How will the current round of politically and environmentally propelled "restorative" logging proposals differ, in practice, from past logging regimes?

It's a bad time for environmentalists to promote more logging even if it were truly "restorative". In this historically low market, federal timber is sold very cheaply. Timber purchasers already sit on huge logging contracts in order to make windfall profits when markets rise. Selling more timber in a low market further devalues our forest and encourages industry to clamor for more.

Practicing forestry for 35 years, I've worked with federal and private foresters, tribal elders, citizen groups, and even industry to design many successful forest restoration projects that don't involve logging. Fact is, when site and soil impacts are considered, "restorative logging" in federal forests is a rarity... more of an oxymoron than a reality.

by Roy Keene, forester and forest activist, March 1, 2011 royhkeene@gmail.com

2011-02-24 -19

# 4 FRI Public Involvement Workshop 4 Comments

## February 24, 2011

Comment period to March 14. Refinements on PA will be worked on for next 2 weeks. A scoping report will be put out as well. Need additional public meetings to try to catch more of the public (weekends and after hours). The scoping period will be extended. Issues and alternatives will be out to the stakeholder group prior to the DEIS.

Summary of what the maps are displayed.

Firescape 1 – Treatment Area 1

What is the definition of firescapes? 750,000 acre area that is broken into 6 firescapes based on watershed boundaries. Within these are treatment areas, and stands (homogeneous areas). Prescriptions will give basic treatment for that area, but these will be adjusted to conditions found on the ground. The change from the landscape group's definition is to add pattern, structure and composition. 1

What does the rest of the stand look like? Are you planning to only measure canopy cover in the tree'd area, thereby excluding the open areas? The metrics stand density, site index.etc will be answered. 2

How do you select within stand openings? In the implementation prescriptions there will be guidance. 3

Will there be a description of your approach in the PA or EIS, so that the public will understand what you are proposing? There will be a description of the DC, metrics, standards and guidelines. You have also asked if there would be a way to visualize the pre and post-treatment conditions, we are gathering examples. 4

Treatment Area 2

Was the Mint Project a fuel reduction or a timber project? 5

Treatment Area 3

Introduced wildlife Goshawk and MSO layer.

General The FS has discovered an assessment of head cutting occurring across the forest. One area was Newman Park that we didn't talk about earlier, where we would be doing head cut restoration.

General City of Flagstaff has requested that the Lake Mary Watershed should be priority number 1 (part of record).

What is the timeline about priority areas? We expect to indicate areas of greater concern. We can't tell you yet where the areas will be since we don't have a contract or timing issues for wildlife. 6

There is a letter coming in regarding the Rio de Flag watershed. general

Will there be maps that come out with the revised PA? general

7 Will these be the potential treatments filtered by wildlife? How will you get at strategically placed and prioritized treatment areas? Will this next map actually show where treatment will occur; a subset showing where treatments will occur? Mary will be able to do some fire path modeling.

When you go thru the refinement process to show the areas most at risk, you won't drop out lower priority areas, right?

Treatment Area 4

Expect to naturalize the first ¼ mile of "closed" road beds, they would show on the refined maps. We are considering decommissioning the entire road segment.

8 Why wouldn't you pull out the entire KV line as a project? It will be the same for any of these lines.

Treatment Area 5

Bill added 119 total PAC's in analysis area, 41 fell out because of MC, steep slopes, wilderness, 47 fell out because already treated, 17 had wildfire, 12 had high reproductive potential or habitat was really good. Proposing 17 PAC's for treatment, and 7 more that need field review. Light treatment in recovery areas, no treatment in nest areas.

Treatment Area 6

9 What will the approach be in Transition Zones in both MC and PJ? Are they being analyzed and planned for treatment?

Firescape 2

Firescape 3 Treatment Area 1

Neil shared his philosophy about treating in Transition areas. If the area is dominated by ponderosa pine, it is a candidate for mechanical treatment. We know that there may be pine strings along the polygons dominated by PJ. We will try to determine if pine dominates, if not it will fall out. Some of these will require a site by site analysis since these are typically in an ecotone and microsite. There may be some areas that are in MC, but dominated by pipo that would be looked at as well.

Will you use the same approaches that you have identified? There is no treatment designed specifically as a transition zone treatment. covered in 9

Will fire be considered in the wildlife areas?

How are you determining a need to treat in the Transition areas? Based on BA within the stand polygon.

covered in 9

Treatment Area 2

10 Is this the area that you are working on the post tornado plan or is this separate? These are not included, and focus just on the tornado path (4000 acres). Will you remove these from the maps?

11 Treatment designed to increase water yield, has this been considered in any of the other treatments? Will it be dealt with quantitatively, monitored? Are you concerned about the effects of treatment for water yield?

12 The whole Sycamore Canyon area would be a prime area to look at water yields and this would be a prime area to increase yields. Put thought into how the treatments would be layed out to include increased water yield. This includes both groundwater recharge and surface water runoff.

Treatment Area 3

13 While there are a lot of prescriptions, there are only 4 ranges of resulting openings. Does this really get us to heterogeneity across the landscape? All actions need to meet the DC. The range within each opening percent represents some differences within areas.

This area has the largest crown fire potential in the project area. There is a glitch in one area where there is more adverse fire potential. A site visit to this area showed there are thick stands of small trees that have a high crown base, but in reality since these are so thick, the potential for wind driven crown fire is high.

Would the continuity of crown bulk density and crown base height help to address the model glitch?

Treatment Area 4

14 The areas southwest of Flagstaff have a high interspersion of state lands, are you working with the State about treating these areas? Typically we can work with the state so that if they know we will be treating in adjacent areas, they will work on these. This is based on funding.

Treatment Area 5

West Fork is in this area (not 4).

Wasn't there disagreement about treatment in West Fork?

15 There are roads above the canyon on both sides which would allow treatment of both sides of the canyon. No treatment within the canyon.

16 Reassess the Kachina and Woody treatments to see if they meet the DC?

Firescape 4 Treatment Area 1

I suggest you do additional meetings in the Williams and Tusayan areas to get more participation.

Treatment Area 2

If we could display the amount of area being dropped out of treatment for the various reasons, this will help people with a concern about the entire project area being mechanically treated. – Note for Henry

Treatment Area 3

Treatment Area 4

17 This is an important groundwater recharge area, and given that this has an open treatment type, I am interested in seeing treatments designed to help retain snow packs.

18 Pumping from the Woody Mountain wells could effect Oak Creek, if you could increase the groundwater recharge in this area, it would benefit other systems.

Treatment Area 5

19 The A-1 Project area was not a restoration based project, so it needs to be reviewed.

Firescape 5 Treatment Area 1

City of Flagstaff will be sending a comment about Rio de Flag.

20 There is an opportunity to collaborate with the City because they have a stormwater montoring program and a network of gauging stations that could be used for monitoring.

21 Area north of MNA is a wildlife corridor, and I think there is a way to accommodate both treatment and wildlife. Need carefully designed treatments.

Treatment Area 2

The Schulz fire area has been pulled out since this will be responding to fire and flood issues.

Firescape 6 Treatment Area 1

Clarify with Bruce regarding too much past/on-going treatment.

22 Cross walk the area with past fire management may indicate that fire only could be used in these areas.

Treatment Area 2

Could you show the density of heritage sites? Will there be issues? When we do survey in areas proposed for burning, we do survey for specific items such as wood structures or similar. The maps displayed are the finals with just high and low site density.

Treatment Area 3

The sagebrush-pipo areas may need different treatments that would be similar to treatments in a savannah grassland, except the grass is sage. Want to ensure the sagebrush would not get overtopped and choked out. Mature trees are a good indication of stocking and historic conditions.

In a field trip on the Tusayan RD with Richard Reynolds, it showed that fire often stopped before burning up the sage. We would want to use an approach to retain the sage versus getting rid of it. (Bill's comment)

Treatment Area 4

General Comments and Questions

The scoping report will look different when it is posted on the web and distributed. We do hope to receive your comments in the traditional NEPA process. The Kaibab NF website and links from the Coconino NF are the websites where the documents will be posted.

There is a huge amount of GIS information being conveyed. It would be helpful on the stakeholder side to review. Can we get the GIS data? Yes, we can provide the info, the metadata has not been developed for this.

The wildlife data is sensitive, I don't want this distributed.

Probably most important are the treatment and fire layers (crown, surface intensity), we'd prefer the raw data now versus the refined data. We recognize that the data is not final and will be shifting.

Jill R – it is important to provide this as a package with the date provided.

23 Monitoring – the PA does not address it, where does this get inserted? The PA does not include a complete monitoring plan, the DEIS would need to have these.

Is the FS planning to do different monitoring than in the past? We haven't heard specifics about science or research areas. I would like to see a commitment from the FS for monitoring and changing the status
24 quo, it is included in the proposal. I think the stakeholders are committed to monitoring and are seeking funding.

We are hoping the science and monitoring will bring a plan forward. We recently had a monitoring workshop to help start the process, but we haven't heard about a monitoring plan.

The stakeholders are committed to bringing a monitoring plan that identifies the components.

25 Is VSS 1 considered as an opening. The range of openings indicated does not include VSS 1.

How does this conform with the Forest Plans? It is a problem.

VSS 1 is part of a forested condition. I am talking about a non-forested opening.

How are you defining your regeneration openings?

We are talking about non-forested openings and forested groups. When a VSS 1 group is established it is intended to be forested.

How is canopy cover calculated? We have talked about VSS and canopy cover. For this analysis, we are going address the canopy cover issue at mid and large scale. We will address 40% cover within VSS 4, 5, 6. We would use xxx images at mid and large scale. At stand and site we would manage for 40% cover. We would use BA as a proxy for canopy cover.

Will you use those data to apply the 40-50% minimum requirement in VSS 4, 5,6 at the stand or larger scale? Will it be a binary measure at those scales of canopy versus non-canopy, versus first pulling out the openings. This does not represent canopy cover. This is a problem of forest plan compliance and wildlife species. Our job is disclose the process used and to consider opposing view points. This has been a drop dead issue for Sierra Club for 25 years. This is why we are focusing on DC. We need pictures to show this.

Provide a glossary of terms so that there is a clear definition being used. Make sure you are speaking about the same things.

This is a process question, do we understand the magnitude between the outcomes for any particular area. Unless we know the landscape area that is represented by groups, how do we understand the magnitude of difference? It could be radically different.

One measure could be 50% is openings. If we called it 50% residual canopy cover, then this would be 25% canopy cover by my definition.

We haven't said what the residual is.

Can we define an approach that would describe the openings. We want to see proportions of groups.

How should we describe this? I think there is some agreement about what restoration is? I think we understand the measurement. We would have to have plan amendments, etc.

I am talking about the science that describes the requirements, the forest plans, etc. These are required for the viability of the species.

To me it is more important to know where the trees are on the ground.

When you look at the literature, you have to remember that silv evolved with even-aged mgt. In the SW it is different where you need the rooting space to support groups and clumps. On the W/L side, I have never seen one standard, there is no consistent measurement used. I don't think that what is proposed is different than any of those measures.

Can the FS provide a glossary of terms with specific definitions? I would like to ask the FS to provide a description of the methodology that bridges the agreement in the field and the disagreement in the conference room. We need to resolve this.

How can we understand the magnitude the difference between these methods and understand it in a timely fashion? Is there an opportunity or way to proceed with planning so that we know what we are

commenting on and not agreeing to? Can you point out some scenarios and show this specific to canopy cover and how to meet goshawk guidelines? We need more information on this.

You could simulate this for pre and post treatment with the different methodologies and get an idea of what it would look like on the ground (Steve S). Could Forest ERA do this rapidly? For a specific area?

Can you clarify the approach that you are recommending for canopy cover? Doesn't the MSO recovery plan require canopy cover at the stand level?

Can you provide additional explanation of the thinning prescriptions being proposed? We know the area left in opening, but we know very little about the forested areas. Is the space left in groups? We need to understand the attributes of the residual forest, and describe this collaboratively.

Are you looking for the desired post treatment conditions?

I think you will have to look at images so that you understand the anticipated outcome. We don't want surprises about what will be left behind. It is critical to monitoring, so that I know I am measuring the right thing so that the silvicultural treatments are producing the same as what I define for monitoring.

Can you provide the definitions, metrics and so on for the effects analysis?

Point person is Taylor McKinnon who will send out an email about the discussion regarding canopy cover. Marcos will lead the discussion about the strategic placement of treatments.

Matt will get with Mark Nigrelli regarding GIS.

**Additional Notes Taken at Meeting**

Q: Will opening be included when calculating canopy cover, at what scale?

Q: How are openings calculated between stands? Will the approach be detailed for the public?

Q: Will maps come out with wildlife filters? Per treatment zone or single filter?

Q: Will next map show likely treatment areas? Will treat- might treat – will not treat

Recommendation: Clarify strategic placement of filters, esp. wildlife

Recommendation: Analyze all areas – regardless of priority

Recommendation: Look at entire KV line across the TAs

Q: What approach is being used in transition zones?

Firescape 3- TA 1

Q: Will intermediate thinning and SI be used?

Q: Would fire be used in wildlife area?

Q: Is post tornado plan included in Firescape 3, Treatment Area 2?

Recommendation: Monitor effects of treatment on water yield

Recommendation: Sycamore Primitive Study Areas – area to study water yield

Q: Do we have true heterogeneity as a result of treatments in 3-2 and 3-3?

Recommendation: Update fire model assumptions/validate

Q: Is the state cooperating on state lands? If so, how?

Recommendation: Oak Creek – West Fork – in TA 3-5 – consider treatments for fire – use existing roads

Recommendation: Re-assess Kachina/Mountainaire compatibility and results

Recommendation: Repeat public meeting in Williams for FS 4

Recommendation: Consider ground water recharge in tree selection – affects Woody Mountain Area water supply

Recommendation: Carefully design for wildlife corridors at water museum

Recommendation: In Firescape 6-1, assess results of past activities to determine need for fire treatment

Recommendation: Protect asset values in 6-1

Q:What is the arch density in 6-2?

Q:Website means where? Kaiabab

Recommendation: Put links to related sites

Recommendation: Make data (GIS) available to non-FS entities – fire, treatment layers (label and date as draft)

Q:When does effectiveness monitoring appear in analysis?

Q:How will monitoring methods differ from past FS methods and designs?

Recommendation: Make overt FS commitment to monitoring (cost sharing with others)

Q: Will an outline proceed the final monitoring plan?

Q: Is VSS 1 considered a group or opening?

Q: If VSS 1 is included it should be included in calculating canopy cover

Q: Will BA be used at stand scale for CC%?

Q: Are stands stratified first?

Q: WHR should be used for canopy cover

Recommendation: Clearly outline methodology used to calculate canopy cover

Recommendation: Develop pictures of DFC

Recommendation: Explain any departure from forest plan'

Recommendation: Clarify difference between tree cover vs canopy cover

Recommendation: Include methods in a glossary

Q:How do we know the potential magnitude of outcome difference with different descriptions?

Q: Use AM and monitoring to assess differences

Recommendation: Develop methodology to reach agreement on canopy cover

Q: Is there a way to proceed with planning with differences noted/tested? Develop scenarios to test/model differences to be able to understand magnitude – test groups, within groups, by stand, etc.

Q: Is a different RX method being used in MSO habitat?

Q: Additional descriptions of thinning and details available? Details of remaining areas in TAs?

4 Forest Restoration Initiative Web-Comment Portal

February 26, 2011

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/26/2011 22:18:04 | Yes | N/A | Unaffiliated individual | John E Ryberg | slots918@commspeed.net | 3875 W Pike | Camp Verde | AZ | 86322 | E-Mail | None yet |

Add to contact list

02 26 011 - 20

2011-03-01 -21

**Department of Energy**
Western Area Power Administration
P.O. Box 281213
Lakewood, CO 80228-8213

MAR 01 2011

Henry Provencio, 4 FRI Team Lead
Coconino National Forest
Attention: Four Forest Restoration Initiative
1814 S. Thompson St.
Flagstaff, AZ 86001

Dear Mr. Provencio:

Western Area Power Administration (Western) has reviewed the January 25, 2011 *Federal Register* notice concerning preparation of an environmental impact statement for the four forest restoration initiative (4FRI) involving National Forest System lands in the Coconino and Kaibab National Forests initially with the Tonto and Apache-Sitgreaves National Forests issuing a companion initiative next year. Western, as a power marketing agency within the Department of Energy, owns transmission lines and related facilities that traverse the forested lands to be restored. These facilities include transmission lines and access to them for the purposes of construction, reconstruction/upgrade, operation and maintenance of the powerlines, as well as fixed communication sites and access to those as well.

Under the 4FRI, the U.S. Forest Service is proposing to cut trees to thin the forests and remove hazardous fuels. It also is proposing to conduct prescribed burns to clear openings and maintain those openings over time. Any activities associated with tree cutting or controlled burning that will occur near or beneath Western's overhead transmission lines or adjacent to one of its fixed sites should be coordinated with Carla Cristelli, Realty Specialist, in Western's Desert Southwest Regional Office, telephone (602) 605-2554. Please call Ms. Cristelli to discuss the areas where trees will be cut or fires will be ignited to ensure Western has no concerns. Ms. Cristelli will also contact Western crews working in the same area where these activities are occurring to alert them about the felling of trees and the possibility of prescribed burns. 1

Another expected outcome of this restoration initiative is to reestablish the desired forest condition where Gambel oak and aspen are present and reproducing. Western supports new growth in the restored forests, but must ensure that any tree species planted underneath or adjacent to its transmission line right-of-way will remain at a height low enough to avoid a vegetation caused outage. Gambel oak and aspen can attain heights over the accepted minimum electrical safety standard for encroachments. Any tree that exceeds that minimum vegetation clearance distance will be removed or trimmed to ensure the safe operation and reliability of the electric power grid. 2

The Coconino and Kaibab National Forests are also planning to decommission closed and unauthorized roads. If a road proposed to be decommissioned is one used by Western to access its facilities, and there are no alternative routes available to the transmission line structure or fixed site, Western will seek an authorization for that road. 3

For additional information or if you have questions, please contact Susan Starcevich at (720) 962-7275 or starcevi@wapa.gov.

Sincerely,

Steven W. Webber
Lands Team Lead

2011-03-04-22



lbaker@blm.gov
03/04/2011 09:41 AM

To 4FRI_comments@fs.fed.us
cc choryza@blm.gov, bhudgens@blm.gov, Lisa_Treichel@ios.doi.gov
bcc
Subject Notice of Intent to prepare an Environmental Impact Statement (EIS) for the Four Forest Restoration Initiative; the Williams and Tusayan districts of the Kaibab National Forest and the Flagstaff, Mogollon Rim, and Red Rock districts of the Coconino National Forest, Coconino County, AZ -- ER11/0086

History: This message has been forwarded.

Thank you for the opportunity to comment on the Four Forest Restoration Initiative. The proposed action would pertain to BLM lands within the Hassayampa Field Office jurisdiction. Due to the nature of lands in the proposed project area (scattered intermittent parcels), the BLM has determined that the proposed action will have no impact on BLM lands in the area and has no further comment on the proposed action and impact analysis.
. . . . . .
. .

Leah Baker
Planning & Environmental Coordinator
Bureau of Land Management
Phoenix District Office
623.580.5656

Chris
Horyza/AZSO/AZ/BL
M/DOI

02/28/2011 07:56
AM

To Leah Baker/PDO/AZ/BLM/DOI@BLM
cc
Subject Fw: ENVIRONMENTAL REVIEW (ER) NEW POSTING NOTIFICATION: ER 11/0086

I think all these forests are within the Hassayampa FO. If you are not going to comment, send a negative declatation to that affect.

Chris Horyza
Planning and Environmental Coordinator
BLM, Arizona State Office
602-417-9446
----- Forwarded by Chris Horyza/AZSO/AZ/BLM/DOI on 02/28/2011 07:55 AM -----

Brenda

4 Forest Restoration Initiative Web-Comment Portal

March 4, 2011

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/4/2011 8:29:22 | Yes | N/A | Unaffiliated individual | Gary Gumbel | ggum1947@hotmail.com | 8388 Garden Home Trail, Snowflake | AZ | 85937 | E-Mail | This whole project is lip service for the Forest Service. In past years, Snowflake has borne the brunt of relentless smoke from uncaring government groups. The problem is when they decide to control burn (you dont know until its too late to leave the area), there is NO collaboration between the 7 national forests in Arizona. On any given day, we recieve smoke from 14 different fires plus smoke from un-attended lightening strikes. Arizona has 8 million acres of forests, busting at the seams, growing as we speak your efforts are a drop in the bucket , producing horrific health problems for many. |

2011-03-04-23

2011-03-06 - 24

March 6th, 2011

To Whom It May Concern:

I wanted to take a minute to send a few comments regarding the Stoneman Lake/Happy Jack/Mormon Lake/Apache Mead areas. As a forth generation/pioneer family I hope you will take my concerns to heart. I strongly support and advocate for cleaning and thinning/logging of the forest areas. If this is not done, I fear another Rodeo Chediski type fire will occur in this area as well. My family still owns 32 acres in this area and similar tragedy would be devastating. Having spent most of my childhood years in the area I have a strong attachment to this much-loved land, and I feel maintaining the forest land is critical to keeping its beauty. I hope you will take consider our opinions when making decisions for this area and help maintain one of Arizona's most valuable resources.

Sincerely,

*Bill Bunger*
On behalf of the Bunger Family

b_bunger59@yahoo.com

2011-03-07 -25

Dorothy Holasek
PO Box 1340
Snowflake AZ 85937-1340

March 4, 2011

USDA
Forest Service
Carl Stewart, Coconino Forest Supervisor
1824 South Thompson Street
Flagstaff AZ 86001

Dear Mr. Stewart,

This letter is in response to the public comment period on the Four Forest Restoration Initiative. In evaluating the Forest Service's plan to include prescribed burns in their operation to maintain spacing of trees or any other burning practices such as for disposal of slash piles, I am requesting that the Forest Service include in their study the amount of cesium-137 and strontium-90 that will be released into the air from the burning. 1

Northern Arizona has a tragic history from above ground atomic testing during the 1950's and 1960's of being the recipient of ten times the amount of radioactive isotopes as were released during the 1986 Chernobyl accident. The long lived cesium-137 and strontium-90 precipitated into the soils of our national forests and were drawn up and stored in the vegetation. When we burn this vegetation we are directly responsible for exposing the downwinders that still live in northern Arizona to the same cesium-137 and strontium-90 that the Department of Energy, through their RESEP program, is currently paying $50,000 per cancer related case. Also we are exposing non-downwinders to the same clearly established deadly isotopes. 1

It takes 300 years before these isotopes are considered safe to ingest. Breathing smoke containing these isotopes is considered ingesting them according to Peer reviewed medical literature on the subject. When the fires of 2010 reached the forest surrounding Chernobyl, Europe reacted with grave concern and sent firefighters so that she would not be dosed again with the same radioactive isotopes. We should learn from Europe's experience.

It is my opinion that proceeding with any prescribed burns by the Forest Service whether in this Four Forest Restoration Initiative or otherwise is gross negligence without a full scientifically reproducible, peer-reviewed study and resulting disclosure to the public of the amount and kinds of radioactive isotopes that the public will be exposed to. In addition, I am requesting that the Forest Service conduct a study to find methods to replace prescribed burns that will encourage forest health without endangering human health. dup 9 1

Sincerely,

Dorothy Holasek

cc: McCain, Kyl, Gosar, Barton, Crandall, Brown

2011-03-07 -26



"Cyndy Cole"
<CCole@azdailysun.com>
03/07/2011 11:05 AM

To <pcote@fs.fed.us>
cc
bcc
Subject 4fri

Hey there:

I've been getting some of the past info … but just making sure: Can I be on the list for the scoping letter that is to come?

Cyndy Cole
News Reporter
Arizona Daily Sun
Flagstaff, Arizona
office 928 913 8607
fax 928 774-4790

Received 2011-03-08
27

GREATER FLAGSTAFF FORESTS PARTNERSHIP

**1300 S. Milton, #209**
**Flagstaff AZ 86001**

**www.gffp.org**

Mar 7th, 2011

Henry Provencio
Four Forests Restoration Initiative Team Leader
Coconino National Forest
1824 S. Thompson Street
Flagstaff, AZ 86001

SUBJECT: Rio de Flag Watershed - Firescape #5

Dear Henry:

1 The Greater Flagstaff Forests Partnership (GFFP) heartedly gives our support to the recent discussion regarding the Schultz Creek and Ft Valley areas (Rio de Flag Watershed - RFW) within Firescape #5. Planning for, and implementing needed forest treatments within this landscape makes sense from both an ecological and social standpoint.

2 The health and resiliency of watersheds is critical to our forests and their sustainability. The RFW is especially important to the Flagstaff community; the resulting flooding following a severe wildfire would be catastrophic to the City and those from the surrounding area who work, shop, or otherwise depend upon city services and infrastructure. This is in addition to the ecological impacts created by the fire itself - loss of wildlife habitat, likelihood of invasive species establishment, soil loss, etc.

3 The Ft. Valley area was our first focus area, dating back to 1998-2000. NEPA planning was completed and some initial treatments were completed. Expansion of past forest treatments, and their on-going maintenance, is important. This area was also the site of many research and monitoring projects, an important component of adaptive management.

The Schultz Creek area was likewise part of a GFFP planning area, completed roughly five years ago. Forest treatments in that area have not been implemented. As with Ft. Valley, forest treatments in the area need to be implemented and maintained over time.

general In 2004, we were one-of-two entities (the other being the Ponderosa Fire Advisory Council) which spearheaded the development and adoption of the Greater Flagstaff Area Community Wildfire Protection Plan (GFA-CWPP). It was subsequently adopted by both the Flagstaff City Council and Coconino County Board of Supervisors, and approved by the AZ State Forestry Division.

Our CWPP (*http://www.gffp.org/PDF_Pages/CWPP_Report.htm*) developed over an eight-month period in a public forum, and incorporating data provided by Northern Arizona University's Forest Ecosystem Restoration Analysis (Forest ERA) team, clearly identifies the RFW as a priority area for future forest treatments.

4

The recent Schultz wildfire and subsequent flooding emphasizes the urgency of the matter. With the on-going environmental planning efforts, highlighted by the recent Firescape discussions, it now seems like the ideal time to move forward in a collaborative fashion on this landscape.

We recognize that differences exist between the *Interface Zone* of the CWPP and the *Community Protection Management Areas* as defined in the Wood Supply Study and utilized in the Landscape Restoration Strategy. In the simplest explanation, the former were identified using a matrix of six overlapping criteria and the later to determine potential wood volumes; the former were adopted by the community at-large with a goal of protection, while the later was done so by a stakeholder group focused on a larger landscape and for a different purpose. Regardless, our joint focus should be toward restoration of the watershed as a whole – to address its protection, enhancement, and resiliency.

5

In closing, we appreciate the opportunity to provide comment, and look forward to working with both the Stakeholder group and the USFS on this effort.

Sincerely,

Paul Summerfelt
President, Board of Directors

CC: Congressman Paul Gosar
Forest Supervisors - Coconino, Kaibab, Tonto, and Apache-Sitgreaves National Forests
Flagstaff City Council and City Manager
Coconino County Board of Supervisors and County Manager
4FRI Stakeholder group
GFFP Partnership Advisory Board members

# COMMUNITY WILDFIRE PROTECTION PLAN

*for*
*Flagstaff and Surrounding Communities*
*in the Coconino and Kaibab National Forests*
*of Coconino County, Arizona*

**January 2005**

---

A collaborative planning and implementation effort coordinated by:

*Greater Flagstaff Forests Partnership*
*&*
*Ponderosa Fire Advisory Council*






Community Wildfire Protection Plan for Flagstaff and Surrounding Communities in the Coconino and Kaibab National Forests of Coconino County, Arizona

# TABLE OF CONTENTS


**Signature Page**
**Introduction**
Context . . . . . 1
Goal . . . . . 1
Partners . . . . . 2
Principles . . . . . 3
Process . . . . . 4
Relationship to Other Plans . . . . . 5
For More Information . . . . . 6
**Community Identification and Description**
Analysis Area . . . . . 7
Wildland/Urban Interface Zone . . . . . 15
**Community Assessment**
Fuel Hazard . . . . . 19
Risk of Ignition & Occurrence. . . . . 24
Community Values-At-Risk . . . . . 27
Community Preparedness & Protection Capability . . . 28
**Community Mitigation Plan**
Fuel Hazard Reduction . . . . . 30
Desired Future Conditions . . . . . 30
Treatment Guidelines . . . . . 31
Wildfire Prevention and Fire Loss Mitigation . . . . 37
Improved Protection Capabilities . . . . . 40
**Implementation and Monitoring**
Community Mitigation Treatments . . . . . 44
Priority Areas and Treatment Costs . . . . 45
Predicted Treatment Effects . . . . . 50
Monitoring and Assessment Plan . . . . . 50
Roles & Responsibilities of Stakeholders . . . . 56
**Assistance** . . . . . 58
**Glossary** . . . . . 60
**Appendices:**
Appendix 1 – GFFP and PFAC Membership . . . . . 63
Appendix 2 – Guiding Principles for Forest Restoration and Community Protection. . . . . 65
Appendix 3 - Attributes utilized to develop Threat Map . . . 74
Appendix 4 – PFAC Operating Plan . . . . . 80
Appendix 5 – PFAC Smoke Management Plan . . . . 89
Appendix 6 – Utilization: Vision, Accomplishments, Plan . . . 93
Appendix 7 – Coconino National Forest Prevention Plan . . . 100
Appendix 8 – After the Fire . . . . . 108
Appendix 9 – GFFP Monitoring & Research Team Adaptive Management Framework . . . . . 116

# LIST OF FIGURES


Photo 1 - Volunteers preparing a future prescribed fire site . . . 2
Photo 2 - A treated forest . . . . . 2
Photo 3 - A FireWise Home . . . . . 2
Map 1 - Analysis Area, Communities . . . . . 8
Map 2 - Analysis Area, Land Ownership . . . . . 9
Map 3 - Analysis Area, Predicted Fire Behavior, Current Conditions . 12
Map 4 - Analysis Area, Threat Level . . . . . 14
Map 5 - Wildland/Urban Interface . . . . . 17
Photo 4 - A common scene in today's forest . . . . . 19
Map 6 - Analysis Area, Dominant Overstory Vegetation . . . 20
Map 7 - Analysis Area, Tree Density . . . . . 21
Map 8 - Completed Treatments, City of Flagstaff – July 2004 . . 24
Map 9 - Analysis Area, Fire Risk . . . . . 26
Map 10 - Rodeo/Chedeski Fire Boundary Overlay on Flagstaff Area . 28
Photo 5 - "Traditional" harvesting operation . . . . . 34
Photo 6 - "Micro" harvesting: cutting with a small shear . . . 34
Photo 7 - "Micro" harvesting: Skidding wood with an ATV . . . 34
Photo 8 - Pile burn operation . . . . . 35
Photo 9 - Broadcast burning . . . . . 35
Photo 10 - Public involvement is critical to success . . . . 37
Map 11A - Wildland/Urban Interface, Potential Treatment Type . . 47
Map 11B - Analysis Area, Potential Treatment Type. . . . . 48
Map 12A - Wildland/Urban Interface, Predicted Post-Treatment Effects
On Fire Behavior . . . . . 51
Map 12B - Analysis Area, Predicted Post-Treatment Effects
On Fire Behavior . . . . . 52
Map 13 - Comparison of Pre and Post-Treatment Fire Behavior . . 54


# LIST OF TABLES


Table 1 - Ownership/Jurisdiction – Analysis Area . . . . 7
Table 2 - Threat Matrix . . . . . 10
Table 3 - Predicted Pre-Treatment Fire Behavior, Analysis Area . . 11
Table 4 - Threat Level, Analysis Area . . . . . 13
Table 5 - Threat Level by Ownership/Jurisdiction, Analysis Area . . 15
Table 6 - Ownership/Jurisdiction, Wildland/Urban Interface zone . . 18
Table 7 - Principles of Fire Resistant Forests . . . . 31
Table 8 - Acreage & Estimated *Initial* Treatment Costs . . . 49
Table 9 - Post Treatment Predicted Fire Behavior . . . . 53
Table 10 - Roles and Responsibilities of Key Stakeholders . . . 57

# SIGNATURE PAGE

***Prepared and Submitted by:*** *(for the CWPP Development Team)*

Steve Gatewood, Program Director – GFFP — DATE 10/4/04

Paul Summerfelt, Member – PFAC — DATE 10/4/04

***Concurrence by:***

Debra Larson, Chair – GFFP — DATE 10/12/04

Nora Rasure, Supervisor – Coconino National Forest — DATE 11-10-04

Palma Wilson, Superintendent – Flagstaff Area National Monuments, National Park Service — DATE 11/1/04

***Approved by:***

Joseph Donaldson, Mayor – City of Flagstaff — DATE 19 NOV 04

Deborah Hill, Chairman – Coconino County Board of Supervisors — DATE Dec 7, 2004

Don Howard, Chair – PFAC (Representing Fire Departments & Fire Districts) — DATE 10/13/04

Kirk Rowdabaugh –State Forester Arizona State Land Department — DATE 1/10/05

# INTRODUCTION

## CONTEXT

Wildfire is a natural event within the southwestern ponderosa pine forest. Its very occurrence is a necessary ingredient to a healthy ecosystem. However, historic fires were predominantly frequent surface fires of low intensity that thinned the forest of fuel accumulations, with occasional intense stand replacement fires occurring in patchy areas or under extreme fire conditions. Due to past societal demands and land-management practices, natural fuel accumulations have been increasing for decades, resulting in an escalating trend in uncharacteristic, danger-ous, destructive, and costly wildfires.

When a forest is "healthy" it would support low intensity, ground fires every 2-20 years across the landscape. Every year hundreds of thousands of acres of surface fuels would burn through natural ignitions or ignitions by native (pre-European) peoples. Thus, one of the best defenses against "catastrophic crown fires" is to live with and adapt to the type of fire that is natural to the system. As one of the goals of the national fire plan states, a "Community-based approach to wildland fire issues combines cost-effective fire prepared-ness and suppression to protect communities and the environment with a proactive approach that recognizes fire as part of a healthy, sustainable ecosystem."

The 1996 fire season in our area clearly focused public attention on the plight of our forests and the risk posed by catastrophic wildfire. The result was an energized community committed to action, the founding of the Greater Flagstaff Forests Partnership (GFFP), and the increased involvement of the Ponderosa Fire Advisory Council (PFAC). Since that time, continued wildfire activity and on-going education and mitigation efforts have resulted in widespread public support of and an expectation for forest treatments. In addition, as we become more effective with our treatments, land managers will be able to make greater use of characteristic, low intensity fires through prescribed burns, appropriate wildland fires for resource benefit and containment of wildland fires as more effective, cost efficient strategies – a true measure of living with and adapting to a fire-dependent ecosystem.

Community protection and preparedness is a critical step toward mitigating immediate fire hazards and restoring adjacent wildlands. A combination of fuel management, FireWise standards, and appropriate fire-use and/or suppression response across ownerships within-and-adjacent to at-risk communities will reduce threats to life and property, protect values-at-risk, and create a safe context for the use of fire in subsequent forest ecosystem:
restoration efforts. This plan outlines actions needed to prepare and equip the greater Flagstaff community to live and thrive within our fire-adapted ponderosa pine forests.

## GOAL

To protect Flagstaff and surrounding communities, and associated values and infrastructure, from catastrophic wildfire by means of:

a) An educated and involved public,
b) Implementation of forest treatment pro-jects designed to reduce wildfire threat and improve long-term forest health, in a progressive and prioritized manner, and
c) Utilization of FireWise building techniques and principles.

The Community Wildfire Protection Plan (CWPP), authorized by the Healthy Forests Restoration Act of 2003, is a strategic plan as well

as an action plan: it provides a broad operating framework for all agencies and ownerships – private, city, county, state, and federal – within the area, while identifying community protection priorities. Site specific planning and implementation remains the responsibility of each owner/jurisdictional agency, acting in concert with the guidelines expressed within this plan.



Photo 1: Volunteers preparing a future prescribed fire site



Photo 2: A treated forest

Fuel management treatments designed to reduce the threat of catastrophic wildfire and protect communities incorporate the principles of ecological restoration. Practices designed to reduce excessive numbers of smaller trees, retain large trees, and accept natural fire (or apply prescribed fire to mimic the natural event) are key to reducing the wildfire threat in our area. These treatments, along with other practices over a period of time, are required to create the conditions necessary for an improvement in overall forest ecosystem health.



Photo 3: A FireWise Home

## PARTNERS:

PFAC is a 16 member group of local emergency and prevention fire agencies; GFFP is a 27 member group committed to ecological forest restoration and community wildfire protection. Membership for each organization is included in Appendix 1. Both groups have partnered to coordinate development of this plan. Staff of the Coconino National Forest (USFS), which is a member of PFAC and operates under a Memorandum of Understanding with GFFP, have been consulted throughout this process as well.

Both PFAC and GFFP, in concert with strong citizen support, have been collaborating for years to reduce the risk of wildfire. Traditionally, PFAC has focused on response to fire events and public education designed to lessen the risk, while GFFP has designed forest restoration and community protection projects in 10,000-acre blocks around the greater Flagstaff area.

Signed by President Bush in December 2003,

the Healthy Forest Restoration Act (HFRA) requires development and approval of a CWPP by communities who wish to receive priority funding for implementation of forest treatments designed to reduce wildfire risks to their respective community.

The GFFP and PFAC have identified five mutual objectives: though not all are specifically referenced or included in the CWPP, they nonetheless influenced plan development. They are:

- Create a healthy and sustainable forest and protect communities by implementing forest treatments designed to reduce the threat of catastrophic wildfire.
- Engage the public by providing opportunities in both preparedness and mitigation efforts.
- Support efforts to establish effective and sustainable methods to utilize small-diameter wood and other forest biomass.
- Promote FireWise building materials and construction techniques, as well as creation and maintenance of defensible properties and neighborhoods.
- Attract necessary funding (appropriations, contracts, donations, grants, etc.) to successfully reduce fire threat.

Both groups take seriously their respective responsibility to resolve the issues we – as a greater community – now face. Together, we are committed to action that will reduce wildfire threat across jurisdictions and within our mutual area-of-interest.

The Northern Arizona University Forest Ecosystem Restoration Analysis (ForestERA) project was engaged to provide baseline data and analysis to assess the impacts of ponderosa pine restoration and fuel-reduction treatments. Using the latest available data (2001 satellite imagery), spatial analysis tools in an ArcGIS environment were used to:

- Identify areas for management focus,
- Provide baseline data on current condi-tions (vegetation, canopy closure, etc.),
- Design treatment scenarios and test and compare the cumulative effects of these modeled treatments on fire behavior, and
- Predict fire hazard and behavior across the entire *Analysis Area.*[+]

It is recognized this is a "coarse-filter" approach restricted to ponderosa pine forest ecosystems that does not exactly match what various agencies would utilize to plan and implement site-specific treatments. Therefore, information presented throughout this plan can and should be augmented by the Jurisdiction-Having-Authority (JHA) with site-specific data during project planning efforts. This may result in adjustments of priorities, locations, and treatments.

The inclusion, application and analysis of ForestERA data is intended to provide a framework for discussion and illustrate both the threat and potential impacts of a range of treatments that could be applied throughout both the *Wildland/Urban Interface* zone and the entire *Analysis Area.*

## PRINCIPLES:

Development of the CWPP has been guided by the following framework:

- ***Fuel Management:*** Reduction of target hazardous fuels is based upon known fire risk, fire behavior, and threats to values-at-risk.
- ***Social and Political.*** Social and political concerns play a major part in defining treatments and their locations.
- ***Operational:*** Due to financial, infra-structure, and personnel constraints, emphasis must be placed on strategically located fuel treatments designed to protect key values-at-risk, and that can serve as anchor points for larger,

[+] NOTE: Interested parties are invited to visit the ForestERA website (www.forestera.nau.edu) for a more detailed discussion of available data and their modeling process.

landscape-scale treatments.

- ***Ecosystem:*** Reduction of hazardous fuels should be integrated with overall ecosystem conservation, restoration and management goals.
- ***Economic:*** Implementation and main-tenance of fuel treatment benefits greatly outweigh their costs
  - They save money by avoiding suppression expenditures, rehabil-itation costs, and compensation for property damage
  - They are an investment in protect-ing firefighter and civilian lives
  - They present new opportunities for rural economic development
  - They may help address issues related to the availability of homeowner's insurance in fire prone forest ecosystems

***Ethical:*** The continuing decline in forest health and the increasing probability of catastrophic fires, and their potential impact on the greater Flagstaff region, is a reality. The need to act now to restore forest health and reverse this dangerous downward spiral is of utmost importance.

In addition, the Arizona Governor's Forest Health Advisory Council developed a set of *"Guiding Principles for Forest Restoration and Community Protection"* through collaboration by a wide variety of forest professionals to help communities think through how to articulate a plan of action for restoring their forests, and for protecting their communities. Those Principles are included as Appendix 2 and were used during development of this plan and in the design of actions to achieve our goal.

## PROCESS:

Development of the CWPP incorporated the eight steps outlined in *"Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities"* (March 2004).

These steps are:
**Step One:** Convene decision makers.
**Step Two:** Involve federal agencies.
**Step Three:** Engage interested parties.
**Step Four:** Establish a community base map.
**Step Five:** Develop a community risk assess-ment
**Step Six**: Establish community hazard re-duction priorities and recommendations to reduce structural ignitability.
**Step Seven:** Develop an action plan and assessment strategy.
**Step Eight:** Finalize the Community Wildfire Protection Plan.

In addition, we endeavored to reflect the standard themes of any emergency plan – Prevention, Mitigation, Response, and Recovery – where appropriate in the plan.

To facilitate development of the CWPP, both PFAC and GFFP, operating together, initiated the following:

1. Issued a press release outlining the effort and offering the public opportunities to become involved and offer comment (CWPP Project Record).
2. Split development of the five sections into separate work groups, with on-going consultation with the USFS.
3. Conducted regular outreach to the community via:
   A. Posting of Development Team meetings in the *AZ Daily Sun*
   B. Informational insert in the July 4th and July 11th edition of the *AZ Daily Sun* – 13,000 copies each day
   C. Article in the summer edition of *CityScape* – 34,000 copies
   D. Article in newsletters.
      1) Summit Fire District – 3,200 copies
      2) Continental Home Owner Asso-ciation (HOA) – 2,400 copies
   E. E-Mail posting to employees –

announcement of CWPP planning effort:
1) City of Flagstaff – 600 addresses
2) Coconino County – 750 addresses

F. Meetings/Programs/Presentations:
1) GFFP *Community Forest Forum* – June 1
2) Flagstaff Mayor's Community Leadership Group – June 15
3) Community Open-House (Flagstaff) – June 16
4) Coconino County Board of Supervisors (Flagstaff) – July 13
5) Power-point overview provided to all City of Flagstaff employees – July
6) Sedona Fire District Board of Directors (Sedona) – July 27
7) Highlands Fire District Board of Directors (Kachina Village) – August 11
8) Pinewood Fire District Open House (Munds Park) – August 21
9) Joint session Flagstaff City Council and Coconino County Board of Supervisors – September 13
10) Kachina Village Open Space event – September 25
11) Parks-Bellemont Fire District Public Meeting (Parks) – September 30

G. Periodic updates in City of Flagstaff Weekly Report.

4. Met with 20 members of the *Communities Committee* (developers of *"Preparing a Community Wildfire Protection Plan*") on April 30th.
5. Drafts of individual sections were reviewed, edited, and compiled into a working draft CWPP document.
6. Monthly status updates were provided at both the PFAC and GFFP Partnership Advisory Board meetings.
7. All members of PFAC and GFFP, along with the public, were afforded an opportunity to provide comment on the working draft.
8. A Final Draft was then prepared and distributed, followed by a formal 45-day public comment period. Nine formal comments were received, with most items incorporated into the Final Plan.
9. Finally, the CWPP:
   A. Received **Concurrence** by the GFFP, PFAC, the Coconino National Forest and the National Park Service.
   B. Was **Approved** by the Coconino County Board of Supervisors, Flagstaff City Council, local Fire Departments and Fire Districts, and the AZ State Land Department – Fire Management Division.

Coordination occurred with both the Kaibab National Forest and the Williams Interagency Fire Advisory Council regarding areas both west and northwest of this CWPP area, and will continue as they work toward development of a CWPP in their area. Other adjacent areas, such as the Blue Ridge area, will be monitored and coordination will occur as they begin development of CWPPs or are added to this plan by amendment. In addition, the CWPP for Flagstaff and surrounding communities will be reviewed in six months and then annually by a CWPP Review Team consisting of representatives of PFAC, GFFP, the USFS, local governments, environmental groups and citizens. If substantive changes are required, it will be submitted to the appropriate authorities for review and approval.

## Relationship To Other Plans

In March 2000, the then Grand Canyon Forests Partnership (GCFP), later renamed the GFFP, in partnership with PFAC, developed a "*Flagstaff Area Wildfire Risk Assessment"* report. That report detailed wildfire risk in the greater Flagstaff area generally based upon a half to 1 mile set-distance from selected communities within the boundaries of the GCFP. This CWPP supercedes that earlier document: we have expanded the analysis area, incorporated additional communities, and utilized data not

available at the time of the earlier report to develop a more realistic picture of both threat and need.

This plan is compatible with and inclusive of on-going planning and implementation efforts of various agencies and jurisdictions engaged in its development. In addition, this plan is designed to compliment both existing and developing emergency/disaster management plans and Homeland Security related efforts.

## For More Information

This plan is posted on the GFFP website at www.gffp.org. Individuals interested in learning more are encouraged to contact either PFAC or GFFP via email at:

fuelmanagement@ci.flagstaff.az.us

or:

info@gffp.org, respectively.

# COMMUNITY IDENTIFICATION AND DESCRIPTION

## ANALYSIS AREA

Map 1 depicts Flagstaff and surrounding communities at-risk included in the CWPP *Analysis Area*. The *Analysis Area* includes portions of two counties (primarily Coconino, with a very small part of Yavapai), two cities and their associated adjacent areas (Flagstaff and Sedona), several unincorporated communities (Munds Park, Mormon Lake, Parks/Bellemont, Cosnino/Winona), the greater Flagstaff Metropolitan Planning Organization area (joint County-City of Flagstaff planning effort), two National Forests (primarily the Coconino, with a small part of the Kaibab), and the Flagstaff-area National Monuments.

Map 2 depicts ownership within the plan boundary. Acreage breakouts for the *Analysis Area* are shown below:

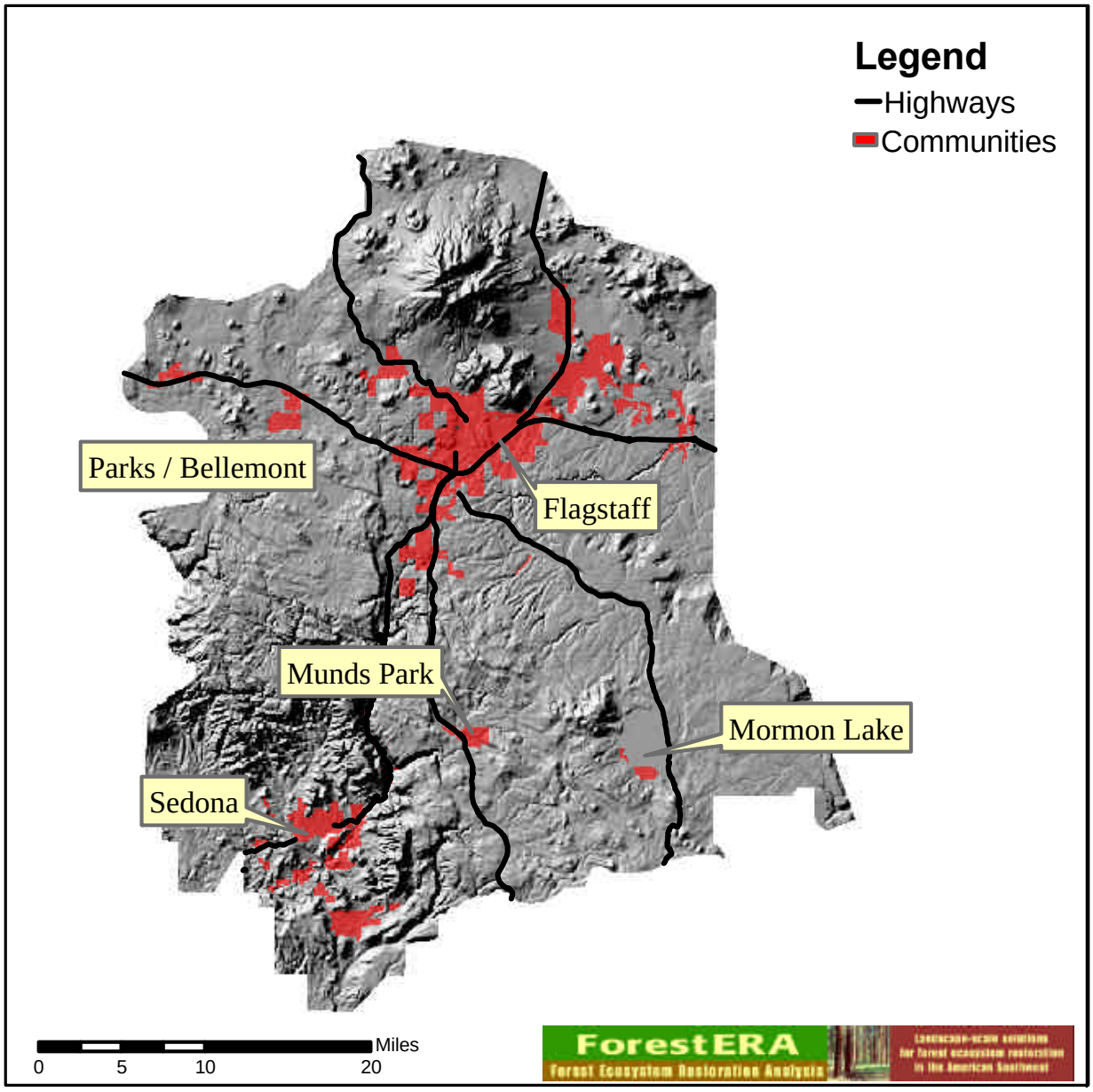
**Table 1**

**Ownership/Jurisdiction – *Analysis Area***

| Ownership/Jurisdiction | Acres | % of Total |
|---|---|---|
| Federal: | | |
| Flagstaff Monuments | 4,832 | 5% |
| Coconino National Forest | 763,064 | 81.0% |
| Kaibab National Forest | 28,619 | 3.0% |
| State: | | |
| Land Department | 34,575 | 3.5% |
| Camp Navajo (Division of Military & Emergency Affairs) | 26,371 | 3.0% |
| **Private/Other** (includes local government) | 82,275 | 9.0% |
| **TOTAL** | **939,736** | **100%** |

The roughly 1,465-square mile *Analysis Area* stretches from the San Francisco Peaks to below the Mogollon Rim, and is in the midst of the largest continuous ponderosa pine forest in the world. The full-time population of the area is approximately 75,000, with another 20,000+/- visitors in the area on any given day.

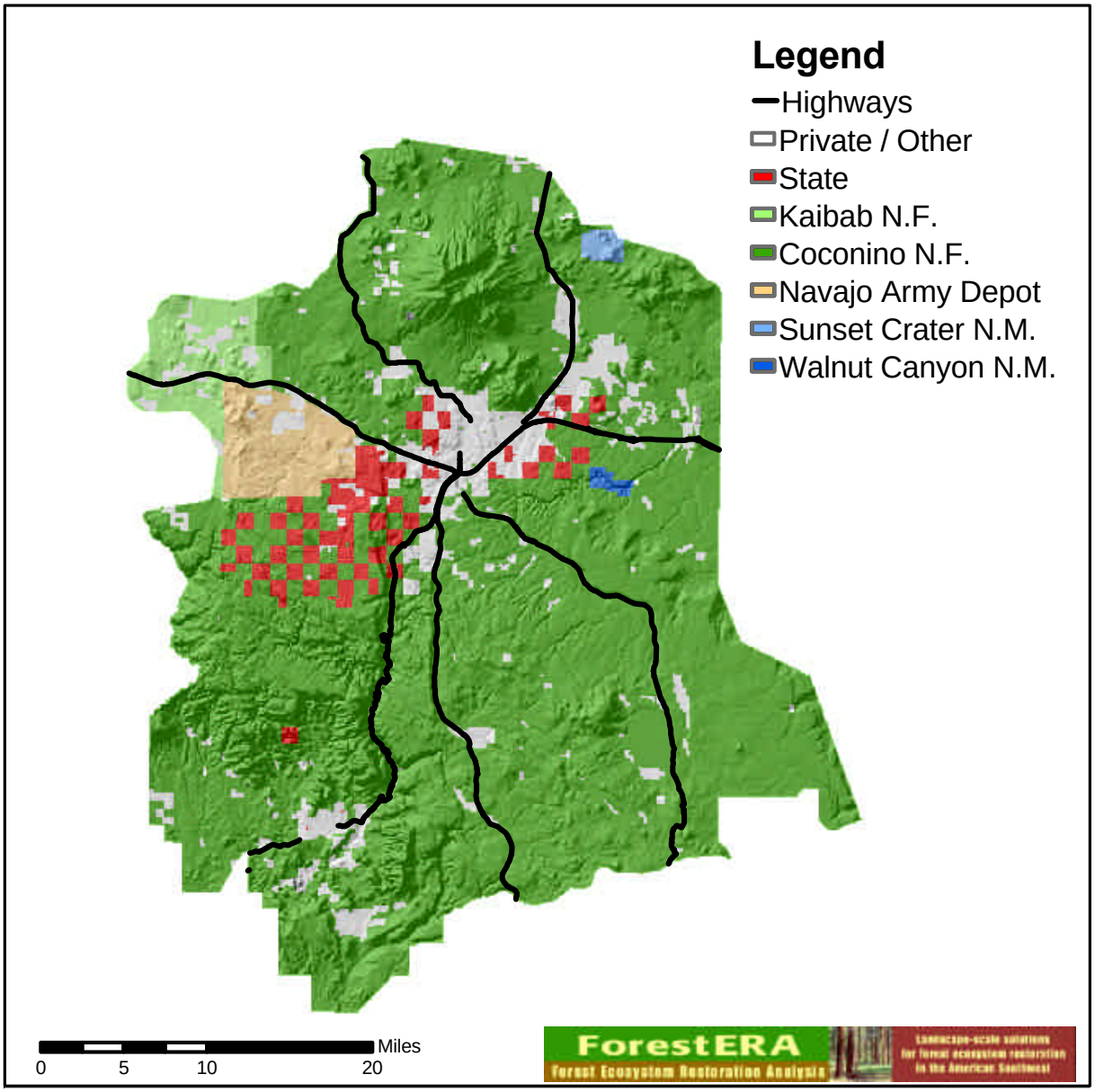
**MAP 1**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – COMMUNITIES***

**MAP 2**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – LAND OWNERSHIP***

In addition, the plan encompasses an area that includes two Interstate Highways (I-17 and I-40), two Arizona Department of Transportation designated scenic byways (Hwy 89A and Hwy 180), a major east-west railroad line (Burlington Northern Santa Fe), a regional airport, a state university and community college, two world-class observatories (three sites), numerous cultural attractions, archaeological treasures, and recreational sites, three critical community watersheds (Flagstaff – Rio de Flag and Lake Mary; Sedona – Oak Creek), and the San Francisco Peaks, the highest mountains in Arizona and a backdrop for the area recognized as a significant site for several Native American tribes.

Headquarters of the Coconino National Forest, the area also serves as the gateway to Grand Canyon National Park. Finally the area is bounded on the west by Camp Navajo, a weapons storage site and AZ Army National Guard training facility, and on the northeast and east by the Flagstaff Area National Monuments (Wupatki, Sunset Crater, and Walnut Canyon).

To facilitate establishment of the *Wildland/Urban Interface*, a Threat Matrix utilizing ForestERA data for the entire *Analysis Area* was developed. Multiple parameters were examined both separately and in combination with others. Those selected to include in the final analysis were as follows:

**Table 2**

**Threat Matrix**

| | |
|---|---|
| **VALUES** | 1. Communities<br>2. Municipal watersheds (Lake Mary) |
| **RISK** | 3. Fire behavior (predicted active and passive crown fire, surface fire)<br>4. Post-fire flooding potential (Rio de Flag and Oak Creek) |
| **OTHER** | 5. Areas upwind (six-mile distance) from at-risk communities |

Items which influenced the selection of these five parameters included:

1. Homes and businesses are the basis of the CWPP. We chose a minimum "buffer" value of 1½ miles around at-risk communities. (Infrastructure was considered separately – see p. 21)
2. The Lake Mary watershed provides approximately 30% of the water supply for the Flagstaff area (since 1949).
3. Predicted fire behavior (Table 3 and Map 3) can be modeled based upon vegetation, slope, weather and other factors.
4. Both the Rio de Flag and Oak Creek have a high potential for flooding (with associated erosion and sedimentation) following a severe wildfire, with significant impacts to Flagstaff and Sedona, respectively.
5. Large fires are typically associated with wind events: it is not uncommon for long-distance spread of several miles to occur in a relatively short period (4-6 hours).

**Table 3**

**Predicted Pre-Treatment Fire Behavior**

***Analysis Area***

| Type Fire Behavior | Acres | % of Total |
|---|---|---|
| Active | 219,181 | 23.5% |
| Passive | 420,282 | 43.5% |
| Surface | 99,207 | 10.5% |
| No Prediction | 201,066 | 21.5% |
| **TOTAL** | **939,736** | **100%** |

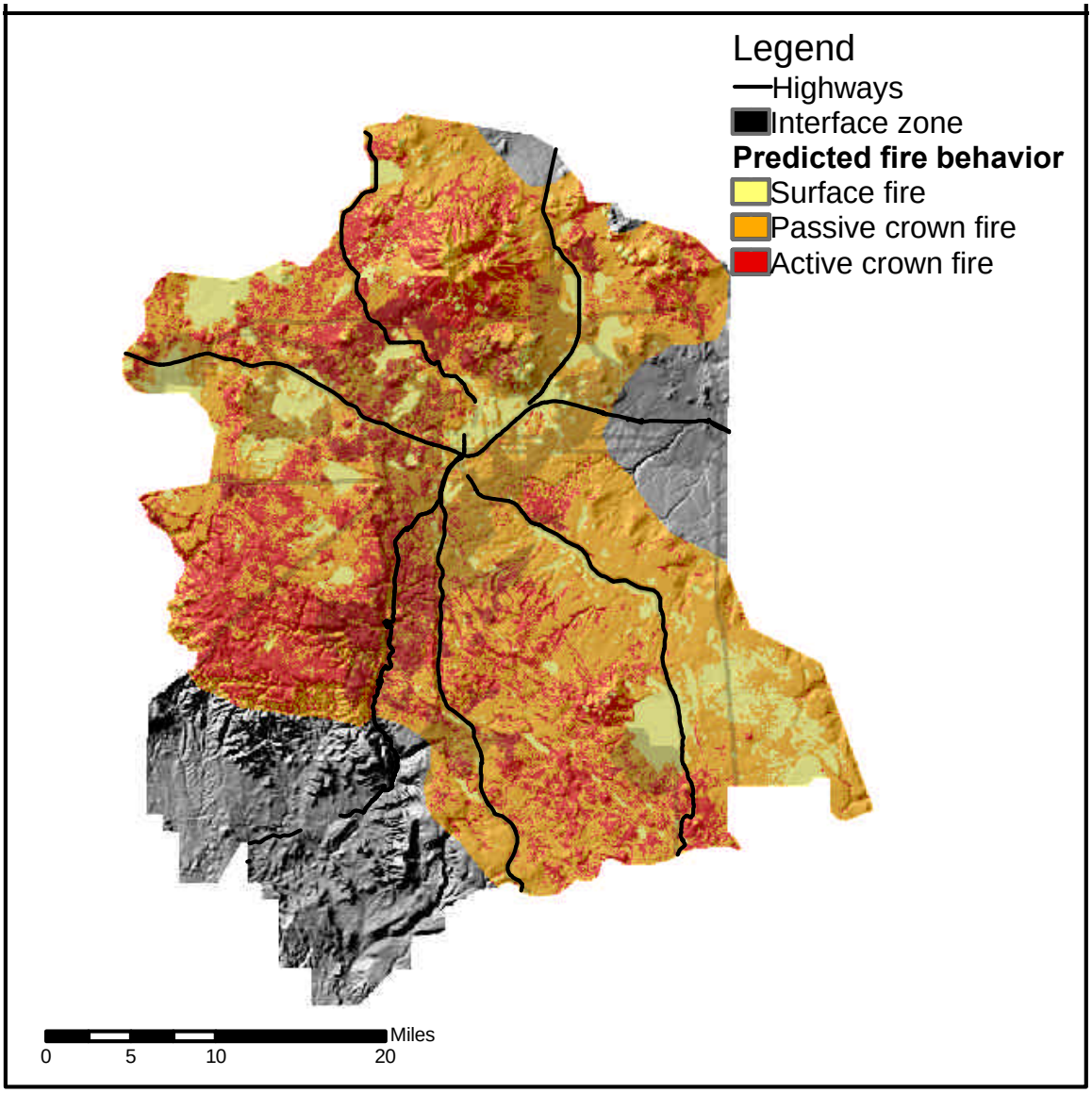
Active Fire Behavior = Fires readily transition into tree crowns and actively moves through the canopy, with large group tree torching common: associated long-range (≥ .5 mile) spotting is common.

Passive Fire Behavior = Fires will transition into tree crowns, but does not move through the canopy and only small-group or individual tree torching common: associated long-range spotting (≥ .5 miles) can occur.

Surface Fire Behavior = Fires stay on the ground, with little tendency to transition into tree crowns except in isolated cases: short-range spotting (≤ ¼ mile) can occur.

No Prediction = No data were available in the ForestERA format that allowed a fire behavior prediction to be made

**MAP 3**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - PREDICTED FIRE BEHAVIOR, CURRENT CONDITIONS***

As depicted in Tables 4 and 5, and Map 4, the Threat Level was divided into three categories: High, Moderate, and Low. Three important items to understand in reviewing this Map are:

1. Based upon this analysis, an indication of High Threat did not appear around the communities of Parks or Mormon Lake. However, a ground assessment of the site reveals that a High Threat does indeed exist. (This reinforces the concept that the ForestERA approach requires site-specific evaluation prior to implementation of any recommended treatment.) To ensure inclusion of protection for all communities, a 1½ mile buffer on the upwind side of communities and a ½ mile buffer on the downwind side was included.
2. Oak Creek Canyon is a "corridor" which links the Sedona area with both the Munds Park and greater Flagstaff areas. Topography and other resource issues may restrict the ability to conduct large-scale treatments in this corridor, but reinforces the need to implement effective FireWise building standards on private property, and to conduct treatments downwind, where fire will exit the canyon and threaten either Munds Park or Flagstaff.
3. This analysis is based upon a landscape-scale study: threats to some areas (Sedona, Winona, City of Flagstaff) are not clearly depicted but all threat levels are known to exist. Site-specific interpretation is required by local experts, owners, and jurisdictional agencies.

Appendix 3 contains a complete set of the five separate maps listed above (Values, Risk, Other) that were utilized to conduct this analysis.

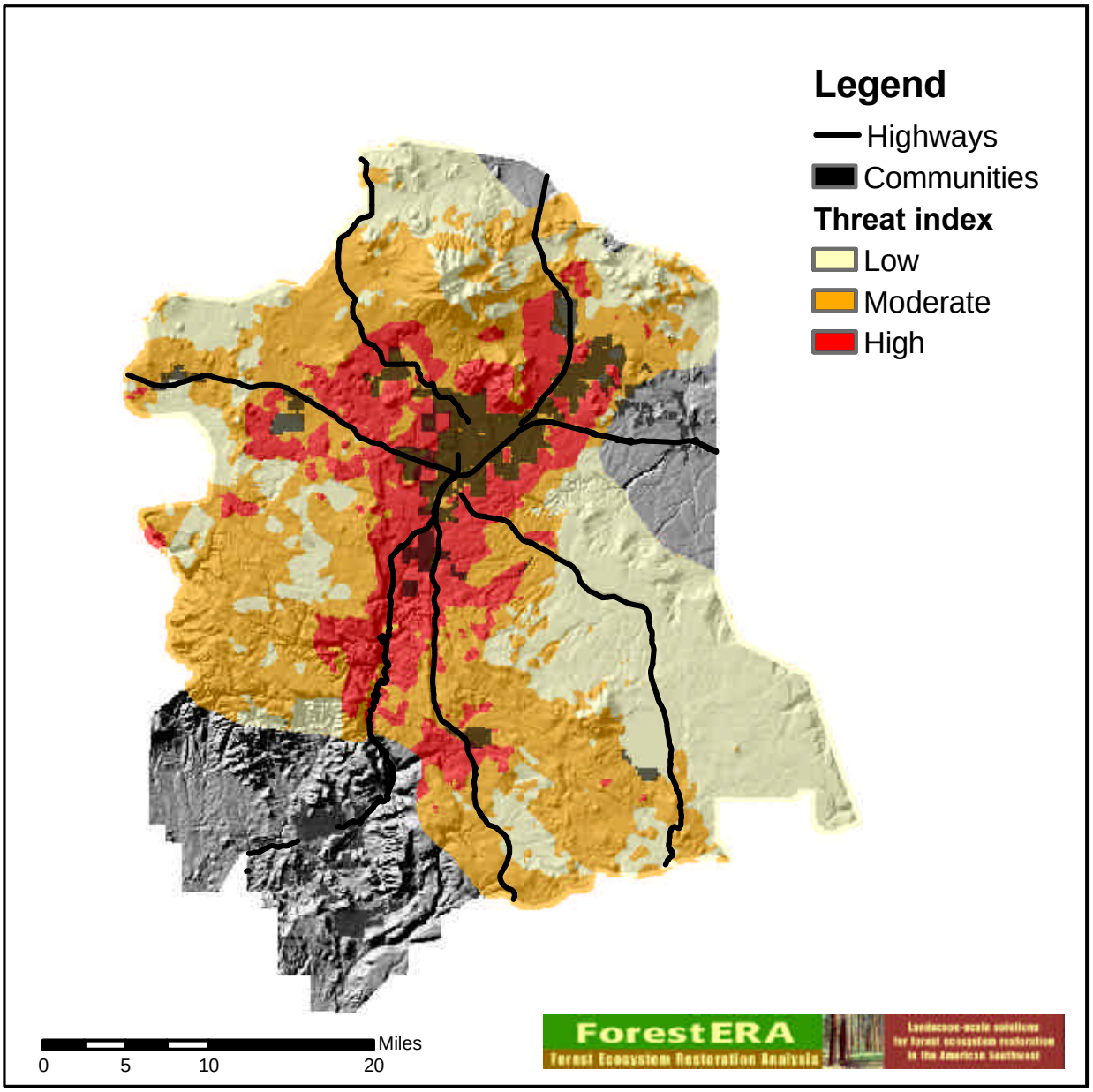
**Table 4**

**Threat Level Acreage**

***Analysis Area***

| Threat Level | Acres | % of Total |
|---|---|---|
| High | 135,041 | 14.5% |
| Moderate | 355,192 | 38.0% |
| Low | 279,243 | 30.0% |
| Data Unavailable | 170,260 | 17.5% |
| **TOTAL** | **939,736** | **100%** |

**MAP 4**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - THREAT LEVEL***

Acreage for each Threat Level by Ownership/Jurisdiction within the entire *Analysis Area* is shown below:

**Table 5**

**Threat Level Acreage by Ownership/Jurisdiction**

***Analysis Area***

| | THREAT LEVEL | | | |
|---|---|---|---|---|
| **Ownership/Jurisdiction** | **High** | **Moderate** | **Low** | **TOTAL** |
| Federal: | | | | |
| Flagstaff area Monuments (NPS) | 0 | 94 | 3,888 | 3,982 |
| Coconino National Forest | 109,652 | 274,701 | 235,401 | 619,754 |
| Kaibab National Forest | 355 | 13,657 | 14,559 | 28,571 |
| **State:** | | | | |
| Land Department | 6,687 | 13,933 | 6,687 | 27,307 |
| Camp Navajo (Division of Military and Emergency Affairs) | 8,523 | 11,391 | 6,346 | 26,260 |
| **Private/Other** (includes local government) | 9,824 | 41,416 | 12,362 | 63,602 |
| **TOTAL** | **135,041** | **355,192** | **279,243** | **769,476** |

## WILDLAND/URBAN INTERFACE

The *Wildland/Urban Interface* for Flagstaff and surrounding communities at-risk encompasses multiple jurisdictions and ownerships within a relatively large geographical area. It extends for some distance outside the City of Flagstaff corporate boundaries, the largest metropolitan community in Northern Arizona. Areas within unincorporated Coconino County include the communities of Munds Park, Kachina Village, Mountainaire, Forest Highlands, Mormon Lake, Bellemont, Timberline-Fernwood, Doney Park, Lower Lake Mary, Flagstaff Ranch, Baderville-Ft. Valley, Mt Elden, Westwood, and Pine Dell Fire Districts (contract entities served by the Flagstaff Fire Department), Cosnino, Winona, Upper Oak Creek Canyon, and Sedona, as well as substantial state and federal land. Overall, this plan incorporates these at-risk communities and their associated infrastructure sites into a single regional CWPP, rather than separate plans for each.

The "interface" is often defined as an easily identified geographic area where structures directly abut wildland fuels. In this perspective, the "interface" is confined to a relatively narrow area a set-distance from neighborhoods or communities. Some view it strictly as the "Home Ignition Zone", a distance of roughly 100-200 ft. from a structure. Others view it in a somewhat larger context: the Healthy Forests Restoration Act (HFRA) identifies it, in the absence of a CWPP, as a distance of a half mile or 1½ miles from an at-risk community, depending on local conditions.

Limiting treatments to a pre-set distance from

structures, while important to individual structure and/or infrastructure protection, does not recognize that a community is more than a collection of structures, and fails to understand the dynamic nature of fire behavior. Further, a strict distance definition does not adequately address the ecological needs of an area.

The *Wildland/Urban Interface* for Flagstaff and surrounding communities, as allowed by the HFRA, is identified as an area where public safety is the over-riding goal: it is sufficiently large to:

1. Reduce the potential of a high intensity fire from entering the community,
2. Create an area whereby fire suppression efforts will be successful,
3. Limit large amounts of wind-driven embers or "fire brands" from settling on the community, and
4. Protect critical infrastructure.

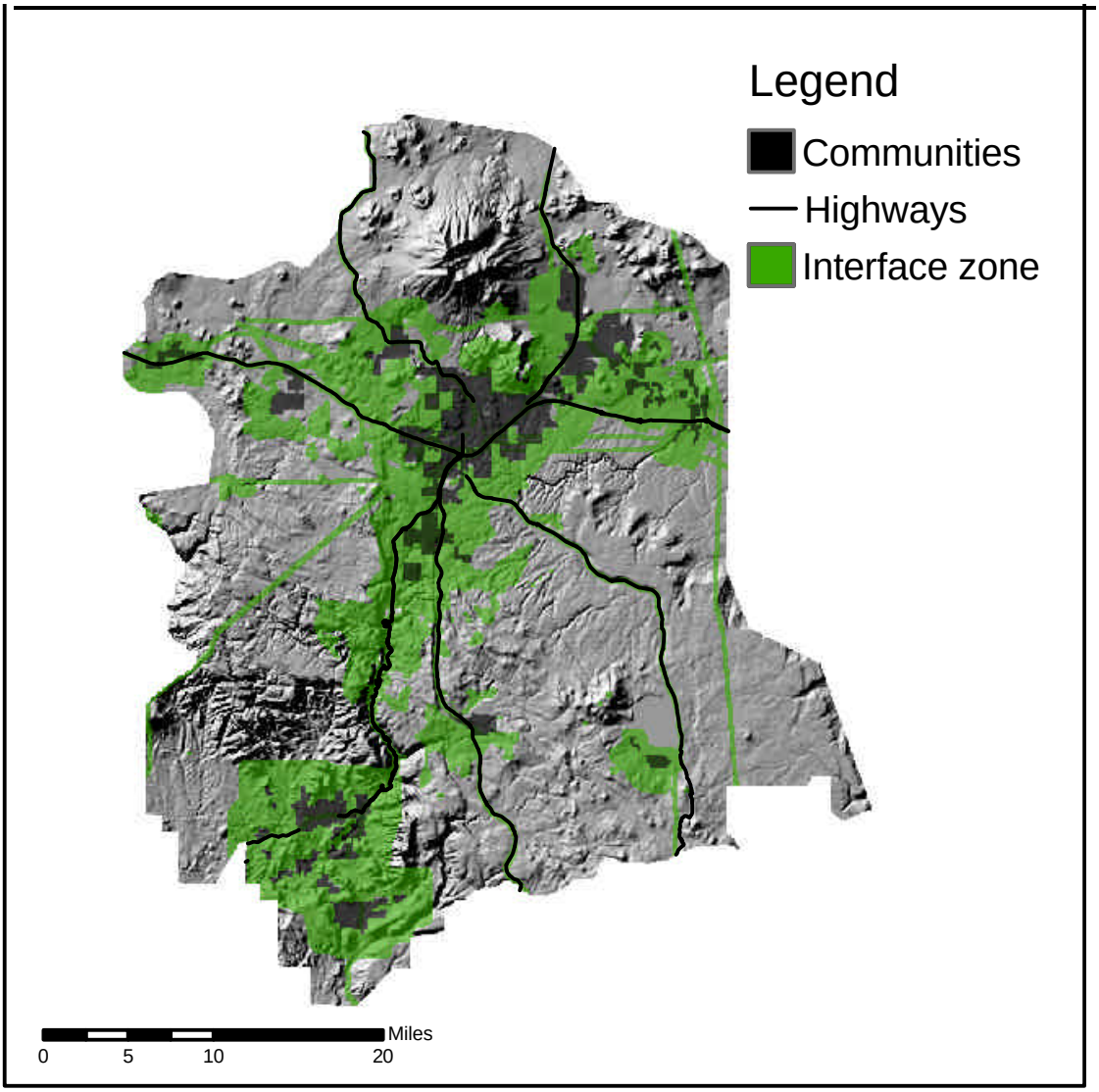
Infrastructure outside of identified at-risk communities was also incorporated into the *Wildland/Urban Interface* zone. We chose to buffer infrastructure, such as is listed below, by a quarter mile treatment zone (1/8 mile either side):

- NOPI Research Facility – Anderson Mesa
- Utilities:
  - High voltage overhead powerlines
  - El Paso Natural Gas aboveground stations
- Transportation:
  - Burlington Northern
  - Santa Fe Railroad
  - Interstate 17 and 40
  - State Highways 3, 89A, and 180
- Communication:
  - Cell Phone Towers
  - Mt. Elden Tower Sites
  - Mormon Mountain Tower Sites
  - Schnebly Hill Tower Sites

In addition, ForestERA data does not exist for the Sedona and Cosnino/Winona areas. We have therefore chosen to include a 1½ mile buffer on the upwind side of each community and a half mile buffer on the downwind side.

When the Threat Map (Map 4) and community and infrastructure buffers were combined, the *Wildland/Urban Interface* for this CWPP was established as depicted on Map 5, with acreage breakouts shown in Table 6.

**MAP 5**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE ZONE***

**Table 6**

**Ownership/Jurisdiction – *Wildland/Urban Interface* zone**

| Ownership/Jurisdiction | Acres | % of Total |
|---|---|---|
| **Federal:** | | |
| Flagstaff Monuments | 146 | .1% |
| Coconino National Forest | 215,166 | 76.7% |
| Kaibab National Forest | 8,633 | 3.1% |
| **State:** | | |
| Land Department | 15,665 | 5.6% |
| Camp Navajo (Division of Military & Emergency Affairs) | 8,963 | 3.0% |
| **Private/Other** (includes local government) | 32,082 | 11.5% |
| **TOTAL** | **280,655** | **100%** |

We recognize that several smaller clusters of homes exist outside the identified at-risk communities and designated *Wildland/Urban Interface* zone but within the overall *Analysis Area.* Their exclusion in no way diminishes the need for those owners to undertake appropriate mitigation efforts or cooperative ventures between themselves and the adjacent landowner and/or jurisdictional authority. However, to include every parcel of private land within the *Wildland/Urban Interface* is to enlarge it beyond realistic treatment capabilities.

# COMMUNITY ASSESSMENT

## FUEL HAZARD

Prior to European settlement in the 1860's, the forest around Flagstaff was comprised of relatively open stands of large-diameter ponderosa pine with scattered oaks, aspen, and other species, and intermingled with denser forests in canyons and on steep slopes, and with open meadows and grasslands common. Tree numbers averaged 30-50 per acre, with these trees arranged in small groups. While some young thickets and open meadows were undoubtedly present, a savanna community structure dominated the landscape. Fires were frequent, returning every 2-7 years, and were relatively low-intensity in nature

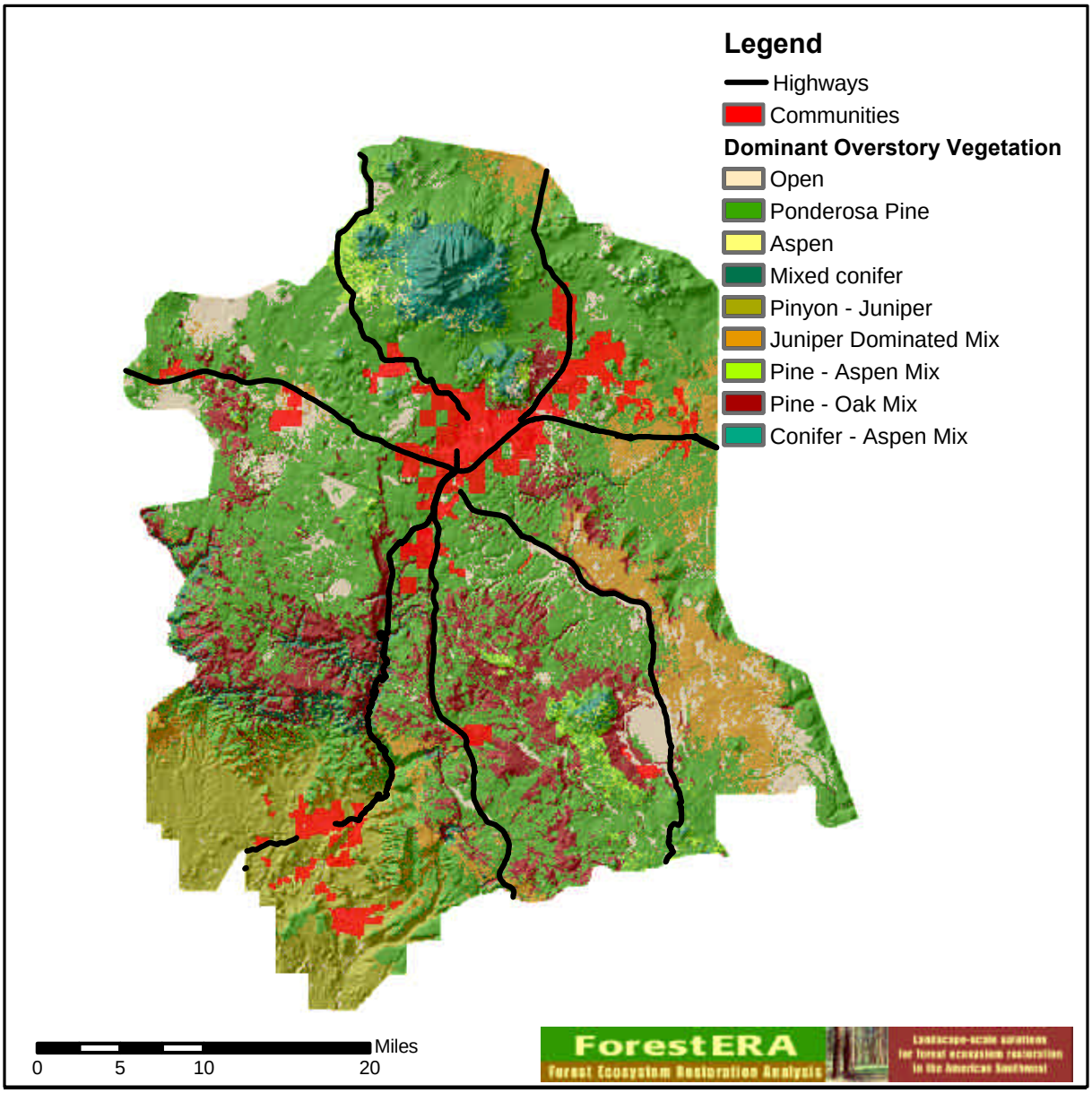
Beginning in the 1880's, and extending until fairly recently, area forests were subjected to societal demands that resulted in intense livestock grazing, harvesting of large-diameter trees, and a policy of fire suppression that embraced fire exclusion. These actions led to profound changes within the forest and set-the-stage for the intense wildfires common today.

From 1917-1920, a period of relatively wet weather, in combination with the exceptional 1919 cone crop, resulted in the establishment of millions of new seedlings. These trees are the very fuels which stoke the wildfires common today.



Photo 4: A common scene in today's forest

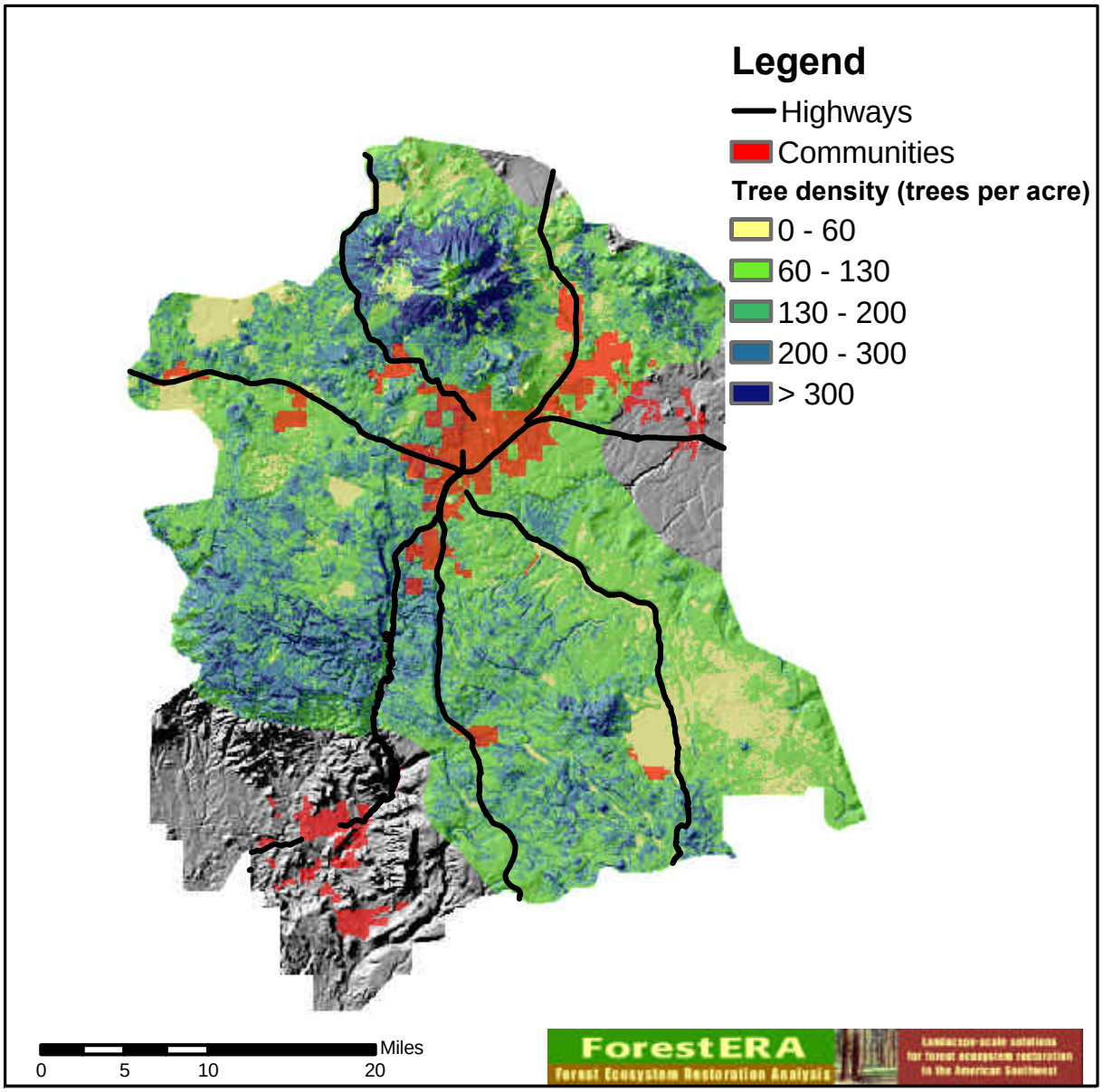
**MAP 6**




## CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

## *ANALYSIS AREA - DOMINANT OVERSTORY VEGETATION*

**MAP 7**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - TREE DENSITY***

As a result, many pine stands are presently overstocked with small and mid-sized second-growth trees. Basal areas commonly range from 150 to well over 200 and tree density from several hundred to over a thousand per acre. Canopy closure typically varies from 50% to 70% but often approaches 100%. An occasional juniper, pinyon pine, Douglas fir, white fir, Gambel oak, limber pine or aspen occurs among the pine stands. Insect and disease problems in these stands include dwarf mistletoe and periodic episodes of various bark beetles and other insects and disease.

Ponderosa pine sites, the overwhelming majority of the entire area, are best represented by Fire Behavior Prediction System (FBPS) Fuel Model #9 - closed-canopy pine stand with needle understory. In the few open areas, ground cover is a mix of grasses and forbs. Logging residue from the early 1900's such as pitchy high stumps and remaining cull trees contribute to the fire hazard and fuel laddering potential.

Fires are natural events, have been present since before humans occupied this area, and will continue to occur. What has changed, however, is the severity of fires we now experience. Our ponderosa pine ecosystem did not evolve with the fire intensity of today's fires, whether natural or human caused.

Three factors influence the spread of wildfire: fuel, weather, and topography. Of these, we can only manage fuel to reduce the intensity and spread of wildfire.

***Fuel*** – The area around Flagstaff is part of the largest continuous ponderosa pine forest in the world. Natural fuel amounts have increased dramatically in the past 80 years. Homes and flameable structures are simply another source of fuel.

***Weather*** – Historically, due to prevailing wind pattern, our local fire spread pattern is from the southwest to northeast. We also experience two other fire weather factors on a fairly routine basis that, like wind, are beyond our ability to control: low relative humidity and high temperature. The southwest is also in the midst of a persistent drought that has greatly increased vegetation mortality, thus increasing fire potential.

***Topography*** – Fires burn faster upslope than down. Canyons, ridges, and drainages funnel wind. South facing slopes dry quicker and burn more readily. Steep slopes present challenges for treating hazardous fuels, thus reinforcing the need to treat adjacent, more easily accessible areas, in a more intensive manner and at a greater scale.

Wildfires teach valuable lessons:

1. They occur in any season of the year. Although the primary concern (both in number and severity) is during the April - July timeframe, fire agencies in the area respond to wildfires virtually year-round when appropriate weather conditions exist.
2. They can be any size. Both small and large fires can be destructive.
3. They occur in any fuel type. Timber fires have the biggest flames, and offer the most resistance to control, but grass fires can be just as frightening to residents, and result in significant damage/loss to homes and infrastructure.
4. They can burn with incredible speed. Most damage within developed areas occurs within a relatively short timeframe. Once a wildfire encroaches upon a community, it is too late to implement widespread, highly effective mitigation measures.
5/ Generally, there are seldom enough resources to protect every home, structure, or improvement during a large, catastrophic wildfire. Emergency responders are often forced to decide which homes to protect and which to abandon. Mitigation actions

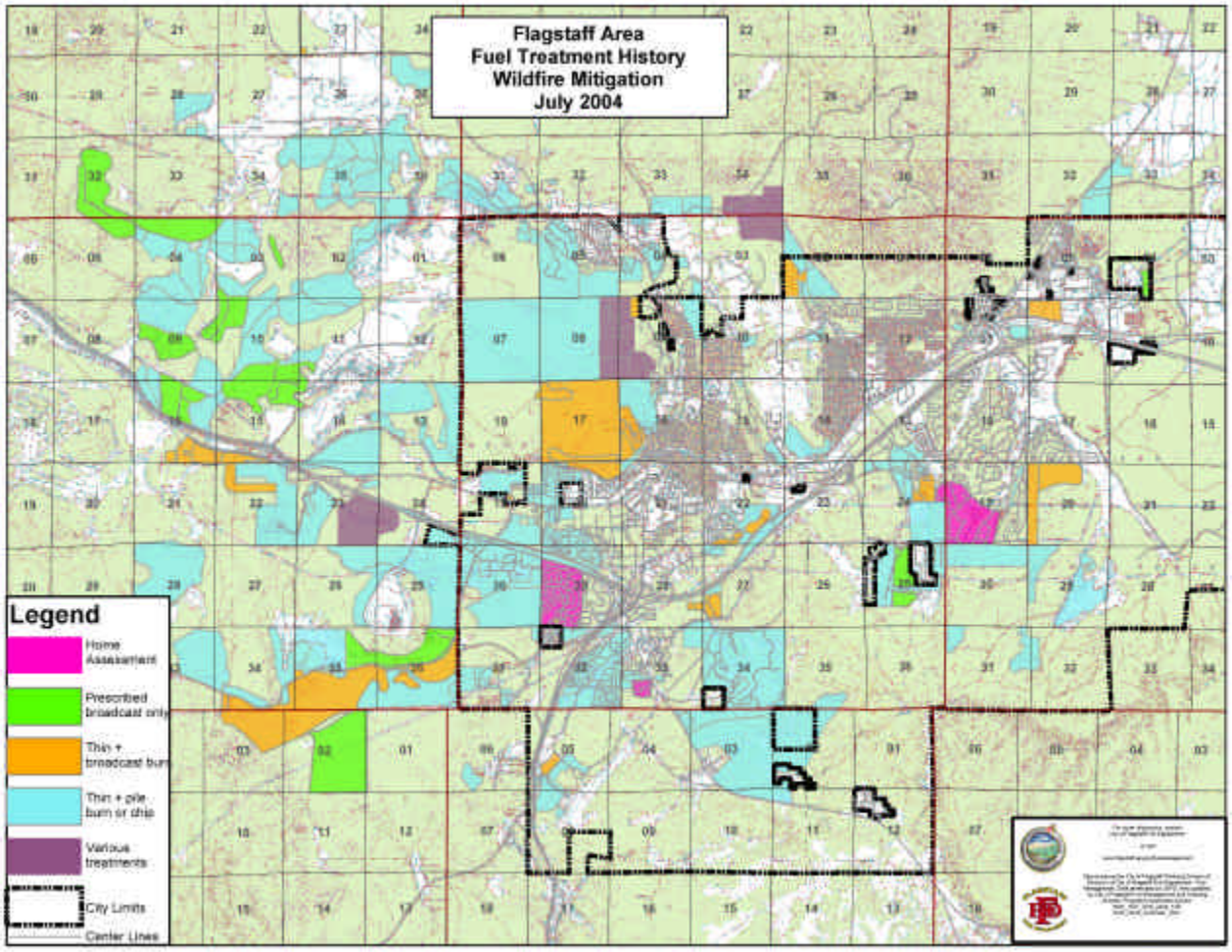
recommended and/or required and implemented now will make a tremendous difference in the survival of homes and property and the protection of community values-at-risk.

6. The trend in wildfire size and intensity, coupled with increasing awareness of other values-at-risk, is resulting in growing pressure to place firefighters in areas of greater-and-greater risk. Firefighter and public safety are the absolute first priority, but it is not uncommon for fire managers to find themselves at-odds with non-fire personnel who insist on dangerous and unsafe actions of questionable value. Responsible fire managers understand that permitting such actions violates their first priority and are obliged to refuse.
7. Wildfires do not respect boundaries or jurisdictions, and they have become increasingly destructive and expensive. A multi-agency, inter-departmental, and multi-faceted program approach is necessary to reduce risk prior to ignition; suppression actions alone are not the answer.
8. The question is not "if" a wildfire will occur, it is "when" and "where" it will happen.

To achieve ***community protection***, forest treatments and FireWise standards focused on public safety must begin in the *Wildland/Urban Interface.* First priority should be given to treating areas of dangerous fuels adjacent to communities, and then working outward in the W/UI. The overall scope-of-work is immense and the need to act quickly and decisively in this priority area is paramount. For ***community benefit,*** treatments in the *Analysis Area* focused on ecological needs and forest health, but reflecting the need to reduce fire threat, should also occur.

Important community protection and forest health restoration work has been implemented throughout the *Analysis Area* during the past several years, and plans are underway to continue treatments. As one example, treatments completed in-and-around the City of Flagstaff as of July 2004 are depicted in Map 8, which was compiled by the Flagstaff Fire Department.

**MAP 8**




CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

COMPLETED TREATMENTS - City of Flagstaff Area – July 2004

## RISK OF IGNITION AND OCCURRENCE

Wildfire is the #1 fire threat to Flagstaff and surrounding communities. The greater Flagstaff area averages around 150 ignitions per year (Map 9), while within the City of Flagstaff alone, there are roughly 60-80 wildfires each year.

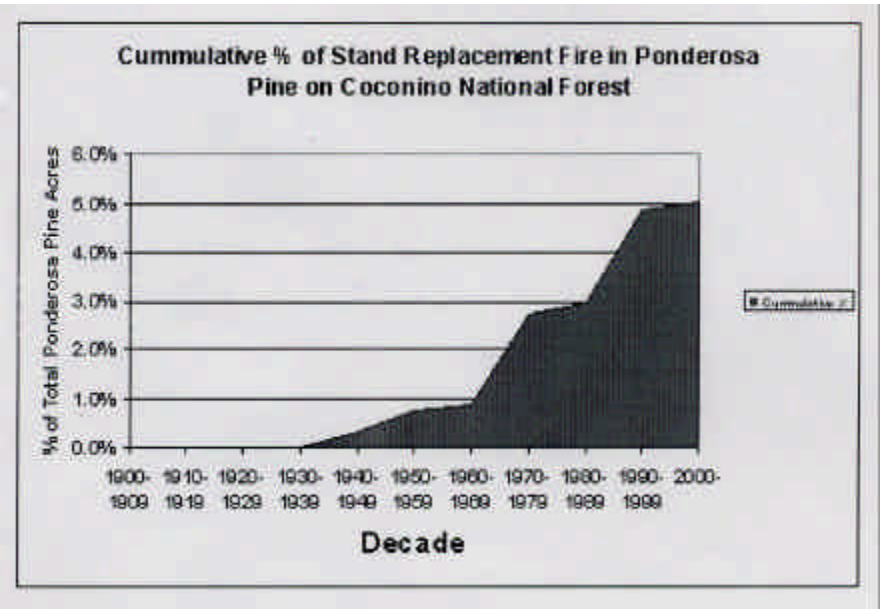
Statistics from the entire Coconino National Forest (#1- #3 below), which includes areas outside the *Analysis Area,* illustrate both risk and occurrence:

1. Total Fires - 1970 thru 2003:

| | |
|---|---|
| Lightning Fires | 10,377 |
| Human Caused Fires | 6,131 |
| Total Fires (1970-2003) | **16,508** |
| Average per year (Lightning) | 314 |
| Average per year (Human) | 185 |
| Average per year (Total) | **499** |

2. Growing trend of Stand-Replacement fires:

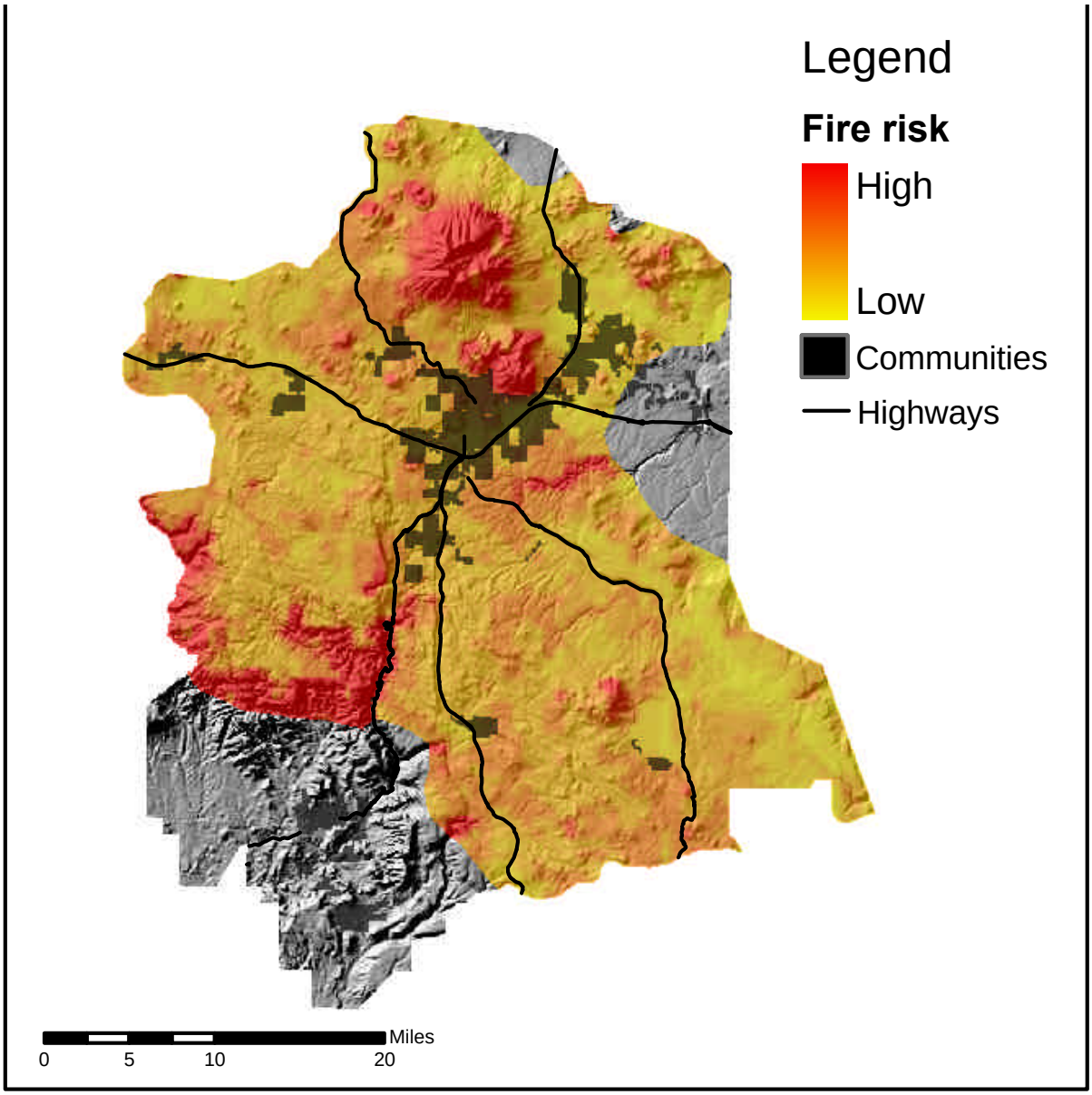
**Graph 1**




3. Closures/restrictions by lengths (based on fire danger):

| | |
|---|---|
| 1996 | 6 weeks |
| 2000 | 3 weeks |
| 2003 | 9 weeks |

**MAP 9**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA – RISK OF FIRE IGNITION***

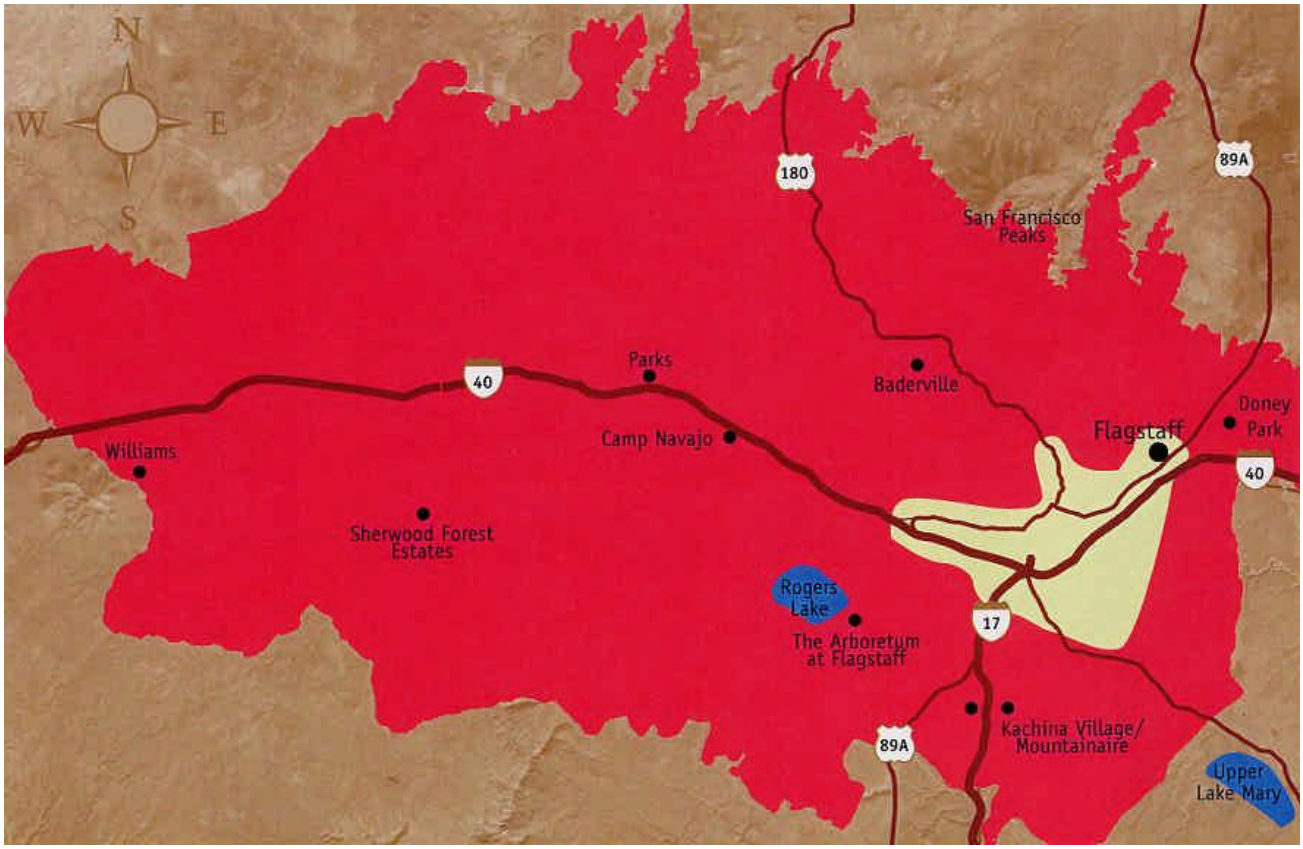
## COMMUNITY VALUES AT RISK

The greater Flagstaff area is dependent upon a healthy forest for community well being. Catastrophic wildfire, fed by excessive fuel amounts, on-going drought, and devastating insect attacks, threaten a myriad of community values. These values may include scenic vistas, emotional and spiritual attachments, cultural resources, watershed values, wildlife habitat, old-growth forests, recreational opportunities, public health, firefighter safety, structures and other infrastructure, and public confidence in government. (A description of these can be found in the article *"The Wildland Urban Interface: What's Really At Risk?"* at the following web site: www.flagstaff.az.gov/fuelmanagement.)

Two other community impacts not commonly considered include the following:

1) The economic shock of catastrophic fires to a local economy is an important, and often overlooked impact. A recent study conducted by the Flagstaff Fire Department, with information supplied by the Greater Flagstaff Economic Council, the Chamber of Commerce, and the City's Sales Tax Division, andutilizing information from other communities affected by large fires, revealed that a fire which damaged and/or destroyed 300 homes in early summer – at the onset of the tourist and visitor season – would have a first-year economic impact to the greater community in excess of $60 million.
2) The Rodeo-Chediski fire (2002) was the largest wildfire in Arizona's recorded history and was visible from Flagstaff. Even though it was more than 80 miles away, it prompted tremendous public concern as evidenced by the large increase and tone of calls into the Flagstaff 911 Emergency Dispatch Center. By overlaying the boundary and footprint of that 460,000 fire on Flagstaff and the northern area of the CWPP (Map 10), we get a dramatic illustration of the extensive impacts a large fire like this might have on our area – communities from Doney Park to Williams devastated, wildlifie habitat and critical watersheds stripped of their vegetative cover, decades to rebuild lives and centuries for ecosystem restoration. The scope of values that could be impacted is truly significant and just the potential for that type of wildifre occurrence is a primary driving force for creation of this CWPP - *to ameliorate the threat of such a fire to the Flagstaff and surrounding communities.*

**MAP 10**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***OVERLAY OF THE BOUNDARY/FOOTPRINT OF THE RODEO-CHEDISKI FIRE ON FLAGSTAFF AND THE NORTHERN CWPP ANALYSIS AREA***

## COMMUNITY PREPAREDNESS AND PROTECTION CAPABILITY

Two primary aspects of the existing readiness-level are found in the Appendices to this plan. Each has been slightly modified from their original document to better fit within the context of this plan.

Appendix 4 – Initial and Extended Attack Wildland Fire Operations Plan for the PFAC Response Area (Also known as the *"PFAC Ops Plan"*). This documents operational procedures to be utilized by all PFAC members for wildfires which do not exceed the complexity of a Type 3 incident.

Appendix 5 – Community Smoke Management Plan for the PFAC Response Area (Also known as the *"PFAC Smoke Management Plan"*). This documents actions to both minimize smoke impacts and educate the public regarding smoke from prescribed fire operations.

Each will be reviewed and revised on an annual basis by PFAC as part of that organization's annual work plan.

# COMMUNITY MITIGATION PLAN

## FUEL HAZARD REDUCTION

As indicated in the Introduction section, the CWPP is both a strategic plan and action plan: it provides a broad operating framework for all agencies and ownerships – private, city, county, state, and federal – within the area and identifies priority areas and treatments. Specific site prescription planning and implementation is the responsibility of each JHA, acting in consideration of the guidelines expressed within this plan.

Mitigation actions designed to reduce dangerous fuel accumulations within the *Analysis Area* are based, in part, on the *"Guiding Principles for Forest Ecosystem Restoration and Community Protection"* promulgated by the Governor's Arizona Forest Health Advisory Council (Appendix 2). These principles include:

1. *The overall strategy is dynamic, adaptive, and coordinated*. Given the current continuing decline in forest health, and the increasing threat of catastrophic wildfire, our actions to reverse this trend must be bold, large-scale, and undertaken immediately. All actions must be considered against the certain results of inaction, and must be continually monitored and revised as necessary.
2. *A sustainable community, with associated values-at-risk, is linked to a sustainable ecosystem.* Appropriate treatments must be based on social and ecological needs, and be geared toward reducing risk of destructive wildfire and restoring functioning ecosystems. Restoration efforts should be directed toward protecting and promoting development of old-growth and large trees, but not – if such a case should exist – at the expense of adequate fire protection to communities at-risk. Fire hazard reduction must be linked to the reintroduction of fire as a keystone ecological process. An active program of prescribed fire, including maintenance burns, and natural fire use, with implementation by land-managers on a site-specific need and basis, is essential. Vegetative treatments, and the pace of their implementation, will vary across the landscape, thereby creating an opportunity for biodiversity to exist and flourish.
3. *The immediate, but not exclusive, focus is on protecting communities.* A fire-resistive condition will be accomplished by modifying forest fuels at sufficient distances from structures and communities so as to reduce severe fire behavior, establishing defensible neighborhoods, and widespread use of fire resistant construction materials and architectural design.
4. *Necessary treatments, both-first entry efforts and maintenance activities, implemented and continued on site-specific needs, require a sustained commitment of public interest, political will, and financial investment.* Reducing wildfire risk and improving forest health is a long-term process measured in decades: because we are dealing with a living and dying ecosystem, it is one that will essentially be required forever.

## DESIRED FUTURE CONDITIONS

Actions and treatments will leave both the landscape and at-risk communities resistant to catastrophic fire. Ponderosa pine stands will generally range from 30-100 larger-diameter trees/acre and/or basal area of 40-80/acre, be found in groups in varying degrees of interlocking canopy, and be separated by openings of various sizes. This pattern of tree clumps and openings will be variable and provide for a diverse, rich,

robust and healthy ecosystem that supports a variety of butterflies, songbirds, mycorrhizae, carabib beetles, pollinators, grasses, flowers, shrubs and herbaceous plants. Further, it will avoid a homogenous, plantation appearance. Thicker groupings of trees, including all sizes, are found scattered throughout the larger area

Specific objectives related to fire behavior in ponderosa pine forest ecosystems (designed to make suppression actions easier, safer, and less costly, and to facilitate prescribed fire use), are as follows:

**Table 7**

**Principles of Fire Resistant Forests**

(Adapted from *"Forest Restoration and Fire-Principlesin the Context of Place",* R.T. Brown et al, 2002)

| Objective | Effect | Advantage | Issues |
|---|---|---|---|
| Reduce Surface Fuels | Reduces potential flame lengths | Less resistance to control | Less surface disturbance with fire than other techniques |
| Increase Canopy Base Heights | Requires longer flame lengths to produce torching | Less torching and resulting spotting | Opens understory: may allow surface winds to increase somewhat |
| Decrease Crown Density | Makes active crown fire less probable | Reduces crown fire potential | Surface wind may increase, with associated drying of fuels |
| Increase Proportion of Fire–Resistant Trees | Thicker bark, taller crowns, higher canopy base height | Increases survivability of trees | Removing smaller trees is economically less profitable |

These principles address only forested ecosystems. One quarter of the *Analysis Area*, such as areas around Sedona and Cosnino/Winona, is composed of other vegetation types, primarily pinon/juniper woodlands and chaparral. As better data becomes available on fire behavior and treatment effects in these vegetation types, this plan will be amended to address fire behavior within these habitats.

## TREATMENT GUIDELINES

This plan provides recommendations for successful outcomes, and not prescriptive options for treatment of ponderosa pine forests. The following discussion is intended to serve as a general guide and framework within which specific prescriptions should be developed. Modification of these concepts, by the JHA based upon specific conditions and objectives for that specific parcel, existing land management plans, legal requirements, and other standards, will be required and is encouraged.

*Tree Selection* - Selective thinning from below, initially focusing on over-topped pines, is a priority. If possible, "leave" trees are left in a clumped pattern rather than evenly spaced. Openings created by the clumpy leave-tree pattern allow a fire to either drop to the ground or stay on the ground permitting effective suppression action. Clumps can vary from 1/10$^{th}$ acre up to as large as 1 or more acres in size. The number of trees in a clump may range from as few as two to 15 or more, with 30 or more occurring in a limited number of clumps throughout specific project areas. Trees, including the crown area, will generally occupy areas ranging from 20-50% of the area. Openings will range from 1/10$^{th}$ to 1-2 acres in size and constitute a variable of 50-80% of the area.

In general, trees designated for removal exhibit one-or-more of the following characteristics:

1. Contributes to crown-fire behavior: ladder

effect into the overstory canopy, low crown-base heights, dense interlocking canopies, etc.

2. Are vulnerable to drought or insect infestation: suppressed, reduced vigor, etc.
3. Currently infested with insects that threaten to spread to other trees, unless the tree is to remain for other benefits.
4. Infected with dwarf mistletoe: Stands with high infestation levels of dwarf mistletoe can be thinned or pruned to reduce crown fire potential during the inevitable wildfire. Small pockets of mistletoe can be Isolated from non-infected trees by a barrier of fifty feet (to reduce further spread of the parasite), or removed.

Conversely, trees considered for retention, will be those, unless other issues or benefits prevail, which are often:

1. Clustered around evidences of historic forest structure (ex: downed logs, stumps, stump-pits, etc) or, alternatively, based on best existing forest structure.
2. The largest diameter, exhibit high crown-base heights, and are the most fire resistant:
3. Old trees exhibiting yellow bark.
4. Oaks, aspen, or other species of wildlife or ecological value

NOTE

- Some variation is needed: trees may vary in-height. Stands should include small intermediate size trees, saplings and seedlings, but none of these should threaten larger, older trees during a fire.
- In the absence of prescribed fire, clumps may be prone to loss due to high surface fuel loadings: retention of clumps requires periodic use of fire.

Removal of the larger diameter trees in a stand, including standing dead snags, is to be avoided unless cutting is required to adequately reduce fire risk, provide for public safety or protection of improvements (ex: trees leaning over home, play area, power line, road, or hiking trail), or for some other ecological benefit. (Removal of "large" trees is a significant issue for many groups and individuals. The GFFP has been discussing this issue for several years and is currently considering adoption of *"A Management Policy for Ponderosa Pine Forest Structure in the Flagstaff Wildland/Urban Interface"*. Such a policy, when adopted, should be incorporated into revisions of this CWPP to address this issue.)

When designating trees for removal, personnel must be aware of fire behavior alignments such as prevailing wind direction, shading, slope, fuel arrangement and continuity, including interlocking crowns, and potential suppression strategy and tactics best-suited to the individual site.

Wind-driven fires are not uncommon in our area. To provide optimal protection, treatments are required upwind of at-risk communities – south and west in our area – to a greater distance to provide adequate protection. Conversely, treatment distance north and east of at-risk communities can be reduced unless circumstances dictate otherwise. However, one should be mindful that plume dominated fire behavior results in extreme fire spread from spotting of several miles in all directions and should be expected.

Topographic features – such as canyons – directly influence fire behavior, but may be impractical to treat due to slope, soil sensitivity, safety, expense, and other values such as critical wildlife habitat. This lends emphasis to enlarging treatments where fire is expected to emerge from a canyon and where firefighting forces have the best opportunity for control

Overall, this approach is considered to be an intermediate-intense modification of most existing stands, involving removal of 50-75% of the

existing trees. Experience has shown that over the entire area, many, but not all, of the trees to be removed will be smaller diameter.

*Cutting Techniques* - The type of mechanized operation is obviously important when conducting treatments. A traditional harvesting operation may be the preferred method in some areas, while in others it may not. For the later, a "micro" harvesting approach may be required: trees are cut either using hand-crews with power saws or by a small shear, and wood can be moved by an All-Terrain-Vehicle (ATV) with a trailer or some other small-equipment approach. Such an approach, however, will likely lengthen the time required to treat the parcel, and may result in higher costs and pose an increased risk to the operator.

Restricting hours of operation in response to local conditions and neighborhood concerns may be warranted. For example, if an operation is immediately adjacent to homes or a neighborhood, activity may need to be restricted to normal working hours within a reasonable distance to lessen the impact to residents. However, doing so should be done with the realization the operation will extend further into the future.

Stumps should be cut as low to the ground and as level as possible. This not only improves post-treatment visual quality, but permits easy access for wood removal and other subsequent land management needs. However, potential adverse impacts from unrestricted post-treatment access (ex: soil compaction, erosion, etc) should be addressed in the planning phase of a project, and subsequently managed.

*Utilization* - The majority of material available for wood production from the greater Flagstaff area will be small diameter ponderosa pine. Opportunities for using this material are constrained by a number of factors including high harvesting costs, structural properties associated with juvenile wood, and a lack of consistent markets and processing facilities. Harvesting costs associated with forest restoration and community wildfire protection, including transportation and handling of raw material, are often quite high even where larger, high-value trees can be harvested. These costs can be prohibitive for smaller businesses.

The difficulty in finding suitable markets for this small diameter material is magnified by poor mechanical properties that make it unsuitable for all but the least demanding structural uses. It is characterized by suppressed growth with low tension and strength due to a high ratio of juvenile wood and difficulty in product drying. Finding suitable markets is further complicated by the fact that currently there are virtually no outlets for the types of timber that will be harvested. New processing facilities will have to match the types of wood material available with the use of contemporary utilization techniques.

Northern Arizona and Flagstaff is uniquely situated to capitalize on contemporary opportunities for solid wood and biomass utilization. (See Appendix 6 for a complete description of this topic.) Solid wood applications in which businesses are actively exploring or have already invested in the Flagstaff area, include roundwood construction, composite products like oriented strand board (OSB) and wood/plastic materials, and engineered lumber like glu-laminate beams and finger-jointed lumber. Biomass applications include wood chips for baseload energy production, densified fuel pellets for heating, and biochemical extractives. Other products for which small diameter pine is currently being used in the region include firewood, posts and poles, landscaping timbers, ground covers or mulch, pallet manufacturing, and crafts.

*Slash Treatment* – Four general slash-disposal methods exist and each may be utilized under the appropriate circumstances. Regardless of the method chosen, the required work (such as piling) should be completed as soon as possible after it is generated.

- Hand Piles: This is a common practice of

handling slash. Hand piles should be a minimum of six feet tall and six feet wide. Piles should be located in openings to minimize scorching leave trees when the piles are later burned. Likewise, placing piles on top of old stumps or logs should be avoided to reduce both the amount of smoke and the chance for "creep" when the piles are later burned.

- Machine Piles: This method is feasible and widely utilized. It is particularly appropriate on larger projects and in more open areas. Piles are typically much larger than those created by hand-piling. Whole tree skidding may also be used with the piles created at the landings. Windrows may also built using dozers: this technique has been successfully utilized in the area.
- Chip or Grind: Although occasionally used, this technique is comparatively expensive and chips decompose slowly in our area. If future under-burning is anticipated for the site, chips may add to smoke management problems. The material can, however, be used for mulch or decorative landscaping. Hauling chips to a disposal site is expensive.
- Lop-and-Scatter: This method, where material is cut so it is less than 12-24 inches above ground-level and then left on-site, should be carefully considered on sites immediately adjacent to structures. If the amount of slash is light and the manager can complete a broadcast burn as soon as the material has dried, it may be effective. However, due to the increased fire hazard, as well as visual concerns, this method is not as common as it once was, and adjacent to homes, it should never be left in-place for an extended period.

*Pile Burning* - Piles should be burned only when consumption will be greater than 90%. All pile burns should be conducted under conditions intended to minimize scorch and smoke impacts.



Photo 5 – "Traditional" harvesting operation




Photo 6 – "Micro" harvesting: cutting with a small shear



Photo 7 – "Micro" harvesting: Skidding wood with an ATV (Roll-over protection recommended for this type operation)

Because the ultimate intent for many treatment sites is to conduct a broadcast burn, some existing dead-and-downed material can be piled during the thinning operation. These piles could then be burned alongside thinning-material slash piles. Although there are financial costs of doing so, which may be prohibitive depending upon the site, removing these materials during the pile burn phase does result in decreased smoke emissions during the subsequent broadcast burn.

Hand Piles: As a standard practice, these piles are burned either when snow cover exists or during an extended wet weather episode. Once ignited and as they burn-down, the piles can be periodically consolidated to ensure complete and timely consumption. Ignited piles should, if at all possible, burn-down by nightfall to minimize smoke impacts to area residents.

Machine Piles: Like pile burns, this type operation requires either snow or an extended wet weather episode. These type piles typically are larger than hand-piles, and will therefore burn longer once ignited. The advantage is that there are fewer piles per acre and they can often be burned under wetter conditions than possible for hand-pile burning.



Photo 8: Pile burn operation

*Broadcast Burning-* Treating ground fuels is a critical component of any effort designed to reduce fire threat, and it has added ecological benefits, such as recycling nutrients. Once an area has been thinned and the slash has been treated, or where a burn only treatment is designated, the site can be broadcast burned. Firelines are usually constructed by hand or with a drag pulled by an ATV, or the burn crew can use natural breaks or roads/trails as a containment line.

Where site objectives dictate that standing dead trees and large downed woody material need to be protected, they can be either hand lined or otherwise excluded from the burn block. Extra protection measures may not be necessary for many fire-tolerant cultural or archaeological sites: treating these areas with prescribed fire has the advantage of protecting them from emergency suppression activities during a wildfire..



Photo 9: Broadcast burning can be successfully implanted both in the forest and adjacent to homes

Deep duff and needle accumulation at the base of the larger older trees will often smolder for days. This essentially bakes the cambium layer and can lead to tree death 1-2 years, or more, after the burn. To avoid this potential loss, the site should be evaluated prior to ignition. If necessary, duff and needle material can be raked-away from high-risk trees: usually raking to a distance of one foot from the bole is sufficient.

Historically, large-scale broadcast burning has occurred in the fall, and to a lesser extent, during breaks in the summer monsoon season. Within the past few years, however, in response to smoke management objectives, burning is also occurring in the spring. As the demands to boost

prescribed fire use increase, one option to enlarge the burn "window" is to shift more burns into the spring and summer months to recreate the historical fire regime. This, however, is a more challenging time to use prescribed fire and will depend on the availability and preparedness of appropriate resources at the local, regional and national levels. Summer burning should become easier, from a fire behavior standpoint, once a site has been previously burned and excessive accumulations of fuel are removed.

Under-burning in pine stands generally calls for target flame lengths of 1 to 3 ft, although some sites require a "hotter" burn to achieve resource objectives.

Ignition by hand with drip torches or with ATV-mounted torches is preferred. Burn operations usually begun by mid-morning following the break-up of the night time temperature inversion and the establishment of the day time wind pattern. Completion of ignition should be targeted early enough to ensure adequate smoke dispersal prior to the onset of cooler nighttime temperatures.

Every burn is to have a completed burn plan. Among many items in this plan are specific objectives for the burn. These may include, but are not limited to, such items as:

1. Fuel Reduction (fuel size classes, percentages, etc)
2. Tree Mortality
3. Scorch

Extensive public notification is an essential element of the program. This can be achieved by posting signs in the area announcing the proposed burn, news releases, and in many cases, door to door contact throughout the nearby neighborhood(s). A continuing education program through talks to civic groups, service clubs, and others to inform the community of the importance and benefits of the program are important as they generate understanding and support for the effort.

Local experience has shown that a previously notified neighborhood is willing to tolerate smoke for a day, but after 2-3 days, patience wears thin. If a particular log, stump, or site within a burn unit becomes a major concern to nearby resident(s), the responsible fire manager may decide to extinguish it the first night.

Burn units should be designed so they can be dispersed throughout the area so as to not constantly impact the same neighborhood(s). Neighborhood air sheds, indicated by diurnal smoke flows, are key to managing nighttime smoke impacts.

*Maintenance:* Once thinning, slash treatment, and first under-burning have been completed, the treated area constitutes an effective fuel-break for the next several years. Follow-up thinning and maintenance burns must be scheduled as necessary to ensure the treated areas remain free of the risk of catastrophic wildfire. Adequate access must be assured, not only to conduct needed follow-up treatments, but also to permit rapid response of fire suppression forces. As part of a long-term maintenance and fire management program, fire containment and wildland fire use should be emphasized as appropriate management options for fire restoration.

*Community Involvement* - Throughout any treatment operation, the Project Manager must maintain contact with potentially affected residents. Input and concerns from such persons must be considered, and where possible, incorporated into the overall effort. Treatments bordering neighborhoods should be explained to residents: one approach would be to go door to door to each residence, explain the project, and gather first-hand comments. In particular instances, a "case-officer", assigned to a specific resident, may be desired so that one person deals with that individual throughout the life-of-the project.

*Costs* - Individual project expenses vary tremendously from site-to-site based on ownership, size, complexity, and need. It is difficult to compare one site to another, especially initial

treatment vs. maintenance requirements. Table presents "average" costs associated with CWPP treatment recommendations in order to establish a ball-park figure of what it may cost to achieve the fire behavior modifications described in this plan.



Photo 10: Public involvement is critical to success

What should also be considered is the cost of doing nothing. For our area, it is no longer a question of "if" a wildfire will occur, but "when", "where", and "how much damage" will result. Working with residents before the wildfire, not during or after it, is preferred.

*Benefits* – Experience with wildfires burning in previously treated areas demonstrates the following:

- Improved access for fire fighters and apparatus
- Increased efficiency when locating and constructing firelines
- Easier detection and suppression of spot fires
- Decreased mop up time and effort
- Reduced fire intensity, torching and mortality
- Improved public safety
- Reduction of loss
- Reduction of air emissions

Another benefit, particularly in interface areas, is reduced trash accumulation through elimination of hiding cover necessary for transient camps and party spots.

*Recommendations and Guidelines* – Experience with *Interface Zone* treatments has led to development of the following procedures:

1. Involve those potentially impacted or affected from the very beginning.
2. Once the project is started, commit to complete it in a timely manner.
3. Use signs, news releases, and other appropriate methods to update people on the status of the project.
4. When mistakes occur, which can and will happen, immediately notify adjacent residents, explain what happened and why, and advise them of what is being done to correct the situation. Assume full-responsibility: allow on-site personnel to make commitments to address a problem.
5. Document and follow-up special concerns or small details that may be important to a concerned individual. Personal "client" service is an absolute necessity. All involved must always strive to establish and maintain professionalism, integrity and credibility.
6. Project staff must stay focused on the ultimate goal. Reduction of fire risk requires the active and on-going involvement of all.
7. Success leads to success. Recent history has demonstrated that many landowners throughout the community have seen ongoing and completed treatments and have implemented similar treatments on their own land.

## Wildfire Prevention and Fire Loss Mitigation

Two documents and one area-of-emphasis contribute greatly to community protection. They include:

**Coconino NF Prevention Management Plan** – See Appendix 7. Only a few pages of the plan are included to demonstrate the ongoing prevention

efforts of the USFS. For detailed annual activities under the plan, visit their web site at: www.fs.fed.us/r3/coconino.

**Volunteer Agreement** – Within the past month, an agreement between the USFS and various fire departments and districts, has been finalized. A long-sought objective of PFAC, the agreement allows fire departments and districts to volunteer personnel and equipment to USFS prescribed burn operations. This promises to permit effective hands-on training and greater treatment accomplishment than previously possible.

**Structure Ignitability** – Implementation of measures to reduce fire risk and improve community protection are not restricted to federal, state, county, or city lands: they must also occur on private property. The interested reader is encouraged to visit www.firewise.org for additional details, or contact either the State Land Department or the appropriate fire department or district (see Section 5).

Wildfire suppression will always be needed, but preparing and equipping homes and neighborhoods to live in a fire-environment is just as critical. Developers and property owners can greatly enhance protection of their investments by establishing a FireWise property and neighborhood. This is done by:

*A. Development Standards* – Working with both Planning Departments and developers and property owners to incorporate FireWise techniques prior to construction can significantly reduce fire threat and improve public safety. Efforts undertaken with a single owner prior to individual lot development is very efficient and greatly preferred. Fire Departments and Districts can provide fuel reduction, access, water source, and street width and slope standards, along with bridge load limits and other fire protection needs/requirements during the planning stage, prior to actual development.

*B. Hazard Fuel Reduction* – Treatment of an entire property, rather than a narrow strip or portion of a site, is the recommended and preferred method. Doing less simply creates the illusion of home or neighborhood protection.

Treatments include selective thinning, brush disposal, and prescribed fire. Varied levels of treatment can occur on the property based on density and species of vegetation present, and location in relation to topography (ridge top, slope, aspect, presence of steep drainages, etc).

The goal is to keep fire intensity low, keep the fire on the ground, and limit flame exposure to structures. This can be accomplished as follows:

1. Thin to reduce crown density with canopy breaks to eliminate crown fire spread,
2. Eliminate low-hanging branches and other material which allows a ground fire to climb into trees (ie - ladder fuels), and
3. Reduce excess fuel accumulations through removal or prescribed fire.

Depending upon the property, these actions can generate large amounts of material that require disposal. Methods utilized are often dependent upon such factors as amount produced, property location, and any restrictions currently in-effect. Techniques include burning, bulk curbside pick-up, transport to a waste management facility, or transformation into a useful product: examples of the later approach include removal for firewood or chipping for landscape use.

*C. Fire Resistive Materials and Construction Techniques* – Incorporation of these items into the design and construction phases of a building project directly contribute to structure survivability. Examples include:

1. Non-combustible roof material: Minimum of Class B or better.
2. Limited combustible siding: large logs, stucco, rock, etc.
3. Enclosed soffits
4. Screened roof and crawl space vents: minimum of ¼ inch wire screen.
5. Limited combustible decking material: to

further promote FireWise efforts, enclose and/or keep areas underneath clear of debris.

6. Double paned windows.
7. Glass skylights (rather than plastic).
8. Home suppression systems: several types are now entering the marketplace. Activated in advance of an approaching wildfire, they are a viable form of home defense. However, they do not replace the need to create a FireWise home environment utilizing all the techniques described in this section of the plan.

*D. Landscaping* – Outdoor plantings are an important component of our community. They add shade and beauty, buffer noise, provide privacy and inspiration, and supply habitat for wildlife. Proper selection, placement, and maintenance of landscape plants can provide the desired benefits and not increase the risk to home and property. However, improper selection, poor placement, or deficient maintenance of plantings can directly contribute to the destruction of a home during a wildfire event. PFAC has produced a brochure on FireWise landscaping – consult their web site for details.

There are four attributes of vegetation that should be considered when purchasing, planting, or conducting maintenance:

1. Location: Vegetation can be close or even adjacent to a home, provided it is of the right kind and not part of a continuous "fuel-bed" leading up to the house. Adjacent to a home, "specimen" type shrub and tree plantings should be considered. These plantings should be isolated from others through both horizontal and vertical separation: grass, flowers, cinders, or mulch can be used to fill-in the gaps.
2. Type: Highly flammable plants high in oils or resins should not be planted close to structures. These plants will ignite easier and burn hotter than other types of vegetation. If such plants are already in-place, consider removal. If unable to do so, separate them from other existing vegetation by removal of adjacent plants. Favor plants which naturally have a high moisture content as evidence by leaves which are often thick, soft, and pliable. Ignition can still occur, but it will take longer and they will not burn as hot.
3. Amount and Arrangement: Large plants are acceptable, provided they are not crowded together in a continuous planting. Tree branches should not interlock and form a closed, continuous canopy overhead. Such an arrangement allows heat and fire to be easily transmitted from one plant to another. Shorter plants should not be placed where their presence could provide a "ladder" for a ground fire to climb higher into adjacent vegetation, thus endangering the home. Consider plants that are low growing: If ignited, there will be less material to burn. Be sure to inspect these plants regularly and remove any fallen leaves and needles that might collect in or under them. In addition, dead material in plants should be removed during routine maintenance. Weeds and grass should be routinely mowed to a height of two inches or less.
4. Vigor: Healthy plants are better able to withstand the challenges of our environment. Plants should be watered as required. Consider use of native plants, many of which require less water than exotics. Mulch should also be utilized to reduce watering needs: wood chips are OK provided they are placed so not to form a continuous fuel bed leading directly to the house.

*E. Annual Maintenance* – Maintaining a FireWise property will decrease yearly fuel accumulations and limit potential ignition sources that could cause structures to ignite. These include:

1. Eliminate readily-combustible materials (ex: needles, hay bales, firewood, etc) to a distance at least 30 feet from structures.
2. Clean needles, leaves, or any other

combustibles from roofs, raingutters, and under decks.

3. Remove tree limbs which overhang fireplace chimneys.
4. Clear vegetation around propane tanks.
5. Remove dead vegetation.
6. Mow weeds and grass to less than 2 inches in height.
7. Remove branches and limbs that are within six feet of the ground.

*F. Home Assessments* – Fire departments and districts will conduct a free home/property assessment, upon request, to educate owners about fire threat and provide recommended mitigation methods.

*G. Neighborhood Coordination* – Individual home protection is a necessary first step, but to achieve community protection, defensible neighborhoods are critical. Recent fires have conclusively demonstrated that an approaching wildfire can ignite individual structures, triggering a neighborhood conflagration beyond the response capability of firefighters. Interested individuals, home owner associations and others, such as Block-Watch or Woods-Watch groups, can be the needed catalyst to spur neighborhood action to reduce fire threat.

## IMPROVED PROTECTION CAPABILITIES

Several potential activities and efforts should be initiated or further developed, thereby increasing community protection. These include, but are by no means limited to, the following:

1. *Survey existing neighborhoods.* Identify, map, and prioritize neighborhoods for neighborhood-wide home ignitibility reduction.
2. *Establishment of a regional fuels crew.* This would involve many different partners and require sufficient funding. Principle among the partners would be PFAC members, but it could also involve NAU-ERI and GFFP as well. The consolidated crew, larger than current separate efforts, would be under single leadership with standardized training, equipment, and treatments standards. In addition to mitigation and prevention efforts, the crew could be available within the local area for fire suppression needs throughout the year
3. *Increased public education activities: Utilization of new outreach methods to prepare the community to receive fire.* Currently, there are a number of education initiatives and outreach methods underway by area partners. These include public meetings, presentations to service clubs, civic organizations and homeowner associations, media notices, periodic workshops and symposia, development/distribution of material, and participation in community events such as the Forest Festival, Science In-The-Park, and the County Fair. Future activities might include involvement in the Northern Arizona Home Show, public service announcements, airing of informational videos on Public Access TV and public service announcements on commercial TV, recognition of FireWise communities by the national FireWise program, and development and maintenance of a joint-agency website devoted to this issue.
4. *Develop/adopt/implement Legislation & Appropriations (State/Federal)* – Adequately fund and/or support, with sufficient oversight to ensure proper and timely application. Items of current interest include:

   Federal:

   **National Fire Plan** (particularly those areas having to do with assistance to local government via the State Fire Assistance grants and other mechanisms),

   **Healthy Forests Restoration Act** (chiefly to ensure professional planning and an increased level of forest treatment implementation, tied to appropriate plans),

   **Forest Landowner Enhancement Program** (a highly effective forest

treatment cost-share program for private landowners).

**Ecological Restoration Institute of Northern Arizona University** (provides the scientific foundation and academic credibility to our efforts, as well as a source of student interns and seasonal employees), and

**Local Community Partnerships/ Collaboratives** (provide interface for federal agencies to address community needs)

State:

**Implementation of HB 2549**, comprised of the following five actions:

Healthy Forest Enterprise Assistance Program (Incentives for wood-based businesses)

- State Forester (establishes office w/associated duties)
- Biomass Energy (Directs State to purchase)
- Urban-Wildland Fire Safety Committee (establishes 12-member committee w/associated duties)
- Interface Code (Permits adoption of code, per Wildland Fire Safety Committee)

**Adopt the remainder of the Governor's Arizona Forest Health Advisory & Oversight Councils recommendations**, provided spring 2004. Among others:

- Increase local planning & zoning authority
- Require real estate disclosure

**Revise the current Environmental Portfolio Standard** (AZ Corporation Commission) to eliminate the expiration date, include a larger total percentage of renewable energy, and emphasize use of biomass energy production.

4. *Recruitment of small-diameter, sustainable wood-based industry.* Utilization of the large amounts of biomass that must be removed from area forests is critical to success. This issue is covered elsewhere in this Section (See Utilization.)
5. *Fire district formation.* Some outlying homes within the CWPP are outside existing fire districts. Owners within these areas should seriously consider formation of Fire Districts – via the County – to facilitate emergency response, prevention, and mitigation efforts.
6. *Compatible data-layers for the Sedona and Winona area to facilitate analysis of the entire CWPP area.* Key information used in the development of this plan is lacking for the Sedona and Winona areas and/or not in the same format as that for the remainder of the area. This somewhat complicated our use of the work of the NAU-ForestERA project. Comparable data for areas with gaps should be developed to make future revision of this plan easier.
7. *Develop a standardized Neighborhood Wildfire Assessment format.* The City of Flagstaff has recently received a donation from Allstate Insurance Foundation for just such an effort. Once developed, it can be readily transferred to other jurisdictions within the CWPP area. The information derived from this effort can augment the threat matrix data contained in this plan, as well as become an educational outreach tool to residents.
8. *Incorporation of CWPP into on-going activities and established land-management and agency plans*. Both PFAC and the GFFP intend to utilize this document to prioritize actions, secure funding, coordinate activities, implement treatments, and monitor desired outcomes. The CWPP also provides guidance to private citizens in their effort to reduce their exposure to wildfire.
9. *Identification of additional resource and equipment need.* Individual agencies are responsible to provide appropriate

administration and planning for their respective organization. In addition, and to facilitate joint discussion and interoperability, PFAC, on an annual basis and with any needed assistance from GFFP, will host a multi-party discussion of current fire response capability within the CWPP area. Centered on the goal of reviewing and revising the PFAC Operations Plan (Appendix 4), the discussion will include all facets of fire management resources and other topics that may be appropriate.

10. *Funding.* This plan, and implementation of the identified activities, is intended to demonstrate our intent to implement and provide general information to appointed and elected officials and grant-funding organizations and agencies. Our coordinated effort to protect the greater Flagstaff community is a key ingredient to attracting additional funding to further implementation efforts.
11. *Wood distribution networks.* Establishment of on-going relationships with individuals and organizations on both the Hopi and Navajo Reservations, as well as with large charity organizations with interest and capability in wood delivery/distribution efforts, is an important utilization initiative. There is tremendous need for wood products – primarily firewood and posts-and-poles throughout both areas. It is estimated that over 75% of all homes on the Reservations have no electricity and require wood for heating and cooking. Creation of a steady "wood-pipeline" will not only benefit those who receive the wood, but also assist in reducing fire threat in our area by removal/utilization of excess small-diameter trees.
12. *Statewide mapping effort.* The "Arizona Fuels, Information, Restoration, and Education Mapping and Assessment Program" or ARIZONA FIRE MAP, is designed to establish and maintain a GIS-based mapping system that will document forest treatments, CWPP status, grant receipts, etc. Forest treatments within the Flagstaff area have been used to develop a prototype map. Involvement with this effort, as it develops, will ensure our area remains at the forefront of statewide activities.
13. *Coordination with adjacent areas during development of their respective CWPP.* Two adjacent areas where future plans may be developed are Sedona/Verde Valley and Williams/Parks-Bellemont. Both Sedona and Parks-Bellemont are included in this plan: inclusion in another plan is encouraged, but synchronization will be required to ensure management conflicts do not occur.
14. *Adoption/implementation of the Coconino County Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) and the Coconino County Emergency Management Plan (EMP).* Wildfire has been identified as one-of-five priority hazards within the County. The MJHMP, upon approval by the Federal Emergency Management Agency (FEMA) opens-the-door for pre-disaster mitigation funding and facilitates post-disaster mitigation and recovery efforts. The all-risk EMP, currently under development, will ensure consistency in emergency prevention, mitigation, response (including evacuation protocols), and recovery efforts throughout the entire county.
15. *PFAC Operations and Smoke Management Plans* – On an annual basis, a review and revision of each plan will occur.
16. *Development of a PFAC Prevention Plan.* On an annual basis, a comprehensive prevention plan, using and incorporating the existing Coconino National Forest plan as a template (see Appendix 7), will be developed to coordinate activities, messages, etc.
17. *Adoption and enforcement of appropriate codes throughout the Greater Flagstaff Area.* Such action will ensure consistency on fire

resistive construction, access, water, and addressing requirements, hazard fuel mitigation efforts, etc. (The adoption of the remainder of the Governor's "Arizona Forest Health Advisory & Oversight Councils" recommendations, identified in this plan, will assist with this need.)

18. *Implement an appropriate monitoring program.* Designed to track both accomplishments and effects of treatments, this will lend credibility to the effort and provide information necessary for the adaptive management of the plan. Perhaps this could be a project for an interested student or volunteer.
19. *Support the USFS in: a) Encouraging development/use of a Wildland Fire Use Plan for application in appropriate wildland areas, b) Application of the Appropriate Management Response for area wildfires, c) Planning, preparation, and implementation of prescribed fire projects*

Both GFFP and PFAC can provide leadership and assist with public educational needs to ensure community support of these two items.

# IMPLEMENTATION AND MONITORING

## COMMUNITY MITIGATION TREATMENTS

The combined effects of fuel reduction treatments implemented through past projects with proposed treatments identified and prioritized in this plan will not create a completely "Fire Safe" community, nor eliminate the need for suppression operations. Due to conditions outside our control, such as drought or extreme weather conditions, no one can guarantee total safety from wildfire. However, this plan is based upon both science and experience, and implementation will greatly reduce fire threat and create a FireWise environment.

Rather than recommending specific treatments, we have chosen to present, as found in Section 3, Desired Future Conditions and general Treatment Guidelines. Variations of these guidelines have been successfully utilized by property owners and land managers in the area for a number of years.

In this section, we have also chosen to present Treatment-Types utilizing the "coarse-filter" approach and vocabulary available with ForestERA data: We recognize that site-specific planning will need to occur prior to implementation of any treatment, and that the application of tree cutting, prescribed fire, etc, may differ somewhat from that described herein and must reflect silviculturally-accurate methodology and terminology. Factors considered in defining these potential Treatment Types included (see "Treatment Types" in Glossary for definitions of terms):

1. Overall reduction of predicted fire behavior from *Active Crown Fire* to *Passive Crown Fire.* It is extremely difficult to move predicted fire behavior to Surface Fire with just initial treatment unless significant tree removal and pruning, along with surface fuel removal, occurs: even then, individual and small groups of trees may ignite.
2. Treatment action in areas currently rated as Surface Fire will be as follows:
   A. Within the *Interface Zone* → Low Thinning Intensity, (if needed), followed byLight Prescribed Burn (Maintenance).
   B. Outside the *Interface Zone,* but within the *Analysis Area* → Light Prescribed Burn only, unless other factors or objectives dictate the need for Low Intensity Thinning.
3. Protection of wildlife habitat (such as Mexican Spotted Owl and Northern Goshawk), municipal or other critical watersheds (such as Lake Mary and Rio de Flag), and specially designated areas (such as Kachina and Red Rock Secret Mountain Wilderness Areas and San Francisco Peaks and Oak Creek Canyon Research Natural Areas) were considered and included in the analysis.

The exact location of the various potential Treatment Types may need to be slightly adjusted to take advantage of topographic or access features in order to facilitate effective and safe suppression actions when a major fire threatens the area. Adaptive management requires adjustment and refinement as the effort moves forward, and we encourage treatments that have as their goal the reduction of fire risk and the improvement of overall forest ecosystem health.

Five treatment types are recommended - three utilizing mechanical removal of trees followed by prescribed (broadcast) burning, and two burn-only treatments. They include:

Mechanical Thinning Followed by Prescribed Burn

**Low Intensity** = Light thinning followed by prescribed fire; representative of a maintenance

fuel reduction or light restoration.

**Intermediate Intensity** = Moderate thinning followed by prescribed fire; representative of a moderate fuels reduction or moderate restoration.

**High Intensity** = Heavy thinning followed by prescribed fire; representative of a heavy fuels reduction or full restoration.

Prescribed Fire Only:

**Light Burn** = No mechanical thinning (not required); maintenance burn (one goal is low tree mortality) on sites with light fuels.

**Heavy Burn** = No mechanical thinning (restricted or impractical); thin with fire (one goal is higher tree mortality) on sites with heavy fuels.

For additional discussion of these fuel treatments and how they were used in the analysis to modify predicted fire behavior, visit the ForestERA web site.

In addition to vegetation treatments, FireWise building techniques and standards are required. The Uniform Fire Code (UFC) and various Wildland Interface Fire Codes all provide the necessary framework, but not all areas can now adopt such codes based upon population, statutory authority, etc. (This issue is addressed in Section 3 - Improved Protection Capabilities, p. 52.) Currently, within the CWPP area, only the City of Flagstaff has requirements that all new developments implement a Fuel Management program prior to construction and that use of limited-combustible building material is mandatory in selected areas.

## Priority Areas and Treatment Costs

The priority area for implementation of appropriate vegetative treatments is the entire *Wildland/Urban Interface* zone (Map 5). Achieving public safety and community protection through treatment of the most severe fuel accumulations nearest communities are the over-riding objectives. Therefore, within the W/UI priority zone, emphasis should be placed on treating areas of predicted active crown fire behavior adjacent to communities or infrastructure. In addition, anywhere surface fire behavior is predicted, these areas can be treated more quickly and at much lower cost with prescribed fire and may also be emphasized.

Over the long term, treatment of the remaining acreage within the *Analysis Zone* will need to be implemented. However, sites within this area should reflect other values: public safety may not be the over-riding emphasis, and treatments must reflect those other values and resource management objectives. Opportunities may arise where appropriate treatments within this area are desirable prior to treatments in the *Wildland/Urban Interface*: if this occurs, and the work will not jeopardize priority projects within the W/UI, the opportunity should not be missed. Work in this area will require the JHA to review and refine any treatments in close collaboration with various stakeholders.

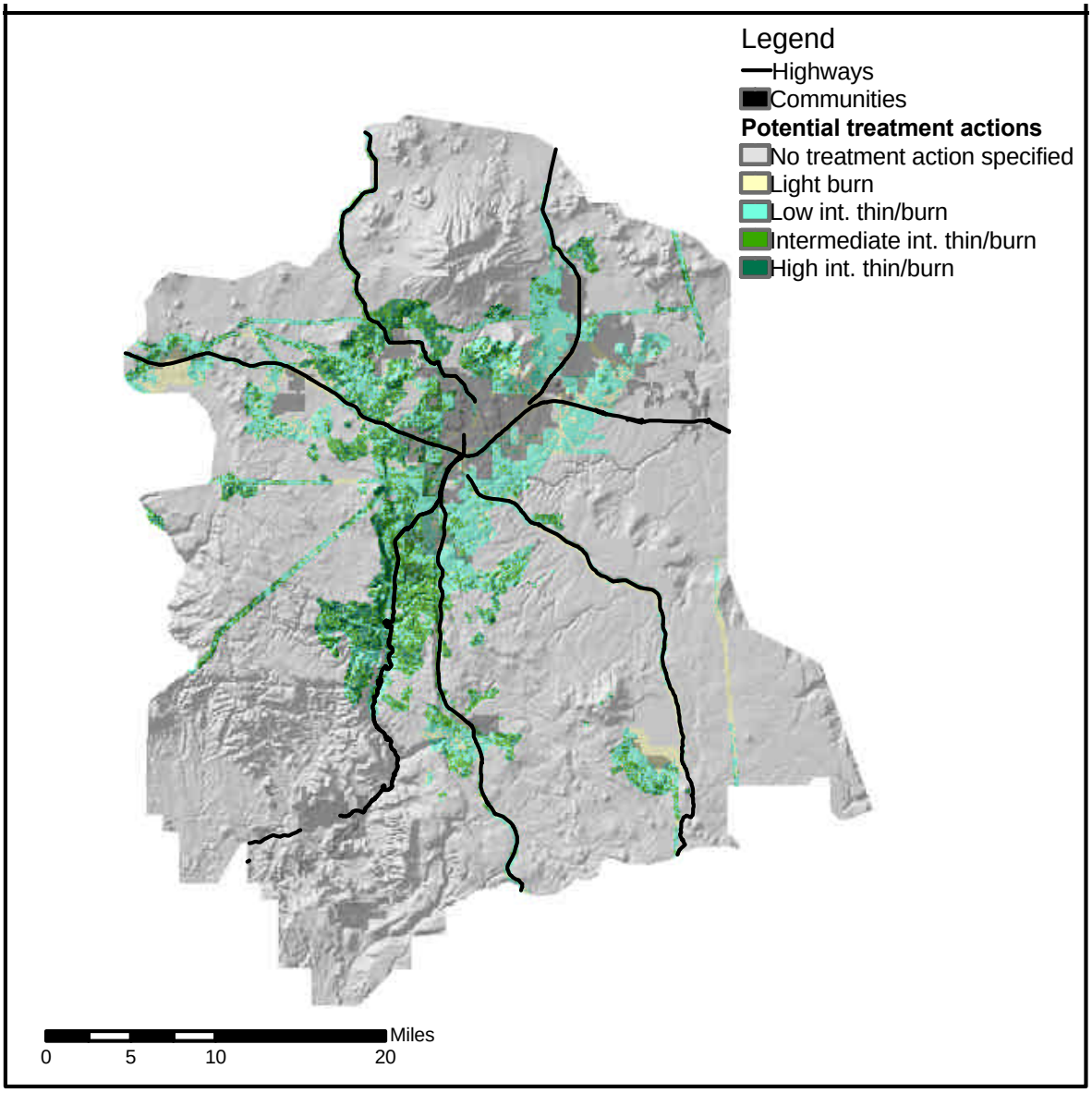
Maps 11A (*Wildland/Urban Interface*) and 11B (*Analysis Area*), depict recommended locations of where the treatments should be located. As indicated earlier, development of detailed prescriptions will be the responsibility of the JHA, and must be consistent with statutory authority and applicable land and resource management plans, be based on detailed knowledge of site conditions, and address specific resource management objectives.

Table 8 identifies the acreage of each treatment type within the *Wildland/Urban Interface* and the remaining *Analysis Area* excluding the W/UI. The table also provides an estimate of potential costs associated with applying the recommended treatments to the appropriate acres. Based on best estimates of typical costs associated with planning and implementation of the five treatments in earlier projects, an “average” per/acre cost was determined and applied. This data dramatically illustrates the financial commitment required to treat the recommended

acres. This cost demonstrates that from a strategic perspective, small-diameter wood-based enterprise development (including infrastructure development, wood utilization technology, sustained supply, and sufficient capital for business establishment and operating), all geared toward the establishment of a sustainable and effective industry that can offset some of the costs associated with hazardous fuel treatment, is critical if we are to succeed.

Needed capital can take many different forms: subsides, low-interest loans, cost-share, profit-sharing ventures, and direct payments. Funding sources may include numerous federal, state, local government, and private corporation ventures, and should include the entire gamut: planning, design, implementation, and monitoring.

**MAP 11A**

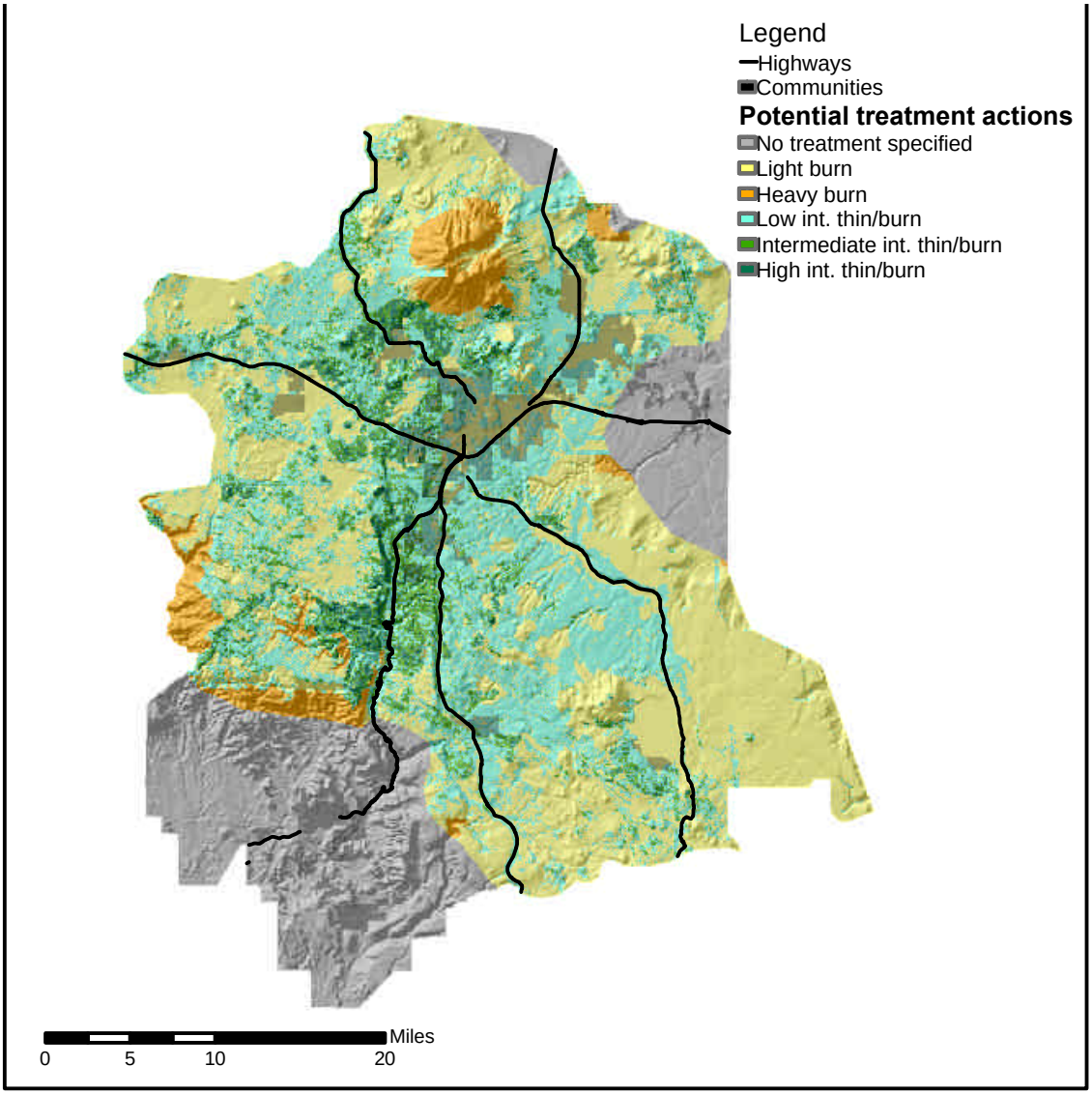



**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE - POTENTIAL TREATMENT TYPE***

**(Requires Site-Specific Analysis and Refinement)**

**MAP 11B**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***ANALYSIS AREA - POTENTIAL TREATMENT TYPE***

**(Requires Site-Specific Analysis and Refinement)**

## Table 8

## Acreage & Estimated *Initial* Treatment Costs

**POTENTIAL TREATMENT TYPE**

| LOCATION | Low Intensity Thin | Intermediate Intensity Thin | High Intensity Thin | Light Burn | Heavy Burn | TOTAL |
|---|---|---|---|---|---|---|
| **Wildland/Urban Interface** | | | | | | |
| Acres | 97,693 | 45,930 | 21,191 | 32,519 | 0 | 197,333 |
| *Cost ($)* | $63.5 M | $36.7 M | $21.2 M | $2.4 M | 0 | $123.8 M |
| **Analysis Area Less W/UI** | | | | | | |
| Acres | 164,420 | 15,979 | 104 | 318,030 | 43,429 | 541,962 |
| *Cost ($)* | $106.9 M | $12.8 M | $0.1 M | $23.4 M | $5.4 M | $148.6 M |
| **ACRES *** | **262,113** | **61,909** | **21,295** | **350,549** | **43,429** | **739,295** |
| **COST ($)** | **$170.4 M** | **$49.5 M** | **$21.3 M** | **$25.8 M** | **$5.4 M** | **$272.4 M** |

***** No treatment specified on 200,441 acres of Analysis Area due to lack of data

**Estimated Treatment Types Costs:**

Thinning Intensity:

Low = $650/acre
Intermediate = $800/acre
High = $1000/acre

Prescribed Burn:

Light = $75/acre
Heavy = $200/acre

**NOTES:**

1) Costs shown above are **for initial treatment only** an annual maintenance budget will be required.
2) Estimates include planning costs.
3) Total **Acres** and **Cost ($)** are low as the above figures do not reflect areas (200,441 acres) where ForestERA data does not exist (ex: Sedona, Cosnino/Winona).

## PREDICTED TREATMENT EFFECTS

When proposed treatments are applied to the appropriate acres as recommended in this plan, the ForestERA model is capable of predicting and displaying potential effects on fire behavior resulting from treatment. Maps 12A and 12B depict the response of fire behavior to implementing the recommended treatments in the *Wildland/Urban Interface* and in the entire *Analysis Area*. Although these are predicted effects, it does serve to illustrate the potential impacts of fuel reduction treatments on one of the parameters of most concern in protecting communities from catastrophic wildfire. For comparison purposes, Map 13 presents three maps side by side: predicted fire behavior under current conditions, predicted fire behavior after all recommended treatments are implemented in the *W/UI*, and predicted post-treatment fire behavior in entire A*nalysis Area*. Table 9 provides acreage and percent change in predicted fire behavior based on these maps.

## MONITORING AND ASSESSMENT PLAN

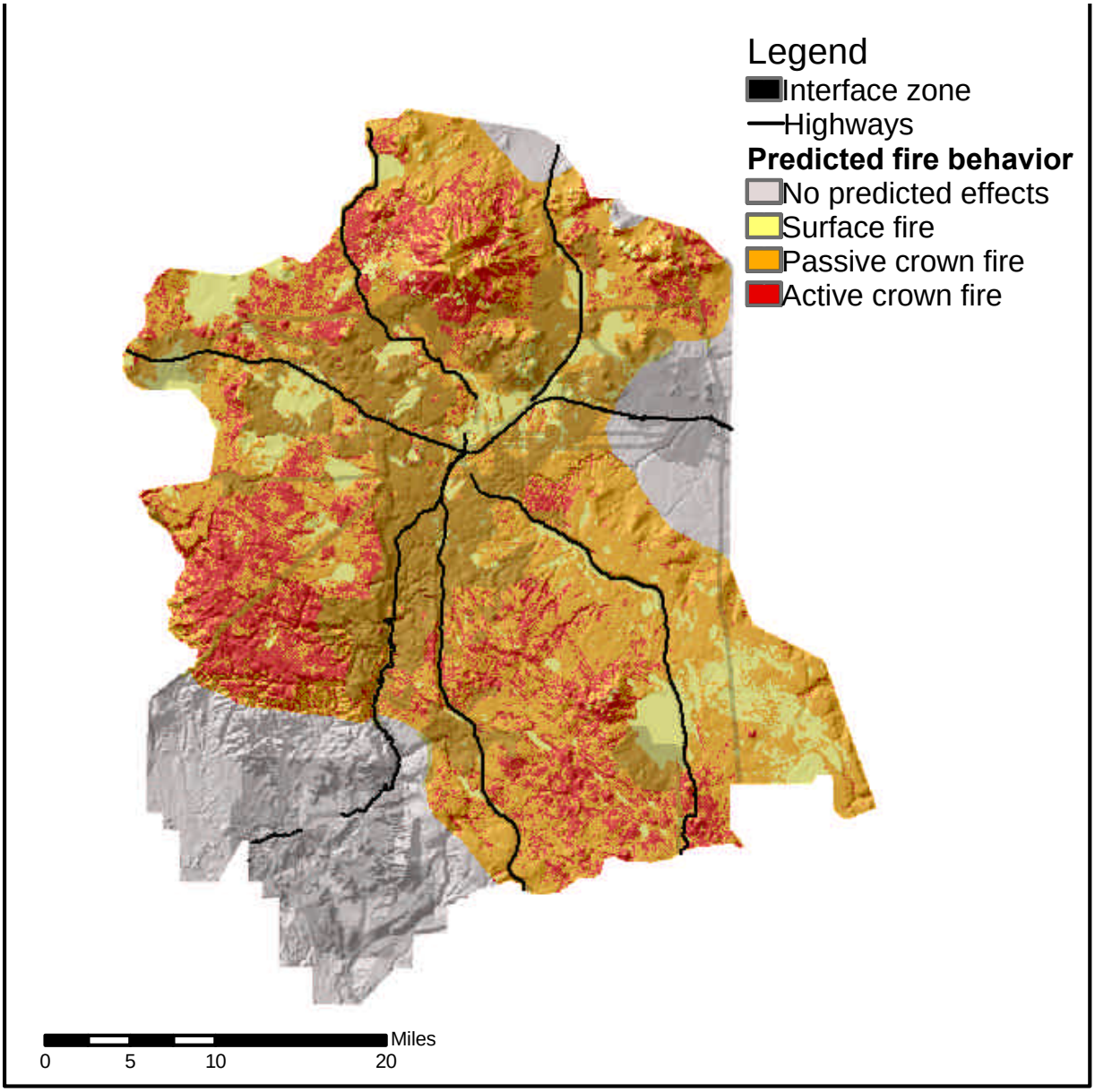
In our efforts to reduce the threat of uncharacteristic wildfire to communities and restore fire to fire adapted ecosystems, we recognize that we do not fully understand the consequences of all management options. Similarly, we do not yet fully realize or appreciate the consequences of traditional treatment options in all areas or ecosystems. In the face of uncertainty regarding the social, ecological, economic, and actual fire behavior changes as a result of fuels reduction efforts, and the concomitant potential "slowing down" of projects due to stakeholders' concerns, appeals, and lawsuits, it is imperative that a targeted, efficient and effective monitoring program be integrated into land management actions. However, to best use the information gathered by such monitoring efforts, it is also imperative that we, as stewards of the land, use a decision making process that is adaptive, or able to alter the course of actions based on the best available information. This is what is intended by the process of *adaptive management*.

To coordinate tracking and monitoring of the implementation of this CWPP, a Review Team should be established to include, at a minimum, representatives from GFFP, PFAC, Forest ERA, the USFS, local government, the environmental community, and citizens at large. Initiating activities right after formal approval of the CWPP and utilizing input from various sources, the Review Team should evaluate and report on the accomplishments and challenges in meeting the overall goal of this plan:

To protect Flagstaff and surrounding communities, and associated values and infrastructure, from catastrophic wildfire by means of:

1. An educated and involved public,
2, Implementation of forest treatment projects designed to reduce wildfire threat and improve long-term forest health, in a progressive and prioritized manner, and
3. Utilization of FireWise building techniques and principles.

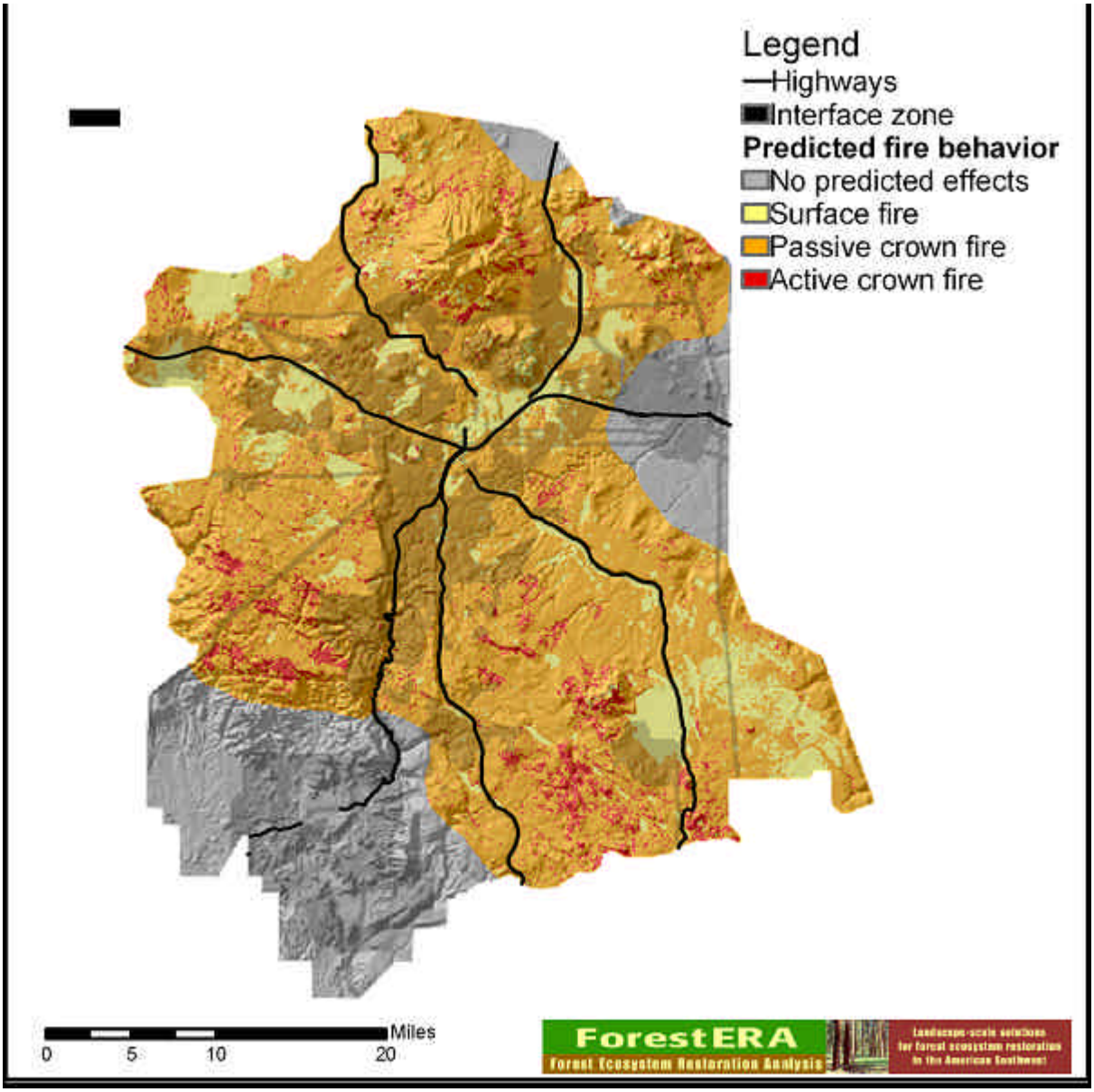
**MAP 12A**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

***WILDLAND/URBAN INTERFACE – PREDICTED POST-TREATMENT EFFECTS ON FIRE BEHAVIOR***

**MAP 12B**




**CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES**

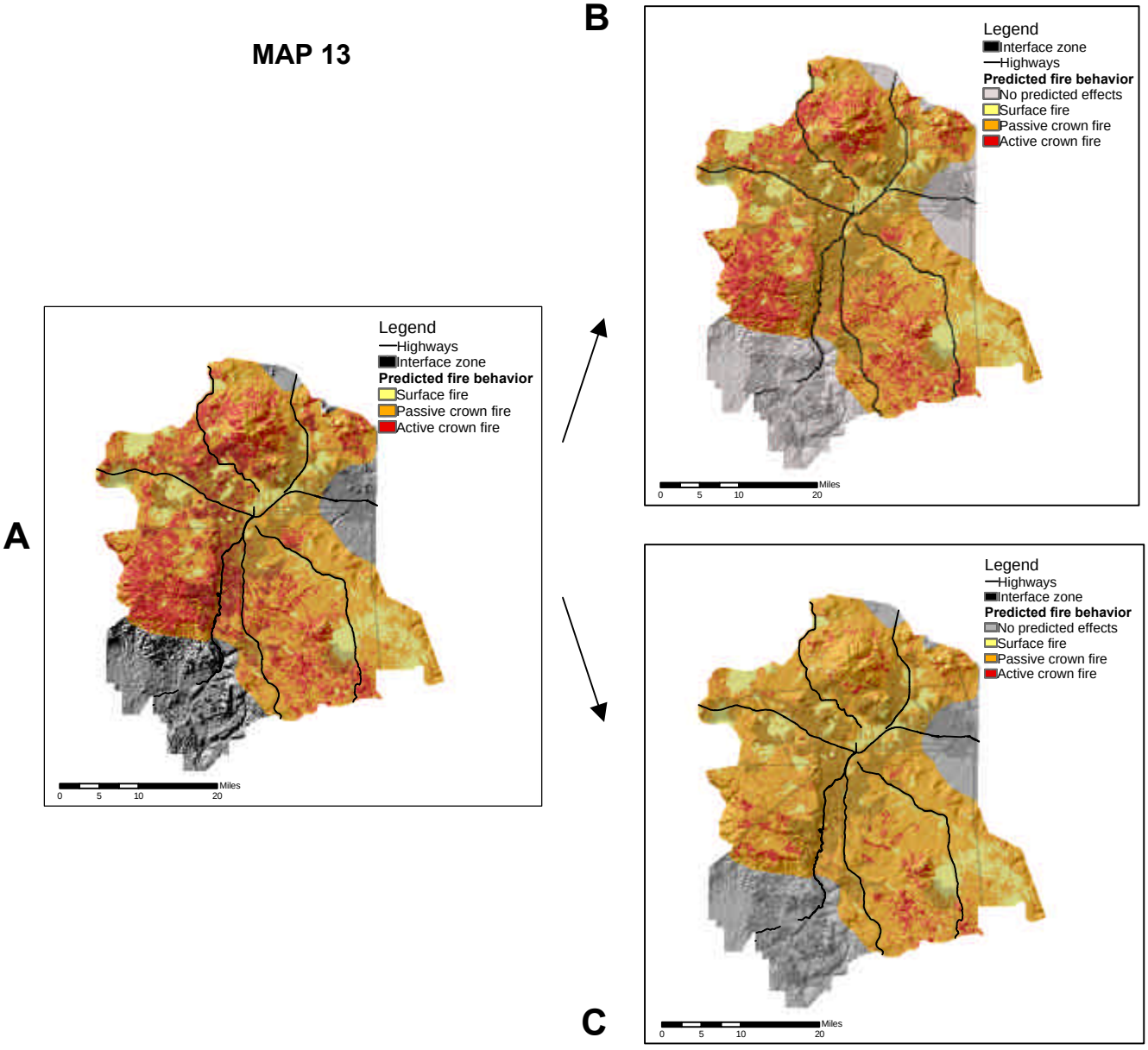
***ANALYSIS AREA – PREDICTED POST-TREATMENT EFFECTS ON FIRE BEHAVIOR***

**Table 9**

**Post Treatment Predicted Fire Behavior**

| Location | Fire Behavior | Pre Treatment Acres | Post Treatment Acres | % Change of Total |
|---|---|---|---|---|
| **W/UI** | Active | 68,248 | 3,606 | - 94% |
| | Passive | 105,353 | 169,834 | + 61% |
| | Surface | 23,757 | 25,765 | + 8% |
| | No Prediction | 0 | 0 | 0% |
| **Analysis Area** | Active | 150,933 | 47,610 | - 69% |
| (Less W/UI) | Passive | 314,929 | 416,405 | + 32% |
| | Surface | 75,450 | 75,450 | 0% |
| | No Prediction | 201,066 | 201,066 | 0% |
| **TOTAL ACRES** | | **939,736** | **939,736** | |

**MAP 13**




## CWPP FOR FLAGSTAFF & SURROUNDING COMMUNITIES

## COMPARISON OF PRE-TREATMENT AND POST-TREATMENT FIRE BEHAVIOR

**Map A shows predicted fire behavior under current conditions. Map B shows predicted fire behavior if all potential treatment actions were to be implemented within the *Wildland/Urban Interface* zone. Map C shows predicted fire behavior if all potential treatment actions were to be implemented within the *Analysis Area*.**

It is proposed that the Review Team also be tasked with designing and coordinating implementation of a multi-party monitoring program to acquire real data with which to accomplish their evaluation and reporting activities and implement adaptive management. The monitoring program will need to address diverse areas such as fuel reduction and fire behavior, ecosystem restoration, ecological impacts, and social and economic issues, and should be based on existing monitoring protocols. A framework of goals, objectives, and measurement methods, such as the *"GFFP Monitoring & Research Teams Adaptive Management Framework"* and which is included as Appendix 9, should be considered for inclusion in CWPP projects, based on the management objectives and potential impacts of each project. Not every project will have the same degree of uncertainty, and not every project has the same number of factors that are potentially impacted. The Review Team (or other appropriate body) may need to assess each project, and decide the level of monitoring that should be accomplished based on site-specific details, management objectives specific to existing conditions, desired future conditions, and the management options available to accomplish those objectives.

All CWPP projects must allocate funds to accomplish monitoring (approximately 5-10% of project costs is a target), and establish a formal process for integrating the results of that monitoring through time back into the land management decision-making process. One of the major benefits of monitoring projects and the cumulative effects of projects at the landscape level is that the process serves as a tremendous tool for public education and involvement, and as we learn from our failures and successes, there is greater agreement about how to proceed into the future.

At a minimum, each of the three items in the goal above will be evaluated based upon the four criteria described below. Not all may be applicable for each item, and additional criteria may be added. They include:

1. Implementation – A crucial aspect of measuring success will be actual implementation of needed treatments: Did they occur and in what locations? Treatment Maps (For example: Map 8) will be updated annually and shared with the community and all responsible parties.
2. Effectiveness – Of equal importance is the question of how effective are the various treatments: have they done what was anticipated in terms of fire risk reduction? Where possible, pre-and-post treatment fuel transects will be inventoried to determine actual change in fuel amounts. Fire affects from subsequent wildfires will be evaluated to refine future treatments and the results shared with the community.
3. better understanding of how fuels reduction and forest restoration actions affect the plants, animals, soils, watersheds, and ecosystems within project areas. If we are to be successful in *restoring* forests, we must understand the ecological effects of our various restoration strategies and actions, both at the project scale, and at the landscape scale.
4. Social Monitoring – Public attitudes toward both on-going and proposed treatments, and the agencies/organizations promoting and implementing them, is critical to success. Assessment of these attitudes will be on-going, and will include review of the following indicators:
   - *Editorials and other media coverage*
   - *Letters to editor*
   - *Requests for assistance*

   At some point, it may be beneficial to engage the Behavioral Sciences Lab at Northern

Arizona University (or another source) to conduct a scientific poll or survey to further refine treatments and guide education and planning efforts.

5. Economic Impacts - If we are to achieve success, a sustainable utilization component is essential. Of importance will be the success in attracting viable small diameter wood-based businesses into the area and evaluating their resulting economic impact. Once in place, evaluation of this aspect will be coordinated with the Greater Flagstaff Economic Council.

The Review Team should hold their initial meeting as soon as the CWPP is approved and establish a process to help facilitate implementation of the plan among the various land management agencies and to design and implement the monitoring program. A formal convening of the Team should also be scheduled for six months after adoption of the CWPP to complete a comprehensive review of the Plan and develop any recommended revisions. Thereafter, the Team should meet at least annually to review progress and make recommendations for appropriate revisions to the document.

## Roles and Responsibilities of Stakeholders

As depicted on Table 10, successful implementation of the CWPP cannot be done without major cooperation from all. Without continued collaboration and mutual assistance, this plan will only provide a false sense of security. Wildfire does not recognize property boundaries, and neither can we.

## Table 10

## Roles and Responsibilities of Key Stakeholders

| Stakeholder | Planning Design Implementation | Education Information Transfer | Advisory | Regulatory Permitting |
|---|---|---|---|---|
| **Private:** | | | | |
| Citizens | X | X | | |
| Businesses | X | X | X | |
| Service Clubs | X | X | | |
| Homeowner Groups | X | X | | X |
| **City:** | | | | |
| Officials/Departments | X | X | X | X |
| Fire Departments | X | X | X | X |
| **County:** | | | | |
| Officials/Departments | X | X | X | X |
| Fire Districts | X | X | X | X |
| Rural Environmental Conservation Corps | X | X | | |
| **State:** | | | | |
| Dept of Emergency & Military Affairs (Camp Navajo) | X | X | X | |
| Land Dept – Fire Management | X | X | X | |
| Dept of Transportation | X | | | |
| Dept of Corrections | X | | | |
| Game & Fish Dept | X | X | X | X |
| Dept of Environmental Quality | | X | X | X |
| Cooperative Extension Service | X | X | X | |
| Northern AZ University: | | | | |
| Ecological Restoration Institute | X | X | X | |
| School of Forestry | | X | X | |
| Forest ERA | X | X | X | |
| Centennial Forest | X | X | | |
| **Federal:** | | | | |
| Naval Observatory | X | | | |
| Forest Service | X | X | X | X |
| Fish & Wildlife Service | X | X | X | X |
| National Park Service | X | X | X | |
| **Other:** | | | | |
| Utilities – | | | | |
| El Paso Natural Gas | | X | X | |
| AZ Public Service | X | X | X | |
| Greater Flagstaff Forests Partnership | X | X | X | |
| Ponderosa Fire Advisory Council | X | X | X | |

# ASSISTANCE

Development of the CWPP is a new initiative established under the HFRA of 2003. Since very few communities have completed plans – per guidelines set forth by the National Association of State Foresters, Communities Committee of the Seventh Forest Congress, Society of American Foresters, National Association of Counties, and Western Governors' Association – reference material from other communities or groups regarding both specific plan content and process was limited. Nonetheless, we believe we have developed a community supported CWPP that meets the intent of the HFRA.

Important documents utilized during development of this plan include:

"*Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities*" (www.safnet.org/policyandpress/cwpp.cfm)
"*Federal Agency Implementation Guidance for the Healthy Forest Initiative and the Healthy Forests Restoration Act*" (www.fs.fed.us/projects/hfi/field-guide)
"*Field Guidance for Identifying and Prioritizing Communities at Risk*" www.stateforests.org/reports/COMMUNITIESATRISK.pdf)
Several websites also provided valuable information. They include:
Arizona Cooperative Extension Service (http://ag.arizona.edu/extesion/fh/)
Arizona Fire Management Division (www.azstatefire.org)
Arizona FireWise Communities (www.cals.arizona.edu/firewise)
Arizona Forest Health Council (www.governor.state.az.us/FHC/)
Forest Ecosystem Restoration Analysis Project (ForestERA) (www.forestera.nau.edu)
Flagstaff Fire Department (www.flagstaff.az.gov/fuelmanagement)
Fire Safe Council (www.firesafecouncil.org)
Grants: Foundation (www.fdncenter.org)
Federal (www.grants.gov)
Greater Flagstaff Forests Partnership (www.gffp.org)
Northern Arizona University Forest Health (www.forestfire.nau.edu/)
Southwest Area Fire & Drought (www.swstrategy.org/fire.html)
The National Fire Plan (www.fireplan.gov)
Western Governor's Association (www.westgov.org)
For recommendations regarding treatments and/or site-specific FireWise information, contact:

| | | |
|---|---|---|
| AZ State Land Department | - | 928-774-1425 |
| Flagstaff Fire Department | - | 928-779-7688 |
| Highlands Fire District | - | 928-525-1717 |
| Mormon Lake Fire District | - | 928- |
| Parks-Bellemont Fire District | - | 928-635-5311 |

| | | |
|---|---|---|
| Pinewood Fire District | - | 928-286-9885 |
| Sedona Fire District | - | 928- |
| Summit Fire District | - | 928-526-9537 |

For information regarding specifics of this plan, contact either of the following:


Paul Summerfelt
FMO-Flagstaff Fire Depatment
211 W. Aspen
Flagstaff AZ 86001
(928) 779-7685 x 7283
psummerfelt@ci.flagstaff.az.us

Steve Gatewood
Program Director - GFFP
1300 S. Milton #218
Flagstaff AZ 86001
(928) 226-0644
steveg@gffp.org

# GLOSSARY

Glossary terms come from several sources including:

Arizona Forest Health Advisory Council. 2003. *Guiding Principles for Forest Ecosystem Restoration and Community Protection*. September 2003.

Ecological Research Institute. 2004. *Western Mogollon Plateau Adaptive Landscape Assessment Draft Report on Initial Workshop Outcomes*. June 2004

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Basal Area (BA): The area of the cross-section of a tree trunk near its base, usually 4½ feet above the ground. Basal area is a way to measure how much of a site is occupied by trees. The term basal area is often used to describe the collective basal area of trees per acre.

Biodiversity (biological diversity): The variety of life and its process, including the variety in genes, species, ecosystems, and the ecological processes that connect everything in the ecosystem.

Coarse-filter analysis: An analysis of aggregates of elements such as cover type or plant community.

Community protection: Actions or programs undertaken for the purpose of protecting human lives, property, and infrastructure.

Conservation: The careful protection, utilization and planned management of living organisms and their vital processes to prevent their depletion, exploitation, destruction, or waste.

Critical habitat: According to Federal Law, the ecosystem upon which endangered and threatened species depend.

Crown fire: This is a fire that travels from one crown (or tree top) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns,

Defensible space: This is the area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to the surrounding forest. Defensible space provides room for the firefighters to do their jobs. Many communities are taking a more holistic approach of creating defensible neighborhoods rather than jus individual properties.

Disturbance: A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.

Ecosystem: Living organisms interacting with each other and with their physical environment, usually described as an area for which it is meaningful to address these interrelationships.

Ecological restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Fire Behavior: As utilized throughout this plan -

*Active Fire Behavior* = Fires readily transition into tree crowns, with large group tree torching

common: associated long-range (≥ .5 mile) spotting is common

*Passive Fire Behavior* = Fires will transition into tree crowns, but only small-group or individual tree torching common: associated long-range spotting (≥ .5 miles) can occur

*Surface Fire Behavior* = Fires stay on the ground, with little tendency to transition into tree crowns except in isolated cases: short-range spotting (≤ ¼ mile) can occur

Fire Frequency (Fire Return Interval): How often fire burns a given area; often expressed in terms of fire return intervals (e.g., fire returns to a site every 5-15 years). (see also Fire Regime Group).

Forest ecosystem health: A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, allowing goals for uses, values, and services of the ecosystem to be met.

Forest ecosystem restoration: Holistic actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes. Generally refers to the process of enabling the system to resume acting, or continue to act, following the effects of a disturbance. Restoration management activities can be active (such as control of invasive species, thinning of over-dense tree stands, or redistributing roads) or more passive (more restrictive, hands-off management direction that is primarily conservation oriented). Frequently, a combination or number of actions is used sequentially to achieve restoration goals.

Hazard: To place something of value in a risky or dangerous situation

Hazardous fuel: Excessive live and dead trees and other vegetation and organic debris that increase the potential for uncharacteristically intense wildland fire and decrease the capability to protect life, property, and natural resources.

Healthy ecosystem: An ecosystem in which structure and functions allow the maintenance of the desired condition of biological diversity, biotic integrity, and ecological processes over time.

Old growth tree; This is an old tree, one that exhibits the complex structural characteristics associated with the oldest age class of trees in a group, clump or stand. In today's forests, an old growth tree in one that has been present since before the onset of commercial logging and fire exclusion. These trees are sometimes referred to as pre-settlement trees. These trees typically have orange or yellow platy bark.

Prescribed fire: A management fire ignited to meet specific fuel reduction or other resource objectives. All prescribed fires are conducted in accordance with prescribed fire plans.

Risk to communities: The risk associated with adverse impacts to communities resulting from unwanted wildfire.

Reference conditions: Conditions characterizing ecosystems composition, structure, and their variability.

Restoration: Actions taken to modify an ecosystem in whole or in part to achieve a desired condition.

Surface fire: A fire that burns over the forest floor, consuming litter, killing aboveground parts of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees.

Sustainability: The ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time.

Threat: An indication that an undesirable event or catastrophe may occur. For this plan, a Threat matrix, using three items, was developed to permit focus upon the Interface Zone.

*Value* – The measure of how strongly something is desired, expressed in terms of effort, money, etc

one is willing to expend to attain or preserve it. Two issues (Communities and Infrastructure, and Municipal Watersheds) were identified in this plan.

*Risk* – The possibility of danger, injury, or loss. Two issues (Predicted Fire Behavior and Post-Fire Flooding) were identified in this plan.

*Other* – Further or additional issues. One item (Areas upwind from at-risk communities (permitting fire spread into at-risk communities) was identified in this plan.

Treatment Types (potential): These are general descriptor terms only, not silvilcultural terms-

*Thinning Intensity*:

*Low* = Simple thinning, w/prescribed fire

*Intermediate* = Moderate thinning, w/prescribed fire

*High* = Heavy thinning w/prescribed fire

*Prescribed Fire only (Rx):*

*Light* = No mechanical thinning: maintenance burn (one goal is lower tree mortality) or sites w/light fuels (less intense fire)

*Heavy* = No mechanical thinning (required or practical): thin with fire (one goal is higher tree mortality) or sites w/heavy fuels (more intense fire

Watershed: An area of land with a characteristic drainage network that contributes surface or ground water to the flow at that point: a basin or a major subdivision of a drainage basin.

Wildland fire use: The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined in Fire Management Plans.

# Appendix 1

## GFFP and PFAC Membership

**GFFP PARTNERSHIP ADVISORY BOARD MEMBERS** – September 2004

Arizona Game & Fish
Arizona Public Service
Arizona State Land Department – Fire Management Division
City of Flagstaff – Fire Department
Coconino County – Community Development Department
Coconino County Farm Bureau / Cattle Growers Association
Coconino Natural Resource Conservation District
Coconino Rural Environment Corps
Cocopai Resource Conservation & Development District
Ecological Restoration Institute at Northern Arizona University
Flagstaff Chamber of Commerce
Flagstaff Native Plant & Seed
Grand Canyon Trust
Greater Flagstaff Economic Council
H & K Consulting
Highlands Fire District (Communities of Kachina Village, Forest Highlands and Mountainaire)
Indigenous Community Enterprises
Northern Arizona University - College of Engineering
Northern Arizona University - School of Forestry
Perkins Timber Harvesting
Ponderosa Fire Advisory Council
Practical Mycology
Southwest Environmental Consultants
Society of American Foresters - Northern Arizona Chapter
The Arboretum at Flagstaff
The Nature Conservancy
US Fish and Wildlife Service

**Cooperators**

USDA Coconino National Forest
USDA Rocky Mountain, Pacific NW and Southern Research Stations
USDA Forest Products Lab

**PONDEROSA FIRE ADVISORY COUNCIL MEMBERS** – September 2004

Arizona State Land Department
Camp Navajo Fire Department
Coconino County Emergency Services
Coconino National Forest
Coconino Sheriff Department
Flagstaff Fire Department
Flagstaff Police Department
Flagstaff Ranch Fire Department
Highlands Fire Department
Kaibab National Forest
Mormon Lake Fire Department
Parks/Bellemont Fire Department
Pinewood Fire Department
Sedona Fire Department
Summit Fire Department
Walnut Canyon-Wapatki-Sunset Crater National Monuments

# Appendix 2

## Guiding Principles for Forest Restoration and Community Protection

# GUIDING PRINCIPLES FOR FOREST ECOSYSTEM RESTORATION AND COMMUNITY PROTECTION

**Arizona Forest Health Advisory Council**
**September 2003**

Steve Campbell ~ Navajo County Cooperative Extension
Dr. Wally Covington ~ Northern Arizona University Ecological Restoration Institute
Dr. Carl Edminster ~ USDA Forest Service Rocky Mountain Research Station
Lori Faeth ~ State of Arizona
Don Falk ~ University of Arizona Laboratory of Tree-Ring Research
Deb Hill ~ Coconino County
John Kennedy ~ Arizona Game and Fish Department
Robert Lacapa ~ Bureau of Indian Affairs
Taylor McKinnon ~ Grand Canyon Trust
Dr. Marty Moore ~ Eastern Arizona Counties Organization
Brian Nowicki ~ Center for Biological Diversity
Kirk Rowdabaugh ~ Arizona State Land Department
Karl Siderits ~ USDA Forest Service Tonto National Forest
Ed Smith ~ The Nature Conservancy
Dr. Tom Swetnam ~ University of Arizona Laboratory of Tree-Ring Research
Richard Van Demark ~ Southwest Forestry
Beth Zimmerman ~ Arizona Division of Emergency Management

## Preamble to the Guiding Principles

*Arizona's high country is home to magnificent forests harboring a diversity of biological, cultural, and economic values. Yet many of Arizona's forests—especially Arizona's extensive ponderosa forests—have undergone a dramatic transformation during the past century due to land use, climate, and other factors. These changes have increased insect and disease outbreaks, abnormally severe fires, and adversely affected biological, cultural, and economic values. The unacceptable risk posed by these conditions requires immediate and strategic action.*

*Recognizing these factors, Arizona Governor Janet Napolitano convened a Governor's Conference on Forest Health and Safety in March 2003. Findings from this conference led to the development of an Action Plan for Arizona, and a call for the creation of a broad, science-based Forest Health Advisory Council to provide recommendations on how to improve the health of Arizona's forests.*

*The Arizona Forest Health Advisory Council has developed these Guiding Principles to provide an overall framework for planning and implementing forest ecosystem restoration and community protection projects statewide. In presenting these Guiding Principles, the Council emphasizes the following:*

*Different forest types have different natural disturbance regimes. For example, where crown fire is unnatural, thinning and prescribed burning may be needed to safely reestablish more natural surface fire regimes. But in forest types where crown fire is natural, such treatments may not be needed, at least from an ecological standpoint.*

*Understanding these differences is fundamental to restoring more natural disturbance regimes in our forests.*

*Community stakeholders must take the lead to implement these principles and make the decisions for their communities at risk. The Council stresses the immediate and urgent need to adequately reduce the risk to communities. This will require a comprehensive effort to reduce hazardous fuels in and around at-risk communities regardless of the adjacent ecosystem type. Fire research and recent fires demonstrate that fuels reduction treatments in and around communities may not prevent the loss of homes. Homeowners must do their part to create defensible space and replace or mitigate flammable building materials.*

*Although Arizona's forest and woodland ecosystems need restoration, it is important to understand that restoration is a young science whose long-term outcomes are uncertain. The Council urges employing a diversity of restoration strategies that fit local ecological, social, political, and economic circumstances. A "one size fits all" approach is not appropriate.*

*Learning about restoration should be an active and ongoing process. A serious commitment to monitoring and adaptive management is critical to understanding the ecological, social, and economic dimensions of restoration. The Guiding Principles should be viewed as dynamic and adaptable to evolving conditions and experiences.*

*The costs of restoration must be weighed against the costs of inaction. Though restoration may seem a weighty investment, it pales in comparison to the immediate and long-term costs and risks of allowing current forest conditions to persist. Restoration is a process of recovery requiring a substantial and sustained investment of funds, and political and public support.*

*The Guiding Principles urge us to think big. Arizona's forests and the ecological processes that sustain them span landscapes. Assessing needs, identifying priorities, and charting progress toward community protection and forest ecosystem restoration goals must occur within an appropriately large landscape context.*

*The Council's ultimate hope is that the Guiding Principles will help guide our movement toward sustainable and reciprocal relationships between human communities and forest ecosystems – relationships that sustain the biological, cultural, and economic values that contribute to a healthy democratic society, both now and into the future.*

# Guiding Principles

## Integration

***The overall strategy for restoring forest ecosystem health and protecting communities must be dynamic, comprehensive and integrated.*** A primary component of the overall strategy is to perform a statewide forest health evaluation to identify high-priority communities, critical infrastructure, habitats, and watersheds at risk. This evaluation can also provide the framework for monitoring individual projects and cumulative effects.

## Sustainable Communities and Economies

***Sustainable economies are linked to sustainable ecosystems.*** We should be building a sustainable future for Arizona's forests and communities

***The immediate focus should be on protecting human communities at risk, critical infrastructure, along with key watersheds and habitats.*** Distinguishing between forest ecosystem restoration and community protection, and focusing on community protection within the entire community—private, public and tribal lands and the wildland-urban interface—will improve the likelihood of success.

***Close collaboration among all stakeholders is essential to a community-based approach to forest ecosystem restoration and community protection.*** Encourage and empower community-based collaborations to demonstrate and implement effective community protection and forest ecosystem restoration. Be sensitive and responsive to the diversity of individuals and communities who value and/or depend on the forest and its resources.

***Decision-making about forest ecosystem restoration and community protection must occur with a serious commitment to rigorous adaptive management.*** Such an approach should include baseline data, short and long-term monitoring, and a transparent mechanism for tracking results, evaluating and incorporating findings into the decision-making process.

## Ecological Integrity

***Appropriate restoration methods are based on ecological need.*** These methods are further defined by the importance of the site in the watershed or landscape, and the timing, techniques and resources needed to restore ecological integrity. Restoration needs to be designed with a clear understanding of desired and ecologically appropriate future conditions.

***Effective forest ecosystem restoration should reestablish fully functioning ecosystems.*** A primary goal of forest restoration is to enhance ecological integrity, natural processes and resiliency to the greatest extent possible. Fire hazard reduction must be linked to the reintroduction of fire as a keystone ecological process. An active program of prescribed and maintenance burns and natural fire use is essential.

***Forest ecosystem restoration and community protection treatments should protect and enhance water and soil resources.*** The development and implementation of forestry best management practices will serve to protect these resources.

***Forest ecosystem restoration should protect and promote development of old-growth trees and large trees needed to restore ecosystem structure and function.***

***Landscape scale forest ecosystem restoration should maintain native plant and wildlife populations and habitat features.*** A key consideration is the need to maintain and restore movement corridors and refugia to avoid biodiversity bottlenecks.

***Project work should be based upon landscape assessments of risks to and status of aquatic and terrestrial resources and of the potential for restoration to be successful.*** The assessment is used to identify the root causes of ecosystem degradation at the eco-regional, intermediate and site level scales, determine appropriate methods for restoring degraded systems and create a spatially-explicit prioritization of restoration needs.

## Land Use and Planning

***Forest ecosystem restoration must include evaluating and changing public land use practices that are scientifically demonstrated to contribute to forest health degradation.***

***Forest ecosystem problems and solutions exist in a context of land use.*** In fire prone areas community officials must develop, adopt, and enforce comprehensive land use plans, zoning regulations and building codes for community protection, forest restoration, ecosystem health requirements and long-term fire management. Zoning and land use have a major impact on fire management, and can make a significant contribution to restoring forest health and protecting communities.

***Forest ecosystem restoration requires effective community protection to establish and maintain a fire-resistive condition for structures, improvements and vegetation.*** Methods for accomplishing this condition are based on public safety needs, fire hazard, and local capability and creativity. A fire-resistive condition will be accomplished by removing and modifying forest fuels, establishing defensible space, and use of fire-resistant construction materials and architectural design.

## Funding and Compliance

***Forest ecosystem restoration and community protection requires a sustained investment of federal, tribal, state, local and private resources.*** Restoration is a long-term process requiring a sustained commitment of funding. Adequate, sustained investment in forest ecosystem restoration and community protection is more cost effective and socially desirable than fire suppression and rehabilitation.

***Forest ecosystem restoration and community protection actions should comply with all applicable environmental laws and regulations.***

## Practices

***Forest ecosystem restoration and community protection programs should use the lowest impact techniques that will be effective and efficient.*** Explore, develop and utilize low impact technologies to sustain and enhance ecosystem integrity and productivity, and minimize negative cumulative effects.

***All forest ecosystem restoration and community protection treatments should use locally adapted native plant materials to the greatest extent possible.*** Non-invasive, non-native species may be considered for emergency rehabilitation.

# GLOSSARY

**Adaptive Management**
A type of natural resource management in which decisions are made as part of an ongoing process. Adaptive management combines planning, implementing, monitoring, research, evaluating, and incorporating new knowledge into management approaches based on scientific findings and the needs of society. Results are used to modify future management methods and policy.

**Biodiversity**
The variety of life forms and processes including complexity of species, communities, gene pools, and ecological functions.

**Biodiversity Bottleneck**
A bottleneck in this context is the assemblage of environmental and/or human-caused factors or ecological "threats" that hamper the ability of ecosystems to support biodiversity at its current level through time. The bottleneck analogy is that fewer organisms (and their genes) in the bottle (current conditions) may be able to emerge on the other side (future conditions) due to resource limitations. (Source: this council.) http://www.usembassy.it/file2001_04/alia/a1041704.htm; http://www.clat.psu.edu/biodiversity/defined/populations/populations-p04.html

**Community Protection**
Actions or programs undertaken for the purpose of protecting human lives, property, and infrastructure. (Source: this council)

**Crown fire**
This is a fire that travels from one crown (or treetop) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below the crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY. p. 282. (See also Surface Fire)

**Cumulative Effects**
Individual actions when considered alone may not have a significant impact on the quality of the human environment. Groups of actions, when added together may have collective or cumulative impacts that are significant. Cumulative effects that occur must be considered and analyzed without regard to land ownership boundaries. Consideration must be given to the incremental effects of past, present, and reasonably foreseeable related future actions of the Forest Service, as well as those of other agencies and individuals. Source: CEQ Regulations applied to US Forest Service regulations http://www.fs.fed.us/emc/nepa/includes/epp.htm#c151

**Defensible Space**
This is an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to the surrounding forest. Defensible space provides room for the firefighters to do their jobs.(New Mexico State Forestry) Many communities are taking a more holistic approach of creating defensible neighborhoods rather than just individual properties.

**Ecosystem**
A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and components of any part of the natural environment within its boundaries. An ecosystem can be of any size-a log, pond, field, forest, range or grassland, or even the earth' s biosphere. (Society of American Foresters, 1998.)

**Ecosystem Function**
The process through which the constituent living and nonliving elements of ecosystems change and interact, including biogeochemical processes and succession.

**Ecosystem/Ecological Integrity**
The completeness of an ecosystem that at multiple geographic and temporal scales maintains its characteristic diversity of biological and physical components, spatial patterns, structure, and functional processes within its approximate range of historic variability. These processes include: disturbance regimes, nutrient cycling, hydrologic functions, vegetation succession, and species adaptation and evolution. Ecosystems with integrity are resilient and sustainable.

**Ecosystem Process**
The actions or events that link organisms and their environment, such as predation, mutualism, successional development, nutrient cycling, carbon sequestration, primary productivity, and decay. Natural disturbance processes often occur with some periodicity (From Webster's dictionary, adapted to ecology).

**Ecosystem Resilience**
The ability of a system to respond to disturbances. Resiliency is one of the properties that enable the system to persist in many different states or successional stages.

**Fire Frequency (Fire Return Interval)**
How often fire burns a given area; often expressed in terms of fire return intervals (e.g., fire returns to a site every 5-15 years). (see also Fire Regime Group).

**Fire Regime Group**
A generalized description of the role fire plays in an ecosystem. It is characterized by fire frequency, predictability, seasonality, intensity, duration, and scale (patch size), as well as regularity or variability. (See also Fire Frequency)

**Forest Ecosystem Health**
A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, allowing goals for uses, values, and services of the ecosystem to be met.

**Forest Ecosystem Restoration**
Holistic actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes. Generally refers to the process of enabling the system to resume acting, or continue to act, following the effects of a disturbance. Restoration management activities can be active (such as control of invasive species, thinning of over-dense tree stands, or redistributing roads) or more passive (more restrictive, hands-off management direction that is primarily conservation oriented). Frequently, a combination or number of actions is used sequentially to achieve restoration goals.

**Hazardous Fuel**
Excessive live or dead trees and other vegetation and organic debris that increase the potential for uncharacteristically intense wildland fire and decrease the capability to protect life, property, and natural resources.

**Invasive or Noxious Weed** (also applies to animals and other organisms)
Any species of plant which is, or is liable to be, detrimental or destructive and difficult to control or eradicate and shall include any species that the director, after investigation and hearing, shall determine to be a noxious weed. Arizona Revised Statutes 3-201 http://www.azleg.state.az.us/ars/3/00201.htm

**Landscape**
An area composed of interacting and inter-connected patterns of habitats (ecosystems) that are repeated because of the geology, landform, soils, climate, biota, and human influences throughout the area. Landscape structure is formed by patches (tree stands or sites), connections (corridors and linkages), and the matrix. Landscape function is based on disturbance events, successional development of landscape structure, and flows of energy and nutrients through the structure of the landscape. A landscape is composed of watersheds and smaller ecosystems. It is the building block of biotic provinces and regions.

**Natural Disturbance Regime**
A natural disturbance (e.g. fire, insect outbreak, flood) with a characteristic frequency, intensity, size, and type that has influence on an ecosystem over evolutionary time.

**Old Growth Tree**
This is an old tree, one that exhibits the complex structural attributes associated with the oldest age class of trees in an old growth stand. In today's forests, an old-growth tree is one that has been standing since before the onset of commercial logging and fire exclusion. These trees are sometimes referred to as pre-settlement trees. Old-growth ponderosa pine trees typically have orange, platy bark. Source: Schubert, G.H. 1974. Silviculture of southwestern ponderosa pine: the status of our knowledge. USDA Forest Service General Technical Report RM , http://www.ancienttrees.org/cfoggа.php#1

**Prescribed Fire**
Any fire ignited by management actions to meet specific objectives. All prescribed fires are conducted in accordance with prescribed fire plans. (See also Wildland Fire Use)

**Risk to Communities**
The risk associated with adverse impacts to communities resulting from unwanted wildland fire.

**Surface fire**
A fire that burns over the forest floor, consuming litter, killing aboveground parts of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY p. 281 (See also Crown Fire)

**Sustainable (Sustainability)**
Meeting the needs of the current generation without compromising the ability of future generations to meet their needs. Ecological sustainability entails maintaining the composition, structure and processes of a system, as well as species diversity and ecological productivity. The core element of sustainability is that it is future-oriented. (Committee of Scientists Report, 1999.)

**Wildland Fire Use**
The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined in Fire Management Plans. (See also Prescribed Fire)

**Wildland-Urban Interface**
The area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel.

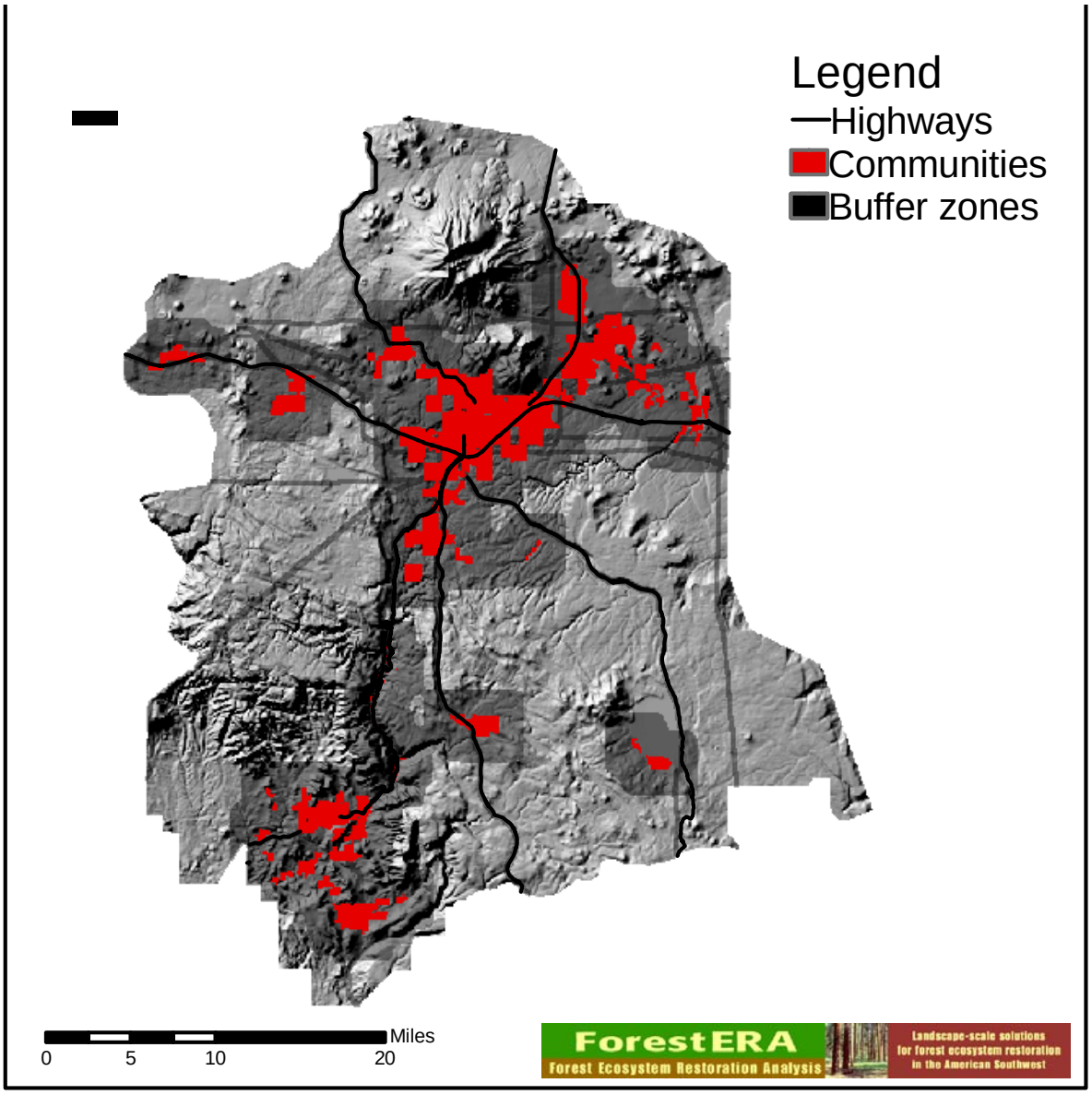
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Unless noted, all definitions come from: “RESTORING FIRE-ADAPTED ECOSYSTEMS ON FEDERAL LANDS - A COHESIVE STRATEGY FOR PROTECTING PEOPLE AND SUSTAINING NATURAL RESOURCES” USDI/USDA Draft unpublished document, pp. 74-78, 12/19/2001.
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# Appendix 3

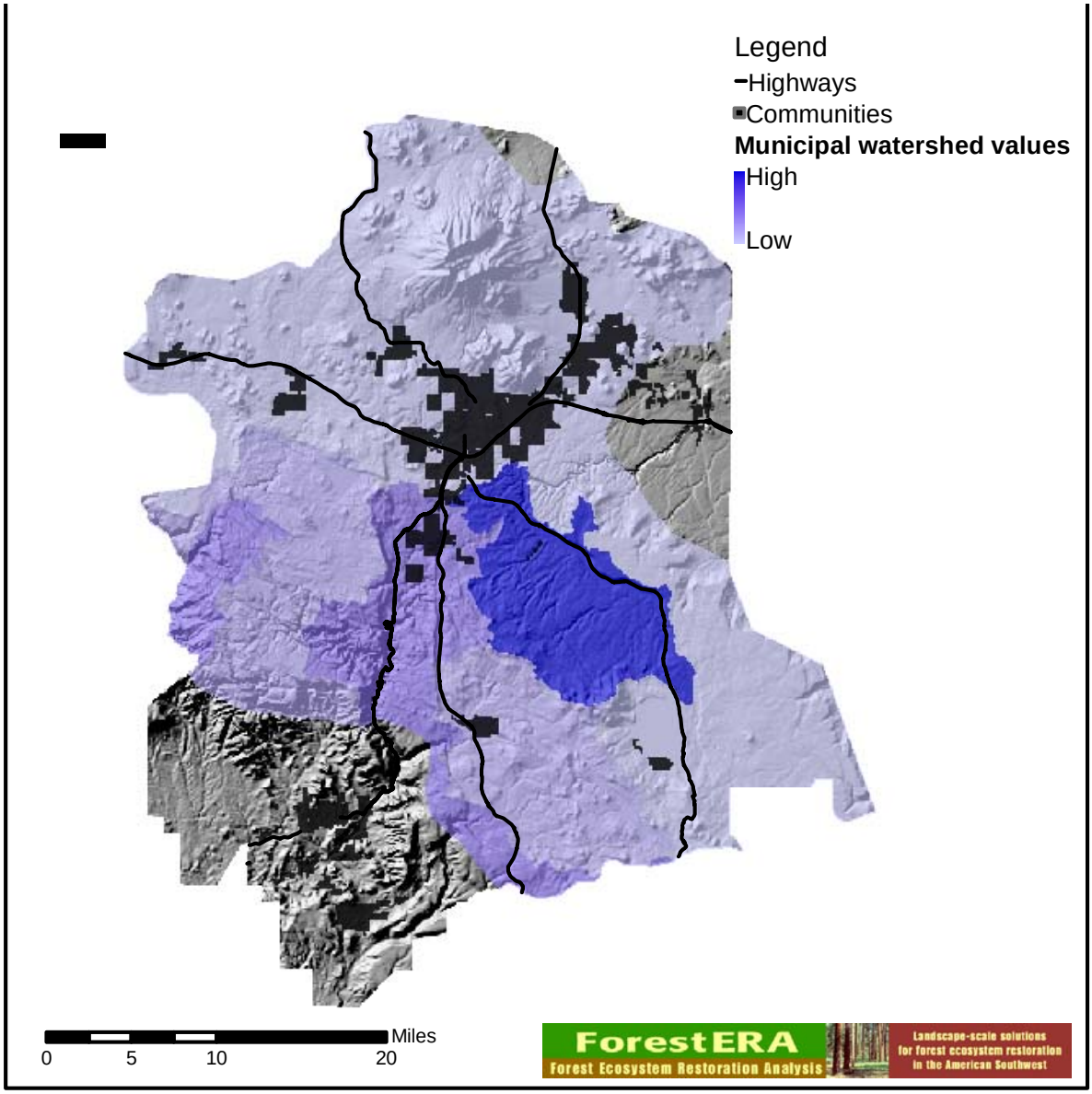
## Attributes Utilized in Development of the Threat Map

## COMMUNITY BUFFER

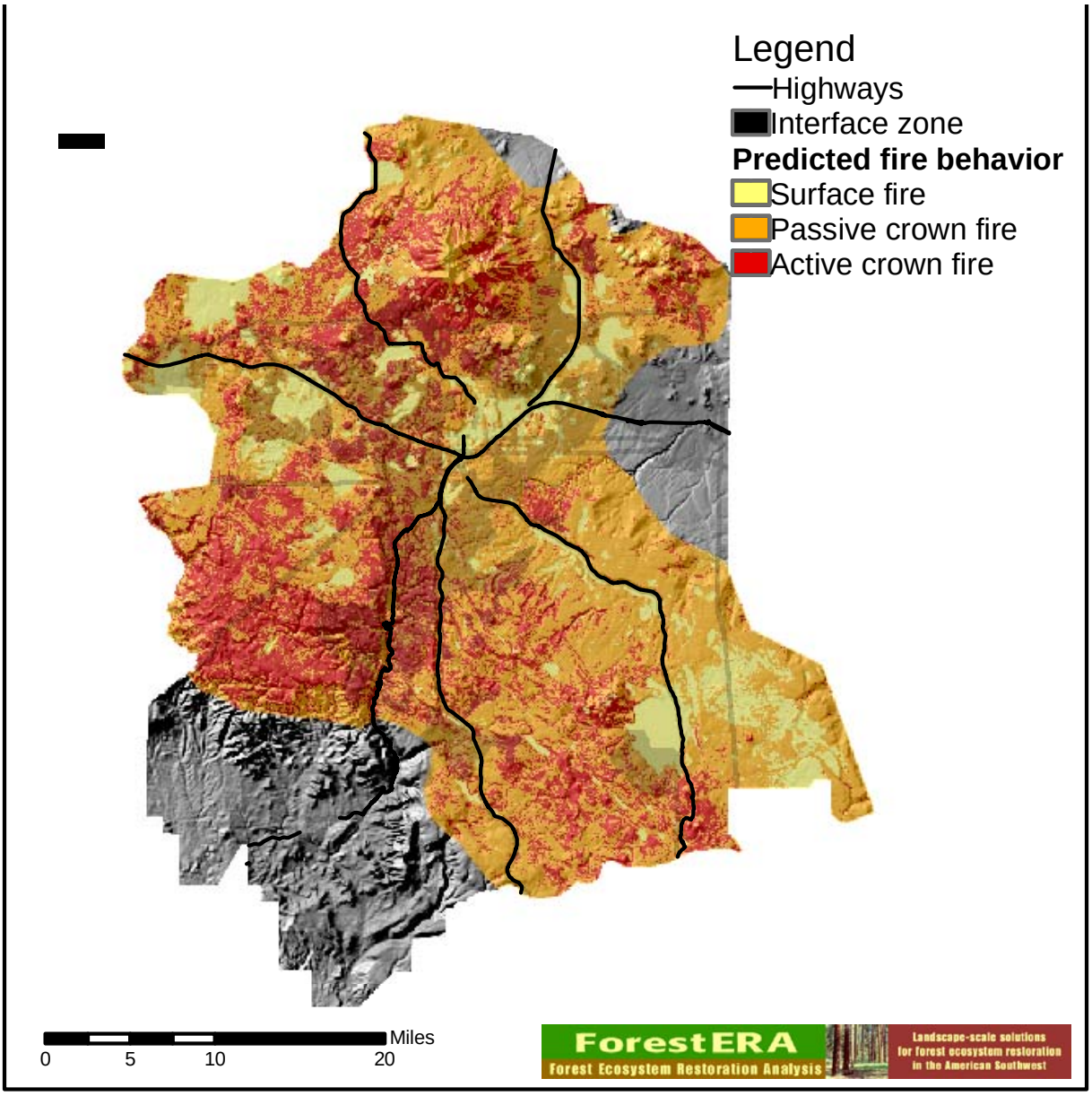



**1½ miles Around At-Risk Communities**

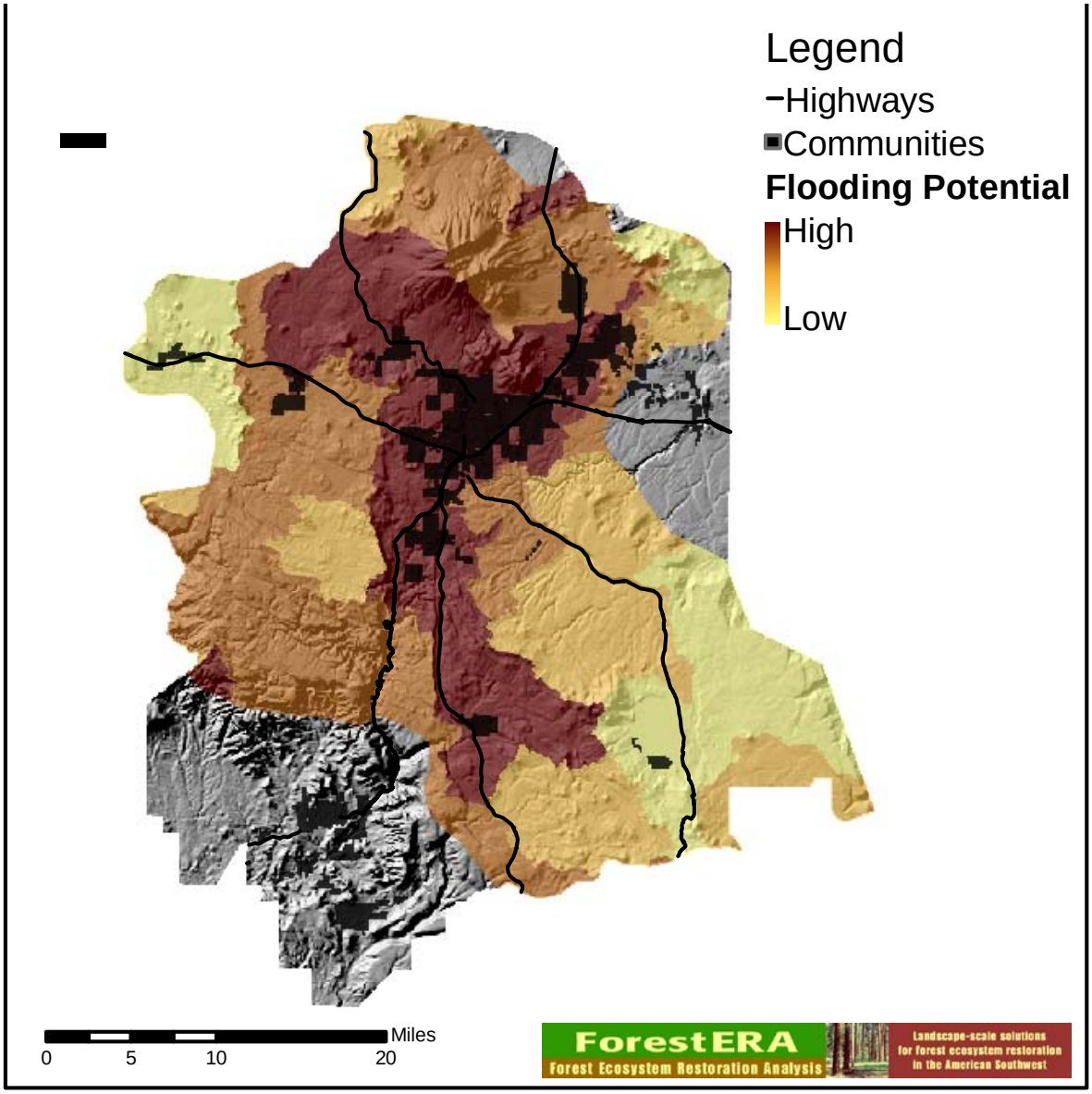
## MUNICIPAL WATERSHED



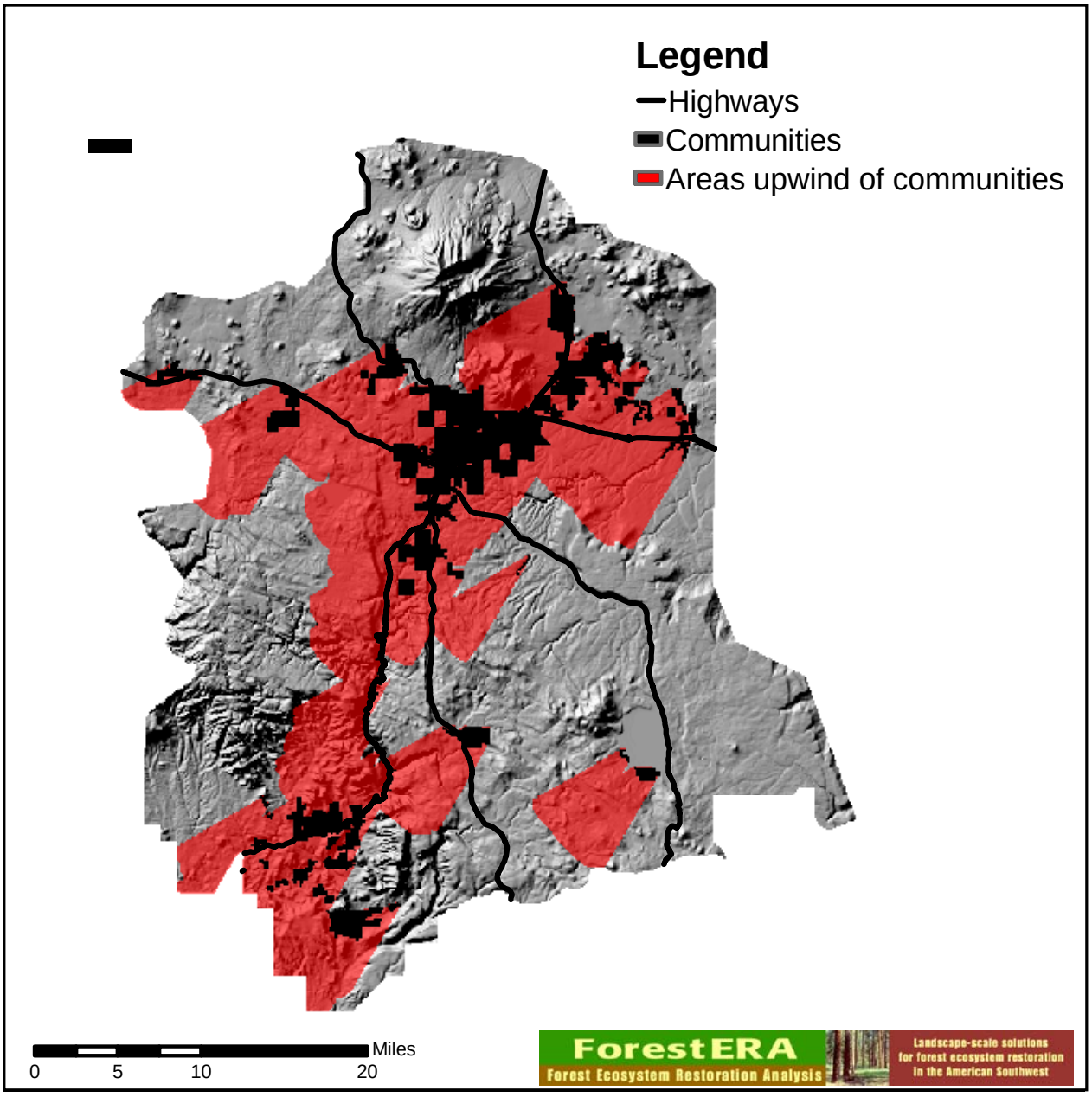
## PREDICTED FIRE BEHAVIOR



## FLOODING POTENTIAL



## AREAS UPWIND FROM AT-RISK COMMUNITIES




**Six-mile Buffer**

# Appendix 4

## PFAC Operating Plan




## A Partnership of Emergency Services In the Greater Flagstaff Area

# Initial and Extended Attack Wildland Fire Operations Plan for the PFAC Response Area

***** MODIFIED *****

**May 1, 2004**

# TABLE OF CONTENTS


I. Initial Incident Notification and Dispatch Procedures

1) Call comes into an Alarm Center

2) Call comes into Flagstaff

3) Call comes into Arizona State Land

II. Dispatch Model for Fire Danger Levels

1) Single Jurisdiction Fire

2) Multi-jurisdictional Fire

III. Emergency Scene Operational Responsibilities

1) Aviation Operations in the Urban Interface / Congested Areas

2) Temporary Flight Restrictions

IV. When Initial Attack Fire becomes an Extended Attack Fire

V. Joint Information Center

VI. Law Enforcement

1) Evacuation

2) Traffic Control

3) Security


### Purpose

The purpose of this document is to prepare an organized operations plan that will be in place in the event of any initial or extended attack fires within the PFAC response area. This area includes the cities of Flagstaff and Sedona as well as the following fire districts; Flagstaff Ranch, Highlands, Mormon Lake, Parks-Bellemont, Pinewood, Sedona and Summit Fire. This area also includes all of the State and Federal lands throughout this area. This plan is meant to deal with incidents that do not exceed the complexity level of a Type 3 incident. This plan builds on the current Mutual Aid Agreement amongst all PFAC members and will help to maximize effectiveness and efficiency in providing safe and professional responses to wildland fire incidents throughout our area.

## Initial Incident Notification and Dispatch Procedures

In order to clearly understand our dispatch procedures, please understand the distinctions between the three primary dispatch centers we will be dealing with.

**"Flagstaff"**- This dispatch center is run by the Coconino National Forest and will be the primary dispatch center for all wildland incidents. While it is not always staffed 24 hours a day, there is an answering service that will begin the activation process if any call is made to the Fire Reporting number, 526-0600.

**"Alarm" (Flagstaff/Coco Co. 911) -** This dispatch center is run by the City of Flagstaff Police Department and also dispatches for the Coconino County Sheriff's Office. "Tones" will be given by this center to initiate a wildland fire dispatch to all northern fire departments, which will then transfer to Channel 10 and have all further communications with "Flagstaff".

**"Alarm" (Sedona FD, Pinewood FD) -** This dispatch center is run by the Sedona Fire Department. "Tones" will be given by this center to initiate a wildland fire dispatch to all southern fire departments, which will then transfer to the Flagstaff Coconino 1 Channel and have all further communications with "Flagstaff".

### *1) Call comes into an Alarm Center*

Alarm locates jurisdictional responsibility and dispatches those resources. After agency notification, Alarm will immediately notify Flagstaff of the incident and which units are responding. Flagstaff will dispatch any additional or requested resources based upon the predetermined Dispatch Model for Fire Danger Levels.

### *2) Call comes into Flagstaff*

Flagstaff will immediately determine jurisdictional responsibility and dispatch closest available state or federal resources based upon the Dispatch Model for Fire Danger Levels. Flagstaff will contact an Alarm Center if the closest available resources are not state or federal units and Alarm will initiate dispatch. Initial dispatching of resources will be based upon the predetermined Dispatch Model for Fire Danger Levels.

### *3) Call comes into Arizona State Land*

In the case of Initial Attack fires, all dispatches for SLD will go through Flagstaff. Flagstaff will dispatch appropriate agencies as indicated in the Dispatch Model for Fire Danger Levels. The ASLD will provide to the responding agency or agencies the authority to make appropriate requests for resources until their arrival.

## **All dispatch duties after the initial dispatch will be done by Flagstaff.**

# Dispatch Model for Fire Danger Levels

(These are minimum dispatch levels and may be adjusted accordingly).

Flagstaff will dispatch resources based on fire danger levels. They are L=Low, M=Moderate, H=High, **VH=Very High, and E=Extreme**.

### *1) Single Jurisdiction Fire:*

L-H The agency of jurisdiction will be dispatched to this incident. Adjacent jurisdiction(s) who feel their jurisdiction could be threatened may also respond.

VH- E Flagstaff will automatically dispatch an additional two (2) engines, water tender, and two (2) overhead above the normal dispatch of resources as available. A dozer will be dispatched as requested by the IC or at the discretion of Flagstaff.

### *2. Multi-jurisdictional Fire:*

L-H Primary Jurisdiction/Closest Available Resources respond as appropriate. **(USFS & FD**) Adjacent jurisdiction(s) who feel their jurisdiction could be threatened may also respond.

VH-E Flagstaff will automatically dispatch an additional two (2) engines, water tender, and two (2) overhead above the normal dispatch of resources as available. A dozer will be dispatched as requested by the IC or at the discretion of Flagstaff.

The purpose of identifying a Dispatch Model for Fire Danger Levels, especially during Very High to Extreme conditions, is to keep small fires from getting large. We encourage fire agencies to monitor USFS Channel 1 and if a **'fire flash'** is in your jurisdiction to initiate a response. It is imperative that if a response is initiated in this manner or if a report comes directly into an agency, **contact with Flagstaff and Alarm should be done immediately.** If Flagstaff gets notification of an incident during Very High to Extreme conditions, **they will immediately dispatch closest available resources** as identified in the Fire Order Model for Dispatch.

Please note that all non-jurisdictional companies will be released as soon as possible to become available back in their home areas. Also, the response request can be denied by the requested agency if they can not meet the demands of the request.

Contact with both Flagstaff and Alarm will also be made when any agency is involved in an incident(s) that removes all of their resources from availability. If this notification is made, a time frame should be given for unavailability. When units become available, contact will be made to both Flagstaff and Alarm of their availability.

After the initial dispatch, all units will use Forest Service Channel 1 to communicate with all units responding to a wildland incident. Upon arrival at the incident, the use of a tactical channel(s) will be used as designated by the IC. The following channels will be identified as Group 2 for Initial Attack (IA) in those radios that are capable of multiple groups or are field programmable. **Please note**: The City of Flagstaff Fire Department does not have multiple group radios and use of our standard group one channels will be necessary. It is only at the request of the IC that the use of the pre-identified Group 2 frequencies will be used.

As this Operations Plan is a supplement to our existing PFAC Mutual Aid Agreement, all agencies agree to allow the use of their frequencies to other agencies while involved in the mitigation of an incident.

# Emergency Scene Operational Responsibilities

Regardless of jurisdiction, first on scene unit will assume Incident Command. IC will communicate with Flagstaff the following:

a. Initial size-up to include size, IC, fire name, etc**. (use IRPG)**
b. Location/Jurisdiction
c. Additional resource requirements
d. Immediate concerns, exposures, access, etc.

At this time, command of the incident may be transferred to the appropriate jurisdictional personnel or may be transferred due to the level of complexity of the incident.

### *2) Aviation Operations in the Urban Interface / Congested Areas*

All aircraft use will be ordered and coordinated through the Flagstaff Zone Dispatch Office in accordance with established procedures in the Southwest Area Mobilization Guide.

The following will apply to determine air-tanker use when dispatched to congested areas:

1. A Lead Plane will be ordered any time an air-tanker has been requested for use in a congested area. Air Tanker Drops may precede before the Lead Plane arrives if communications are established between the aircraft and Incident Commander, authorization is granted from the IC, and the line is cleared of personnel and equipment prior to commencing retardant operations.

2. Aerial supervision (Air Tactical Group Supervisor) is recommended when there are more that two aircraft or a mix of aircraft (fixed/rotor-wing) over the incident at the same time.
3. An Air Operations Branch Director will be ordered for any fire requiring continuous air-tanker or helicopter operations within the congested area to coordinate with the Flagstaff Airport Manager and/or Control Tower in the designing and implementation of Temporary Flight Restrictions and aviation operations. The AOBD may also assist in the establishment of dip-sites and heli-base operations.

### *3) Temporary Flight Restrictions*

When fires occur, there may be a need to request Temporary Flight Restrictions to secure airspace over the incident for aviation operations. These restrictions will be requested by the Incident Commander, Air Tactical Group Supervisor, or the Air Operations Branch Director through the Flagstaff Zone Dispatch Center. The request will be made to the Southwest Coordination Center, who will advise when the TFR goes into effect. This may take 2-4 hours. When the restriction is no longer needed, it should be rescinded as soon as possible.

The TFR will need to be configured and closely coordinated with the Flagstaff Airport Manager and Control Tower as nearly every portion of our urban interface areas have the potential to impact airport operations. A guide for Incident Commanders in determining the need for a TFR includes:

- Type and number of aircraft operating (Air Tactical, air-tanker, helicopter) within the incident and their aeronautical requirements including orbit dimensions horizontally and vertically.
- Entry and exit points and routes for incident aircraft.
- Multiple incidents in close proximity.
- When the extent and complexity of the operation creates a hazard to non-participating aircraft.
- Incident is expected to attract sight-seeing aircraft.
- Operations are being conducted near or in the dimensions of a military training areas
- Incident is being conducted in or near a Victor flyway.
- "See and Avoid" capabilities are reduced or compromised.

# When Initial Attack Fire becomes Extended Attack

When it is determined by the IC that this Initial Attack Fire has become an Extended Attack Fire, a request will be made by the IC for an activation of the Flagstaff Zone Type 3 team, or a Type 1 or Type 2 IMT based upon the Coconino National Forest's Complexity Analysis.

When the Type 3 Team is called for, Flagstaff will begin the notification process for the Type 3 Team. The County Emergency Services Coordinator and/or City Manager will be notified immediately by Flagstaff through the appropriate Alarm Center. It will be the County Emergency Coordinator or City Manager's decision to activate the EOC.

# Joint Information Center

If an EOC is established a Joint Information Center will also be established at the EOC. If an EOC is not established, the Joint Information Center will be located at the Peaks Ranger District, the Flagstaff Law Enforcement Administrative Facility (LEAF) or Sedona Fire Station #1.

# Law Enforcement

Law enforcement is recognized as a needed and essential part of any IA fire of any consequence. The appropriate LE agency having jurisdiction in the area of a fire will be notified immediately. The Law Enforcement Representative will meet with either the Liaison Officer or IC. As needed, a Law Enforcement Branch will be established.
Responsibilities for Law Enforcement will be determined by their representative and the Incident Commander.

### *1) Evacuation*

Upon determination by the Incident Commander and/or the Sheriff that evacuation procedures are warranted, the Coconino County Sheriff's Office, the City of Flagstaff Police Department, the Sedona Police Department, the Arizona Department of Public Safety, the Arizona Department of Transportation, or any other appropriate law enforcement agencies shall be responsible for implementing an appropriate evacuation. The Law Enforcement Liaison shall report evacuation progress to the Incident Commander, on a regular basis. CCEM must be notified early in this process, to provide appropriate reception areas/shelters.

### *2) Traffic Control*

The Coconino County Sheriff's Office, City of Flagstaff Police Department, and other law enforcement agencies shall be responsible for implementing a traffic control plan. Continued communication with the Liaison or the IC is essential.

It is important that a law enforcement liaison be established early in the incident (at the Command Post) in order to minimize traffic congestion and maintain safety to the public.

### *3) Security*

It shall be the responsibility of the jurisdictional law enforcement agency to establish, when appropriate, a security patrol for evacuated areas yet to be immediately threatened by fire (pre-cautionary evacuation mode), in conjunction with the law enforcement coordinator assigned to the command staff. The appropriate LE agency will assist in securing the perimeter of the incident to allow authorized persons only into and out of the area.

# Appendix 5

## PFAC Smoke Management Plan




## A Partnership of Emergency Services In the Greater Flagstaff Area

# Community Smoke Management Plan for the PFAC Response Area

***** MODIFIED *****

**May 12, 2004**

**Purpose:** Catastrophic wildfire is the #1 threat to the greater Flagstaff area. A wide range of community values – documented elsewhere – are impacted by these type wildfires. Reducing overabundant natural fuel accumulations and improving forest health within and adjacent to communities must occur.

One method to do so is the application of prescribed (Rx) fire. Rx fires reduce slash accumulations produced during fuel reduction projects, as well as forest surface fuels that have accumulated during the past decades. Restoring fire to the ecosystem improves forest health increases community protection capability.

**Background:** Smoke is a natural result of fire: the issue we must focus on is not if we should have smoke - we have no choice: it will either be wildfire or prescribed – but when, where, and under what conditions it will occur. The only way we can focus on, and manage, these issues, is with application of Rx fire and implementation of a Community Smoke Management Plan (CSMP).

**Components:** The three primary components of this plan are:

*Emission Reduction Techniques:* These include, but are no means limited to –

- Removing wood products (firewood, post-and-pole, etc)
- Allowing sufficient time for material to dry
- Avoiding stumps, downed logs, snags
- Restricting piles or acreage
- Limiting consecutive burn days in same area
- Utilizing proper ignition patterns
- Timing ignitions to coincide with favorable weather events
- Scheduling to avoid special event days or high-occupancy sites

*Public Awareness:* Three separate areas require continuing attention -

1) On-Going: Brochures, website information, special presentations, and media interviews are valuable techniques to establish the purpose of Rx fire, methodology of planning, ERT's and control efforts, future plans, agency coordination practices, and results of previous burns. Together, these will serve to reduce concerns associated with Rx fire.

2) Pre-Fire: These announcements must inform the public of project locations, dates and times of implementation, and homeowner mitigation measures they can implement to reduce impacts to their own health, property, and daily activities. They can be distributed through the media, posting specific project information on agency websites; notifying homes and neighborhoods immediately adjacent to burns as well as areas which will be significantly impacted (both day and night), and personal contacts to individuals with high health concerns. Fire managers must provide a common message including project goals and smoke mitigation efforts.

3) During Burn: Techniques during an on-going Rx fire could include empowering each person on-site to act as an Information Officer if approached by the public, placement of a designated person at a site easily accessible to the public and within site of the burn to answer questions, or leading field tours for interested people. If unexpected conditions occur during the operation, efforts to minimize impacts should be announced, what is being done to mitigate the impacts, and responsibility stated to ensure continued public acceptance of the program.

*Agency Coordination:* A culture of open-and-continuing communication and coordination between land management agencies, fire management professionals, public health organizations, and air quality regulators is critical for an efficient and effective Rx fire program. Project planning, treatment priorities, coordination with adjacent Rx fires, resource sharing, public notification, and potential smoke impacts and mitigation efforts require discussion and joint involvement.

Monitoring day and night smoke movements through personal observations, mapping, and photographs will enable local fire managers to document and share information on smoke-travel patterns, effectiveness of smoke mitigation efforts, and potential accuracy of forecasted weather information. Instrument-based air-quality monitoring, the responsibility of regulatory agencies, can help determine visual and health impacts, compliance with air quality standards, and provide information necessary to refine future Rx fire efforts. In addition, post-Rx fire reviews are beneficial so lessons can be identified and shared with others.

**Permits:** Local Fire Depts and Fire Districts are allowed, through an agreement with the AZ Dept of Environmental Quality (ADEQ), to issue permits for small debris burns within their jurisdiction. State and Federal agencies, and larger burns within the Fire Dept/Fire District jurisdictions, require a permit from ADEQ. Permit information is available at:
www.adeq.state.az.us/environ/air/assess/smp.html

**Public Notification Contacts:**

1) Contact information for PFAC agency personnel can be found in PFAC Operating Plan (Appendix 1 to the CWPP)

2) Each agency will maintain their own individual homeowner/business contact list

**Result:** Effectiveness of the CSMP will be determined by level of public awareness, including acceptance of reasonable smoke, the success of agency coordination, and the continued-and-timely application of ERT's. Efforts to further the Rx fire program will pay dividends in the future: the wise use of Rx fire will reduce fire threat, improve forest health, and protect our community.

# Appendix 6

## Utilization: GFFP UET Accomplishments & Work Plan

# *STATUS REPORT*

***Small Diameter Timber Utilization*** ***July 15, 2004***

## GREATER FLAGSTAFF FORESTS PARTNERSHIP ECONOMIC VISION

Twenty years from now, the greater Flagstaff area will be home to a small but thriving sector of businesses based on the ecologically sustainable utilization of forest products. Revenues created through the sale of these forest products will provide the economic engine for ecosystem restoration efforts in the region's forests.

Businesses will include primary producers of forest products and "value-added" processors employing technologies that maximize the value of forest products. Availability of these forest products will be based on long-term forest management planning, and healthy ecosystem functioning, seeking a sustainable and stable flow of products to users, which in turn will provide stable jobs and benefits for local workers and the community.

***PARTNERSHIP ENDORSED PROJECTS***

**The Arboretum at Flagstaff:** The Arboretum applied for and received $50,000 from the *Southwest Sustainable Forests Partnership* for the purchase and installation of a wood pellet boiler system for district heating. Preliminary engineering studies have been completed by *Forest Energy, Corp.,* and marketing and interpretation plans are being developed.

**Arizona Corporation Commission:** Consultation with the Corporation Commission regarding the inclusion of woody biomass as an energy option in the revision of the Environmental Portfolio Standard.

**Arizona Governor's Office:** Consultation with the Governor's staff and the *Greater Flagstaff Economic Council* on a pending executive order requiring consideration of wood/pellet heating in state facilities.

**Arizona Public Service:** Three locations have been identified in the Flagstaff area for the siting of biomass energy power plants. Preliminary feasibility and air quality studies have been completed by APS. Projects are on hold pending financing and final approval.

**Indigenous Community Ventures (ICV):** ICV is the recipient of $95,000 from the Partnership to purchase an LT300 Wood-Mizer to expand business operations to log home construction. ICV is currently producing log hogans in partnership with Indigenous Community Enterprises and has hired marketing consultants to expand production to off-reservation log homes.

**Northern Arizona University:** University officials are exploring the installation of a district wood pellet heating system for the central campus in conjunction with *Forest Energy, Corp*. Meetings and negotiations are on-going with project partners to initiate a feasibility study.

**Savannah Pacific Corp., LLC:** Company officials are proposing the location of a glulam plant and small diameter sawmill facility in the Flagstaff area capable of processing 25 million board feet annually. Preliminary site assessment has been completed and a conditional use permit has been approved for the glulam operation. Project is currently on hold pending financing for the Flagstaff area operation.

**Total Timber:** Total Timber is the recipient of $100,000 from the Partnership to purchase equipment and initiate business operations for a commercial firewood processing plant in Flagstaff. The business is currently in production and meeting targeted first year sales.

***PROJECT MONITORING***

**Arizona Lumber Industries, Inc.:** Proposed location of an oriented strand board (OSB) facility in the greater Flagstaff area capable of processing small diameter ponderosa pine. Project is currently in the due diligence phase.

**City of Tusayan:** The city has hired a bioenergy consultant to assess the feasibility of a fluidized bed (gasification system) for converting woody biomass and municipal solid wastes to energy.

**Forest Energy, Corp., LLC:** Proposed location of a wood pellet processing facility in the Flagstaff area to manufacture densified fuels for commercial heating systems. Project is in the due diligence phase.

**Mogollon Brewery, Co.:** Proposed location of biomass ethanol facility in Flagstaff. Project is currently in the scoping phase to assess feasibility of ethanol production.

**National Relief Charities:** The non-profit organization is developing partnerships among the *Hopi Nation, High Desert Investments,* and the *Coconino National Forest* to provide approximately 400 cords of donated firewood to tribal members over 65 years of age.

**BIOgen Power Group, LLC:** Proposed location of 10MW biomass energy plant in Prescott
**Dakota Hauling and Timber, Inc.:** Sawlog processing in Humboldt within the Prescott basin
**Fred Merritt Sawmill:** Sawlog processing in Ash Fork
**LB International, Inc.:** Heating and camping log production at *Eco-Lena, LLC* in Winslow
**Perkins Sawmill, Co.:** Sawlog and firewood processing in Williams
**Twin Mountain Ranch**: Pallet Division: Wood pallet operations in Williams
**Zellner's Firewood:** Mobile firewood operations in Williams

***PARTNERSHIP MARKETING & REPORTS***

- Small Diameter Timber Utilization & Marketing Brochure (2004)
- In-Woods MicroMill Economic Assessment (2004)
- Coordinated Resource Offering Protocol – CROP (2003)
- Enterprise Development Fund for Small Wood Utilization in the Greater Flagstaff Region (2003)
- Preliminary Feasibility Assessment for a Biomass Power Plant in Northern Arizona (2002)
- Small Log Sawmill Site Assessment Study for Northern Arizona (2002)
- Small Diameter Sawmill and Small Log Processing Mill Run (2002)
- Small Diameter Wood Utilization Strategy (2002)
- Lumber Recovery From Small Diameter Ponderosa Pine From Flagstaff, Arizona (2001)
- Log Sort Yard Model and Commentary (2001)
- Does a Log Sort Yard Make Sense for Forest Restoration? (2000)
- Market & Utilization Options for Low-Value Wood Products: Preliminary Assessment of Markets (1999)
- Southwest U.S. Regional Wood Products Industry Survey: Summary of Findings (1999)
- Northern Arizona Post and Pole Enterprise Feasibility Assessment (1999)
- Feasibility Assessment for Development of a Log Merchandising & Manufacturing Center in N. AZ (1999)
- Feasibility of Producing Commercial Products From Pinon-Juniper Woodlands (1997)
- Potential for Using Small Diameter Ponderosa Pine Resources in Arizona: A Feasibility Study (1997)

***PARTNERS IN UTILIZATION***

- Greater Flagstaff Economic Council
- Small Business Development Center
- Coconino County
- City of Flagstaff
- Coconino National Forest, USFS
- Rocky Mountain Research Station, USFS
- Pacific Northwest Research Station, USFS
- Forest Products Laboratory, USFS
- Arizona Sustainable Forests Partnership
- Southwest Sustainable Forests Partnership
- Four Corners Sustainable Forests Partnership
- Northern Arizona Forest Products Association
- AZ Dept. of Commerce, Industries of the Future
- Arizona Governor's Office

# Utilization and Economics Annual Work Plan

Guiding Principles

- Providing information and resources to existing and prospective small businesses.
- Getting small companies to relocate or expand to Flagstaff.
- Keeping the momentum going with the Utilization & Economics Team.
- Seeking expanded utilization of Pinyon-Juniper in addition to Ponderosa Pine.
- Seeking economically feasible ways to do forest thinnings.
- Seeking funding to conduct research and product development.
- Identifying and expanding markets for small diameter material.
- Finding suitable markets to reduce the costs of service contracts.
- Strengthening partnerships in light of rapidly changing regulatory situations.
- Matching of utilization options to community needs and capacities.
- Regional coordination of partners.
- Positioning partnership for national priorities in regard to utilization.

2004 UET Projects & Strategies (Proposed)

**1) Continue efforts focused on biomass and expand focus on district heating systems**

- Continuing to work with the AZ Corporation Commission on the Environmental Portfolio Standard (EPS) – write letters of support, seek expansion of EPS to include biomass from forest thinnings, seek expansion of EPS beyond 2012 deadline.
- Seek thermal credits for using wood heating.
- Conduct a feasibility or demonstration study on a wood-heating district leading to private and commercial investment.
- Continued identification of viable biomass technologies.
- Encourage local wood pellet consumption and market expansions – pursue wood pellet manufacturing in or near Flagstaff.

**2) Continue efforts focused on forest supply issues**

- Expansion of the CROP pilot project to include more suppliers, levelization of supply, and out-year planning and coordination among suppliers. Seek a 5-year funded project to coordinate local supply based on projected sustainability (GFFP-led).
- Encourage Forest Service to use stewardship authorities for levelized supply.

**3) Formalize relationships between key UET partners and establish protocols for the sharing of information – Staff & UET partners**

- Formalize relationships among key UET partners (GFFP, GFEC, SBDC, County, etc.).
- Establish protocols for sharing information sharing with similar/ related organizations.
- Provide a clearinghouse of UET-related information in coordination with the SBDC.
- Project development and management – point of contact to assist business development.
- Display and promote past accomplishments – the list of pubs in the PowerPoint posted on the web and able to download.
- Small business outreach and coordinate with Southwest Strategy (SWSFP, Region 3)

**4) Increase and expand efforts to develop grant opportunities and other means of financial support for existing and prospective businesses**

- Secure funding for continuation of the Enterprise Development Fund (EDF)
- Work closely with the GFEC and SBDC to identify and provide financial support to existing and prospective businesses.
- Establishing a revolving loan fund, perhaps with the sale of GFFP purchased stumpage.
- Host workshop(s) to assist landowners, contractors, and small businesses to better use grant opportunities (NRCS, ASLD, SBDC, etc.). Provide technical assistance to aid them in finding and applying for financial assistance.

**5) Provide market assistance to existing businesses (UET partners)**

- Provide technical assistance and counseling to businesses in identifying markets, developing marketing strategies, and understanding market drivers.
- Provide assistance to small businesses to develop effective business plans (SBDC).
- Create a database of raw material users and producers for the greater Flagstaff region.
- Develop marketing materials for prospective businesses to include existing studies, ongoing research, and other pertinent information and resources.
- Improve capacity of private sector small businesses by providing technical support.

**6) Seek GFFP staff support for UET functions**

- Hire a utilization and marketing staff person to carry out UET priorities.
- Out-source for project implementation.
- Share tasks with SWSFP on intern basis and overlap with other partner functions.
- Separate UET priorities from the work individual partners are doing. Share and elaborate that information. Identify GFFP capabilities to do remaining work.

**7) Develop political strategies for all of the above priorities**

- Track funding priorities of the Healthy Forest Act.
- Focus on locating sources of funding.
- Advocate in state, local, and federal government for support for forest restoration, development and program funding.

<u>Long-Range UET Projects & Strategies (Proposed)</u>

**8) Education of small diameter timber utilization terms and practices**

- Educate public and the GFFP partnership on local issues including technological advances in harvesting and feasibility of small diameter timber uses.
- Public awareness is high but there is deep mistrust of the wood products industry and the Forest Service relationship with private industry.
- Educate public on the ecological aspects of small diameter timber, its sustainability, and linkages to economic practices, community health, and related environmental impacts.
- Educate the public on the need to manage forests, wood products and the wood product industry as a cohesive unit with sustainability emphasized.

**9) Experiment with the GFFP purchasing stumpage from Coconino NF to sell to others.**

**10) Serve as a catalyst for a sustained yield-type unit**

**11) Continuation of Savannah-Pacific type mills – focus on economies of scale and ramping up volume processed**

**12) Develop strategies for linking healthy forests to healthy communities with appropriately scaled industries providing living wages and ecologically driven forest based products.**

- Continue community involvement in decisions regarding matching scale of restoration efforts and value-added, technically suitable utilization options with community needs.
- Can we play a role in creating the framework for ecologically and economically sustained use of our forest? We need to replace the boom-bust cycle of extractive industries.

**13) Invasive species and erosion from harvesting and wildfires**

**14) Portable, in-woods processing feasibility to reduce processing costs**

**15) Monitoring of community benefits from restoration projects and utilization**

- Social and economic impacts
- Ecological impacts of project implementation

**16) Explore green certification for local processors and National Forest lands**

**17) Create strategies to work with private landowners**

- Establish protocol to work with private landowners with less than 40 acres

**18) Seek long-term strategy to add value to small diameter timber linked to stumpage**

# Appendix 7

## Coconino National Forest Prevention Management Plan

**Only a few pages of the plan are included here. For details on compartment assessment rankings, which may change on a regular basis, please consult the USFS/Coconino NF web page:**

**www.fs.fed.us/r3/coconino**

**Coconino National Forest**
**Prevention Management Plan**




February 11, 2004

***** ABBREVIATED *****

# Contents

Introduction & Management Objectives

Fire Prevention Compartment Listing

Compartment Detail
Compartment Assessment Rankings
- Fuels Hazard
- Protection Capability
- Ignition Risk
- Fire History
- Values
- Catastrophic Fire Potential
- Composite Compartment Assessment Ranking

Prevention Responsibilities

Prevention Work
- Prevention Specific and General Actions

## Introduction

This Plan has been prepared for the Coconino National Forest using the Risk Assessment and Mitigation Strategies (RAMS) planning process. RAMS was developed for fire managers to be a holistic approach to analyzing wildland FUELS, HAZARD, RISK, VALUE, and SUPPRESSION CAPABILITY. It considers the effects of fire on unit ecosystems by taking a coordinated approach to planning at a landscape level, and allows users to develop fire prevention and/or fuels treatments programs.

The steps involved in this process included:

- Listing Management Objectives for the Coconino National Forest
- Identification of spatial Compartments for study
- Assessment of significant issues within each Compartment
- Identification of Management Objectives within each Compartment
- Identification of Fire Management Zones (FMZs) and Sub-Units
- Development of Alternative Fire Prevention Program Options
- Creation of Personnel and other Expense Prevention Budgets
- Identification of detailed Prevention Work Programs
- Development of a total Fire Prevention Program and budget

Management Objectives

The following Management Objectives are identified for the Coconino National Forest:

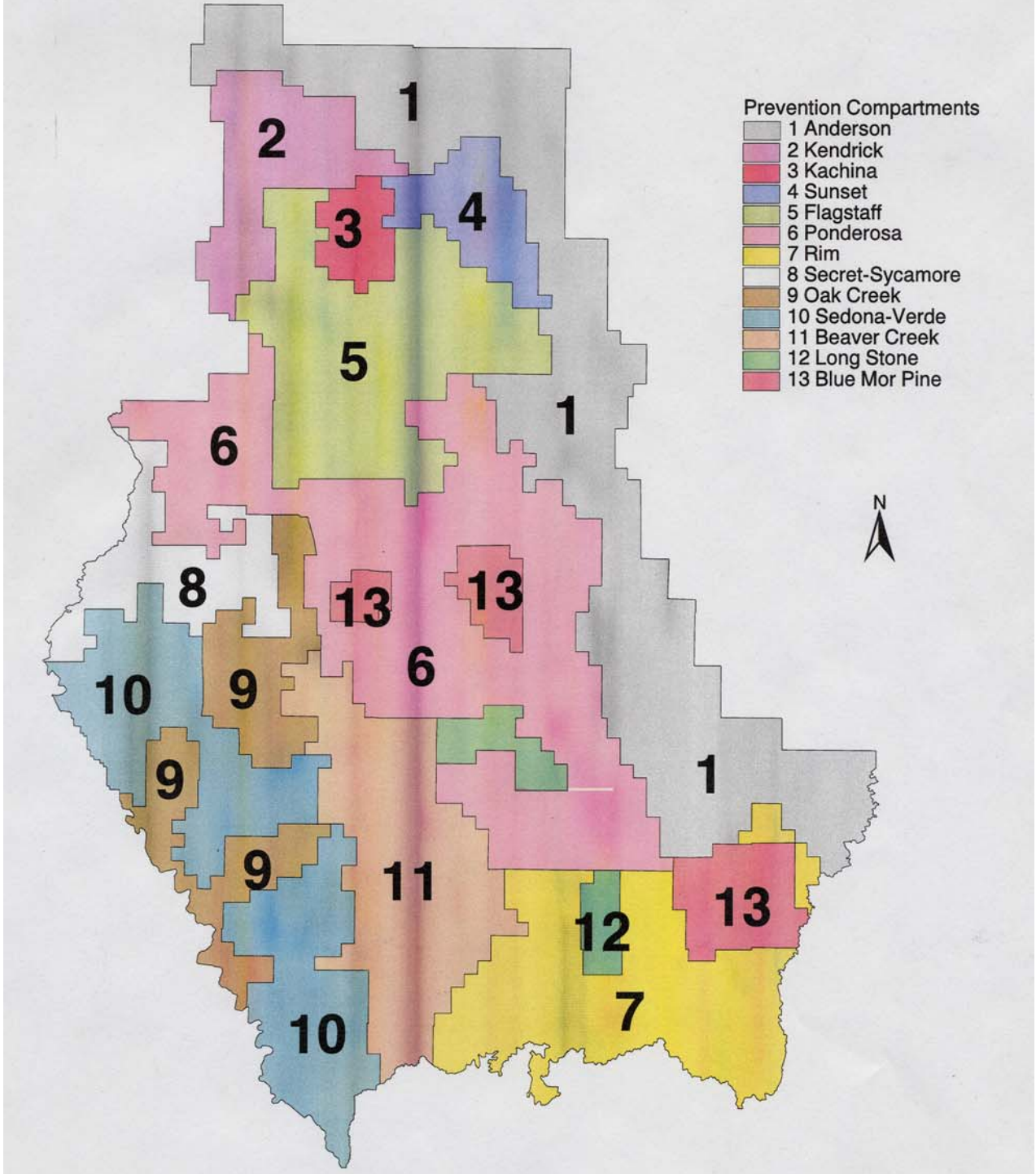
1. Maximize firefighter and public safety
2. To reduce resource loss due to human caused fires.
3. Cooperate with agencies in a combined wildfire and public fire education effort
4. Implement Fire Prevention Plan in a cost-effective manner

**Fire Prevention Compartment Listing**

| Code | Description | Code | Description |
|---|---|---|---|
| 1 | Anderson | 8 | Secret - Sycamore |
| 2 | Kendrick | 9 | Oak Creek |
| 3 | Kachina | 10 | Sedona – Verde |
| 4 | Sunset | 11 | Beaver Creek |
| 5 | Flagstaff | 12 | Long - Stone |
| 6 | Ponderosa | 13 | Blue - Mor - Pine |
| 7 | Rim | | |

# Coconino National Forest

## Fire Prevention Compartments



## ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ *EXAMPLE OF A COMPARTMENT LISTING* ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~

**Compartment 5: Flagstaff - Catastrophic Fire: Likely**

Fuels Hazard characteristics are rated:
- Fuels (flame length produced): **High**
- Crowning Potential: **Moderate**
- Slope Percent: **Moderate**
- Aspect: **High**
- Elevation: **Moderate**

Protection Capability ratings are:
- Initial Attack: 0 - 20 minutes **(Low)**
- Suppression Complexity: Complex **(High)**

Ignition Risk factors include:
- Population Density - Wildland Urban Interface
- Power Lines & Sub-station
- Maintenance/service contracts
- Active timber sale
- Construction project
- Debris/slash burning
- Off highway vehicle use
- Developed camping areas & Dispersed camping areas
- Gas pumps or storage
- Gas or oil wells/transmission
- Electronic installations
- Incendiary
- Government operations
- Woodcutting area, power equipment
- Dump
- Fireworks, children with matches
- Cultural Activities
- Shooting/target
- Railroads
- Public Access Road(s)
- County road(s)
- State/Federal highway(s)

## Compartment Assessment Ranking
## Fuels Hazard

| Rating | Compartment | | |
|---|---|---|---|
| High | 8: Secret – Sycamore | Low | 2: Kendrick |
| High | 9: Oak Creek | Low | 11: Beaver Creek |
| | | Low | 1: Anderson |
| Mod | 13: Blue - Mor – Pine | Low | 4: Sunset |
| Mod | 12: Long – Stone | | |
| Mod | 6: Ponderosa | | |
| Mod | 5: Flagstaff | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 3: Kachina | | |
| Mod | 7: Rim | | |

## Compartment Assessment Ranking
## Protection Capability

| Rating | Compartment | | |
|---|---|---|---|
| High | 8: Secret – Sycamore | Low | 9: Oak Creek |
| High | 7: Rim | Low | 5: Flagstaff |
| High | 3: Kachina | Low | 12: Long - Stone |
| High | 13: Blue - Mor - Pine | | |
| High | 1: Anderson | | |
| | | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 6: Ponderosa | | |
| Mod | 2: Kendrick | | |
| Mod | 11: Beaver Creek | | |
| Mod | 4: Sunset | | |

## Compartment Assessment Ranking
## Ignition Risk

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 2: Kendrick |
| High | 10: Sedona – Verde | Low | 3: Kachina |
| High | 13: Blue - Mor – Pine | Low | 8: Secret – Sycamore |
| High | 9: Oak Creek | | |
| | | | |
| Mod | 12: Long - Stone | | |
| Mod | 11: Beaver Creek | | |
| Mod | 4: Sunset | | |
| Mod | 7: Rim | | |

## Compartment Assessment Ranking
## Fire History

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 2: Kendrick |
| High | 4: Sunset | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 11: Beaver Creek |
| High | 7: Rim | Low | 8: Secret - Sycamore |
| High | 9: Oak Creek | | |
| | | | |
| Mod | 13: Blue - Mor – Pine | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 12: Long – Stone | Mod | 3: Kachina |

## Compartment Assessment Ranking
## Values

| Rating | Compartment | | |
|---|---|---|---|
| High | 5: Flagstaff | Low | 12: Long - Stone |
| High | 10: Sedona – Verde | Low | 4: Sunset |
| High | 9: Oak Creek | Low | 2: Kendrick |
| High | 7: Rim | Low | 1: Anderson |
| High | 6: Ponderosa | | |
| | | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 13: Blue - Mor - Pine | | |
| Mod | 11: Beaver Creek | | |
| Mod | 3: Kachina | | |

## Compartment Assessment Ranking
## Catastrophic Fire Potential

| Rating | Compartment | | |
|---|---|---|---|
| High | 13: Blue - Mor – Pine | Low | 2: Kendrick |
| High | 12: Long – Stone | Low | 1: Anderson |
| High | 9: Oak Creek | | |
| High | 7: Rim | | |
| High | 6: Ponderosa | | |
| High | 5: Flagstaff | | |
| | | | |
| Mod | 11: Beaver Creek | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 4: Sunset | | |
| Mod | 3: Kachina | | |

## Compartment Assessment Ranking
## Composite Compartment Assessment Rating

| Rating | Compartment | | |
|---|---|---|---|
| High | 9: Oak Creek | Low | 11: Beaver Creek |
| High | 7: Rim | Low | 1: Anderson |
| High | 6: Ponderosa | Low | 2: Kendrick |
| High | 13: Blue - Mor - Pine | | |
| High | 5: Flagstaff | | |
| | | | |
| Mod | 10: Sedona - Verde | | |
| Mod | 8: Secret - Sycamore | | |
| Mod | 3: Kachina | | |
| Mod | 12: Long - Stone | | |
| Mod | 4: Sunset | | |

# Appendix 8

## After the Fire

# *AFTER THE FIRE…*

## Returning Resident

## Safety

## Tips

### *Ponderosa Fire Advisory Council*

### Fire Recovery Contacts

| | |
|---|---|
| American Red Cross | 928-779-4594 |
| AZ Department of Public Safety | 928–773-3600 |
| Arizona Public Service | *928-779-6911* |
| Citizen's Arizona Gas | 928 774-4592 |
| Coconino County Animal Shelter | 928-526-1076 |
| Coconino County Emergency Services | 928-526-2735 |
| Coconino County Sheriff Department | 928-774-4523 |
| Coconino National Forest | 928-527-3600 |
| FEMA Help Line | 1-800-621-FEMA |
| Flagstaff Clean & Green (Haz Waste) | 928-779-7622 |
| Flagstaff Fire Department | 928-779-7688 |
| Flagstaff Medical Center | 928-779-3366 |
| Flagstaff Police Department | 928-774-1414 |
| Flagstaff Water/Sewer | 928-779-7646 |
| Highlands Fire Department | 928-525-1717 |
| Parks-Bellemont Fire District | 928-635-5311 |
| Pinewood Fire District | 928-286-9885 |
| Summit Fire District | 928-526-9537 |
| US West (residential) | 800-244-1111 |

**Table Of Contents**

***Electrical……4***
*Electric Safety Facts*
Electric Safety Tips
Electric locations to avoid
Special Info. on Fuses and Circuit Breakers
Emergency Procedures on Electrical Fire
To Restore a fuse
To Reset a Circuit Breaker

**Drinking Water…….……..6**
Restoring Water Systems

**Solid Waste……..……6**
Removing Debris

**Heating Fuels…….…….7**
Checking Propane Tanks
Checking Home Heating Oil Tanks

**Miscellaneous Safety Awareness…….…….7**
Ash Pits
Evaluation of Trees Damaged by Fire
Residual Smoke in Fire Interior

## Fire Recovery Safety Tips

REMEMBER – *use caution and good judgment. Hazards may still exist, even though the fire is controlled.*

# ELECTRICAL

## Electrical Safety Facts

**General: An important part of the disaster recovery is hazard recognition. Should you come across damaged or fallen power poles or lines, contact your local electrical power authorities. DO NOT TOUCH THE DOWNED WIRES. In the cleanup area, be especially careful when cutting trees and operating heavy equipment around power lines. Vegetation and power poles may have lost stability due to fire damage.**

**If a power line or pole should fall next to you while working in the area, *do not walk – hop out of the area.* (Using this technique, you will be less likely to be a conductor of electricity).**

**Electricity is always trying to go somewhere. It goes easily through conductors; it does not go easily through non-conductors.**

| Conductors | Non-Conductors |
|---|---|
| Metal | Rubber |
| Water | Glass |
| Wet Things | Plastic |
| Things In Water (including animals/pets) | |

**One of the most important fixtures in the conduction of electric current are utility poles. The fire or fire suppression actions may have dislodged or broken some of these poles, causing the wires to sag or break, resulting in extremely hazardous conditions. *Do not touch anything at the scene*.**

**Trees can also be dangerous conductors of electricity. When a tree falls or grows into contact with power wires, the electric power diverts and finds a path to the ground through the branches and the trunk. Anyone who comes into contact with these trees is subject to tragic consequences, since electric power can easily jump from the tree to the person.**

## Electrical Safety Tips

- **Do not overload circuits; don't operate several large appliances at the same time on the same circuit.**
- **Do not use extension cords to plug in many items on one outlet.**
- **Turn off appliances when you finish using them. Provide adequate air circulation around all appliances to prevent over-heating. Keep appliances clean, repaired and serviced.**
- **Check wires and plugs regularly. Replace worn or frayed wires. Do not run cords under carpets or across doorways.**
- **Be careful when replacing fuses or breakers. Keep the area near the circuit box dry and turn the main switch off before changing the fuse/breaker.**
- **Temporary lines should be removed from service.**

## Electrical Locations To Avoid

- **Electrical meters and service lines coming into the home or other outbuildings.**
- **Any power supply line which appears to sag, show bare wire, or have insulation missing.**
- **Secured power sub-stations or any area identified as high voltage.**
- **Downed power lines.**

## Emergency Procedures for an Electrical Fire

- **Call the fire department.**
- **Shut off power supply at the breaker if possible.**

## Restoring Electric Power

**If, upon returning to your residence, there is no electrical power, please check to make sure the main breaker is on. If the breakers are on and power is still not present, please call to report the power outage to your local electrical power authorities. Reporting problems like a down or broken wire will speed up the process of power restoration.**

- **Stand off to one side of the breaker box when turning on the main breaker.** ***Do not stand directly in front of the box.***
- **If any smells of hot electrical insulation or sparking occurs*, turn of the breaker immediately and call an electrician.***
- **If electrical lights or appliances appear brighter than normal, turn off main breaker**. ***The service entrance needs to be checked.***

## To Change A Fuse

**Try to find the cause of the blown fuse, and correct it by disconnecting the defective appliance or appliances causing the overload or short circuit. Shut off the main power switch when you change the fuse.**

- **Do not replace fuses with a higher amp rating fuse than you removed.**
- **Turn on the main switch to restore the power.**
- **If the fuse blows again, leave it alone and contact a certified electrician. Other problems may exist and should be investigated to remove the possibility of an electrical fire.**

## To Reset A Circuit Breaker

**Try to find the cause of the overload or short circuit and correct it by disconnecting the defective appliance or appliances. Turn the switch to "on" to reset and restore power. If breaker trips again leave it alone, and contact a certified electrician. Other problems may exist and should be found to remove the possibility of an electrical fire.**

## Special Information of Fuses & Circuit Breakers

**Fuses and circuit breakers shut off the current whenever too much current tries to flow through a wire because of:**

- **A short circuit, possibly caused by a bare wire touching the ground;**
- **Overloading, possibly caused by too many lights or appliances on one circuit; or**
- **By defective parts in an appliance.**

**Know where the main circuit or fuse box is located in your house. Be sure you can locate the main switch; it controls all of the power coming into the house and is usually inside the circuit box. In some cases, however, it may be located outside of the house. Fuse or circuit boxes generally are labeled to designate which area of the house the circuits or fuses serve.**

---

# DRINKING WATER

## Restoring Water Systems

**Unless impacted by a fuel spill, the fire should not have affected wells at undamaged homes. If your house was damaged, your water system may potentially have become contaminated with bacteria due to loss of water pressure. In this case it is recommended that the well be disinfected and the water be tested before consumption. To disinfect your water system, pour ½ - 1 cup of chlorine bleach inside the**

**well casing and turn on all faucets until a chlorine scent in noticed. Allow the chlorine solution to remain in the system overnight. The following morning, open all faucets and flush the system until free of chlorine smell.**

**If you have a public use well or water system, contact the County Health Department for specifics on testing prior to consumption of any water.**

## SOLID WASTE

### Removing Debris

**Cleanup of your property can expose you to potential health problems from hazardous materials. Wet down any debris to minimize health impacts from breathing dust particles. The use of a two-strap dust particulate mask with nose clip and coveralls will provide the best minimal protection. Leather gloves should be worn to protect your hands from sharp objects while removing debris.**

**Hazardous materials such as kitchen and bathroom cleaning products, paint, batteries, contaminated fuel and damaged fuel containers must be handled properly. Contact the City of Flagstaff or Coconino County for specific handling restrictions and disposal options.**

**All hazardous materials should be labeled as to their contents if known!**

## HEATING FUELS

### Checking Propane Tanks

**Propane suppliers recommend homeowners contact them for an inspection prior to reusing their system. If the fire burned the tank, pressure relief valve probably opened and released the contents of the tank. Tanks, brass and copper fittings, and lines may be heat-damaged and unsafe. Valves should be turned off and remain closed until the propane suppliers inspect the system.**

### Checking Home Heating Oil Tanks

**Heating oil suppliers recommend homeowners contact them for an inspection prior to reusing their system. The tank may have shifted or fallen from the stand and fuel lines may have kinked or weakened. Heat from the fire may have caused the tank to warp or bulge. Non-vented tanks are more likely to bulge or show signs of stress. The fire may have loosened or damaged fittings and filters. If the tank is in tact and heating oil remains in the tank, the heating oil should still be good. If you have questions on the integrity of the tank, fuel lines, tank stand, or the fuel, or need assistance in moving the tank or returning it to service, contact your fuel supplier.**

# MISCELLANEOUS SAFETY AWARENESS

## Ash Pits

**Holes created by burned trees and stumps create ash pits, which are full of hot ashes. Mark them for your safety, as they can stay hot for many days following the fire, causing serious burns. Warn your family and neighbors, especially children. Tell them to watch for ash pits and to not put hands or feet in these holes—they are hot!**

## Evaluation of Trees Damaged by Fire

**The following information will assist you in evaluating any trees that have been scorched or burnt by the fire. Identification of the type of tree affected is important and can easily be done. Two basic types of trees exist in this area: deciduous and evergreen. Deciduous trees are broad leaf trees that lose their leaves in the fall.**

**In this area we have quaking aspen (deciduous). Evergreen trees have needles and in this area we have ponderosa pine, Douglas-fir and Rocky Mountain juniper.**

***First:*** ***visually check the tree stability.*** **Any tree weakened by fire may be a hazard. Winds are normally responsible for toppling weakened trees. The wind patterns in your area may have changed as a result of the loss of adjacent tree cover.**

**If the tree looks stable:**

- **Visually check for burnt, partially burnt or broken branches and tree tops that may fall.**

- **Check for burns on the tree trunk. If the bark on the trunk of the tree has been burned off or scorched by very high temperatures completely surround the tree's circumference, the tree will not survive. This is because the living portion of the tree (cambium) was destroyed. The bark of the tree provides protection to the tree during fire. Bark thickness varies based upon tree species: check carefully to see if the fire or heat penetrated the bark. Where fire has burnt deep into the tree trunk, the tree should be considered unstable until checked.**

- **Check for burnt roots by probing the ground with a rod around the base of the tree and out away from the base several feet. The roots are generally six to eight inches below the surface. If you find that the roots have been burned you should consider this tree very unstable; it could easily be toppled by wind.**

**If the tree is scorched**

**A scorched tree is one that has lost part or all of its needles. Leaves will be dry and curled. Needles will be a light red or straw colored. Healthy deciduous trees are resilient and may possibly produce new branches and leaves, as well as sprouts at the base of the tree. Evergreen trees, particularly long-needled trees, may survive when partially scorched. An evergreen tree that has been damaged by fire is subject to bark beetle attack. Please seek professional assistance concerning measures for protecting evergreen trees from bark beetle attack.**

***Seek professional assistance before felling trees near power lines, houses or other improvements.***

## Residual Smoke In Fire Interior

**Smoke may be present on the interior of the fire for several days following containment. This occurs as a result of stumps, roots, and other surface materials being exposed to changing temperatures and wind conditions. Smoke volume from these materials may fluctuate depending on weather conditions. This activity should not pose a risk and smoke will continue to dissipate until materials are fully consumed or extinguished by fire crews or weather.**

# Appendix 9

## GFFP Monitoring & Research Team
## Adaptive Management Framework

# GFFP Monitoring & Research Team
# Adaptive Management Framework
Discussion Draft 10/01/04

The following tables were developed by the Greater Flagstaff Forests Partnership (GFFP) Monitoring and Research Team as the initial makings of a monitoring and research plan for the 180,000 acre project area of the GFFP (see www.gffp.org). This framework could be applied to a smaller or larger landscape. The following five broad areas of concern reflect the monitoring needs categories of this partnership, and are divided into **fuels reduction, ecosystem restoration, social issues, economic health, and institutional health**. This is a very broad framework of what areas **COULD** be monitored within the larger area. The actual application of what **SHOULD** be monitored within individual projects may be a much smaller, and more focused subset of these variables. Decisions about which goals are desirable for individual projects should be decided by the actual project designers (e.g., ID team), and determined based upon very specific project objectives, the specific landscape that is affected by the project, the desired conditions for that landscape, and how those desired conditions are proposed to be achieved. Also, an explicit relationship needs to be developed between an analysis of the outcomes of the monitoring, and how those outcomes affect future management.

## GOAL: Reduce threat of uncharacteristic* fire)

| Objective | Indicator | Metric | What are known thresholds? | Frequency | Scale (spatial and temporal) | Cost<br>L - <$1000/yr<br>M - $1K-10K/yr<br>H - >$10K/yr |
|---|---|---|---|---|---|---|
| Create conditions that are conducive to the increased use of **frequent, low intensity fire*** in the fire-adapted landscape, including fires resulting from both | 1. Forest Vegetation Simulator (FVS) with Fire & Fuels Extension.<br>2. Fire model (e.g. NEXUS or FLAMMAP) runs indicate that fuels reduction treatments | Canopy cover<br>Stand height<br>Crown base height<br>Crown bulk density<br>Deadwood fuel loading<br>Litter, dead, and live fuels moisture levels. | Depends on fuel model, but thresholds exist for surface or ground fire, passive canopy fire, and active canopy fire. | Before and after treatments.<br>FVS uses stand data typically collected by USFS personnel.<br>FLAMMAP gives predictive ability; factor in continued treatment. | Project and roll up to landscape | H |

| | | | | | | |
|---|---|---|---|---|---|---|
| human and natural ignitions. | are effective in reducing the risk of active and passive canopy fire*.<br>3. Cumulative acres in characteristic and uncharacteristic fire condition<br>4. Fire Regime Condition Class<br>5. # of acres in Fire Use plans.<br>6. # of acres where "monitoring" or containment is considered an appropriate suppression tactic. | Annual reports of acres treated. ForestERA analysis process. | | | | |
| Reduce risk of **uncharacteristic*** fire for community protection and other special areas. | Ditto above | | | | | |

- For terms marked with an asterisk, please see glossary at end of document for current definitions and references, or click on hyperlink.

References: Brown 1974, Anderson 1978, Scott 1999, http://fire.org/nav.mas?pages=fire&mode=14; http://www.frcc.gov/

-

# GOAL: Restore Forest Ecosystem Health

| Objective | Indicator | Method or Metric | Frequency | Scale (spatial and temporal) | Cost |
|---|---|---|---|---|---|
| Increase use of frequent, low intensity | 1. Number of acres that will support a surface | USFS, State/Private, county, and city review | Annual & cumulative | Project & Landscape Short & Long-term | L if fuels reduction monitoring is done |

| | | | | | |
|---|---|---|---|---|---|
| fire in the landscape (or ponderosa pine and associated ecosystems). Improve fire regime*. | fire.<br>2. Number of acres burned by characteristic* surface fire (both Rx and wildfire individ. And combined).<br>3. Number of Rx fires. | of accomplishments (units in ac/ha and # of burns). List by FY and CY. | | | |
| Create conditions that are conducive to the increased use of frequent, low intensity fire in the landscape. | 1. Number of acres that will support a surface fire. | See above in **Fuels Reduction** | Annual & cumulative | | L |
| Retain, enhance, and develop old and large trees*, both living and dead, and mature ecosystems. | 1. Number of old/large trees/acre.<br>2. Number and decay class of snags & dead/down trees/acre.<br>3. Number of acres of existing and developing old growth* ecosystems. | USFS and Partner surveys of trees per acre by stand. Cumulative survey of OG areas. | Before and after projects | Project scale rolled up to landscape level. | L at project<br>H at landscape |
| Conserve and enhance native species*' populations and their habitat and reduce invasive, nonnative species*. | 1. Abundance, distribution & diversity of selected native species.<br>2. Abundance, distribution & diversity of nonnative selected species.<br>3. Number of acres of intact native habitat*. | Species transects and quadrats, point-intercept data and time-constrained sampling in selected areas and for selected species.<br><br>USFS surveys | Before and after treatment/projects, annual/seasonal. | Project scale rolled up to landscape level. | H |

| | | | | | |
|---|---|---|---|---|---|
| Conserve soil resources. | 1. Degree of erosion<br>2. Amount of bare ground. | Field surveys | Before and after projects | | M? |
| Maintain and improve watershed function. | 1. Amount of water flow, timing (hydrograph), and water quality.<br>2. Degree of erosion & sedimentation. | Stream gages, direct water sampling, geomorphology measures. | Before and after projects, Annually | | M |
| | | | | | |

*For words underlined and marked with an asterisk, please see glossary.

References: Harrington, Michael G.; Sackett, Stephen S. 1992, Coconino LMP 1987; Pellant et al. 2000, Pyke et al. 2002; Herrick et al. 2002 (Jornada experimental range); Taylor 1999, O'Dea 2003;

## GOAL: Improve Social Understanding & Acceptance of Land Management Practices

**Sub goal: MAINTAIN QUALITY OF LIFE**

| Objective | Indicator | Metric<br>*Measured as baseline data → for pre-treatment and measured at post-treatment* | Frequency | Scale<br>*Project vs. GFFP Area* | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Reduce the perceived risk of uncharacteristic (high intensity) fire.** | Perceived risk/threat of uncharacteristic (high intensity) wildfire that will directly or indirectly affect residents' quality of life. | 1. Survey residents to determine the perceived risk/threat of uncharacteristic (high intensity) fire.<br>2. Focus groups during GFFP field trips/presentations. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Increase the perceived benefits of characteristic (frequent, low-intensity) prescribed and natural fires.** | Perceived benefit of characteristic (frequent, low-intensity) prescribed and natural fires that will directly or indirectly affect residents' quality of life. | 1. Survey residents to determine the perceived benefit of characteristic (frequent, low-intensity) prescribed and natural fires.<br>2. Focus groups during GFFP field trips/presentations. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Reduce the risk of uncharacteristic (high intensity) fire.** | 1. Fire model<br>2. Defensible space. | 1. See "Fuels Reduction" metrics<br>2. Amount of defensible space around neighborhoods/homes. | Pre- and Post-treatment; Seasonally (bi-annually or quarterly) | Short term-Project<br>Long term-GFFP area | H |
| **Increase/maintain public's perception of recreational opportunities, in the context of restoration activities, in the local community.** | Public perception of access and level of use for recreational activities in the forests in and around the local community (in the context of restoration activities). | Survey residents to determine perception of recreational opportunities in the forests in and around the local community (in the context of restoration activities). | Pre- and Post-treatment surveys | Short term-Project<br>Long term-GFFP area | M |
| **Protect/promote the aesthetic value of the** | Public perception that restoration projects will/are | 1. Survey residents to determine perception of the | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |

| | | | | | |
|---|---|---|---|---|---|
| **forest.** | preserving and promoting forest aesthetics in and around their community. | effects of restoration efforts on forest aesthetics in and around their community.<br>2. Focus groups during GFFP field trips/presentations. | | | |
| **Protect/promote spiritual value of the forest.** | Public perception that restoration projects will/are preserving and promoting the spiritual value of the forest. | 1. Survey residents to determine perception of restoration efforts in protecting the spiritual value of the forest. Over sample Native American members of the community. Conduct personal interviews/focus groups with Native American members of the community. | Pre- and Post-treatment surveys/focus groups | Short term-Project<br>Long term-GFFP area | M |
| **Reduce the number of unplanned human-caused forest fires in the GFFP area.** | Number of human-caused fires in the forest in the GFFP area. | Forest Service logs of fire occurrences and the ignition sources. | Pre- and Post- program implementation | Long term-GFFP area | M |
| **Public's perception of forest closures.** | Public's knowledge of the reasons for forest closures. | Survey residents to determine knowledge of why forest closures occur; does the public link it to restoration activities? | Pre- and Post-program survey | Short term-Program<br>Long term-GFFP area | M |
| **Public's perception of forest restrictions.** | Public's knowledge of the reasons for forest restrictions. | Survey residents to determine knowledge of why forest restrictions occur; does the public link it to restoration activities? | Pre- and Post-program survey | Short term-Program<br>Long term-GFFP area | M |

**Sub Goal: INCREASE PUBLIC INVOLVEMENT IN RESTORATION EFFORTS**

| **Objective** | **Indicator** | **Metric**<br>***Measured as baseline data***<br>**→**<br>***for pre-treatment and measured at post-treatment*** | **Scale**<br>*Project vs. GFFP Area* | **Frequency** | **Cost**<br>**(H, M, L)** |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Increase the knowledge/ perception of "Fire Wise" principles/communities and implementation of defensible space.** | 1. Amount of public knowledge/perceptions of "Fire Wise" principles/communities.<br>2. Public knowledge/perceptions of implementing "defensible space" (space near and around homes). | Survey residents to determine the knowledge/perceptions of "Fire Wise" principles/communities and implementation of defensible space. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase the number of communities* that are recognized as "Fire Wise" in the GFFP area.** | Number of communities in the GFFP geographic area designated as "Fire Wise." | Determine number of communities in the GFFP region that are recognized as "Fire Wise" through certification of Firewise/Communites/USA. (Currently in AZ → Timber Ridge) | Long term-GFFP area | Pre- and Post-program implementation | H |
| **Increase the number of neighborhoods/households that are implementing "Fire Wise" principles around their homes.** | 1. Number of households that are implementing (the degree of) "Fire Wise" principles around their homes.<br>2. Number of neighborhoods that are implementing "Fire Wise" principles. | 1. Survey residents to determine their level of implementing "Fire Wise" principles around their homes.<br>2. Interview fire station personnel in neighborhood/home assessments.<br>3. Review fire station field survey logs. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase community involvement in restoration activities. Pay special attention to youth service corps programs that include middle-high school age students.** | 1. Number of GFFP sponsored workshops, field trips, etc.<br>2. Number of youth programs established by GFFP that promote involvement & education with restoration efforts.<br>3. Number of participants and/or groups attending GFFP events.<br>4. Number of service groups | 1. Review GFFP logs.<br>2. Review event coordinator logs. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |

| | | | | | |
|---|---|---|---|---|---|
| | participating in GFFP events.<br>5. Attendance of GFFP meetings - public and GFFP members. | | | | |
| **Improve public access and participation in forest restoration.** | 1. Public's perception of the ability to participate in restoration activities and forest planning.<br>2. Public's access to information pertaining to restoration activities.<br>3. Media types utilized to disseminate GFFP information.<br>4. Most common media sources used by the public to access restoration information. | 1. Survey residents to assess their perceived ability to participate and obtain information regarding restoration activities and forest planning.<br>2. Review number and type of GFFP public announcements for restoration activities.<br>3. Survey public to determine most desirable media source(s) to access the information. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |

**Sub goal: INCREASE PUBLIC INFORMATION/SUPPORT FOR RESTORATION PROJECTS**

| Objective | Indicator | Metric<br>*Measured as baseline data →*<br>*for pre-treatment and measured at post-treatment* | Scale<br>*Project vs. GFFP Area* | Frequency | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Increase perceptions of "healthy forests" resulting from forest restoration activities that include characteristic wildfire, wildlife habitat and watershed function in and around communities/GFFP geographic areas.** | Public perception of restoration activities resulting in "healthy forests" in and around their community. | Survey residents to determine perceptions of restoration activities resulting in a "healthy forest." | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation | M |
| **Increase awareness/support/notification for restoration projects.** | 1. Campaigns that are in place as informational tools for restoration projects.<br>2. Number of public notifications that include: prescribed burns-posting signs, new releases, door-to-door in neighborhoods, public meetings, presentations to service clubs/organizations, press releases, development and distribution of material and participation of GFFP in community events. | 1. Review number of GFFP sponsored workshop, field trips, etc.<br>2. Review of the number of community participants in the events.<br>3. Review number of public notifications for prescribed burns-posting signs, new releases, door-to-door in neighborhoods, public meetings, presentations to service clubs/organizations, press releases, development and distribution of material and participation of GFFP in community events.<br>4. Perform content analysis of campaign types and messages.<br>5. Conduct focus groups to assess perceived messages | Short term-Program<br>Long term-GFFP area | Pre- and Post-program surveys/focus groups | M |

| | | | | | |
|---|---|---|---|---|---|
| | | of GFFP literature. | | | |
| **Increase awareness/support for restoration projects.** | 1. Number and content of local publications, editorials and letters to the editor regarding restoration efforts (Non-GFFP members)<br>2. Number and content of USFS public comments. | 1. Content analysis: review number and content of local publications, editorials and letters in to the editor regarding restoration efforts.<br>2. Content analysis/frequency of public comments submitted to the USFS | Short term-Program<br>Long term-GFFP area | Pre- and Post-treatment/implementation | M |
| **Increase public support for mechanical thinning, road construction, and smoke as necessary tools for ecological restoration.** | 1. Number of complaints to authorities regarding thinning, road construction and smoke resulting from a restoration project(s).<br>2. Number of complaints to authorities for faster and more efficient implementation of restoration efforts. | 1. Examine local fire department and police logs.<br>• Review type and number of complaints filed per restoration project.<br>• Review number and type of requests to initiate or complete restoration projects. | Short term-Program<br>Long term-GFFP area | Pre- and Post-program/treatment implementation | M |
| **Improve awareness and public attitude towards partners & cooperators involved in restoration projects** (e.g., USFS, ERI, NPS, GCT, TNC, Flagstaff Fire Dept., etc.). | Public's awareness and perceptions of GFFP partners and cooperators. | 1. Survey residents to determine attitudes towards GFFP partners and cooperators in regards to their involvement in restoration efforts.<br>2. Focus groups of residents to determine attitudes towards GFFP partners and cooperators. | Long term-GFFP area | Pre- and Post-treatment surveys/focus groups | M |
| **Decrease number of appeals and lawsuits filed against GFFP projects.** | 1. Number of appeals of GFFP supported projects.<br>2. Number of lawsuits of GFFP supported projects.<br>3. Number of acres analyzed | 1. Review appeals to determine number filed against GFFP projects.<br>2. Review lawsuits to determine number filed against GFFP supported | Short term-Program<br>Long term-GFFP area | Pre- and Post-program implementation or annual | M |

| | | | | | |
|---|---|---|---|---|---|
| | and treated through the NEPA process. | projects.<br>3. Review the results of the appeal. Was it upheld?<br>4. Length of time it took the agency to process the appeal. | | | |
| **Increase public's knowledge of ecologically-based fuels reduction.** | Public's knowledge of ecologically-based fuels reduction. | 1. Survey residents to determine knowledge of ecological-based fuels reduction.<br>2. Focus groups during GFFP filed tips/presentations | Short term-Program<br>Long term-GFFP area | Pre- and Post-program surveys/focus groups | M |

# Steps in the Evaluation Process

Longitudinal Study – Process Evaluation – assess changes over time.

1. Collect baseline data-establish an understanding of what currently exists; before intervention (treatments or programs).
2. Collect data at stages as projects progress; either at regular time intervals or after major interventions.
3. What is the change from pre- to post-test? Analyze the data.
4. Answer the question – Have goals been met? Establish criteria for successful outcomes.
5. Recommendations – refine treatments and programs; guide planning and education efforts.

***A sustainable community is linked to a sustainable ecosystem.***

***Healthy forest → Community well-being.***

## Areas to explore

1. Insurance industry – current status of homeowner insurance for forest fire loss.

2. USFS and congressional representatives – determine public pressure thresholds to either suspend or omit restoration prescriptions.

# References


Greater Flagstaff Forest Partnership and The Ponderosa Fire Advisory Council. 2004. *Greater Flagstaff Community Wildfire Protection Plan.* Retrieved July 26, 2004 (http://www.gffp.org/docs/June_draft.htm).

United States Forest Service and Ecological Restoration Institute. 2004. *The Multiparty Monitoring Handbook Series.*

"Monitoring Social and Economic Effects of Forest Restoration." Handbook Five. Retrieved July 8, 2004 (http://www.fs.fed.us/r3/spf/cfrp/monitoring/index.shtml).

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Royse, David, Bruce A. Thyer, Deborah K. Padgett and T. K. Logan. 2001. *Program Evaluation*. 3d ed., Belmont, CA:Wadsworth/Thompson Learning.

The Federal Emergency Management Agency. 2004. "At Home in the Woods. Lessons Learned in the Wildland/Urban Interface." Retrieved July 30, 2004 (http://www.fema.gov/regions/viii/athome_woods.shtm).

## GOAL: Improve Economic Health of Community

| Objective | Indicator | Metric /Method | Scale<br>*Project vs. GFFP Area* | Frequency | Cost<br>(H, M, L) |
|---|---|---|---|---|---|
| **Ensure the availability of forest material at a sustainable and constant level to support <u>appropriate forest product</u> industries.** | 1) # of acres and total volume in long-term (10 years or greater) contracts in the Flagstaff region. | Annual review of acres/total volumes in long-term contracts provided by public agencies (USFS and State). | Multiple: local, GFFP, & w/in 150 miles. | Annual | L |
| **Provide employment opportunities to Flagstaff area residents in forest restoration projects & forest product or other related industries.** | 1) # of employees in forest-restoration & product related companies in Flagstaff region.<br>2) Proportion of Flagstaff area residents (as % of total) employed by forest product and restoration-related companies.<br>3) Proportion of permanent to temporary employees in …<br>4) Number of locally owned businesses. | Annual surveys/questionnaires with all forest product companies utilizing small diameter material. GFEC collected data. NAU College of Business (Bank 1 center). | GFFP area of product/material distribution | Annual | L |
| **Provide technical and professional training to Flagstaff area residents to work on forest restoration projects.** | 1) Number and duration of training events and programs per year.<br>2) # of participants in training events & programs/year.<br>3) Level of training (professional, technical, accredited, on the job). | Identify all area institutions providing professional training related to forest products and restoration. Annual survey of those institutions to count events, level of training, and participants. | GFFP area of product/material distribution. **Need help from economist on scale decision.** | | L |

| | | | | | |
|---|---|---|---|---|---|
| **Expand uses and products associated with small diameter material (SDM) and biomass.** | 1) Total number, size, and longevity of operational businesses utilizing small diameter material in Flagstaff area.<br>2) Total # of products and uses for SDM and biomass.<br>3) Total volume (cords) of small diameter material processed locally in Flagstaff area by businesses. | Annual surveys/questionnaire with all forest product companies utilizing small diameter material & biomass. GFEC, NAU, etc. | | | M |
| Flagstaff area = 150 mile radius | | | | | |
| Small diameter material = <16" **Need to define*** | | | | | |

## GOAL: Institutional Health

| Objective | Indicator | Method/Metrics | Scale *Project vs. GFFP Area* | Frequency | Cost (H, M, L) |
|---|---|---|---|---|---|
| *Increase annual budget to facilitate forest ecosystem restoration* | Annual budget of GFFP, with operations as %. | review of annual budget | All GFFP Area | Annual | L |
| | # of donors, gifts, grants & contracts awarded (public & private) reported by category. | review of development database | All GFFP Area | Annual | L |
| | # of 5-6 figure project budgets/grants by category | review of annual budget and/or development database | All GFFP Area | Annual | L |
| *Increase satisfaction among partners with GFFP operations* | partner satisfaction (strategic direction, conflict resolution, consensus building, etc) | Survey (D. Hospodarsky) | All GFFP Area | Annual | M |

| | | | | | |
|---|---|---|---|---|---|
| *Maintain & enhance collaborative effort among partners* | # of PAB members; PAB and work team participation and attendance; content analysis of meetings. | meeting minutes review | All GFFP Area | Annual | L, M |
| | # of independent projects between partners fostered by GFFP. | reports from partners | All GFFP Area | Annual | L |
| *Achieve annual objectives & develop long term strategy* | Proportion of annual goals & objectives achieved | annual objectives review and cumulative achievement of goals | All GFFP Area | Annual | L |
| | Long term strategic plan development and perception among members of its implementation. | creation of document, survey of members | All GFFP Area | Annual | M |
| *Implement MOUs developed with USFS Cooperators (RMRS PNWRS, SRS, FPL, CNF)* | % of "shalls" in MOUs followed | MOU annual reviews | All GFFP Area | Annual | L |
| *Increase communication among GFFP partners and cooperators* | Project updates are current<br><br>Minutes are shared betw/ BOD and PAB, and among work teams<br><br>Partners' perception of communication | Survey of minutes, website and partners | All GFFP Area | Annual | L<br><br>M |
| *Increase visibility of GFFP at regional & national level* | # of visits to website, project areas, media hits<br><br>requests for GFFP documents, presentations | web log, interviews, elected officials meeting, GFFP records | All GFFP Area | Annual | L |

## Partial Glossary for Greater Flagstaff Forests Partnership Research and Monitoring Team

**Characteristic & Uncharacteristic**– In ecological systems, this refers to whether or not a variable or condition of the ecosystem or its parts is included in what is known about its historic or natural range of variability, which may be specific to a given geographic area. E.g., we know from tree ring studies around Flagstaff that the historic range of variability for low intensity fires for the period of 1500 to 1872 was 2-15 years. Thus fires that currently occur within that range are characteristic in frequency (see **Fire Regime**).

**Crown Fire, Active and Passive --** This is a fire that travels from one crown (or treetop) to another in dense stands of trees, killing most trees in its path. However, even in intense crown fires, unburned strips may be left due to powerful, downward air currents. A passive (or dependent) crown fire relies upon heat transfer from a surface fire burning below the crowns. An active (or independent) crown fire does not require transfer of heat from below the crowns. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY. p. 282. (see also **Surface Fire**)

**Fire Regime** -- A fire regime is defined according to fire characteristics such as intensity, frequency, severity, season, extent, duration, behavior, spatial distribution, and type of fire (see **Crown Fire**).

**Fire Regime Condition Class (FRCC)--** - http://www.frcc.gov/

**Surface Fire --** A fire that burns over the forest floor, consuming litter, killing aboveground parst of herbaceous plants and shrubs, and typically scorching the bases and crowns of trees. Source: Barnes, Burton V., Donald R. Zak, Shirley R. Denton, and Stephen H. Spurr. 1997. Forest Ecology (4th Edition). John Wiley and Sons, Inc. New York, NY p. 281 (se also **Crown Fire**).

**Monitoring Cost Categories**
**L – Low = $1-1,000 per year or monitoring period/effort**
**M – Medium = $1,000 – 10,000**
H – High = $10,000 - $100

2011-03-08 – 28

# United States Department of the Interior

## U.S. FISH AND WILDLIFE SERVICE

Ecological Services
P.O. Box 1306, Room 6034
Albuquerque, New Mexico 87103

MAR 08 2011

In Reply Refer To:
FWS/R2/ES-HC/EC/047661

Mr. Henry Provencio
U.S. Forest Service
Coconino National Forest, Attention: 4FRI
1814 South Thompson Street
Flagstaff, Arizona 86001

Dear Mr. Provencio:

Thank you for your January 21, 2011, and January 25, 2011, requests to the U.S. Fish and Wildlife Service (FWS) for comments concerning the scope of the analysis for the Four Forest Restoration Initiative (Restoration Initiative), Coconino and Kaibab National Forests, Coconino County, Arizona. The Coconino and Kaibab National Forests are proposing to conduct various restoration activities within a 750,000-acre ponderosa pine forest ecosystem (project area) over approximately 10 years. Treatment areas are located on the Williams and Tusayan districts of the Kaibab National Forest and on the Flagstaff, Mogollon Rim, and Red Rock districts of the Coconino National Forest. The objective of the Restoration Initiative is to re-establish forest structure, pattern, and composition, which will lead to increased forest resiliency and function.

Overall, the FWS supports the U.S. Forest Service's efforts to plan and implement landscape-level forest restoration, and will continue to actively assist your agency in the development of the Draft Environmental Impact Statement (DEIS) for the project. The comments provided below are intended to assist in providing technical assistance toward the development of the proposed action and DEIS. Our comments are based upon both the January 21, 2011, project summary, and the January 25, 2011, Federal Register notice (76 FR 4279).

General Comments

1. The FWS is concerned the current proposed action does not provide sufficient detail about the Restoration Initiative and management actions to occur over the next 10 years. Many stakeholders, in cooperation with the U.S. Forest Service, have spent much of their time and effort developing a landscape strategy for the project area along with other documents to assist in describing the purpose and need for the proposed action. We believe these documents provide much needed detail to the public. Therefore, we recommend the U.S. Forest Service incorporate these documents into the public process

to ensure recommendations made by the stakeholder group are clear to other interested parties.

2. The FWS is aware of the public concern for projects involving tree removal and the protection of old-growth trees and forests. The proposed action states "treatments will be designed to manage for old trees." However, there is no ecological need to cut these trees to conduct restoration, and efforts should be made to ensure the public is aware of the intent to protect old-growth forests across the project area. Therefore, we recommend the DEIS explicitly state no old-growth trees (trees pre-dating Euro-American settlement) shall be cut.

2

3. Ecological restoration should guide, and be the goal of, the proposed action. The project summary and Federal Register notice state the projects' objective is to re-establish forest structure, pattern, and composition, leading to increased forest resiliency and function. The documents list several traditional silvicultural treatment methods to be used, but do not describe how the U.S. Forest Service will use ecological science to frame the action and achieve desired ecological conditions. Therefore, we recommend the DEIS clearly describe the foundational science upon which restoration will occur within the project area (forests, ephemeral channels, aquifer recharge), articulate the specific post-treatment desired conditions expected to be achieved, and depict longer-term desired future conditions for the ponderosa pine forest.

3

4. The FWS is currently assisting the U.S. Forest Service in developing possible forest management actions that could occur within and adjacent to threatened Mexican spotted owl (*Strix occidentalis lucida*) protected activity centers (PACs) within the project area. The goal is to design actions to benefit the Mexican spotted owl and its habitat. The Federal Register notice and project summary both state "the proposed action will cut trees within selected Mexican spotted owl PACs to improve habitat." This statement does not accurately describe the detailed planning the two agencies are conducting to improve Mexican spotted owl nesting and roosting habitat along with forest management (thinning and burning) and monitoring activities to increase the sustainability of existing core activity areas. Therefore, we recommend the U.S. Forest Service continue to work with FWS staff to develop language for the DEIS to clearly articulate the process, planning, and monitoring needed to assist the species' recovery within the project area.

4

5. The FWS feel it is important to ensure the public is aware we are fulfilling our trust responsibilities by providing movement corridors and connectivity across the project area. Therefore, we recommend all future documents describing the proposed project include information regarding wildlife corridors provided by the FWS and Arizona Game and Fish Department.

5

6. The scope and size of the Restoration Initiative is much greater than other forest restoration projects designed in the past. To effectively implement forest restoration at this scale, there is a need to develop a robust monitoring framework. Therefore, we recommend the U.S. Forest Service work with the stakeholder group to develop specific desired conditions for each restoration element, clearly articulate triggers for management change, and ensure the adaptive management strategy identifies a process for modifying management actions when objectives are not met.

6

We appreciate this opportunity to provide comments on the Restoration Initiative, and we look forward to continuing our work with your agency in developing the proposed action and DEIS. If you have any questions, please contact Shaula Hedwall, Ecological Services Field Sub-Office, Flagstaff, Arizona, at 928-226-0614, extension 103, or Brenda Smith, Ecological Services Field Sub-Office, Flagstaff, Arizona, at 928-226-0614, extension 101.

Sincerely,

Joy E. Nicholopoulos

ACTING Regional Director

cc: Regional Environmental Officer, Office of Environmental Policy and Compliance, Oakland CA
Director, Assistant Fisheries and Habitat Conservation-Branch of Conservation Planning Assistance, Attention: Stephanie Nash
Supervisor, Ecological Services Field Office, Phoenix, AZ
Assistant Field Supervisor, Ecological Services Field Sub-Office, Flagstaff, AZ
Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Regional Supervisor, Arizona Game and Fish Department, Flagstaff, AZ

## Literature Cited

Barrow, W.C., Jr., L.A. Johnson Randall, M.S. Woodrey, J Cox, E. Ruelas, I., C.M. Riley, R.B. Hamilton, and C. Eberly. 2003. Coastal Forests of the Gulf of Mexico: A description and some thoughts on their conservation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

2011-03-09 -29

Four Forest Restoration Initative
Coconino and Kaibab National Forest

# Comment Sheet

**Did you attend a meeting/workshop? _____ Yes __X__ No**

**If yes, what date(s)? _____**

Please check the area related to your comments, **using a separate comment form for <u>each</u> area.**

__X__ Coconino Forest-Wide
____ Flagstaff District – North of I-40
____ Flagstaff District – South of I-40
____ Kaibab Forest-Wide
____ Tusayan District
____ Red Rocks/Sedona
____ Verde Valley
____ Mogollon Rim
____ Williams District

**Comment Topic**

____ Purpose and Need
____ Vegetation/Silviculture
____ Wildlife – Big Game
____ Wildlife – T&E
____ Wildlife – Sensitive Species
____ Wildlife – Birds
____ Wildlife – Aquatic
____ Wildlife – Other
____ Fuels and Fire Behavior
____ Soils and Watershed
____ Air Quality
____ Transportation
____ Cultural Resources
__X__ Comment Applies to All
____ Other
____ Recreation Special Uses
____ Developed Recreation
____ Dispersed Recreation
____ Scenery/Visuals
____ Special Areas/Designations

**Comment:**

I support control burnings for all of the above. I also believe in the multi-use of our National Forests. All of the above site multi-use except correct logging and grazing of cattle. Last comment, we should punish those that abuse our roads instead of closing the roads.

Thank you for your comments! (over)

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

Submitted by Fred Amator Cell 623-980-6007
email famator@aol.com

Four Forest Restoration Initative
Coconino and Kaibab National Forest

We have a cabin at Happy Jack and I appreciate the control burning to help protect our forests and our home there. Control burnings also increase food for cattle, & wildlife.

**Comment Continued:**

The burning of the dense shrubs and trees also increase the watershed that fills our lakes for recreation and drinking water.

As you can tell I am an advocate of multi-use of our forests which includes the entire list on the reverse side of this questionaire. However, the list does not include correct logging or cattle grazing which are important to our country.

Lastly, I am concerned about the abuse that some of our roads and forests are getting by a small percentage of our population. I think that those that are abusing should be punished and that the use of those areas not be closed to the rest of us. If necessary to close some roads, please keep main roads open so that those of us who like to hike can access the areas.


Name: Fred Amator

Address: 14247 W. Broadway 2012 Green Top Dr. Lot 105
Goodyear, AZ 85338 Happy Jack, AZ 86024

Cell 623-980-6007


Please note: Names and addresses submitted in response to any request for comments are considered part of the public record for this project and may be released to the public if requested under the Freedom of Information Act. Providing contact information is optional.

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

Four Forest Restoration Initative
Coconino and Kaibab National Forest

***Please Tell Us Your Preference for Receiving Documents including the Scoping Letter, DEIS, FEIS/ROD*** *(we would like to keep printing costs down and send documents via e-mail or share by posting to our website):*

✓ I prefer to receive documents by e-mail which is: famator@aol.com

___I prefer to view documents on the forest web-site

___I would like to receive a CD copy of the DEIS and FEIS/ROD (*Note: Scoping letter will not be available via CD)*

___I would like to receive documents in hard-copy form (***please make sure you have provided your address)***

***Has Your Address Changed? Please provide your new address:***

_____

_____

_____

**Please submit all comments no later than March 14, 2010.** This will allow the 4 FRI team sufficient time to consider your comments in order to identify issues, alternatives, mitigation and monitoring options.

**Web Site:** http://www.fs.usda.gov/goto/kaibab/4fri

**Email Address:** 4FRI_comments@fs.fed.us Please note: there is an underscore "_" between the words "4FRI" and "comments" (4FRI_comments)

**US Mail:** Coconino National Forest, 1824 South Thompson St., Flagstaff, AZ 86001, *Attn*: 4FRI

**PLEASE NOTE: General comments will always be accepted and considered in subsequent steps of the 4 FRI NEPA process.**

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

2011-03-10 -30

Flagstaff, AZ 86001
http://fs.usda.gov/goto/kaibab/4fri
4FRI Stakeholders http://4fri.org
Phone (928) 226-4684
Cell (928) 525-6581
Paula Cote/R3/USDAFS

-



**RICK ERMAN**
**<ermanaz7746@msn.com>**
03/10/2011 09:39 PM

To "Mary Lata" <mlata@fs.fed.us>
cc "Bill O Noble" <bnoble@fs.fed.us>, "Paula Cote" <pcote@fs.fed.us>
Subject Re: comment due date

Mary, thank you for your detailed response, I am one who likes the details the "high elevation" single sentence DFC's and blanket statements don't mean much when your standing on the ground and looking at long term sustainability.

today came another reference which I also had a copy of but had miss filed: Managing Coarse Woody Debris in Forests of the Rocky Mtns, INT-RP-477 by: Graham, Harvey, Jorgensen, Jain, Tonn & Page-Dumrosese. ( 477 )

what we are hoping for is the Forest / Agency will, for the first time in the 30 plus years we have been interacting with the it, provide ( In Writing ) an integrated plan / explanation to how it will combine:
Scott & Burgan, the aspect where there is enough fuel to carry a "natural-ground fire"
477; where there is large woody material greater than 3 inches in diameter
FSH 2209.90 grazing of non-native species and yet leave enough material to carry the fire described in Scott & Burgan and not remove the needed debris described in 477
FSH 2509.18 - 2.05 "Litter, Organic material on the soil surface that are at least 1.25 cm (0.5 inches) thick. This includes needles, leaves and all woody material." discussions of this point is a merging of 477 and 2509.18. this alone is a key element to provide all the things this mulch / ground cover provides including but not limited to: soil protection & cooling & top soil development, erosion, food and cover for small species, setting of seeds for the distribution and diversity of small plants as well as watershed improvements of yield and protection,,,,,,,,, AND help carry the next fire.

all of this on the ground ASAP after the first fire after mechanical treatment to reduce the BA of pine / large woody species,,, to get ready for the second or AKA as a "natural" fire, and so on moving forward long into time so the current condition does not reoccur.

This will be a Real Test for the Agency to show the public it is truly willing to "turn the page" and do "what's right for the Land" or once again pay lip service to the "big picture" and in fact just cut trees and close roads, ignoring the impacts of herbivore of non-native species ?

I am quite sure you cannot provide any details to this depth of specificity at least right now, at some point given you or the Agency is willing and wanting we are most willing to have a face to face and discuss.

Rick

**From:** Mary Lata
**Sent:** Thursday, March 10, 2011 4:11 PM

**To:** ermanaz7746@msn.com
**Cc:** Bill O Noble ; Paula Cote
**Subject:** Re: comment due date

I'm always pleased to hear from people paying close attention to what is being proposed/planned. Yes, it can often cause us more work, but the whole point of the process is for those of us charged with being stewards of public lands to combine our experience/training/knowledge with what we hear from the public to make good decisions. Thank you for paying attention, and feel free to ask more questions if you have them.

The Scott and Burgan publication you mention is one of the 'bibles' for fire management these days, having produced 40 models, where for a couple of decades there were only 13 (Anderson, 1982) (this was the 'old bible' until S and B published in 2005, and will always be a valuable reference). S and B describe the physical characteristics of the vegetative structure of different ecosystems as they relate to fire behavior, and, unlike in Anderson, they gave their models 'dynamic' characteristics, allowing modelers to vary the moisture to better represent burning conditions). I'm leaning heavily on it as I'm doing the fire modeling that helps us identify where, on the landscape, we currently have the greatest potential for catastrophic fire.

Fuel models are chosen based on the fire behavior they produce, NOT the exact match of vegetation type. Primarily, they're chosen based on *what carries the fire* - thus, in a stereotypical healthy ponderosa pine 'forest' (which is pretty open), fires are carried by the grass fuels on the surface. The fuel models representing the largest areas for the CURRENT CONDITION of the analysis area are:

TL8 (188) Long-Needle Litter
GS1 and GS2 (low and moderate load, dry climate grass-shrub)
GR 2 (102) low load, dry climate grass
GS3 (183) Moderate Load Conifer Litter

The 188 is the biggest concern, since the majority of our ponderosa pine is not healthy in that condition. From a fire modeling standpoint, based on the synthesis of the combined analyses of soil/water, silviculture and fire, we expect to set many of these areas on a trajectory towards a condition where the fire behavior (and effects) would be more like a grass model - frequent, low intensity fire, producing low severity.

If you want to look at the Anderson publication, here's a link:
http://www.fs.fed.us/rm/pubs_int/int_gtr122.html

Ponderosa pine was, for the most part, included as fuel model 2 - considered a grass model. To model it with S and B's models, one would most accurately use a grass model (refer to page 13 in S and B).

I realize this may be more than you wanted so, if it leads to more questions, feel free to contact me.

><><<<><>><><<<
Mary Lata, Fire Ecologist
Four Forest Restoration Initiative (4FRI)

United States
Department
of Agriculture

Forest Service

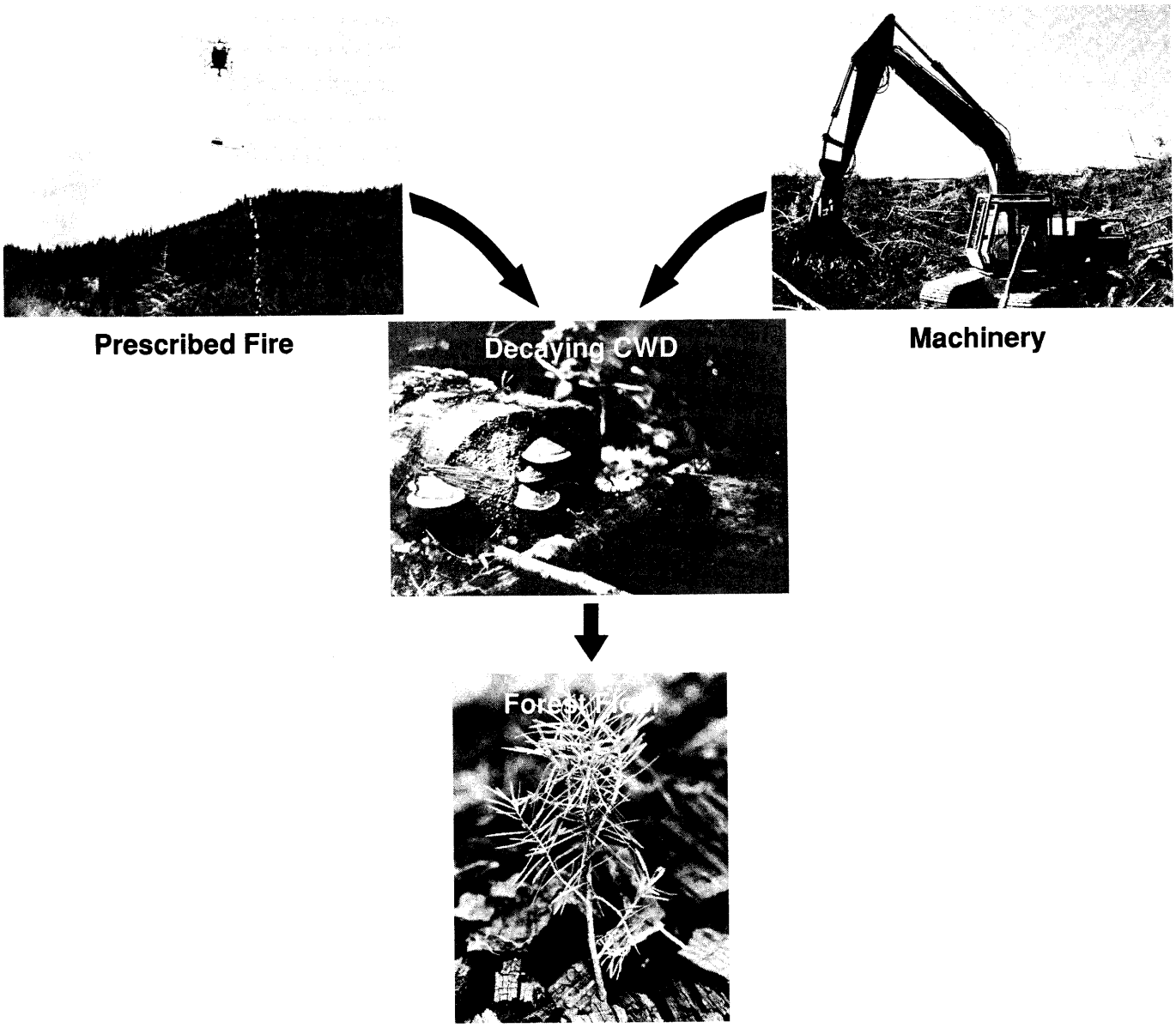
**Intermountain
Research Station**

Research Paper
INT-RP-477

September 1994

# Managing Coarse Woody Debris in Forests of the Rocky Mountains

**Russell T. Graham
Alan E. Harvey
Martin F. Jurgensen
Theresa B. Jain
Jonalea R. Tonn
Deborah S. Page-Dumroese**



## The Authors

**Russell T. Graham** is a Research Forester with the Intermountain Station's Forestry Sciences Laboratory in Moscow, ID. He received a B.S. degree in forestry (1972), an M.S. degree in forestry (1976), and a Ph.D. degree in forestry (1981).

**Alan E. Harvey** is principal Plant Pathologist with the Intermountain Station's Forestry Sciences Laboratory in Moscow, ID. He received a B.S. degree in biology (1960), an M.S. degree in plant pathology (1962), a Ph.D. degree in plant pathology (1968), and spent an academic year of postgraduate work in plant pathology (1972).

**Martin F. Jurgensen** is a Professor of Forest Soils in the Department of Forestry at Michigan Technological University in Houghton, MI, where he conducts research in forest soils and forest microbiology. He received a B.S. degree in forestry (1961), an M.S. degree in silviculture (1965), and a Ph.D. degree in soil science (1967).

**Theresa B. Jain** is a Forester with the Intermountain Station's Forestry Sciences Laboratory in Moscow, ID. She received a B.S. degree in forest resources (1982) and an M.S. degree in forestry (1994).

**Jonalea R. Tonn** is a Forester with the Intermountain Station's Forestry Sciences Laboratory in Moscow, ID. She received a B.S. degree in forestry (1974), an M.S. degree in forestry (1976), and is completing a Ph.D. degree in forestry.

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## Research Summary

Coarse woody debris is a major component of Rocky Mountain forests. Debris has many functions ranging from soil protection to wildlife and microbial habitat. The management of coarse woody debris is critical for maintaining functioning ecosystems in the Rocky Mountains. These forests have great diversity, with each forest habitat type developing and retaining different amounts of debris. Fourteen habitat types were examined, ranging from ponderosa pine (*Pinus ponderosa*) habitat types of Arizona to subalpine fir (*Abies lasiocarpa*) habitat types of western Montana. Coarse woody debris management recommendations were developed by using ectomycorrhizae as a bioindicator of healthy, productive forest soils. These recommendations are intentionally conservative to ensure that enough organic matter is available after timber harvest to maintain long-term forest productivity.

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# Managing Coarse Woody Debris in Forests of the Rocky Mountains

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## Introduction

Coarse woody debris (CWD) is woody material derived from tree limbs, boles, and roots in various stages of decay. The decay stages of woody debris in the Northern Rocky Mountains have been categorized as: new residue—recently dead material with little or no decay; incipient residue—decay is beginning; and advanced residue—decay has consumed much of the material (Jurgensen and others 1984). These materials can occur in many sizes and shapes. Residue with minimum diameters from 2.5 cm (1 inch) to 15 cm (6 inches) are often termed CWD (Harmon and others 1986). For our purposes, and to make our research consistent with those of fire researchers and managers in the Rocky Mountain region, we are defining CWD as any woody residue larger than 7.5 cm (3 inches) in diameter.

Forested ecosystems evolve with a continual flux of CWD. The creation and accumulation of CWD depends on forest type, successional stage, insect and disease activity, weather events, fire-return intervals, decay rates, and timber management activities. In some forest ecosystems, CWD can persist for hundreds of years (500 years); in other ecosystems its life span is rather short (60 years) (Harmon and others 1986; Harvey and others 1987). In the more productive, moist ecosystems, such as those dominated by western hemlock (*Tsuga heterophylla* [Raf.] Sarg.) and western redcedar (*Thuja plicata* Donn ex D. Don), fire frequencies are relatively long (greater that 200 years). Coarse woody debris has greater longevity in such ecosystems than in those dominated by ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) where fire frequencies are often less than 10 years. In the cedar/hemlock forests of the Northern Rocky Mountains an average of 66 Mg per ha (29.4 tons per acre) of CWD has accumulated. In the ponderosa pine forests an average of 23 Mg per ha (10.3 tons per acre) of CWD has accumulated (Brown and See 1981). During the last 100 years, the fire frequencies in all of the Rocky Mountain ecosystems have been greatly extended, potentially increasing CWD accumulations.

Coarse woody debris performs many physical, chemical, and biological functions in forest ecosystems. Physically, CWD protects the forest floor and mineral soil from erosion and mechanical disturbances (Page-Dumroese and others 1991) and it protects new seedlings from livestock damage (Graham and others 1992). It also is a key habitat component (especially large logs) for many forms of wildlife (Reynolds and others 1992) and is important in stream ecology (Harmon and others 1986). Coarse wood debris disrupts air flow and provides shade, insulating and protecting new forest growth. In moist forest types it can be a seedbed and nursery area for new conifer seedlings (Harmon and Franklin 1989; Minore 1972). When decay has advanced, CWD can hold large amounts of water, making it an important source of moisture for vegetation during dry periods (Harmon and others 1986; Harvey and others 1987).

Many nutrients especially sulfur, phosphorous, and nitrogen are released as CWD decays or is burned. Especially in the advanced stages of decay, CWD has high concentrations of nutrients (Larson and others 1982; Means and others 1992). In the absence of nitrogen-fixing plants, such as *Ceanothus* spp., CWD is a very important site for nonsymbiotic nitrogen fixation (Larson and others 1978). This form of nitrogen input can be very significant (Jurgensen and others 1991, 1992).

Organic materials, especially humus and buried residue in the advanced stage of decay, are excellent sites for the formation of ectomycorrhizal root tips (Harvey and others 1981). Even though these materials may make up only a small portion of a soil horizon they may contain the majority of ectomycorrhizae. Ectomycorrhizae help woody plants take up water and nutrients, and their fruiting bodies play important roles in the food chains of many small rodents and larger predators (Maser 1990; Maser and others 1986; Reynolds and others 1992).

Coarse woody debris can be incorporated into the surface soil horizon as freezing and thawing cycles move CWD into the soil. Additionally, CWD can be covered as soil moves downhill. Depending on the forest type, large amounts of CWD can be left in the form of decaying tree roots. All of these materials, in the advanced stages of decay, can be active parts of the soil system as soil wood.

Because CWD is an important component of a functioning ecosystem, a portion of this material must be maintained. As the demand for forest products and the ability to utilize more fiber increases, less material is being left after timber harvesting or after salvage operations. These operations, in combination with past practices of slash disposal and site preparation, have reduced organic material in the forest floor, making CWD management critical (Harvey and others 1987). Consequently, recommendations for maintaining CWD for different ecosystems and forest types are needed.

This study was undertaken to provide managers with initial recommendations for managing CWD to maintain long-term forest productivity in different forest types of the Rocky Mountains. Recommendations were developed on the amounts of CWD needed after timber harvesting for specific habitat types using data from undisturbed stands.

## Methods

The habitat types for this study were selected in consultation with forest managers, soil scientists, and silviculturists of the Northern, Intermountain, and Southwestern Regions of the Forest Service, U.S. Department of Agriculture. The habitat types chosen represented a range of the environmental conditions normally encountered within each of the Regions (fig. 1). The habitat types were:

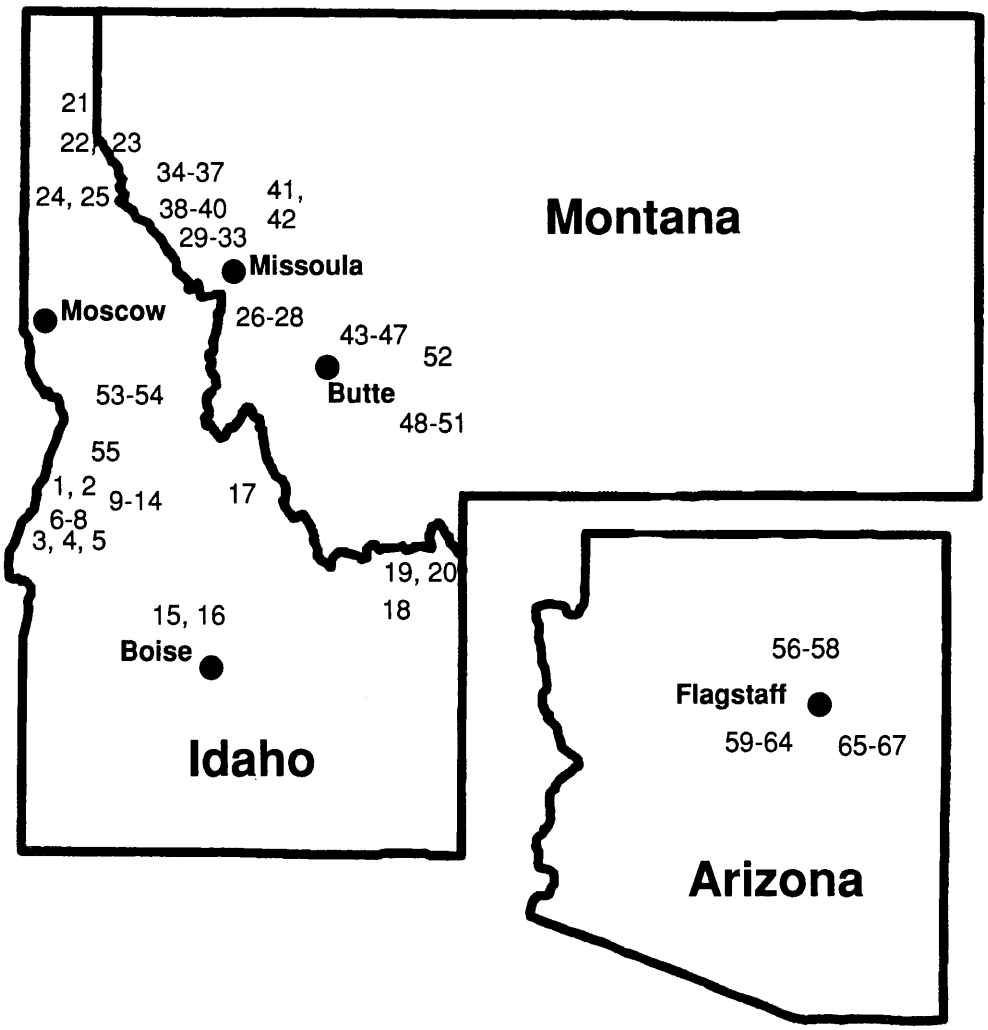



**Figure 1**—Location of stands sampled throughout western Montana, Idaho, and Arizona.

Central Idaho (Steele and others 1981)
- Grand fir/snowberry (*Abies grandis* [Dougl. ex D. Don] Lindl./*Spiraea betulifolia* [Dougl.] Hitchc.), GF/SPBE
- Grand fir/mountain maple (*Abies grandis* [Dougl. ex D. Don] Lindl./*Acer glabrum* Torr.), GF/ACGL
- Subalpine fir/huckleberry (*Abies lasiocarpa* [Hook.] Nutt./*Vaccinium globulare* Rydb.), AF/VAGL
- Douglas-fir/ninebark (*Pseudotsuga menziesii* [Mirb.] Franco./*Physocarpus malvaceus* [Greene] Kuntze), DF/PHMA
- Douglas-fir/pinegrass (*Pseudotsuga menziesii* [Mirb.] Franco/*Calamagrostis rubescens* Buckl.), DF/CARU

Western Montana (Pfister and others 1977)
- Douglas-fir/ninebark (*Pseudotsuga menziesii* [Mirb.] Franco/*Physocarpus malvaceus* [Greene] Kuntze), DF/PHMA
- Grand fir/beargrass (*Abies grandis* [Dougl. ex D. Don] Lindl./*Xerophyllum tenax* [Pursh] Nutt.), GF/XETE
- Subalpine fir/beargrass (*Abies lasiocarpa* (Hook.) Nutt./*Xerophyllum tenax* [Pursh] Nutt.), AF/XETE
- Douglas-fir/pinegrass (*Pseudotsuga menziesii* [Mirb.] Franco/*Calamagrostis rubescens* Buckl.), DF/CARU
- Subalpine fir/twinflower (*Abies lasiocarpa* [Hook.] Nutt./*Linnaea borealis* L.), AF/LIBO
- Subalpine fir/whortleberry (*Abies lasiocarpa* [Hook.] Nutt./*Vaccinium scoparium* Leiberg), AF/VASC

Northern Idaho (Cooper and others 1991)
- Western hemlock/queencup beadlily (*Tsuga heterophylla* [Raf.] Sarg./*Clintonia uniflora* [Schult.] Kunth.), WH/CLUN

Arizona (Larson and Moir 1986)
- Ponderosa pine/Arizona fescue (*Pinus ponderosa* [Dougl. ex Laws.]/*Festuca arizonica* Vaspy), PP/FEAR
- Ponderosa pine/Gambel oak (*Pinus ponderosa* [Dougl. ex Laws.]/*Quercus gambelii* Nutt.), PP/QUGA

### Data Collection

After the habitat types were chosen, we assembled a list of minimally disturbed mature old forest stands located in each of the habitat types. For each of the habitat types, a minimum of three stands were randomly selected having similar elevations, slopes, and aspects (table 1).

The stands were verified in the field to ensure that they met the selection criteria. Within each stand 12 randomly located soil cores were systematically extracted using a 10-cm (4-inch) diameter core sampler to a mineral soil depth of 10 cm (4 inches) (Jurgensen and others 1977). After extraction, each core was separated into its organic and mineral soil components including: litter (horizon $O_i$), humus (horizon $O_a$), soil wood, advanced stage decay of CWD, and mineral soil (up to 10 cm, 4 inches). Each component was labeled and placed in a cloth bag; the depth of each layer was recorded.

## Analysis

The proportion by volume of the organic component for each soil core was computed using the depths recorded in the field. Computation was based on the total volume of the soil core to a depth of 10 cm of mineral soil and the volume of each organic layer following the formula:

$$\text{Percent Organic Materials} = \frac{\text{LV} + \text{HV} + \text{SWV} + \text{CWDV}}{\text{Total volume} * 100}$$

where

LV = Litter volume
HV = Humus volume
SWV = Soil wool volume
CWDV = Advanced CWD volume.

Based on the proportion of organic materials in each soil core the core was assigned to one of four classes (for instance, 0-15 percent, 16-30 percent, 30-45 percent, >45 percent). The organic matter volume class limits were chosen to balance the distribution of cores in each class within each habitat type.

In the laboratory each soil component was sieved through a 2-mm mesh screen to remove root systems and rocks. All active ectomycorrhizal root tips on the conifer roots were counted using 20X binocular microscopes (Harvey and others 1976). After the ectomycorrhizae were counted, the root systems were oven-dried at 60 °C (140 °F) for 24 hours and weighed. The number of ectomycorrhizal root tips and weight of fine woody roots were totaled for each soil core. In addition, the root biomass and the number of ectomycorrhizae in each core were summed to form another variable (root weight + total ectomycorrhizae). For each habitat type the proportion of ectomycorrhizal root tips, fine root biomass, and the sum of the root tips plus the root biomass for each organic matter volume class was computed according to the formula:

$$\text{Percentage } Y \text{ for each habitat type} = \frac{T_{VC}}{T_{HT} * 100}$$

where

$Y$ = Ectomycorrhizae, root biomass, or ectomycorrhizae and root biomass
$T_{VC}$ = Total ectomycorrhizae, root biomass, or ectomycorrhizae and root biomass in each volume class
$T_{HT}$ = Total ectomycorrhizae, root biomass, or ectomycorrhizae and root biomass in each habitat type.

**Table 1**—Description of stands sampled. See table 2 for an explanation of the habitat type acronyms

| National Forest | District | | Habitat type | Cover type | Age | Aspect | Slope | Elevation | Parent material |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Years* | *Degrees* | *Percent* | *Meters* | |
| Payette | New Meadows | 1 | GF/ACGL | GF/DF/PP | 350 | 30 | 58 | 1,433 | Basalt[1] |
| | | 2 | GF/ACGL | GF/DF/PP | 100 | 184 | 30 | 1,646 | Basalt |
| | Weiser | 3 | GF/SPBE | GF/DF/PP | 135 | 67 | 45 | 1,585 | Basalt |
| | | 4 | GF/SPBE | GF/DF/PP | 100 | 350 | 55 | 1,494 | Basalt |
| | | 5 | GF/SPBE | GF/DF/PP | 100 | 96 | 20 | 1,585 | Basalt |
| | Council | 6 | GF/SPBE | GF/DF/PP | 150 | 173 | 50 | 1,798 | Basalt |
| | | 7 | GF/SPBE | GF/DF/PP | 100 | 194 | 40 | 1,798 | Basalt |
| | | 8 | GF/ACGL | GF/DF/PP | 150 | 85 | 45 | 1,433 | Basalt |
| | McCall | 9 | AF/VAGL | AF/ES/LP | 130 | 313 | 5 | 1,951 | Granitic[2] |
| | | 10 | AF/VAGL | AF/ES/LP | 180 | 342 | 14 | 1,890 | Granitic |
| | | 11 | AF/VAGL | AF/ES/LP | 140 | 313 | 5 | 1,890 | Granitic |
| | | 12 | AF/VAGL | AF/ES/LP | 86 | 290 | 15 | 2,012 | Granitic |
| | | 13 | AF/VAGL | AF/ES/LP | 86 | 290 | 8 | 2,085 | Granitic |
| | | 14 | AF/VAGL | AF/ES/LP | 105 | 284 | 24 | 1,951 | Granitic |
| Boise | Lowman | 15 | DF/CARU | DF/PP | 80 | 250 | 35 | 1,798 | Granitic |
| | | 16 | DF/CARU | DF/PP | 80 | 0 | 40 | 1,829 | Granitic |
| Salmon | Ledore | 17 | DF/CARU | DF | 150 | 10 | 40 | 2,134 | Belt[3] |
| Targhee | Dubois | 18 | DF/CARU | DF | 179 | 296 | 40 | 2,134 | Volcanic[4] |
| | Island Park | 19 | DF/CARU | DF | 130 | 226 | 5 | 2,164 | Volcanic |
| | | 20 | DF/CARU | DF | 130 | 208 | 16 | 1,280 | Volcanic |
| Idaho Panhandle | Priest Lake | 21 | WH/CLUN | WH/DF/WL/WP | 100 | 310 | 45 | 1,280 | Ash/Belt[5] |
| | Fernan | 22 | WH/CLUN | WH/DF/WL/WP | 100 | 45 | 30 | 823 | Ash/Belt |
| | | 23 | WH/CLUN | WH/DF/WL/WP | 100 | 30 | 30 | 853 | Ash/Belt |
| | Wallace | 24 | WH/CLUN | WH/DF/WL/WP | 250+ | 90 | 3 | 975 | Ash/Belt |
| | | 25 | WH/CLUN | WH/DF/WL/WP | 250+ | 90 | 12 | 1,280 | Ash/Belt |
| Lolo | Missoula | 26 | DF/PHMA | DF/PP/WL/LP | 113 | 90 | 68 | 1,737 | Belt |
| | | 27 | DF/PHMA | DF/PP/WL/LP | 125 | 116 | 58 | 1,554 | Belt |
| | | 28 | DF/PHMA | DF/PP/WL/LP | 97 | 130 | 55 | 1,707 | Belt |
| | Nine-Mile | 29 | DF/PHMA | DF/PP/WL/LP | 144 | 42 | 15 | 1,311 | Belt |
| | | 30 | DF/PHMA | DF/PP/WL/LP | 129 | 140 | 35 | 1,097 | Belt |
| | | 31 | DF/PHMA | DF/PP/WP/LP | 69 | 100 | 35 | 1,311 | Belt |
| | | 32 | AF/XETE | AF/ES/LP | 85 | 138 | 45 | 1,707 | Belt |
| | | 33 | AF/XETE | AF/ES/LP | 76 | 150 | 45 | 1,737 | Belt |
| | Thompson Falls | 34 | GF/XETE | GF/DF/WL/LP | 77 | 50 | 60 | 1,402 | Belt |
| | | 35 | GF/XETE | GF/DF/WL/LP | 70 | 230 | 28 | 1,097 | Belt |
| | | 36 | GF/XETE | GF/DF/WL/LP | 67 | 60 | 26 | 1,097 | Belt |
| | | 37 | AF/XETE | AF/ES/LP | 127 | 5 | 40 | 1,585 | Metasediments[6] |
| | Superior | 38 | GF/XETE | GF/DF/WL/LP | 60 | 227 | 48 | 1,341 | Metasediments |
| | | 39 | GF/XETE | GF/DF/WL/LP | 75 | 302 | 40 | 1,585 | Metasediments |
| | | 40 | AF/XETE | AF/ES/LP | 76 | 119 | 54 | 1,524 | Metasediments |
| | Seeley Lake | 41 | AF/XETE | AF/ES/LP | 98 | 280 | 20 | 1,768 | Metasediments |
| | | 42 | AF/XETE | AF/ES/LP | 78 | 40 | 24 | 1,433 | Metasediments |
| Deerlodge | Butte | 43 | DF/CARU | DF/LP | 86 | 260 | 20 | 1,920 | Granitic |
| | | 44 | DF/CARU | DF/LP | 92 | 120 | 14 | 2,073 | Granitic |
| | | 45 | DF/CARU | DF/LP | 80 | 192 | 15 | 2,073 | Granitic |
| | | 46 | AF/VASC | AF/LP/ES | 65 | 124 | 21 | 2,073 | Volcanic |
| | | 47 | AF/VASC | AF/LP/ES | 65 | 110 | 33 | 2,073 | Volcanic |
| | Jefferson | 48 | DF/CARU | DF/LP | 79 | 327 | 10 | 1,951 | Granitic |
| | | 49 | AF/LIBO | AF/LP/ES | 67 | 54 | 10 | 2,042 | Volcanic |
| | | 50 | AF/LIBO | AF/LP/ES | 119 | 270 | 35 | 2,012 | Granitic |
| | | 51 | AF/VASC | AF/LP/ES | 127 | 38 | 15 | 2,105 | Granitic |
| Helena | Townsend | 52 | AF/VASC | AF/LP/ES | 68 | 104 | 17 | 2,195 | Granitic |
| Nez Perce | Clearwater | 53 | DF/PHMA | DF/PP/WL | 100 | 90 | 70 | 914 | Metamorphic[7] |
| | | 54 | DF/PHMA | DF/PP/WL | 81 | 96 | 30 | 1,219 | Metamorphic |
| | Salmon River | 55 | DF/PHMA | DF/PP/WL | 125 | 60 | 45 | 1,585 | Basalt |
| Kaibab | North Kaibab | 56 | PP/FEAR | PP | 127 | 0 | 0 | 2,460 | Limestone[8] |
| | | 57 | PP/FEAR | PP | 125 | 0 | 0 | 2,469 | Limestone |
| | | 58 | PP/FEAR | PP | 123 | 0 | 0 | 2,487 | Limestone |

(con.)

Table 1 (Con.)

| National Forest | District | | Habitat type | Cover type | Age | Aspect | Slope | Elevation | Parent material |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Years* | *Degrees* | *Percent* | *Meters* | |
| Coconino | Mormon Lake | 59 | PP/QUGA | PP | 141 | 0 | 0 | 2,134 | Basalt |
| | | 60 | PP/QUGA | PP | 150 | 0 | 0 | 2,134 | Basalt |
| | | 61 | PP/QUGA | PP | 145 | 0 | 0 | 2,134 | Basalt |
| | | 62 | PP/QUGA | PP | 114 | 0 | 0 | 2,134 | Basalt |
| | | 63 | PP/QUGA | PP | 145 | 0 | 0 | 2,134 | Basalt |
| | | 64 | PP/QUGA | PP | 103 | 0 | 0 | 2,134 | Basalt |
| Apache-Sitgreaves | Chevelon | 65 | PP/FEAR | PP | 156 | 0 | 0 | 2,316 | Limestone |
| | | 66 | PP/FEAR | PP | 135 | 0 | 0 | 2,316 | Limestone |
| | Heber | 67 | PP/FEAR | PP | 139 | 0 | 0 | 2,336 | Limestone |

[1]Black volcanic rock rich in iron, calcium, and magnesium; composed primarily of augite and plagioclase feldspar.
[2]Crystallized igneous rock composed mostly of orthoclase and plagioclase feldspar along with quartz and either mica or hornblende.
[3]Mildly metamorphosed sedimentary rocks, including argillites, siltites, quartzites, and dolomites.
[4]Rhyolite: lava or shallow intrusion, fine grained, with composition equivalent to granite.
[5]Volcanic ash from Mount Mazama over belt series rocks.
[6]Weakly weathered layers of metasedimentary rock that produce hard angular rock fragments.
[7]Igneous or sedimentary rocks that have been altered and reconstituted by crystallization of new minerals under great pressure or heat or both.
[8]Sedimentary rock consisting of calcium carbonate.

Harvey and others (1987) developed a model relating ectomycorrhizal activity to organic material. This model indicated the relationship between active ectomycorrhizal root tips and organic matter was normally distributed within a habitat type (fig. 2). The proportion of ectomycorrhizae occurring in a habitat in a given volume class of forest soil increased until the proportion of the organic components in surface soil approached or exceeded 30 percent. At higher concentrations, the proportion of ectomycorrhizae occurring in a habitat for a given class of soil usually decreased. Therefore, the optimum volume class of organic matter for the formation of ectomycorrhizal root tips was identified for each habitat type (fig. 2).

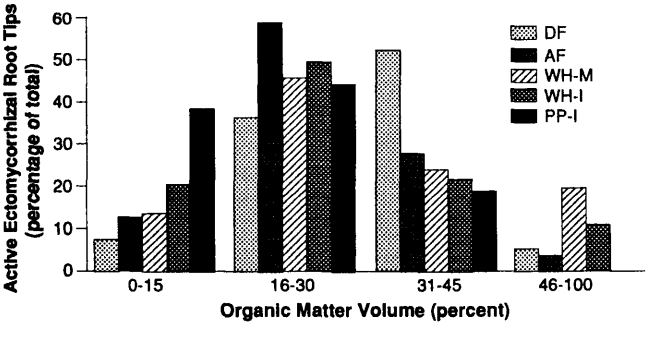



**Figure 2**—The distribution of active ectomycorrhizal root tips (percentage of total) to soil organic matter content in undisturbed stands: DF = Douglas-fir habitat series, WH-M = Western hemlock series in western Montana, WH-I = Western hemlock series in Idaho, AF = Subalpine fir series in Montana, PP-I = Ponderosa pine series in Idaho (Harvey and others 1987).

We also tested the relationship of organic matter volume classes with fine root weights and with the sum of ectomycorrhizal root tips and fine root weight. Those relationships were similar to the relationship between organic matter volume classes and the percentage of ectomycorrhizal root tips. Therefore, only the percentage of ectomycorrhizae was used in our analysis.

After determining the optimum volume class of forest soil for the formation of ectomycorrhizae, the amount of organic matter for this class was estimated. Using the ovendried weights of each organic component, the total weight of organic matter per unit area for each volume class was computed.

Obviously, not all of the organic matter in the forest floor is derived from CWD; some is derived from foliage, fine woody material, or other organic components. Harmon and others (1986) summarized the few studies showing the contribution of CWD to the forest floor and found it to range from 24 to 74 percent. Our past work showed that CWD contributed up to 58 percent of the organic materials to the forest floor; in this study CWD contributed up to 100 percent of the organic materials. Because of this variation, the range of 25 to 50 percent seemed suitable and conservative for the sites we sampled in the Rocky Mountains.

Before fresh CWD becomes an active part of the soil system, it loses about 40 percent of its mass, leaving most of the lignin and a portion of the cellulose fractions, depending on species and piece size. Therefore, we adjusted the ranges of organic matter that CWD contributes to the forest floor to 60 percent of the weight of undecayed materials. These computations resulted in the amount of fresh CWD we recommend leaving after timber harvesting.

## Results and Discussion

Ectomycorrhizae absorb moisture and nutrients, and translocate them to their host plants, making ectomycorrhizae essential for the development of forest ecosystems (Harley and Smith 1983; Harvey and others 1979; Harvey and others 1987; Marks and Kozlowski 1973; Maser 1990). Therefore, we assume their presence and abundance to be a good indicator of a healthy, functioning forest soil. Ectomycorrhizae have a strong positive relationship with soil organic materials (Harvey and others 1981). Soil wood, humus, and the upper layers of mineral soil that are rich in organic matter are the primary substrates for the development of ectomycorrhizae. Using these strong relationships, Harvey and others (1987) developed a model relating ectomycorrhizal activity to organic materials (fig. 2).

Until a good process model is available for modeling the diverse functions of organic matter in forested ecosystems, it seems rational and relatively conservative to use ectomycorrhizal activity as a primary indicator of a healthy forest soil. Using this approach, Harvey and others (1987) made a generic recommendation of leaving 22 to 36 Mg per ha (10 to 15 tons acre) of CWD after timber harvesting for most sites in the Northern Rocky Mountains. While this model still appears appropriate, it will be refined as more information on the function of CWD becomes available.

In this study the relationships between ectomycorrhizae and organic matter volume classes was similar to those found by Harvey and others (1987), except for the PP/QUGA, GF/ACGL, AF/LIBO, and WH/CLUN habitat types (fig. 3, tables 2, 3). The optimum volume of organic matter for the formation of ectomycorrhizal root tips in the GF/ACGL habitat type was less than 30 percent; the optimum volume was less than 20 percent in the PP/QUGA habitat type. Ectomycorrhizal activity never decreased with increasing organic matter volume in the AF/LIBO and WH/CLUN habitat types, even when the volumes exceeded 40 percent.

The amount of organic material that accumulates and is used by ectomycorrhizae in Rocky Mountain forests is highly dependent on climate and fire cycles. Natural fire-return intervals as short as 2 to 5 years occur in ponderosa pine ecosystems; fire-return intervals range to more than 100 years in high elevation subalpine-fir ecosystems (Arno 1980, 1988). Fire frequencies control the accumulation of organic materials and the amount available for the use by ectomycorrhizae. For example, in the drier habitat types (such as PP/QUGA, DF/PHMA, GF/SPBE) the optimum

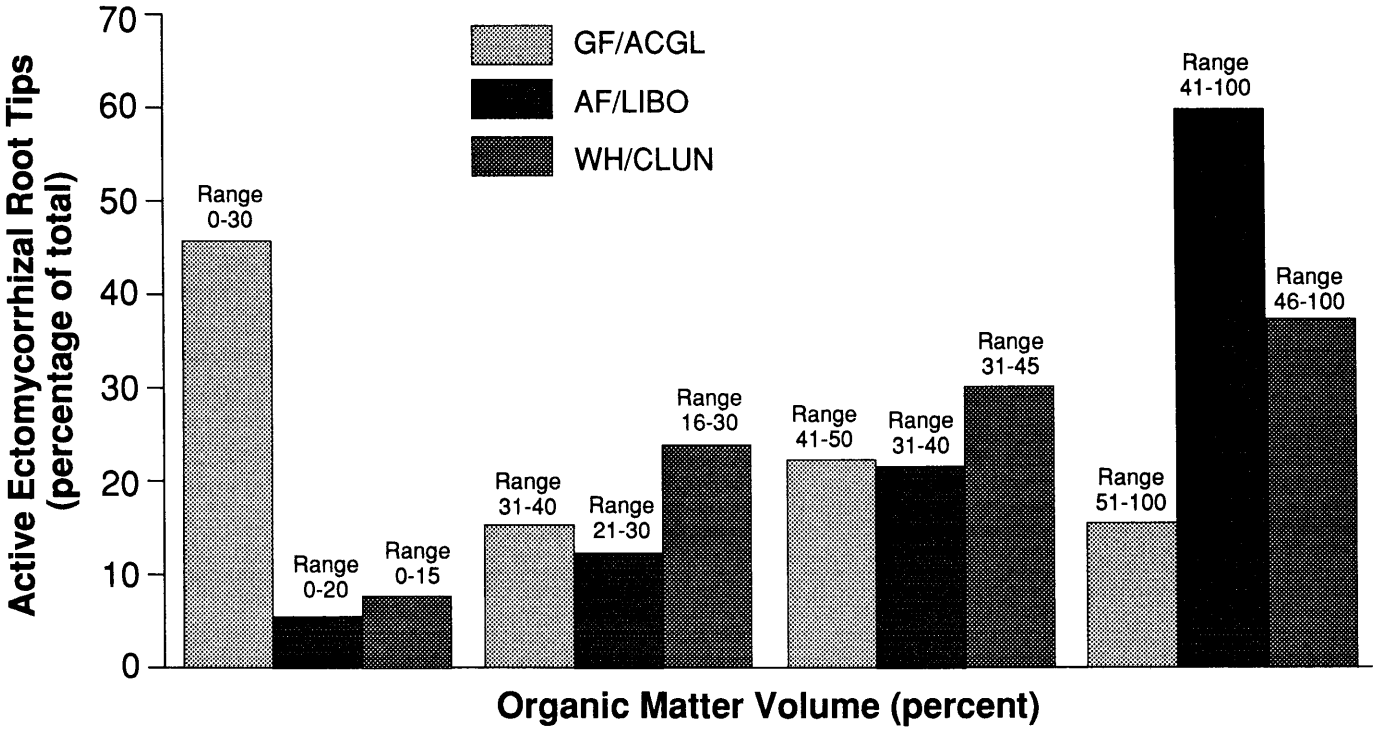



**Figure 3**—The distribution of active ectomycorrhizal root tips (percentage of total) to soil organic matter content in undisturbed stands. To balance the distribution of soil core samples among volume classes, different class limits were used: GF/ACGL = Grand fir/mountain maple (*Abies grandis/Acer glabrum*), AF/LIBO = Subalpine fir/twin flower (*Abies grandis/Linnaea borealis*), WH/CLUN = Western hemlock/queen cup beadlily (*Tsuga heterophylla/Clintonia uniflora*).

**Table 2**—Acronyms for habitat types

| Acronym | Habitat type |
|---|---|
| AF/LIBO | Subalpine fir/twinflower (*Abies lasiocarpa/Linnaea borealis*) |
| AF/VAGL | Subalpine fir/huckleberry (*Abies lasiocarpa/Vaccinium globulare*) |
| AF/VASC | Subalpine fir/whortleberry (*Abies lasiocarpa/Vaccinium scoparium*) |
| AF/XETE | Subalpine fir/beargrass (*Abies lasiocarpa/Xerophyllum tenax*) |
| DF/CARU | Douglas-fir/pinegrass (*Pseudotsuga menziesii/Calamagrostis rubescens*) |
| DF/PHMA | Douglas-fir/ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*) |
| GF/ACGL | Grand fir/mountain maple (*Abies grandis/Acer glabrum*) |
| GF/SPBE | Grand fir/snowberry (*Abies grandis/Spiraea betulifolia*) |
| GF/XETE | Grand fir/beargrass (*Abies grandis/Xerophyllum tenax*) |
| PP/FEAR | Ponderosa pine/Arizona fescue (*Pinus ponderosa/Festuca arizonica*) |
| PP/QUGA | Ponderosa pine/Gambel oak (*Pinus ponderosa/Quercus gambelii*) |
| WH/CLUN | Western hemlock/queencup beadlily (*Tsuga heterophylla/Clintonia uniflora*) |

organic matter volume class for ectomycorrhizae was less than 30 percent, even though higher volumes of organic matter were present in the habitat type. The large accumulations of organic material in the forest floor (more than 45 percent) on some of these sites was probably due to fire exclusion. Because of low precipitation, these large amounts or organic materials were probably too dry for ectomycorrhizal growth much of the year.

The AF/LIBO habitat type occurs at higher elevations. It is a moist habitat type with a short growing season (Pfister and others 1977). Organic matter on the forest floor appears to retain moisture throughout the growing season. It is highly decomposed, making

**Table 3**—Distribution of active ectomycorrhizal root tips (percentage of total) to soil organic matter content and number (n) of samples in each organic matter volume class. Asterisks indicate the volume class with the most ectomycorrhizal activity. See table 2 for an explanation of the habitat type acronyms

| Forest | Habitat type | Organic matter volume class[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1(0-10) | | 2(11-20) | | 3(21-30) | | 4(31-100) | |
| | | *Percent* | *n* | *Percent* | *n* | *Percent* | *n* | *Percent* | *n* |
| Boise, Salmon, Targhee | DF/CARU | 18.3 | 24 | 36.0 | 16 | *42.8 | 25 | 3.0 | 8 |
| Payette | GF/SPBE | 10.5 | 12 | 26.6 | 9 | *40.5 | 24 | 22.3 | 15 |
| Deerlodge | AF/VASC | 14.9 | 8 | 32.8 | 18 | *45.2 | 12 | 7.2 | 10 |
| | | **1(0-15)** | | **2(16-30)** | | **3(31-45)** | | **4(46-100)** | |
| Nez Perce | DF/PHMA | 7.0 | 8 | *50.9 | 10 | 16.1 | 12 | 25.9 | 6 |
| Lolo | DF/PHMA | 11.7 | 9 | *51.7 | 40 | 18.3 | 17 | 18.3 | 6 |
| Idaho Panhandle | WH/CLUN | 7.4 | 4 | 23.9 | 29 | 30.6 | 21 | *38.1 | 6 |
| Lolo | AF/XETE | 1.5 | 10 | 34.5 | 30 | *47.9 | 20 | 16.1 | 12 |
| Payette | AF/VAGL | 8.3 | 7 | 37.7 | 28 | *38.4 | 27 | 15.7 | 11 |
| | | **1(0-20)** | | **2(21-30)** | | **3(31-40)** | | **4(41-100)** | |
| Deerlodge | DF/CARU | 15.5 | 15 | 30.0 | 18 | *30.9 | 8 | 23.6 | 7 |
| Deerlodge | AF/LIBO | 5.1 | 3 | 12.1 | 9 | 22.0 | 6 | *60.8 | 6 |
| Coconino | PP/QUGA | *40.0 | 26 | 24.4 | 20 | 14.9 | 12 | 20.7 | 14 |
| Kaibab and Apache-Sitgreaves | PP/FEAR | 25.0 | 19 | *41.8 | 21 | 25.9 | 28 | 7.4 | 13 |
| | | **1(0-25)** | | **2(26-35)** | | **3(36-45)** | | **4(46-100)** | |
| Lolo | GF/XETE | 27.8 | 26 | *34.2 | 13 | 22.6 | 9 | 15.3 | 12 |
| | | **1(0-30)** | | **2(31-40)** | | **3(41-50)** | | **4(51-100)** | |
| Payette | GF/ACGL | *45.9 | 18 | 15.3 | 8 | 22.7 | 5 | 15.9 | 5 |

[1]Organic matter volume classes are based on the proportion of a soil core in organic materials to a mineral depth of 10 cm (3.94 inches) plus the surface organic layers. Different class sizes were used to balance the distribution among the classes.

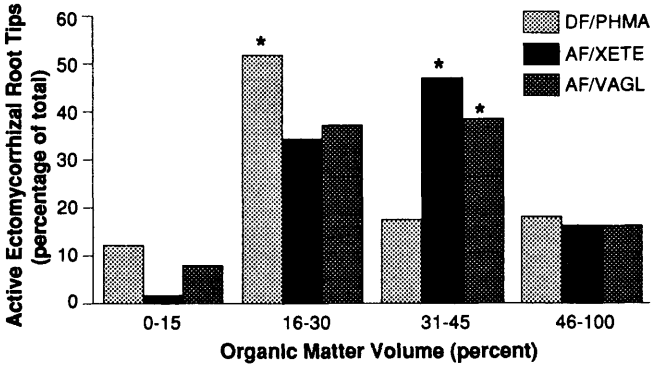



**Figure 4**—The distribution of active ectomycorrhizal root tips (percentage of total) to soil organic matter content in undisturbed stands. Bars marked with asterisks (*) indicate the optimum organic matter class for ectomycorrhizal activity: DF/PHMA = Douglas-fir/ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*), AF/XETE = Subalpine fir/beargrass (*Abies lasiocarpa/Xerophyllum tenax*), AF/VAGL = Subalpine fir/huckleberry (*Abies lasiocarpa/Vaccinium globulare*).

it an important part of the soil system even when the majority of the soil surface and upper mineral layers are composed of organic materials. Similarly, WH/CLUN sites are moist (Cooper and others 1991). The humus and soil wood stay wet, making them ideal ectomycorrhizae habitat even when the amount of organic materials in the surface soil exceeds 45 percent.

The majority of habitat types we sampled had an optimum level of organic matter for the formation of ectomycorrhizae when the percentage of organic matter was represented by volume classes 2 and 3 (similar to the results of Harvey and others 1987) (table 3). A small proportion of ectomycorrhizal activity occurred in the highest volume class (class 4), while ectomycorrhizal activity remained minimal in the first volume class. For example, in the DF/PHMA habitat type the optimum volume of organic matter for ectomycorrhizae formation was volume class 2 (16 to 30 percent); in the AF/XETE and AF/VAGL, it was volume class 3 (31 to 45 percent) (fig. 4, table 3).

The amount of organic matter on the forest floor represented by the optimum volume class (table 4) ranged from 15.5 Mg per ha (6.9 tons per acre) to 89 Mg per ha (39.7 tons per acre) depending on the habitat type. The DF/PHMA habitat type had 24 Mg per ha (10.7 tons per acre), the AF/XETE habitat type had 61.2 Mg per ha (27.3 tons per acre) and the AF/VAGL habitat type had 50.4 Mg per ha (22.5 tons per acre) of organic materials on sites represented by the optimum volume classes (fig. 5, table 4).

After adjusting these values for the proportion contributed by CWD (25 to 50 percent), the range of optimum organic matter derived from CWD on a DF/PHMA habitat type would range from 6.0 to 12.0 Mg per ha (2.7 to 5.4 tons per acre), on the AF/XETE habitat type it would range from 15.3 to 30.6 Mg per ha (6.8 to 13.6 tons per acre), and on the AF/VAGL habitat type it would range from 12.6 to 25.2 Mg per ha (5.6 to 11.2 tons per acre) (fig. 6).

Because CWD loses 40 percent of its weight before it becomes an active part of the soil system, 10.0 to 20.0 Mg per ha (4.5 to 8.9 tons per acre) of fresh CWD would need to be left after timber harvesting on the DF/PHMA habitat type for the optimum amount of organic matter. Similar calculations established the recommended amounts of CWD for the other habitat types (fig. 7). These amounts should ensure sufficient organic materials to replace the organic matter of the forest floor and upper mineral soil.

# Application

We believe the CWD recommendations presented here are conservative for maintaining forest productivity; they are the best currently available, based on our limited knowledge of the function of CWD in forest ecosystems. As more information becomes available on the role of CWD in Rocky Mountain forests, particularity in the area of nitrogen cycling, these recommendations could change. Douglas-fir and western larch (*Larix occidentalis* Nutt.) stems are particularity good sources of CWD and soil wood because of their longevity (Harvey and others 1987; Sollins and others 1987), but CWD from all species contributes organic matter to the forest floor. The true firs do not persist long as CWD and soil wood because they decay relatively quickly. The pines are intermediate in their decay rates and residence times (Harmon and others 1986).

Our recommendations for CWD do not include stumps. We recognize that considerable amounts of CWD can be derived from stumps, but these materials always remain on site, even after stand-replacing wildfires or extensive timber harvesting and site preparation. The CWD recommendations developed by this study are for wood larger than 7.5 cm (3.0 inches) in diameter. These materials have the greatest probability of contributing to the forest floor and soil wood before they totally decay or are consumed by fires. On the wetter habitat types, fire is not as prevalent but decay can be rapid; large pieces of CWD have more heartwood than small pieces; therefore, they last longer. Smaller materials, such as needles and small branches, are usually considered hazard fuels by fire managers and are easily consumed by both

**Table 4**—Mean amounts of organic matter and standard errors for organic matter volume classes by habitat types. Asterisks indicate the volume class with the most ectomycorrhizal activity. See table 2 for an explanation of the habitat type acronyms

| Forest | Habitat type | Organic matter volume class[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1(0-10) | | 2(11-20) | | 3(21-30) | | 4(31-100) | |
| | | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| | | Mg/ha | | | | | | | |
| Boise, Salmon, Targhee | DF/CARU | 6.1 | 1.3 | 21.6 | 4.5 | *32.7 | 5.6 | 55.4 | 14.3 |
| Payette | GF/SPBE | 7.6 | 2.2 | 20.8 | 5.8 | *37.4 | 5.8 | 43.3 | 7.8 |
| Deerlodge | AF/VASC | 10.3 | 4.5 | 32.3 | 6.9 | *39.5 | 9.4 | 52.7 | 14.1 |
| | | 1(0-15) | | 2(16-30) | | 3(31-45) | | 4(46-100) | |
| | | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Nez Perce | DF/PHMA | 11.9 | 4.7 | *35.4 | 8.7 | 60.5 | 12.8 | 91.5 | 30.0 |
| Lolo | DF/PHMA | 6.1 | 3.8 | *24.0 | 3.1 | 46.2 | 7.6 | 73.1 | 22.2 |
| Idaho Panhandle | WH/CLUN | 24.0 | 14.1 | 32.7 | 5.8 | 54.2 | 10.5 | *88.8 | 30.3 |
| Lolo | AF/XETE | 0.7 | 0.4 | 34.5 | 4.5 | *61.2 | 10.5 | 86.8 | 20.4 |
| Payette | AF/VAGL | 3.1 | 1.8 | 26.9 | 4.0 | *50.4 | 7.2 | 76.9 | 17.9 |
| | | 1(0-20) | | 2(21-30) | | 3(31-40) | | 4(41-100) | |
| | | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Deerlodge | DF/CARU | 12.1 | 3.4 | 30.7 | 7.8 | *65.9 | 20.6 | 66.6 | 14.8 |
| Deerlodge | AF/LIBO | 33.6 | 15.0 | 39.0 | 14.1 | 56.8 | 25.6 | *66.0 | 38.3 |
| Coconino | PP/QUGA | *26.9 | 4.7 | 46.4 | 5.2 | 49.8 | 6.1 | 74.6 | 8.5 |
| Kaibab and Apache-Sitgreaves | PP/FEAR | 21.1 | 3.1 | *35.2 | 2.9 | 43.5 | 4.3 | 44.4 | 5.2 |
| | | 1(0-25) | | 2(26-35) | | 3(36-45) | | 4(46-100) | |
| | | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Lolo | GF/XETE | 27.3 | 4.3 | *37.7 | 7.2 | 54.7 | 11.9 | 62.3 | 15.2 |
| | | 1(0-30) | | 2(31-40) | | 3(41-50) | | 4(51-100) | |
| | | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Payette | GF/VAGL | *15.5 | 4.5 | 31.8 | 10.1 | 46.6 | 7.2 | 49.7 | 18.6 |

[1]Organic matter volume classes are based on the proportion of a soil core in organic materials to a mineral depth of 10 cm (3.94 inches) plus the surface organic layers. Different class sizes were used to balance the distribution among the classes.

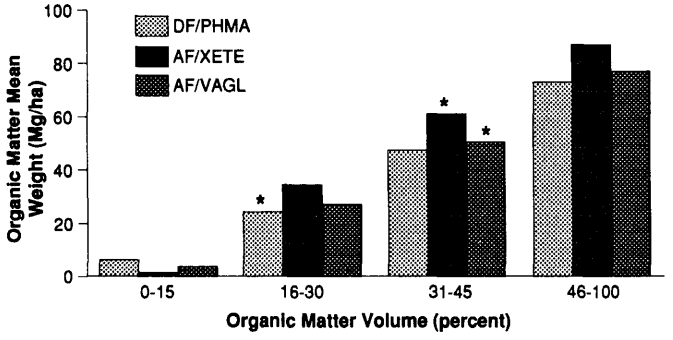



**Figure 5**—The mean weight of organic matter found on the forest floor for each of the organic matter volume classes. Bars marked with asterisks (*) indicate the optimum organic matter class for ectomycorrhizal activity: DF/PHMA = Douglas-fir/ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*), AF/XETE = Subalpine fir/beargrass (*Abies lasiocarpa/Xerophyllum tenax*), AF/VAGL = Subalpine fir/huckleberry (*Abies lasiocarpa/Vaccinium globulare*).

wild and prescribed fires; they decay easily in most forest types. Such fine materials are not included in these recommendations.

Historically, Rocky Mountain wildfires left large amounts of CWD. For example, if fires did not consume the standing boles on the poorest ponderosa pine site, over 100 Mg per ha (44.6 tons per acre) of CWD could remain. Similarly, on a good site in northern Idaho, over 600 Mg per ha (267.6 tons per acre) of CWD could be left after a wildfire. These calculations are based on the yield of a ponderosa pine stand with a site index 40 at age 200 years (4,200 $ft^3$) (Meyer 1938) and the yield of a western white pine stand with a site index 80 at age 160 years (21,000 $ft^3$) (Haig 1932) and assuming a conversion of 25 $lb/ft^3$ for ponderosa pine and 28 $lb/ft^3$ for western white pine.

However, we are not recommending that such amounts be left after timber harvesting. Other resource issues, such as wildfire potential, reforestation, and future management options should be considered. Considering some of these other resource values, Reinhardt and others (1991) recommended

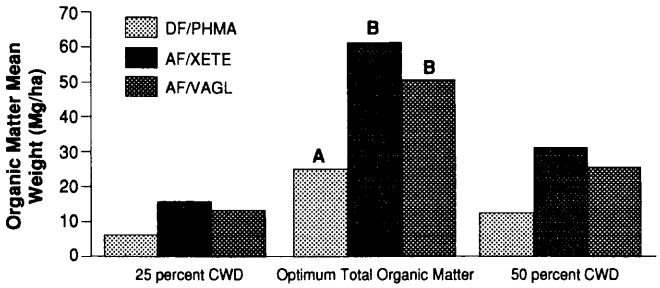



**Figure 6**—The weight of the active organic matter found on the forest floor for the optimum organic matter classes for ectomycorrhizal activity (A = 16-30 percent, B = 31-45 percent) and the weight that would be derived from coarse woody debris if coarse woody debris made up 25 percent or 50 percent of the total: DF/PHMA = Douglas-fir/ninebark (*Pseudotsuga menziesii*/*Physocarpus malvaceus*), AF/XETE = Subalpine fir/beargrass (*Abies lasiocarpa*/*Xerophyllum tenax*), AF/VAGL = Subalpine fir/huckleberry (*Abies lasiocarpa*/*Vaccinium globulare*).

that no more than 89.6 Mg per ha (40 tons per acre) of CWD be left after harvesting mixed stands in the WH/CLUN habitat type.

The recommended amount of CWD should be distributed across harvest units. Localized concentrations of CWD, such as at a landing after whole tree harvesting or at machine-made piles, should be minimized. Dozer piling logging slash to reduce fire hazard and prepare sites for tree regeneration could distribute CWD, but fine fuels are often difficult to separate, from large fuels and operations are limited by slope angle and soil conditions. Grapple piling of logging slash appears to more easily separate fine fuels from CWD; often these machines provide more flexibility on steeper slopes than dozers and minimize soil compaction (USDA Forest Service).

Roller chopping, chipping, or smashing of logging slash should be done with care. These procedures have the potential to create deep or compacted layers of organic matter that can insulate the mineral soil surface. These deep layers could keep soil temperatures cool, slowing organic matter decomposition and interfering with root growth, especially on the subalpine fir habitat types (Benson 1982). Also, chopping or chipping of slash likely destroys many of the attributes of CWD that are important for nitrogen fixation, animal habitat, and site protection.

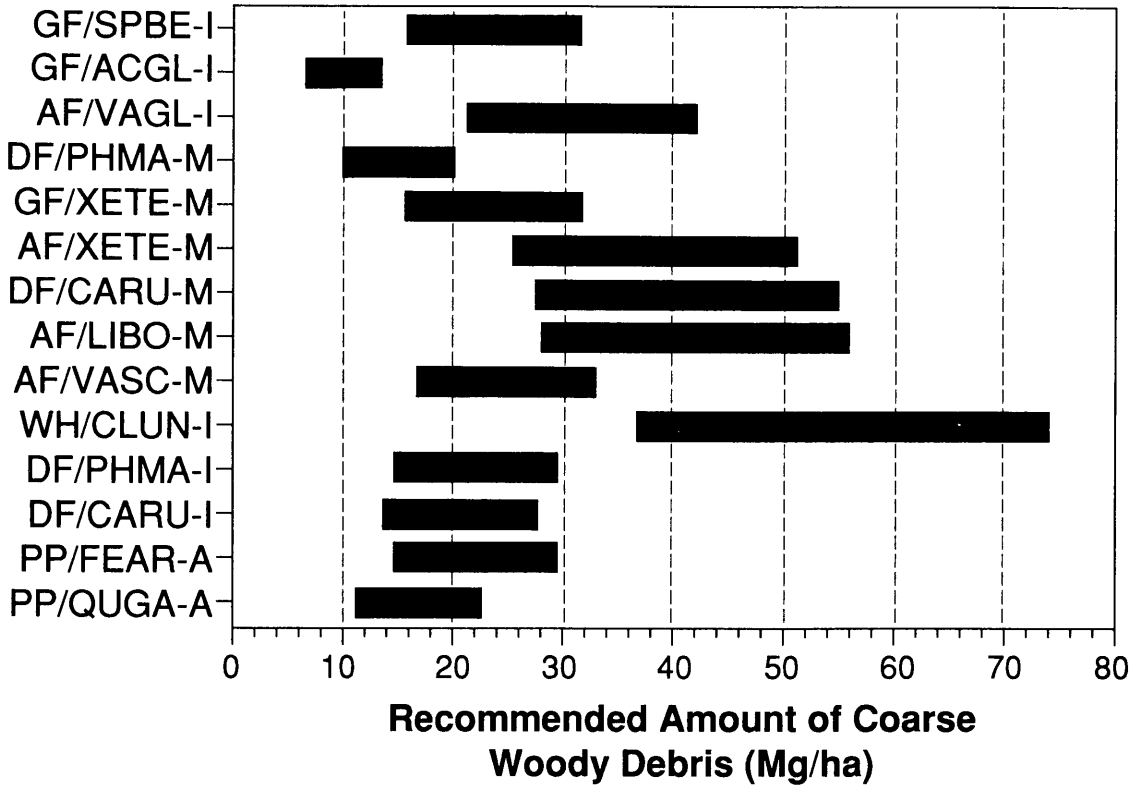
Prescribed fire can be applied so it primarily removes the needles and small branches (the hazard fuels) and maintains much of the organic matter on and in the forest floor. The fine materials can also be an important source of nutrients as they decay; if properly handled, nutrient losses can be minimal during prescribed fires. For example, if the moisture conditions are high (about 100 percent) in the lower forest floor, and the forest floor is not consumed when logging slash is broadcast burned, nutrients released from the fine fuels can be deposited or condensed in these lower layers (Harvey and others 1989).

Prescribed fire is an excellent method for managing CWD. Charring does not interfere substantially with the decomposition or function of CWD. From our observations charred CWD checks and cracks, especially after the first winter, allowing decay fungi to colonize most pieces. The greatest limitation on the use of fire arises when desired burning conditions do not exist or when they exist only for short periods. Also, smoke emission standards may limit the use of prescribed fire.

These recommendations for CWD are based on maintaining forest productivity. On some forest sites productivity might be enhanced by leaving even more CWD. For example, the productivity of the GF/ACGL habitat type, which had little organic matter, may benefit from more CWD than the recommended 6.3 Mg per ha (2.8 tons per acre). Additional CWD could increase the amount of nitrogen fixation occurring on the site and help protect the soil from erosion. Also, more material than we recommended might enhance or maintain wildlife habitat, particularly in riparian zones (Harmon and others 1986).

Coarse woody debris will have little effect if the forest floor is destroyed or the shallow mineral soil is displaced or compacted by poor log yarding or poor site preparation. Depending on CWD decomposition rates, new residue may take hundreds of years to become fully incorporated into the forest floor and play an active role in the soil system. These recommendations are not designed to immediately replace the present forest floor and mineral soil organic matter, but to ensure their replacement over the next 100 years or more. Coarse woody debris is left after harvesting for the development and function of the next forest as much as for the present forest.

Management of CWD should be integrated into silvicultural systems designed for sustaining forest ecosystems.



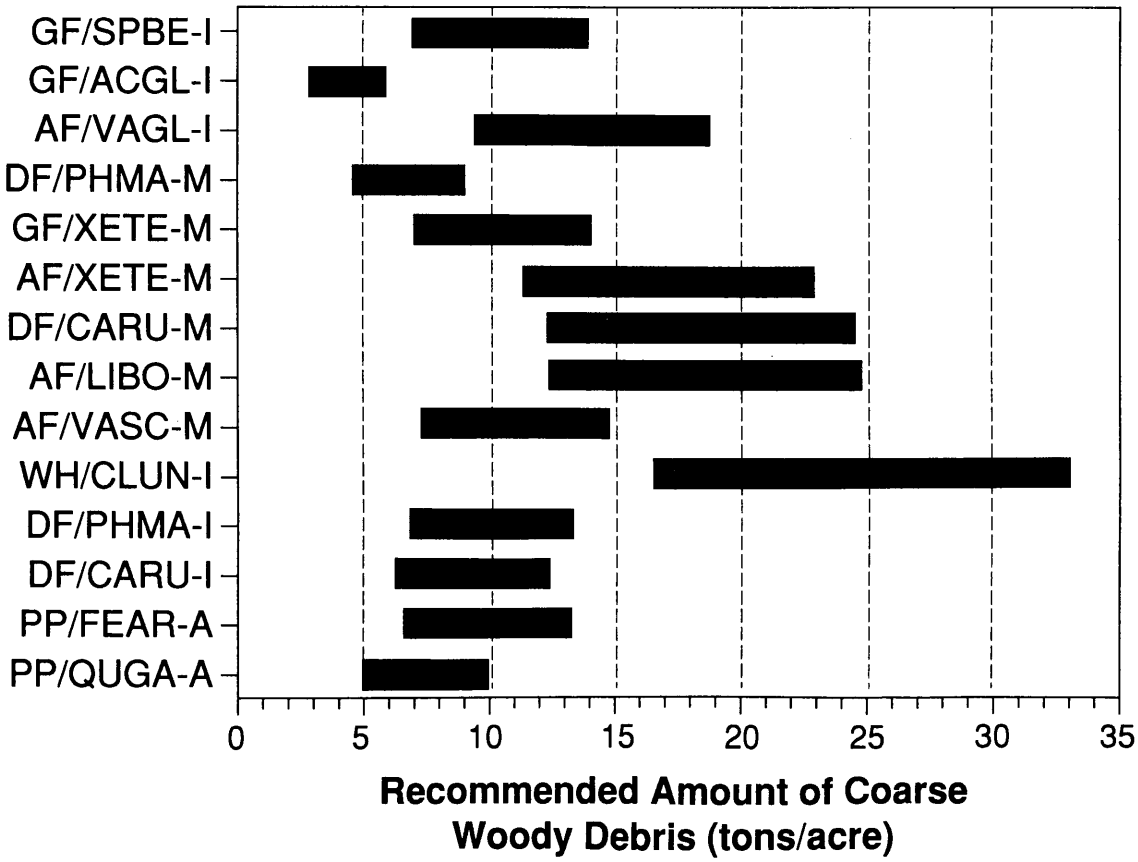




**Figure 7**—Recommended amount of coarse woody debris to leave after timber harvesting to maintain forest productivity. See table 2 for an explanation of the habitat type acronyms. "I" stands for Idaho; "M" stands of Montana; and "A" stands for Arizona.

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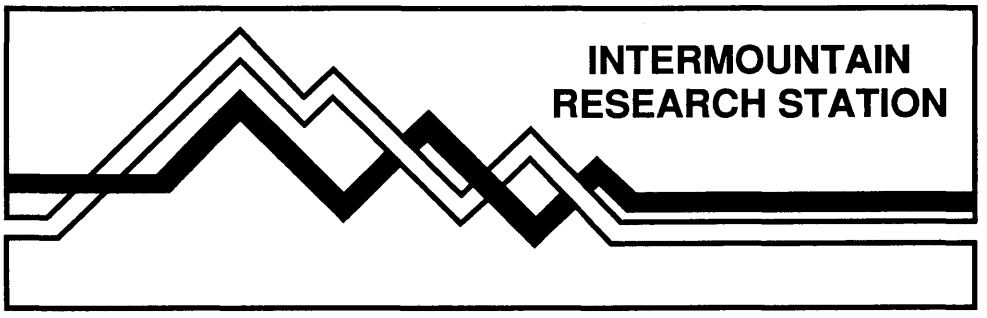


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Graham, Russell T.; Harvey, Alan E.; Jurgensen, Martin F.; Jain, Theresa B.; Tonn, Jonalea R.; Page-Dumroese, Deborah S. 1994. Managing coarse woody debris in forests of the Rocky Mountains. Res. Pap. INT-RP-477. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 12 p.

Recommendations for managing coarse woody debris after timber harvest were developed for 14 habitat types, ranging from ponderosa pine (*Pinus ponderosa*) habitat types of Arizona to subalpine fir (*Abies lasiocarpa*) habitat types of western Montana. Ectomycorrhizae were used as a bioindicator of healthy, productive forest soils. Undisturbed stands were studied to determine the optimum amounts of organic material for ectomycorrhizal activity. The management recommendations are intentionally conservative to ensure that enough organic matter is left after timber harvest to maintain long-term forest productivity.

Keywords: slash, ectomycorrhizae, soil organic matter, silviculture, utilization, forest ecology, habitat type, Idaho, Montana, Arizona




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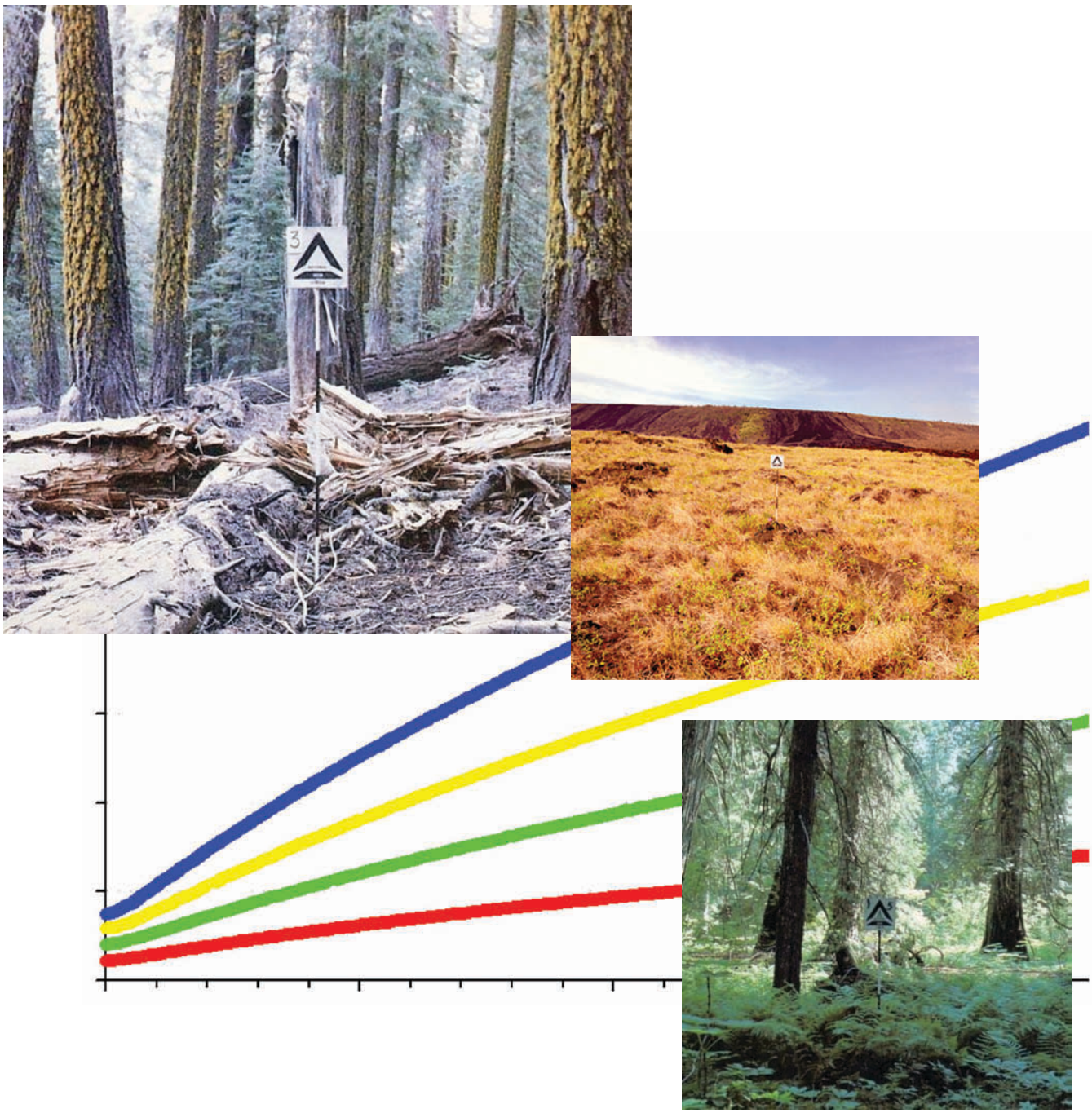
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# Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model

**Joe H. Scott**
**Robert E. Burgan**



## Abstract

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This report describes a new set of standard fire behavior fuel models for use with Rothermel's surface fire spread model and the relationship of the new set to the original set of 13 fire behavior fuel models. To assist with transition to using the new fuel models, a fuel model selection guide, fuel model crosswalk, and set of fuel model photos are provided.

Keywords: fire behavior prediction, fire modeling, surface fuel, dynamic fuel model

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# Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model

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## Contents

Page

Introduction ..... 1
- Need ..... 2
- Scope ..... 3
- Development ..... 3

Characteristics ..... 4
- Naming Convention ..... 4
- Dynamic Fuel Models ..... 6
- Moisture Scenarios ..... 8

Fuel Model Selection ..... 8
- Fuel Model Selection Guide ..... 8
- Fuel Model Crosswalks ..... 12

Fuel Models ..... 17
- Fuel Model Parameters ..... 17
- Fuel Type Page ..... 17
- Fuel Model Page ..... 19
- Nonburnable Fuel Type Models (NB) ..... 19
- Grass Fuel Type Models (GR) ..... 25
- Grass-Shrub Fuel Type Models (GS) ..... 35
- Shrub Fuel Type Models (SH) ..... 40
- Timber-Understory Fuel Type Models (TU) ..... 50
- Timber Litter Fuel Type Models (TL) ..... 56
- Slash-Blowdown Fuel Type Models (SB) ..... 66

References ..... 71

# Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model

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## Introduction

Predicting the potential behavior and effects of wildland fire is an essential task in fire management. Mathematical surface fire behavior and fire effects models and prediction systems are driven in part by fuelbed inputs such as load, bulk density, fuel particle size, heat content, and moisture of extinction. To facilitate use in models and systems, fuelbed inputs have been formulated into fuel models. A fuel model is a set of fuelbed inputs needed by a particular fire behavior or fire effects model. Different kinds of fuel models are used in fire science; this document addresses only fire behavior fuel models for use in the Rothermel (1972) surface fire spread model.

Fire behavior fuel models are used as input to the Rothermel (1972) fire spread model, which is used in a variety of fire behavior modeling systems. The fire behavior fuel model input set includes:

- Fuel load by category (live and dead) and particle size class (0 to 0.25 inch, 0.25 to 1.0 inch, and 1.0 to 3.0 inches diameter)
- Surface-area-to-volume (SAV) ratio by component and size class
- Heat content by category
- Fuelbed depth
- Dead fuel moisture of extinction.

The National Fire Danger Rating System (NFDRS; Deeming and others 1977) uses Rothermel's (1972) spread model as its core. However, there are differences in the calculations that require the use of different fuel models than those for fire behavior prediction. Therefore, there is a separate set of fuel models for use within NFDRS. This paper does not address NFDRS fuel models; they are not affected by this work. The fuel models described here should not be used in the NFDRS.

Rothermel (1972) defined a fire behavior fuel model as a "complete set of [fuel] inputs for the mathematical fire spread model," and listed parameters for 11 fuel models. To assist in understanding the sensitivity of certain inputs, Rothermel held constant the fuel particle properties (total and effective mineral content, heat content, and particle density). Extinction moisture content was not listed for each fuel model separately, but instead held at 30 percent for all models. Thus, variation in predicted spread rate among models could be attributed to fuel load by size class, fuelbed depth, and fuel particle size. Parameters for 10-hr and 100-hr SAV were listed for each fuel model, but did not vary among models – 109 1/ft and 30 1/ft, respectively.

Albini (1976) refined those 11 fuel models and added two others, Dormant Brush (6) and Southern Rough (7). His tabulated set became what is now called the original 13 fire behavior fuel models. Whereas extinction moisture content was held constant for Rothermel's 11 fuel models, Albini's fuel models specified this value for each fuel

model. Albini noted that "other variables needed to complete the [fuel] descriptions are held constant for the entire set."

Anderson (1982) described the 13 fuel models listed by Albini and provided aids to selecting a fuel model. Fuel model parameters did not change from Albini's set. Anderson listed as model parameters only fuel load by size class, fuelbed depth, and dead fuel extinction moisture.

The BEHAVE fire behavior prediction and fuel modeling system (Andrews 1986; Burgan and Rothermel 1984) included fuel particle heat content as a fuel model parameter that could vary from model to model, whereas previous work had left that parameter constant. FARSITE (Finney 1998) and BehavePlus (Andrews and others 2003) allow the user to specify separate live and dead heat content values. The ability to specify heat content is primarily for greater precision when building a custom fuel model; the original 13 fuel models still used a single value of 8000 BTU/lb for live and dead heat content for all fuel models.

Although a fuel model technically includes all fuel inputs to the Rothermel surface fire spread model, several fuel inputs have never been subject to control by a user when creating a custom fuel model: total and effective mineral contents, and fuel particle density. The 10-hr and 100-hr SAVs were listed as model parameters for the original 13 fuel models but are generally not subject to control of the user when making custom fuel models in fire modeling systems. For the above reasons, we did not consider using values for fuel particle properties or 10-hr and 100-hr SAVs other than the constant values originally published by Rothermel (1972). We list as parameters only those fuel model inputs that vary among models:

- Fuel load by size class and category
- Live woody, live herbaceous, and dead 1-hr SAV
- Fuelbed depth
- Dead fuel extinction moisture content
- Heat content of live and dead fuels

For all fuel models in this new set:

- 10-hr dead fuel SAV is 109 1/ft, and 100-hr SAV is 30 1/ft.
- Total mineral content is 5.55 percent; effective (silica-free) mineral content is 1.00 percent.
- Ovendry fuel particle density is 32 lb/ft$^3$.

## Need

The original 13 fire behavior fuel models are "for the severe period of the fire season when wildfires pose greater control problems..." (Anderson 1982). Those fuel models have worked well for predicting spread rate and intensity of active fires at peak of fire season in part because the associated dry conditions lead to a more uniform fuel complex, an important assumption of the underlying fire spread model (Rothermel 1972). However, they have deficiencies for other purposes, including prescribed fire, wildland fire use, simulating the effects of fuel treatments on potential fire behavior, and simulating transition to crown fire using crown fire initiation models. Widespread use of the Rothermel (1972) fire spread model and desire for more options in selecting a fuel model indicate the need for a new set of models to:

- Improve the accuracy of fire behavior predictions outside of the severe period of the fire season, such as prescribed fire and fire use applications. For example, the original grass models 1 (short grass) and 3 (tall grass) are fully cured to represent the most severe part of the fire season. Applying those fuel models to situations

in which the grass fuelbed is not fully cured (that is, outside the severe part of the fire season) leads to overprediction.

- Increase the number of fuel models applicable in high-humidity areas. With the Rothermel spread model, the only way to accommodate fuel complexes that burn well at high humidity is through the moisture of extinction parameter. Only a few of the original 13 fuel models are appropriate for fuelbeds that burn well at relatively high dead fuel moistures.
- Increase the number of fuel models for forest litter and litter with grass or shrub understory. Predicted surface fire behavior drives crown fire models (Alexander 1988; Van Wagner 1977), so increased precision in surface fire intensity prediction will lead to increased precision in crown fire behavior prediction and hazard assessment.
- Increase the ability to simulate changes in fire behavior as a result of fuel treatment by offering more fuel model choices, especially in timber-dominated fuelbeds. This fuel model set does not attempt to directly simulate the effects of the wide variety of available fuel treatment options.

## Scope

The development of a new set of standard fire behavior fuel models does not address deficiencies in the Rothermel surface fire spread model itself. Like the original set of 13, the new fire behavior fuel model set is applicable to fire behavior modeling systems that use Rothermel's surface fire spread model. Any description of the presence or absence of overstory trees is due to their potential effect on surface fuels (for example, needle litter in a grass fuel model).

Also like the original fuel models, the new set is for simulating surface fire behavior at the flaming front only, not residual combustion that takes place after the flaming front has passed. Other methods of describing fuel and other types of fuel models are used for prediction of postfrontal combustion, fuel consumption, smoke production, and crown fire behavior. The fuel model parameters presented in this set should not be used as fuelbed characteristics for fuel consumption models.

Finally, the same fuelbed assumptions of homogeneity and continuity apply to these as well as the original 13 fuel models (Rothermel 1972). Methods of addressing heterogeneous or discontinuous fuels are available in fire modeling systems.

## Development

We compiled fuel complex information from several volumes of the Natural Fuels Photo Series (Ottmar and Vihnanek 1998, 1999, 2000, 2002; Ottmar and others 1998, 2000, 2002, 2003; Wright and others 2002) and other sources. The range of fuel complex characteristics suggested the range of fuel conditions for which fuel models were needed. We subjectively assigned a fire-carrying fuel type and dead fuel extinction moisture content to each fuel complex, then grouped the complexes by fine fuel load, fuel type, and extinction moisture. We created one fuel model for each of the approximately 60 groups. Surface-area-to-volume ratio for 1-hr timelag, live herbaceous and live woody classes were assigned subjectively for each draft fuel model. Fuelbed depth was assigned after subjective interpretation of fuel complex data and visual inspection of photographs. Heat content of live and dead fuels is 8000 BTU/lb for all fuel models except GR6 (High Load, Humid Climate Grass), which is 9000 BTU/lb for both live and dead fuels.

Next, we made fire behavior simulations over a range of midflame wind speeds and several fuel moisture scenarios. Although the groups of fuel complexes appeared to be distinct from one another, the fuel models we created from them often led to similar flame length and rate of spread, so several models were eliminated. Also, after comparing fire

behavior outputs from the draft fuel model set with outputs from the original 13 fuel models, we added stylized fuel models to simulate specific fire behavior characteristics not simulated by any of the draft models. Finally, we adjusted the parameters of many draft fuel models to better coordinate fire behavior outputs of related fuel models.

The draft fuel model set was sent to more than three dozen fire science researchers and managers for review; their comments were incorporated into the final fuel model set and its documentation, which was reviewed again by a smaller cadre.

## Characteristics

This new set of standard fire behavior fuel models is designed to stand alone; none of the original 13 fire behavior fuel models is repeated in the new set; the fuel model selection guide points to the new fuel models only. However, the original 13 fire behavior fuel models will still be available, and they are still called fire behavior fuel models 1-13. There is no immediate need to reanalyze existing fuel model maps or lookup tables that are sufficient for their purpose. However, we anticipate that new fuel model mapping projects will use this new set rather than the original 13.

Documentation and naming of the new fuel models refer to fuel or fuel types, not vegetation or vegetation types. For example, what was formerly termed a "Chaparral" fuel model might now be called a "Heavy Load, Tall Brush" model because one fuel model can be applied in many vegetation types. Likewise, the fuel model selection guide does not refer to specific vegetation types except as necessary to illustrate an example.

In this new set, all fuel models with an herbaceous component are dynamic. In a dynamic fuel model, live herbaceous load is transferred to dead as a function of the live herbaceous moisture content. Although the new fuel model parameters can be input to a nondynamic fire behavior processor, that approach does not produce the intended result. Using the dynamic fuel models in a nondynamic fire behavior model would leave the live herbaceous load in the live category, regardless of moisture content. The grass models will therefore predict no (or very little) spread and intensity under any wind or moisture condition. The change to dynamic fuel models is really a change in both the fire behavior processors and, concurrently, how fuel models for grass- or herbaceous-dominated fuelbeds are conceived. In this case, our desire for grass and herbaceous fuel models that could be used at various levels of curing precipitated the change in fire behavior processors.

Fire behavior modeling systems must be modified in order to use the new dynamic fuel models correctly. Check the documentation of each fire behavior processor to be sure it implements the dynamic fuel models as intended.

### Naming Convention

Fuel models in the new set are grouped by fire-carrying fuel type. The number of fuel models within each fuel type varies. Each fuel type has been assigned a mnemonic two-letter code. Nonburnable fuel models, even though not really a "fuel," were included in the set to facilitate consistent mapping of these areas on a fuel model map. Fuel types were ordered in a way similar to the original 13, with hybrid fuel types (such as Timber-Understory) generally between the two types that compose the hybrid. Fuel types are as follows:

- (NB) Nonburnable
- (GR) Grass
- (GS) Grass-Shrub
- (SH) Shrub
- (TU) Timber-Understory

- (TL) Timber Litter
- (SB) Slash-Blowdown

To facilitate both communication and computation, we use a three-part fuel model reference scheme:

- Fuel model number (between 1 and 256; for use in computer code and mapping applications)
- Fuel model code (three digits; used for oral and written communication and input to fire modeling systems)
- Fuel model name (any length string of characters; used for description and long-hand written communication)

For example:

| number | code | name |
|---|---|---|
| 101 | GR1 | Short, sparse, dry climate grass |

Within a fuel type, fuel models are ordered by increasing heat per unit area (at 8 percent dead, 75 percent live fuel moisture content). Wind speed and slope steepness do not affect heat per unit area. Fuel model numbers were kept below 256 so that an eight-bit number could be used for storing fuel model information in mapping or database applications.

Each fuel type has been assigned a block of fuel model numbers (table 1) so that fuel model maps colored by fuel type are simple to create. For example, a coarse-scale map (for which identifying a specific fuel model is not required) can be colored such that all fuel model numbers in a block (representing a fuel type) are the same color. Only a portion of each block is used by the new fuel model set. The unused fuel model numbers are reserved for future standard fuel models and for custom fuel models. This allows future standard and custom fuel models to be in the correct fuel type number block.

The dead fuel extinction moisture assigned to the fuel model defines the weighted-average dead fuel moisture content at which the fire will no longer spread in the Rothermel model. This modeling parameter is generally associated with climate (humid versus dry), though fire science research has yet to explain the mechanism for the association. Fuel models for dry climates tend to have lower dead fuel moistures of extinction, while fuel models for humid-climate areas tend to have higher moistures of extinction. Fuel model names (and the fuel model selection guide) include reference to the general climate where the fuel model is found.

**Table 1**—Assignment of current fuel model numbers to standard and custom fuel models.

| Fuel type | Fuel model number block | Used in original or new set | Reserved for future standard fuel models | Available for custom fuel models |
|---|---|---|---|---|
| | 1-13 | 1-13 | | |
| | 14-89 | | | 14-89 |
| NB | 90-99 | 91-93, 98-99[a] | 94-95 | 90, 96-97 |
| GR | 100-119 | 101-109 | 110-112 | 100, 113-119 |
| GS | 120-139 | 121-124 | 125-130 | 120, 131-139 |
| SH | 140-159 | 141-149 | 150-152 | 140, 153-159 |
| TU | 160-179 | 161-165 | 166-170 | 160, 171-179 |
| TL | 180-199 | 181-189 | 190-192 | 180, 193-199 |
| SB | 200-219 | 201-204 | 205-210 | 200, 211-219 |
| | 220-256 | | | 220-256 |

[a] The gap in the NB numbering sequence is to retain fuel model numbers 98 as open water and 99 as “rock” (bare ground), as has been convention in FARSITE.

## Dynamic Fuel Models

In this new set, all fuel models that have a live herbaceous component are "dynamic," meaning that their herbaceous load shifts between live and dead depending on the specified live herbaceous moisture content. In the Fuel Models section, refer to the model parameters list ("fuel model type" column) to see which models contain live herbaceous load and are therefore dynamic.

The dynamic fuel model process is described by Burgan (1979); the method is outlined and outlined below, with graphic presentation in figure 1.

- If live herbaceous moisture content is 120 percent or higher, the herbaceous fuels are green, and all herbaceous load stays in the live category at the given moisture content.
- If live herbaceous moisture content is 30 percent or lower, the herbaceous fuels are considered fully cured, and all herbaceous load is transferred to dead herbaceous.
- If live herbaceous moisture content is between 30 and 120 percent, then part of the herb load is transferred to dead. For example, if live herb moisture content is 75 percent (halfway between 30 and 120 percent), then half of the herbaceous load is transferred to dead herbaceous, the remainder stays in the live herbaceous class.

Load transferred to dead is not simply placed in the dead 1-hr timelag class. Instead a new dead herbaceous class is created so that the surface-area-to-volume ratio of the live herbaceous component is preserved. However, for simplicity the moisture content of the new dead herbaceous category is set to the same as that for the dead 1-hr timelag class.

When evaluating dynamic models, be aware that live herbaceous moisture content significantly affects fire behavior because herbaceous load shifts between live and dead, and dead fuel usually has much lower moisture content than live. It will often be preferable to estimate live herbaceous moisture content by working backward from observed or estimated degree of herbaceous curing (table 2). For example, if the fuelbed is observed to be 50 percent cured, use a value of 75 percent for live herbaceous moisture content.

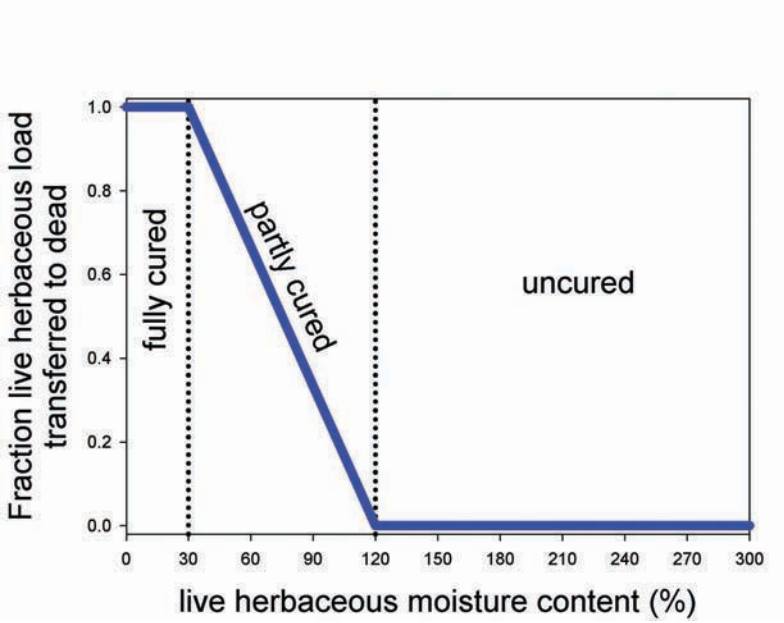



**Figure 1**—Graphical representation of the dynamic fuel model process.

**Table 2**—Level of curing versus live herbaceous moisture content.

| Level of curing | | Live herbaceous moisture content |
|---|---|---|
| Uncured | 0 percent | 120 percent or more |
| One-quarter | 25 | 98 |
| One-third | 33 | 90 |
| One-half | 50 | 75 |
| Two-thirds | 66 | 60 |
| Three-quarters | 75 | 53 |
| Fully cured | 100 | 30 or less |

None of the original 13 fire behavior fuel models is dynamic. Therefore, direct comparisons between the new and original fuel models can only be made if the live herbaceous moisture content is 30 percent (fully cured) or lower. For example, models GR6 and GR8 are similar to original fuel model 3, but their behavior over a range of live herbaceous moisture content is very different (fig. 2). Fuel model 3 does not have a live herbaceous component, so its behavior does not change as that input is varied. Fuel models GR6 and GR8 are both dynamic, so fire behavior decreases rapidly with higher levels of live fuel moisture (less curing).

To preserve the static nature of original fuel model 2 (which contains live herbaceous load as well as dead grass) and to preserve the ability to create custom fuel models in which dynamic load transfer does not take place, the fuel model description includes a fuel model type. A static fuel model with live herbaceous load should keep that load in the live category regardless of moisture content, whereas the same fuel model would undergo the load transfer if its type is dynamic. Custom fuel models can be either static or dynamic. If a fuel model does not have load in the live herbaceous category, then the fuel model type is irrelevant.

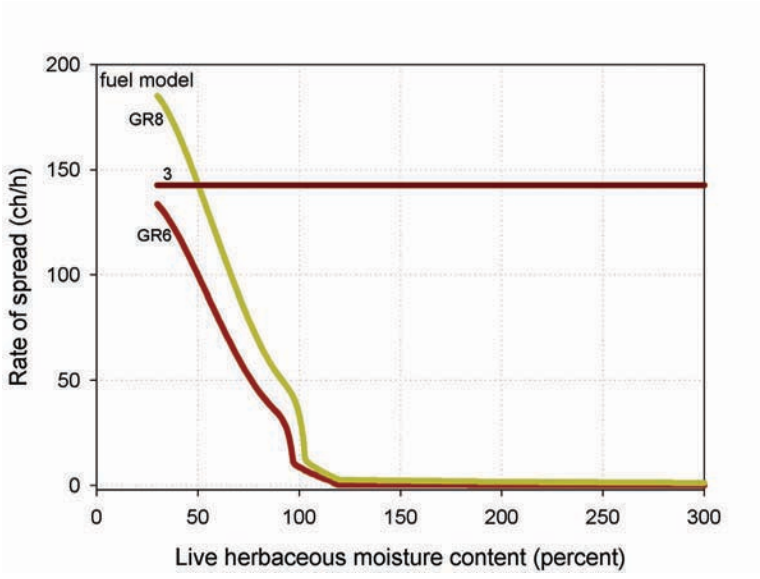



**Figure 2—**Comparison of dynamic fuel models GR6 and GR8 with static fuel model 3.

## Moisture Scenarios

To facilitate standard comparisons of the new fire behavior fuel models with the original 13 fuel models and with each other, we developed standard dead (table 3) and live (table 4) fuel moisture scenarios. Separate live and dead scenarios were needed so that live and dead fuels could vary independently. There are 16 unique moisture scenario combinations. However, fire behavior predicted with fuel models without a live fuel component is not affected by the live moisture scenario. Live moisture scenarios cover a range of live herbaceous moisture corresponding to fully cured (30 percent) to uncured (fully green; 120 percent).

**Table 3**—Dead fuel moisture content values (percent) for the dead fuel moisture scenarios.

| | D1<br>**Very low** | D2<br>**Low** | D3<br>**Moderate** | D4<br>**High** |
|---|---|---|---|---|
| 1-hr | 3 | 6 | 9 | 12 |
| 10-hr | 4 | 7 | 10 | 13 |
| 100-hr | 5 | 8 | 11 | 14 |

**Table 4**—Live fuel moisture content values (percent) for the live fuel moisture scenarios.

| | **L1**<br>**Fully cured**<br>**Very low** | **L2**<br>**Two-thirds cured**<br>**Low** | **L3**<br>**One-third cured**<br>**Moderate** | **L4**<br>**Fully green (uncured)**<br>**High** |
|---|---|---|---|---|
| Live herbaceous | 30 | 60 | 90 | 120 |
| Live woody | 60 | 90 | 120 | 150 |

# Fuel Model Selection

This document contains two aids to fuel model selection: a fuel model selection guide and a set of crosswalks. Use the crosswalks if you have an area already designated as one of the 13 original fuel models and you want guidance on selecting one of the new models for that area. Use the fuel model selection guide for assistance in selecting a fuel model from knowledge of general fuelbed properties.

Both the selection guide and crosswalks offer suggestions to consider, not conclusive results. The final fuel model selection must be made by the user based on experience with fire behavior in the fuelbed under consideration.

## Fuel Model Selection Guide

To select a fuel model:

1. Determine the general fire-carrying fuel type: grass, grass-shrub, shrub, timber litter, timber with (grass or shrub) understory, or slash or blowdown fuels. Estimate which stratum of surface fuels is most likely to carry the fire. For example, the fire may be in a forested area, but if the forest canopy is open, grass, not needle litter, might carry the fire. In this case a grass model should be considered.

2. The dead fuel extinction moisture assigned to the fuel model defines the moisture content of dead fuels at which the fire will no longer spread. This fuel parameter, unique to the Rothermel surface fire spread model, is generally associated with climate (humid versus dry). That is, fuel models for dry areas tend to have lower dead fuel moistures of extinction, while fuel models for wet humid areas tend to have higher moistures of extinction.

3. Note the general depth, compactness, and size of the fuel, and the relative amount of live vegetation.

4. Do not restrict your selection by fuel model name or fuel type. After selecting a fuel model, view its predicted fire behavior to be sure the predicted behavior agrees with your expectation or observation.

In this guide we refer to spread rates and flame lengths as being very low, low, moderate, high, very high, and extreme—assuming two-thirds cured herbaceous, dry dead fuels (moisture scenario D2L2), a midflame wind speed of 5 mi/h, and zero slope (table 5).

**Table 5**—Adjective class definitions for predicted fire behavior.

| Adjective class | ROS (ch/h) | FL (ft) |
|---|---|---|
| Very Low | 0-2 | 0-1 |
| Low | 2-5 | 1-4 |
| Moderate | 5-20 | 4-8 |
| High | 20-50 | 8-12 |
| Very High | 50-150 | 12-25 |
| Extreme | >150 | >25 |

The general fire-carrying fuel type is:

1. **Nearly pure grass and/or forb type (Grass)**
   a. Arid to semiarid climate (rainfall deficient in summer). Extinction moisture content is 15 percent.
      i. **GR1** Grass is short, patchy, and possibly heavily grazed. Spread rate moderate; flame length low.
      ii. **GR2** Moderately coarse continuous grass, average depth about 1 foot. Spread rate high; flame length moderate.
      iii. **GR4** Moderately coarse continuous grass, average depth about 2 feet. Spread rate very high; flame length high.
      iv. **GR7** Moderately coarse continuous grass, average depth about 3 feet. Spread rate very high; flame length very high.
   b. Subhumid to humid climate (rainfall adequate in all seasons). Extinction moisture content is 30 to 40 percent.
      i. **GR1** Grass is short, patchy, and possibly heavily grazed. Spread rate moderate; flame length low.
      ii. **GR3** Very coarse grass, average depth about 2 feet. Spread rate high; flame length moderate.
      iii. **GR5** Dense, coarse grass, average depth about 1 to 2 feet. Spread rate very high; flame length high.
      iv. **GR6** Dryland grass about 1 to 2 feet tall. Spread rate very high; flame length very high.
      v. **GR8** Heavy, coarse, continuous grass 3 to 5 feet tall. Spread rate very high; flame length very high.
      vi. **GR9** Very heavy, coarse, continuous grass 5 to 8 feet tall. Spread rate extreme; flame length extreme.

2. **Mixture of grass and shrub, up to about 50 percent shrub coverage (Grass-Shrub)**
   a. Arid to semiarid climate (rainfall deficient in summer). Extinction moisture content is 15 percent.
      i. **GS1** Shrubs are about 1 foot high, low grass load. Spread rate moderate; flame length low.
      ii. **GS2** Shrubs are 1 to 3 feet high, moderate grass load. Spread rate high; flame length moderate.
   b. Subhumid to humid climate (rainfall adequate in all seasons). Extinction moisture content is 30 to 40 percent.
      i. **GS3** Moderate grass/shrub load, average grass/shrub depth less than 2 feet. Spread rate high; flame length moderate.
      ii. **GS4** Heavy grass/shrub load, depth greater than 2 feet. Spread rate high; flame length very high.

3. **Shrubs cover at least 50 percent of the site; grass sparse to nonexistent (Shrub)**
   a. Arid to semiarid climate (rainfall deficient in summer). Extinction moisture content is 15 percent.
      i. **SH1** Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate very low; flame length very low.
      ii. **SH2** Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate low; flame length low.
      iii. **SH5** Heavy shrub load, depth 4 to 6 feet. Spread rate very high; flame length very high.

iv. **SH7** Very heavy shrub load, depth 4 to 6 feet. Spread rate lower than SH5, but flame length similar. Spread rate high; flame length very high.

b. Subhumid to humid climate (rainfall adequate in all seasons). Extinction moisture content is 30 to 40 percent.

i. **SH3** Moderate shrub load, possibly with pine overstory or herbaceous fuel, fuel bed depth 2 to 3 feet. Spread rate low; flame length low.

ii. **SH4** Low to moderate shrub and litter load, possibly with pine overstory, fuel bed depth about 3 feet. Spread rate high; flame length moderate.

iii. **SH6** Dense shrubs, little or no herb fuel, depth about 2 feet. Spread rate high; flame length high.

iv. **SH8** Dense shrubs, little or no herb fuel, depth about 3 feet. Spread rates high; flame length high.

v. **SH9** Dense, finely branched shrubs with significant fine dead fuel, about 4 to 6 feet tall; some herbaceous fuel may be present. Spread rate high, flame length very high.

**4. Grass or shrubs mixed with litter from forest canopy (Timber-Understory)**

a. Semiarid to subhumid climate. Extinction moisture content is 20 percent.

i. **TU1** Fuelbed is low load of grass and/or shrub with litter. Spread rate low; flame length low.

ii. **TU4** Fuelbed is short conifer trees with grass or moss understory. Spread rate moderate; flame length moderate.

iii. **TU5** Fuelbed is high load conifer litter with shrub understory. Spread rate moderate; flame length moderate.

b. Humid climate. Extinction moisture content is 30 percent.

i. **TU2** Fuelbed is moderate litter load with shrub component. Spread rate moderate; flame length low.

ii. **TU3** Fuelbed is moderate litter load with grass and shrub components. Spread rate high; flame length moderate.

**5. Dead and down woody fuel (litter) beneath a forest canopy (Timber Litter)**

a. Fuelbed is recently burned but able to carry wildland fire.

i. **TL1** Light to moderate load, fuels 1 to 2 inches deep. Spread rate very low; flame length very low.

b. Fuelbed not recently burned.

i. Fuelbed composed of broadleaf (hardwood) litter.

1. **TL2** Low load, compact. Spread rate very low; flame length very low.
2. **TL6** Moderate load, less compact. Spread rate moderate; flame length low.
3. **TL9** Very high load, fluffy. Spread rate moderate; flame length moderate.

ii. Fuelbed composed of long-needle pine litter.

1. **TL8** moderate load and compactness may include small amount of herbaceous load. Spread rate moderate; flame length low.

iii. Fuelbed not composed broadleaf or long-needle pine litter.

1. Fuelbed includes both fine and coarse fuels.
   a. **TL4** Moderate load, includes small diameter downed logs. Spread rate low; flame length low.
   b. **TL7** Heavy load, includes larger diameter downed logs. Spread rate low; flame length low.
2. Fuelbed does not include coarse fuels.
   a. **TL3** Moderate load conifer litter. Spread rate very low; flame length low.

b. **TL5** High load conifer litter; light slash or mortality fuel. Spread rate low; flame length low.
c. **TL9** Very high load broadleaf litter; heavy needle-drape in otherwise sparse shrub layer. Spread rate moderate; flame length moderate.

6. **Activity fuel (slash) or debris from wind damage (blowdown) (Slash-Blowdown)**
   a. Fuelbed is activity fuel.
      i. **SB1** Fine fuel load is 10 to 20 tons/acre, weighted toward fuels 1 to 3 inches diameter class, depth is less than 1 foot. Spread rate moderate; flame length low.
      ii. **SB2** Fine fuel load is 7 to 12 tons/acre, evenly distributed across 0 to 0.25, 0.25 to 1, and 1 to 3 inch diameter classes, depth is about 1 foot. Spread rate moderate; flame length moderate.
      iii. **SB3** Fine fuel load is 7 to 12 tons/acre, weighted toward 0 to 0.25 inch diameter class, depth is more than 1 foot. Spread rate high; flame length high.
   b. Fuelbed is blowdown.
      i. **SB2** Blowdown is scattered, with many trees still standing. Spread rate moderate; flame length moderate.
      ii. **SB3** Blowdown is moderate, trees compacted to near the ground. Spread rate high; flame length high.
      iii. **SB4** Blowdown is total, fuelbed not compacted, foliage still attached. Spread rate very high; flame length very high.

7. **Insufficient wildland fuel to carry wildland fire under any condition (Nonburnable)**
   a. **NB1** Urban or suburban development; insufficient wildland fuel to carry wildland fire.
   b. **NB2** Snow/ice.
   c. **NB3** Agricultural field, maintained in nonburnable condition.
   d. **NB8** Open water.
   e. **NB9** Bare ground.

## Fuel Model Crosswalks

These crosswalks will help users of the original 13 fuel models make the transition to using the new set. For each of the 13 original fuel models we suggest one or more fuel models from the new set to consider. However, you are not limited to these choices; always use the fuel model that provides the best fit for fire behavior prediction.

The crosswalks use adjective classes to compare spread rate and flame length between the original fuel models and their related models from the new set (table 6).

**Note:** We computed the relative change in fire behavior between original and new models using 5 miles/hour midflame wind speed, low dead fuel moisture, two-thirds cured herbaceous fuels, and low live woody fuels (moisture scenario D2L2). Relative change among fuel models might be different for different environmental conditions; use these crosswalks as a guide only.

There is a crosswalk table for each major fire-carrying fuel type of the original 13 fuel models. The crosswalk uses adjective classes to compare spread rate and flame length between the original 13 fuel models and their related models from the new set.

**Table 6**—Adjective class definitions for fire behavior comparisons.

| Adjective class | Relative change in fire behavior (percent change from original model) |
|---|---|
| Comparable | 0-15 |
| Slightly higher/lower | 15-50 |
| Higher/lower | 50-100 |
| Much higher/lower | 100-200 |
| Significantly higher/lower | 200+ |

## Grass fuel type

| Consider using one of these fuel models from the new set... | ... if you used one of these models from the original set. | | |
|---|---|---|---|
| | 1 Short Grass | 2 Timber Grass and Understory | 3 Tall Grass |
| GR1 | For very sparse or heavily grazed grass; for lower spread rate and flame length | | |
| GR2 | For slightly lower spread rate and comparable flame length | For comparable spread rate and slightly lower flame length | |
| GR3 | | | For lower spread rate and slightly lower flame length |
| GR4 | For slightly lower spread rate and much higher flame length | For higher spread rate and slightly higher flame length | |
| GR5 | | | For lower spread rate and slightly lower flame length |
| GR6 | | | For slightly lower spread rate and comparable flame length |
| GR7 | For comparable spread rate and significantly higher flame length | For much higher spread rate and flame length | For comparable spread rate and slightly higher flame length |
| GR8 | | | For comparable spread rate and higher flame length |
| GR9 | | | For higher spread rate and much higher flame length |
| GS1 | | For slightly lower spread rate and lower flame length | |
| GS2 | | For slightly lower spread rate and flame length | |

**Note:** All grass fuel models from the new set are dynamic fuel models, which means that herbaceous load is transferred between live and dead categories according to live herbaceous moisture content. Original models 1 and 3 have only a dead component. Original fuel model 2 has a live herbaceous component but is static. Exact fire behavior comparisons between original and new grass models can only be made when live herbaceous moisture content is 30 percent or less. These comparisons were made with a live herbaceous moisture content of 60 percent (two-thirds cured).

## Shrub fuel type

| Consider using one of these fuel models from the new set... | ... if you used one of these models from the original set. | | | |
|---|---|---|---|---|
| | 4 Chaparral | 5 Brush | 6 Dormant Brush | 7 Southern Rough |
| SH1 | | For lower spread rate and flame length | For lower spread rate and flame length | |
| SH2 | | For lower spread rate and slightly lower flame length | For lower spread rate and flame length | |
| SH3 | | | | For lower spread rate and flame length |
| SH4 | | | For slightly lower spread rate and comparable flame length | For comparable spread rate and flame length |
| SH5 | For slightly lower spread rate and flame length | For much higher spread rate and flame length | | |
| SH6 | | | For slightly lower spreadrate and higher flame length | For slightly lower spread rate and higher flame length |
| SH7 | For slightly lower spread rate and flame length | For slightly higher spread rate and much higher flame length | | |
| SH8 | | | | For slightly lower spread rate and higher flame length |
| SH9 | | | | For slightly higher spread rate and much higher flame length |
| TU5 | | For lower spread rate and slightly higher flame length | | |
| GS2 | | For comparable spread rate and slightly lower flame length; with grass component | | |

## Timber fuel type

| Consider using one of these fuel models from the new set... | ... if you used one of these models from the original set. | | |
|---|---|---|---|
| | 8<br>Compact Timber Litter | 9<br>Hardwood Litter | 10<br>Timber (Understory) |
| TL1 | For lower spread rate and slightly lower flame length | | |
| TL2 | | For lower spread rate and flame length | |
| TL3 | For comparable spread rate and flame length | | |
| TL4 | For slightly higher spread rate and flame length | | |
| TL5 | For much higher spread rate and higher flame length | | |
| TL6 | | For slightly lower spread rate and comparable flame length | |
| TL7 | For slightly higher spread rate and higher flame length | | |
| TL8 | | For slightly lower spread rate and slightly higher flame length | |
| TL9 | | For comparable spread rate and higher flame length | |
| TU1 | For higher spread rate and flame length | | For lower spread rate and flame length |
| TU2 | | | For slightly higher spread rate and slightly lower flame length; high extinction moisture |
| TU3 | | | For much higher spread rate and slightly higher flame length; high extinction moisture |
| TU4 | | | For slightly higher spread rate and comparable flame length |
| TU5 | | | For comparable spread rate and slightly higher flame length |
| SH2 | | | For lower spread rate and flame length |

## Slash fuel type

| Consider using one of these fuel models from the new set... | ... if you used one of these models from the original set. | | |
|---|---|---|---|
| | 11 Light Logging Slash | 12 Medium Logging Slash | 13 Heavy Logging Slash |
| TL5 | For slightly lower spread rate and flame length | | |
| SB1 | For comparable spread rate and flame length | For lower spread rate and flame length | |
| SB2 | For much higher spread rate and higher flame length | For comparable spread rate and slightly lower flame length | For comparable spread rate and slightly lower flame length |
| SB3 | | For much higher spread rate and comparable flame length | For higher spread rate and comparable flame length |
| SB4 | | | For significantly higher spread rate and slightly higher flame length |

# Fuel Models

In this section we list the fuel model parameters and describe each fuel model and fuel type.

## Fuel Model Parameters

Parameters of the new fuel models include load by class and component, surface-area-to-volume (SAV) ratio by class and component, fuel model type (static or dynamic), fuelbed depth, extinction moisture content, and fuel particle heat content (table 7). Fuel inputs not listed are constant for the entire set: 10-hr dead fuel SAV ratio is 109 1/ft, and 100-hr SAV ratio is 30 1/ft. Total fuel particle mineral content is 5.55 percent; effective (silica-free) mineral content is 1.00 percent. Ovendry fuel particle density is 32 lb/ft$^3$.

## Fuel Type Page

A fuel type page consists of a brief description of the fuel type followed by a pair of charts depicting predicted fire behavior over a range of midflame wind speeds, one for headfire spread rate and one for headfire flame length. These charts are for moisture scenario D2L2 (low dead fuel moisture, two-thirds cured live herbaceous, low live woody fuel moisture). The moisture contents by class and category are:

| | |
|---|---|
| Dead 1-hr | 6 percent |
| Dead 10-hr | 7 |
| Dead 100-hr | 8 |
| Live herbaceous | 60 (2/3 cured) |
| Live woody | 90 |

Use the charts to compare the relative behavior of the various models within a fuel type, but be aware that the relative behavior may be different at other moisture contents.

Fuel models with herbaceous load are sensitive to live herbaceous moisture content. The herbaceous fuel in moisture scenario D2L2 is two-thirds cured, which means that 67 percent of the herbaceous load is actually at the dead 1-hr moisture content, while the remaining 33 percent retains the 60 percent moisture content.

**Table 7**—Fuel model parameters.

| Fuel model code | Fuel load (t/ac) | | | | | Fuel model type[a] | SAV ratio (1/ft)[b] | | | Fuel bed depth (ft) | Dead fuel extinction moisture (percent) | Heat content BTU/lb)[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-hr | 10-hr | 100-hr | Live herb | Live woody | | Dead 1-hr | Live herb | Live woody | | | |
| GR1 | 0.10 | 0.00 | 0.00 | 0.30 | 0.00 | dynamic | 2200 | 2000 | 9999 | 0.4 | 15 | 8000 |
| GR2 | 0.10 | 0.00 | 0.00 | 1.00 | 0.00 | dynamic | 2000 | 1800 | 9999 | 1.0 | 15 | 8000 |
| GR3 | 0.10 | 0.40 | 0.00 | 1.50 | 0.00 | dynamic | 1500 | 1300 | 9999 | 2.0 | 30 | 8000 |
| GR4 | 0.25 | 0.00 | 0.00 | 1.90 | 0.00 | dynamic | 2000 | 1800 | 9999 | 2.0 | 15 | 8000 |
| GR5 | 0.40 | 0.00 | 0.00 | 2.50 | 0.00 | dynamic | 1800 | 1600 | 9999 | 1.5 | 40 | 8000 |
| GR6 | 0.10 | 0.00 | 0.00 | 3.40 | 0.00 | dynamic | 2200 | 2000 | 9999 | 1.5 | 40 | 9000 |
| GR7 | 1.00 | 0.00 | 0.00 | 5.40 | 0.00 | dynamic | 2000 | 1800 | 9999 | 3.0 | 15 | 8000 |
| GR8 | 0.50 | 1.00 | 0.00 | 7.30 | 0.00 | dynamic | 1500 | 1300 | 9999 | 4.0 | 30 | 8000 |
| GR9 | 1.00 | 1.00 | 0.00 | 9.00 | 0.00 | dynamic | 1800 | 1600 | 9999 | 5.0 | 40 | 8000 |
| GS1 | 0.20 | 0.00 | 0.00 | 0.50 | 0.65 | dynamic | 2000 | 1800 | 1800 | 0.9 | 15 | 8000 |
| GS2 | 0.50 | 0.50 | 0.00 | 0.60 | 1.00 | dynamic | 2000 | 1800 | 1800 | 1.5 | 15 | 8000 |
| GS3 | 0.30 | 0.25 | 0.00 | 1.45 | 1.25 | dynamic | 1800 | 1600 | 1600 | 1.8 | 40 | 8000 |
| GS4 | 1.90 | 0.30 | 0.10 | 3.40 | 7.10 | dynamic | 1800 | 1600 | 1600 | 2.1 | 40 | 8000 |
| SH1 | 0.25 | 0.25 | 0.00 | 0.15 | 1.30 | dynamic | 2000 | 1800 | 1600 | 1.0 | 15 | 8000 |
| SH2 | 1.35 | 2.40 | 0.75 | 0.00 | 3.85 | N/A | 2000 | 9999 | 1600 | 1.0 | 15 | 8000 |
| SH3 | 0.45 | 3.00 | 0.00 | 0.00 | 6.20 | N/A | 1600 | 9999 | 1400 | 2.4 | 40 | 8000 |
| SH4 | 0.85 | 1.15 | 0.20 | 0.00 | 2.55 | N/A | 2000 | 1800 | 1600 | 3.0 | 30 | 8000 |
| SH5 | 3.60 | 2.10 | 0.00 | 0.00 | 2.90 | N/A | 750 | 9999 | 1600 | 6.0 | 15 | 8000 |
| SH6 | 2.90 | 1.45 | 0.00 | 0.00 | 1.40 | N/A | 750 | 9999 | 1600 | 2.0 | 30 | 8000 |
| SH7 | 3.50 | 5.30 | 2.20 | 0.00 | 3.40 | N/A | 750 | 9999 | 1600 | 6.0 | 15 | 8000 |
| SH8 | 2.05 | 3.40 | 0.85 | 0.00 | 4.35 | N/A | 750 | 9999 | 1600 | 3.0 | 40 | 8000 |
| SH9 | 4.50 | 2.45 | 0.00 | 1.55 | 7.00 | dynamic | 750 | 1800 | 1500 | 4.4 | 40 | 8000 |
| TU1 | 0.20 | 0.90 | 1.50 | 0.20 | 0.90 | dynamic | 2000 | 1800 | 1600 | 0.6 | 20 | 8000 |
| TU2 | 0.95 | 1.80 | 1.25 | 0.00 | 0.20 | N/A | 2000 | 9999 | 1600 | 1.0 | 30 | 8000 |
| TU3 | 1.10 | 0.15 | 0.25 | 0.65 | 1.10 | dynamic | 1800 | 1600 | 1400 | 1.3 | 30 | 8000 |
| TU4 | 4.50 | 0.00 | 0.00 | 0.00 | 2.00 | N/A | 2300 | 9999 | 2000 | 0.5 | 12 | 8000 |
| TU5 | 4.00 | 4.00 | 3.00 | 0.00 | 3.00 | N/A | 1500 | 9999 | 750 | 1.0 | 25 | 8000 |
| TL1 | 1.00 | 2.20 | 3.60 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.2 | 30 | 8000 |
| TL2 | 1.40 | 2.30 | 2.20 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.2 | 25 | 8000 |
| TL3 | 0.50 | 2.20 | 2.80 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.3 | 20 | 8000 |
| TL4 | 0.50 | 1.50 | 4.20 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.4 | 25 | 8000 |
| TL5 | 1.15 | 2.50 | 4.40 | 0.00 | 0.00 | N/A | 2000 | 9999 | 1600 | 0.6 | 25 | 8000 |
| TL6 | 2.40 | 1.20 | 1.20 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.3 | 25 | 8000 |
| TL7 | 0.30 | 1.40 | 8.10 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 0.4 | 25 | 8000 |
| TL8 | 5.80 | 1.40 | 1.10 | 0.00 | 0.00 | N/A | 1800 | 9999 | 9999 | 0.3 | 35 | 8000 |
| TL9 | 6.65 | 3.30 | 4.15 | 0.00 | 0.00 | N/A | 1800 | 9999 | 1600 | 0.6 | 35 | 8000 |
| SB1 | 1.50 | 3.00 | 11.00 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 1.0 | 25 | 8000 |
| SB2 | 4.50 | 4.25 | 4.00 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 1.0 | 25 | 8000 |
| SB3 | 5.50 | 2.75 | 3.00 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 1.2 | 25 | 8000 |
| SB4 | 5.25 | 3.50 | 5.25 | 0.00 | 0.00 | N/A | 2000 | 9999 | 9999 | 2.7 | 25 | 8000 |

[a] Fuel model type does not apply to fuel models without live herbaceous load.
[b] The value 9999 was assigned in cases where there is no load in a particular fuel class or category
[c] The same heat content value was applied to both live and dead fuel categories.

## Fuel Model Page

A fuel model page consists of:

- The three-part fuel model naming
- A set of three photos
- A brief description of the fuel model
- A summary of computed fuel model characteristics
- A pair of charts depicting fire behavior over a range of midflame wind speeds

Further details follow.

**Naming**—The fuel model code and number (in parentheses) are displayed on the first line, followed on the next line by the full fuel model name. The fuel model code is used for oral and written communication and for input to fire behavior models. The fuel model number is used internally by some fire behavior models and for mapping applications. The fuel model name is a brief description of the fuel model.

**Photos**—Up to three representative photos were selected to illustrate each fuel model. Conditions other than those illustrated may still be appropriate for the fuel model; use the photos as a general guide only.

**Description**—Main characteristics of each fuel model are briefly described.

**Summary characteristics**—Summary characteristics of each fuel model include fine fuel load, characteristic surface-area-to-volume ratio (SAV), packing ratio, and extinction moisture content.

Fine fuel load is defined as the dead 1-hr load plus the live herbaceous and live woody loads. Across the new set of 40 fuel models, fine fuel load ranges from 0.30 to 13.05 tons/acre.

Characteristic SAV is the average SAV across all fuel classes and categories, weighted by the surface area within each class and category. Characteristic SAV ranges from 1,144 to 2,216 1/ft in this new set of fuel models.

Packing ratio is the fraction of fuelbed volume that is occupied by fuel particles, a function of fuel load, fuelbed depth, and fuel particle density. In this fuel model set, packing ratio varies from 0.00143 to 0.04878 (dimensionless).

Extinction moisture content is the weighted average dead fuel moisture content at which the fire spread model predicts spread will not take place. More important, the amount by which the extinction moisture content exceeds the actual determines (in part) fire behavior. Thus, for a given dead fuel moisture content, predicted fire spread increases with increasing extinction moisture content.

**Fire behavior charts**—A pair of charts depicts predicted fire behavior (spread rate and flame length) for each fuel model over a range of midflame wind speeds. All predictions use live moisture scenario L2 (60 percent live herbaceous moisture content, 90 percent live woody), which corresponds to a two-thirds cured herbaceous fuelbed. The four lines on each chart refer to dead fuel moisture scenarios (table 3).

## Nonburnable Fuel Type Models (NB)

The nonburnable "fuel models" are included on the next five pages to provide consistency in how the nonburnable portions of the landscape are displayed on a fuel model map. In all NB fuel models there is no fuel load—wildland fire will not spread.

## *NB1 (91)*

## *Urban/Developed*





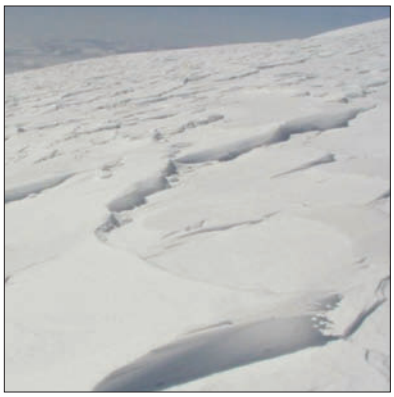
**Description:** Fuel model NB1 consists of land covered by urban and suburban development. To be called NB1, the area under consideration must not support wildland fire spread. In some cases, areas mapped as NB1 may experience structural fire losses during a wildland fire incident; however, structure ignition in those cases is either house-to-house or by firebrands, neither of which is directly modeled using fire behavior fuel models. If sufficient fuel vegetation surrounds structures such that wildland fire spread is possible, then choose a fuel model appropriate for the wildland vegetation rather than NB1.

**Expected fire behavior:**

No fire spread

## *NB2 (92)*

## *Snow/Ice*





**Description:** Land covered by permanent snow or ice is included in NB2. Areas covered by seasonal snow can be mapped to two different fuel models: NB2 for use when snow-covered and another for use in the fire season.

**Expected fire behavior:**

No fire spread

## *NB3 (93)*

## *Agricultural*





**Description:** Fuel model NB3 is agricultural land maintained in a nonburnable condition; examples include irrigated annual crops, mowed or tilled orchards, and so forth. However, there are many agricultural areas that are not kept in a nonburnable condition. For example, grass is often allowed to grow beneath vines or orchard trees, and wheat or similar crops are allowed to cure before harvest; in those cases use a fuel model other than NB3.

**Expected fire behavior:**

No fire spread

## *NB8 (98)*

## *Open Water*





**Description:** Land covered by open bodies of water such as lakes, rivers and oceans comprises NB8.

**Expected fire behavior:**

No fire spread

## *NB9 (99)*

## *Bare Ground*





**Description:** Land devoid of enough fuel to support wildland fire spread is covered by fuel model NB9. Such areas may include gravel pits, arid deserts with little vegetation, sand dunes, rock outcroppings, beaches, and so forth.

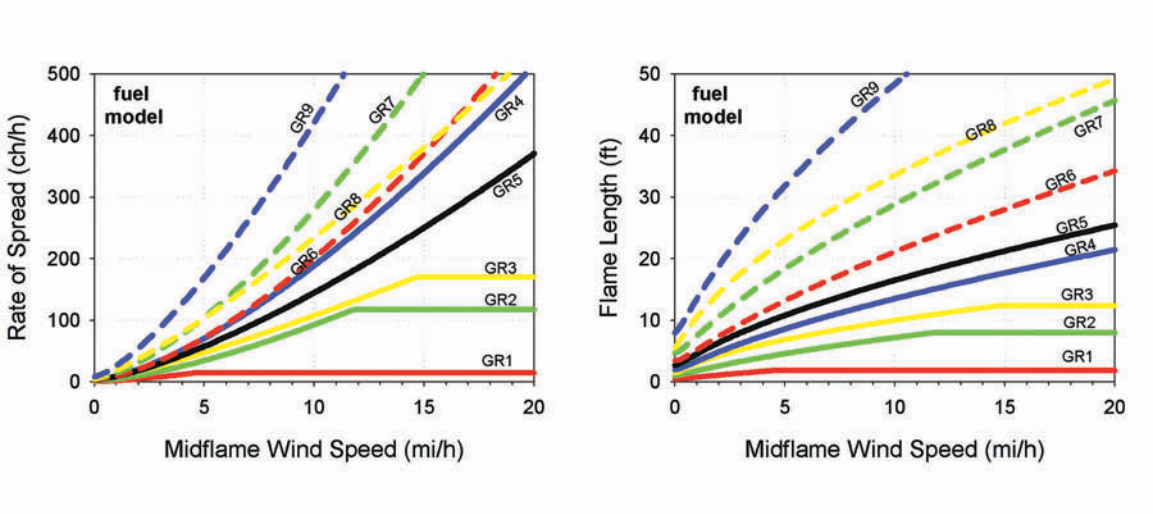
**Expected fire behavior:**

No fire spread

## Grass Fuel Type Models (GR)

The primary carrier of fire in the GR fuel models is grass. Grass fuels can vary from heavily grazed grass stubble or sparse natural grass to dense grass more than 6 feet tall. Fire behavior varies from moderate spread rate and low flame length in the sparse grass to extreme spread rate and flame length in the tall grass models.

All GR fuel models are dynamic, meaning that their live herbaceous fuel load shifts from live to dead as a function of live herbaceous moisture content. The effect of live herbaceous moisture content on spread rate and intensity is strong.



## *GR1 (101)*

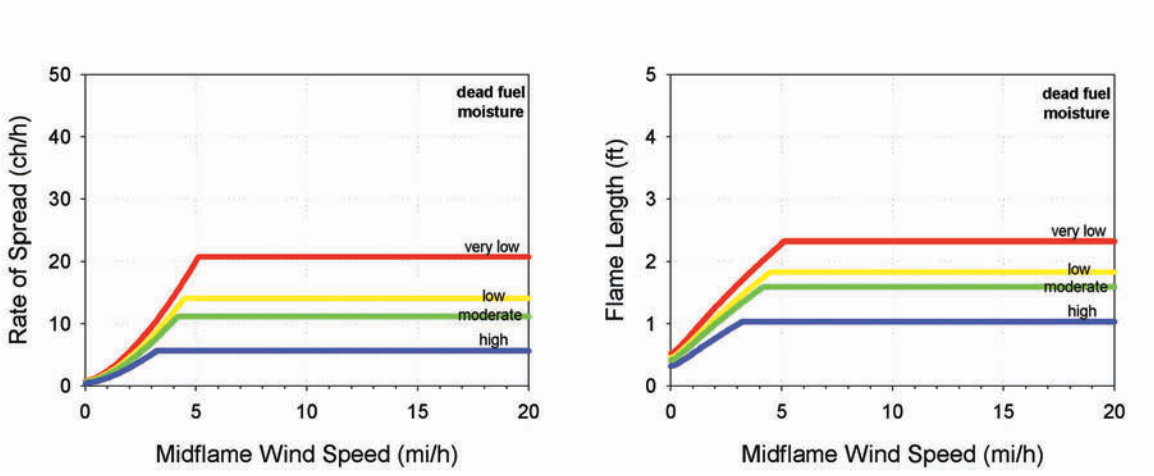
### *Short, Sparse Dry Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR1 is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short, either naturally or by grazing, and may be sparse or discontinuous. The moisture of extinction of GR1 is indicative of a dry climate fuelbed, but GR1 may also be applied in high-extinction moisture fuelbeds because in both cases predicted spread rate and flame length are low compared to other GR models.

| | |
|---|---|
| Fine fuel load (t/ac) | 0.40 |
| Characteristic SAV (ft-1) | 2054 |
| Packing ratio (dimensionless) | 0.00143 |
| Extinction moisture content (percent) | 15 |



## *GR2 (102)*

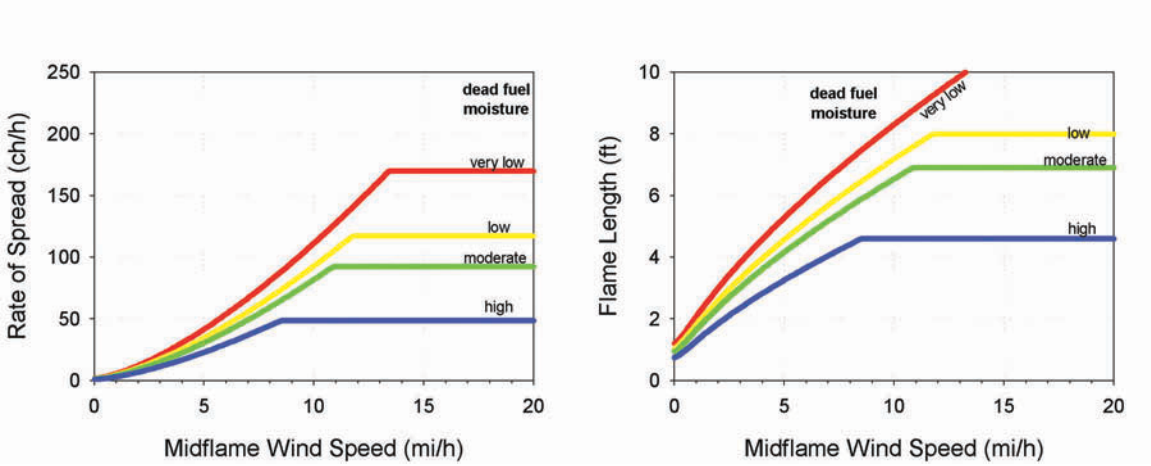
### *Low Load, Dry Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR2 is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuelbed may be more continuous. Shrubs, if present, do not affect fire behavior.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.10 |
| Characteristic SAV (ft-1) | 1820 |
| Packing ratio (dimensionless) | 0.00158 |
| Extinction moisture content (percent) | 15 |



## *GR3 (103)*

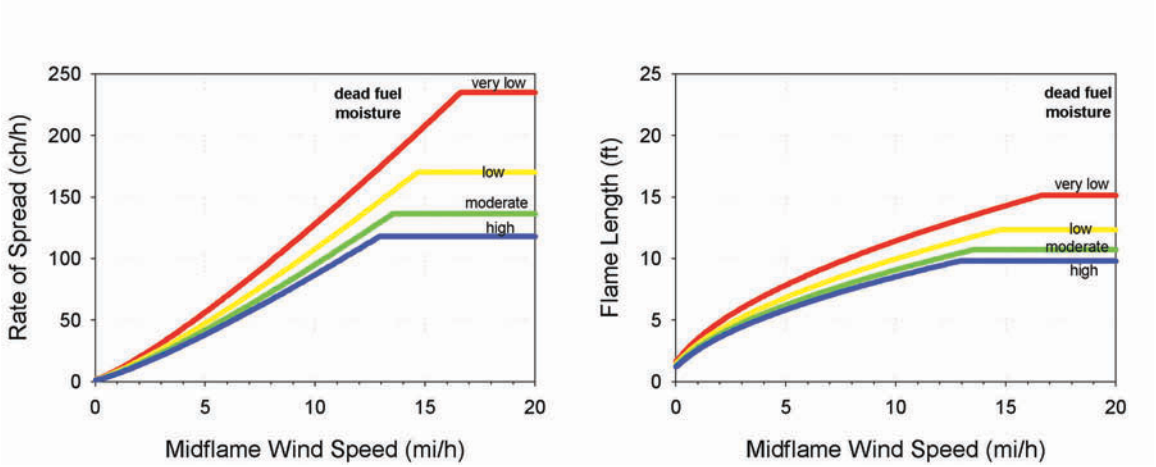
### *Low Load, Very Coarse, Humid Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR3 is continuous, coarse, humid-climate grass. Grass and herb fuel load is relatively light; fuelbed depth is about 2 feet. Shrubs are not present in significant quantity to affect fire behavior.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.60 |
| Characteristic SAV (ft-1) | 1290 |
| Packing ratio (dimensionless) | 0.00143 |
| Extinction moisture content (percent) | 30 |



## *GR4 (104)*

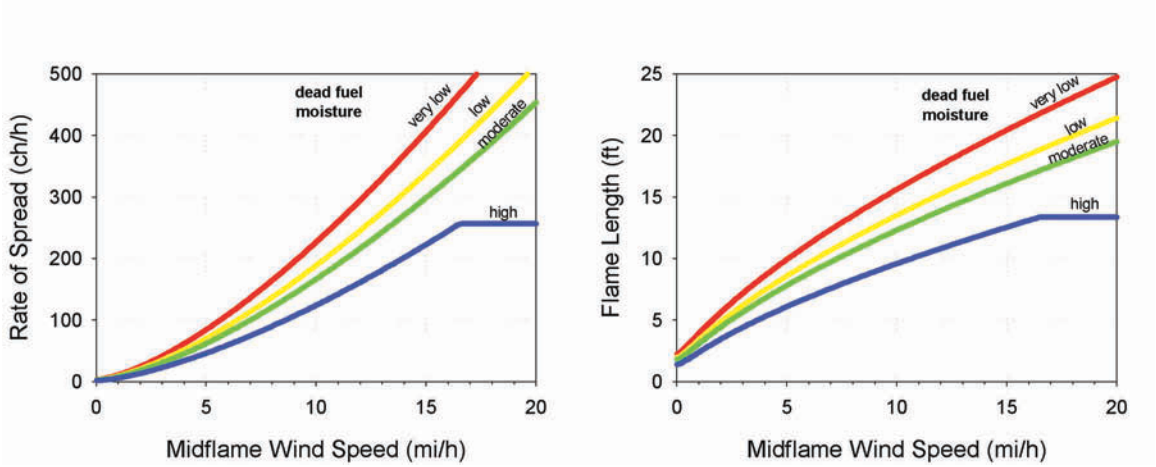
### *Moderate Load, Dry Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR4 is continuous, dry-climate grass. Load and depth are greater than GR2; fuelbed depth is about 2 feet.

| | |
|---|---|
| Fine fuel load (t/ac) | 2.15 |
| Characteristic SAV (ft-1) | 1826 |
| Packing ratio (dimensionless) | 0.00154 |
| Extinction moisture content (percent) | 15 |



## *GR5 (105)*

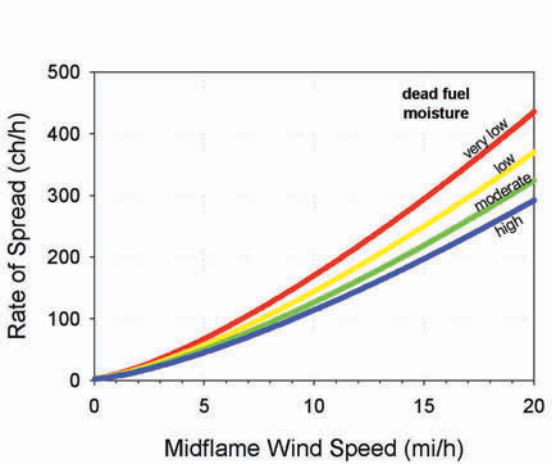
### *Low Load, Humid Climate Grass (Dynamic)*

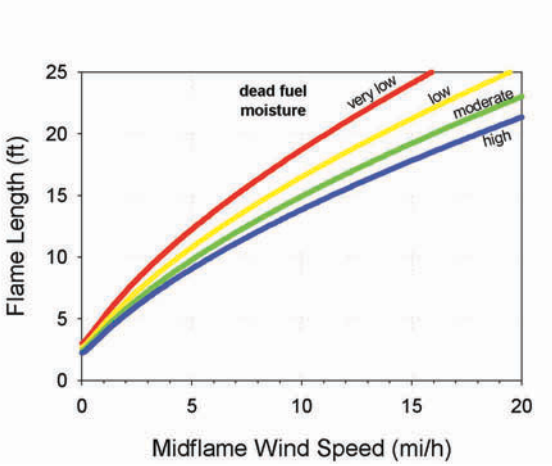




**Description:** The primary carrier of fire in GR5 is humid-climate grass. Load is greater than GR3 but depth is lower, about 1 to 2 feet.

| | |
|---|---|
| Fine fuel load (t/ac) | 2.9 |
| Characteristic SAV (ft-1) | 1631 |
| Packing ratio (dimensionless) | 0.00277 |
| Extinction moisture content (percent) | 40 |



## *GR6 (106)*

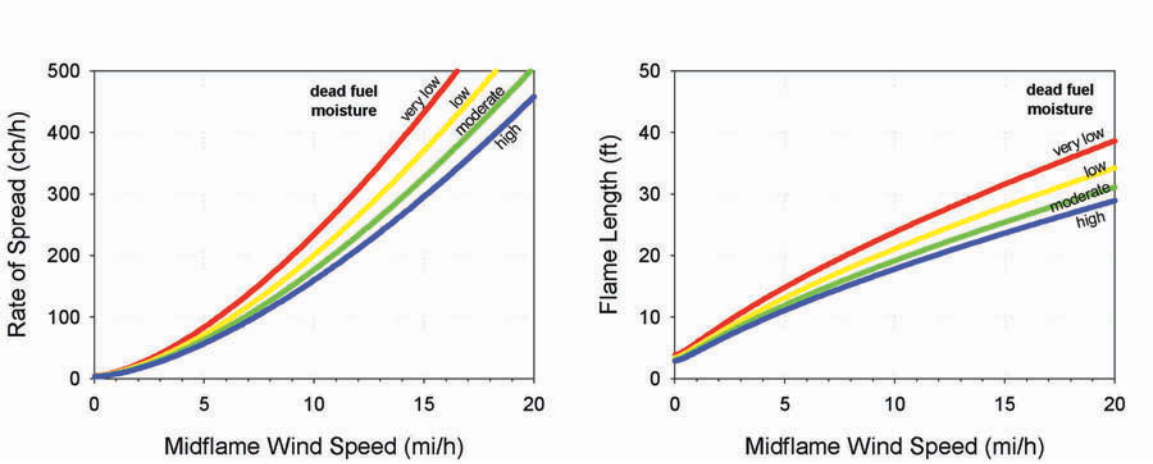
### *Moderate Load, Humid Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR6 is continuous humid-climate grass. Load is greater than GR5 but depth is about the same. Grass is less coarse than GR5.

| | |
|---|---|
| Fine fuel load (t/ac) | 3.5 |
| Characteristic SAV (ft-1) | 2006 |
| Packing ratio (dimensionless) | 0.00335 |
| Extinction moisture content (percent) | 40 |



## *GR7 (107)*

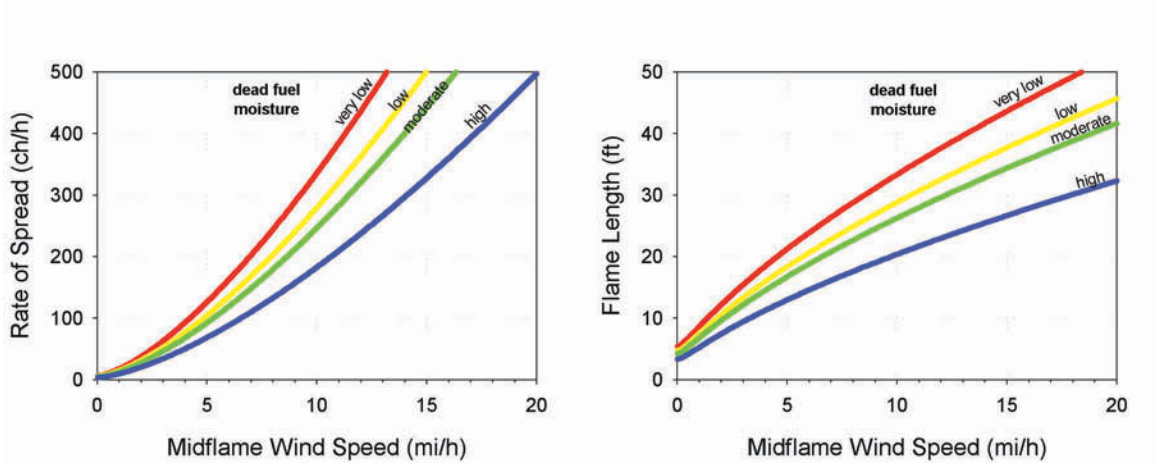
### *High Load, Dry Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR7 is continuous dry-climate grass. Load and depth are greater than GR4. Grass is about 3 feet tall.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.4 |
| Characteristic SAV (ft-1) | 1834 |
| Packing ratio (dimensionless) | 0.00306 |
| Extinction moisture content (percent) | 15 |



## *GR8 (108)*

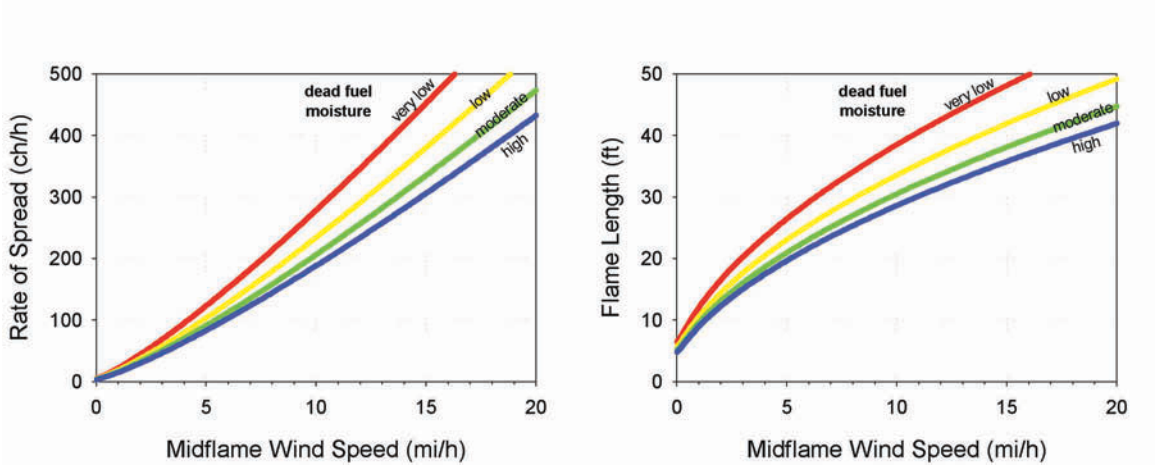
### *High Load, Very Coarse, Humid Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR8 is continuous, very coarse, humid-climate grass. Load and depth are greater than GR6. Spread rate and flame length can be extreme if grass is fully cured.

| | |
|---|---|
| Fine fuel load (t/ac) | 7.8 |
| Characteristic SAV (ft-1) | 1302 |
| Packing ratio (dimensionless) | 0.00316 |
| Extinction moisture content (percent) | 30 |



## *GR9 (109)*

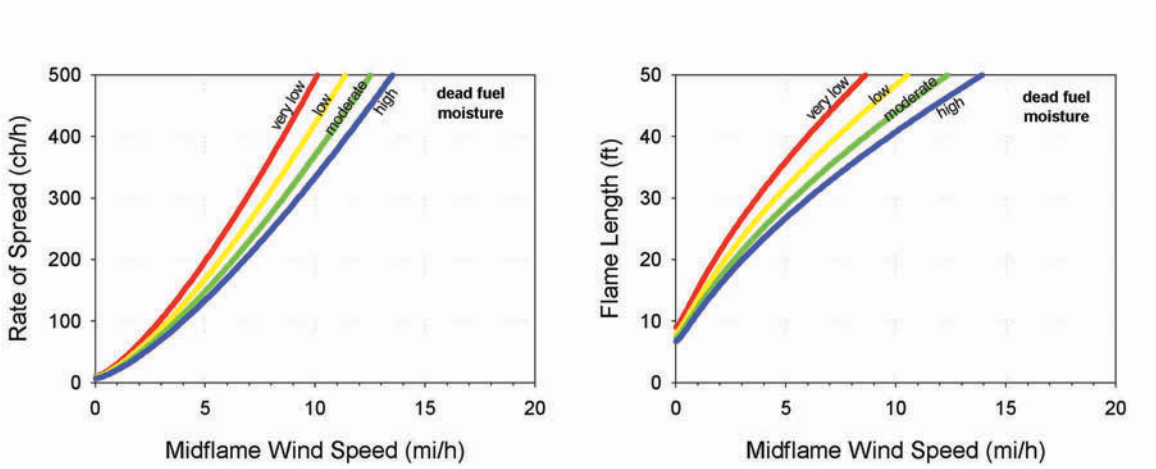
### *Very High Load, Humid Climate Grass (Dynamic)*





**Description:** The primary carrier of fire in GR9 is dense, tall, humid-climate grass. Load and depth are greater than GR8, about 6 feet tall. Spread rate and flame length can be extreme if grass is fully or mostly cured.

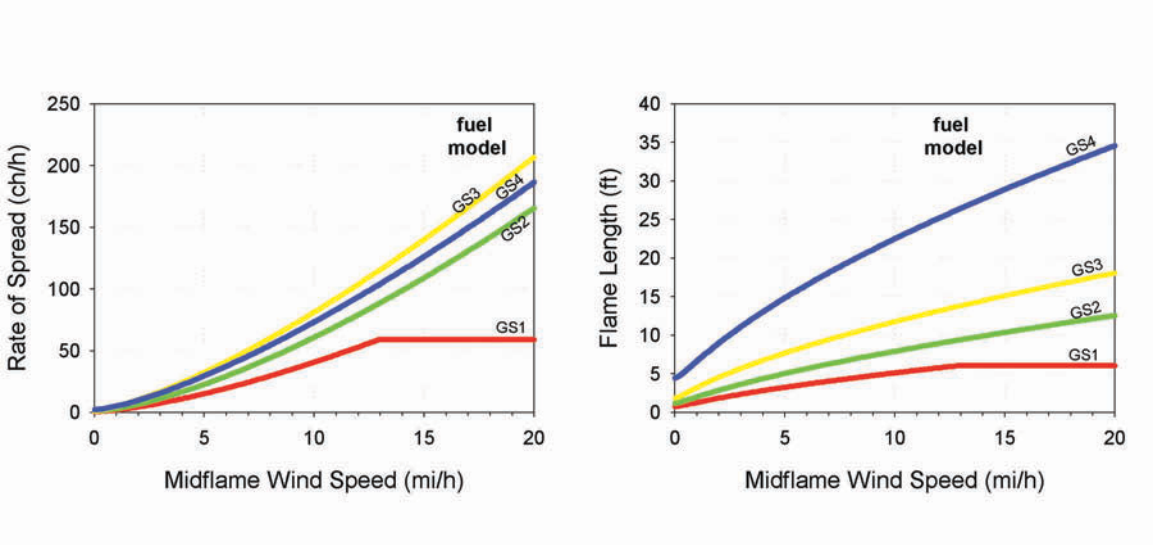
| | |
|---|---|
| Fine fuel load (t/ac) | 10.0 |
| Characteristic SAV (ft-1) | 1612 |
| Packing ratio (dimensionless) | 0.00316 |
| Extinction moisture content (percent) | 40 |



## Grass-Shrub Fuel Type Models (GS)

The primary carrier of fire in the GS fuel models is grass and shrubs combined; both components are important in determining fire behavior.

All GS fuel models are dynamic, meaning that their live herbaceous fuel load shifts from live to dead as a function of live herbaceous moisture content. The effect of live herbaceous moisture content on spread rate and intensity is strong and depends on the relative amount of grass and shrub load in the fuel model.



## *GS1 (121)*

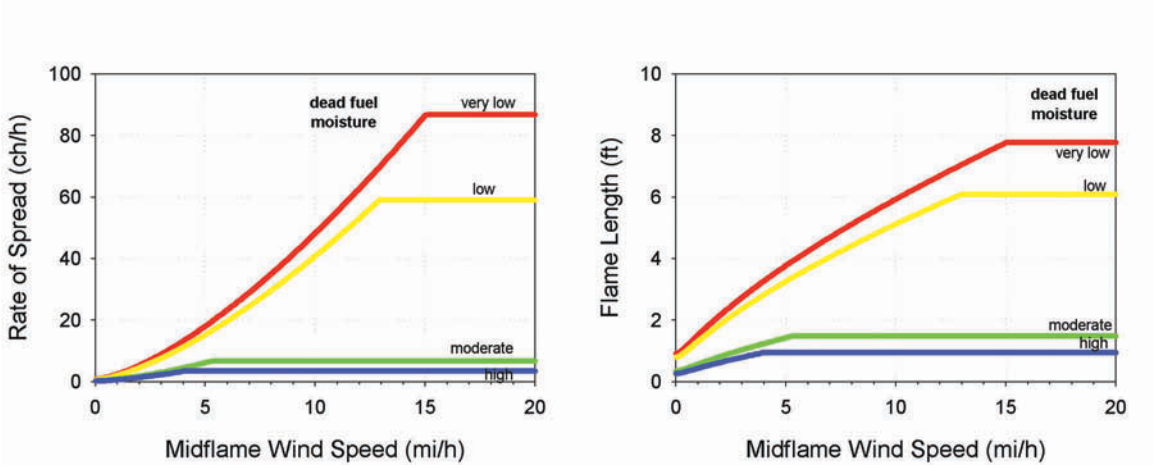
### *Low Load, Dry Climate Grass-Shrub (Dynamic)*





**Description:** The primary carrier of fire in GS1 is grass and shrubs combined. Shrubs are about 1 foot high, grass load is low. Spread rate is moderate; flame length low. Moisture of extinction is low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.35 |
| Characteristic SAV (ft-1) | 1832 |
| Packing ratio (dimensionless) | 0.00215 |
| Extinction moisture content (percent) | 15 |



## *GS2 (122)*

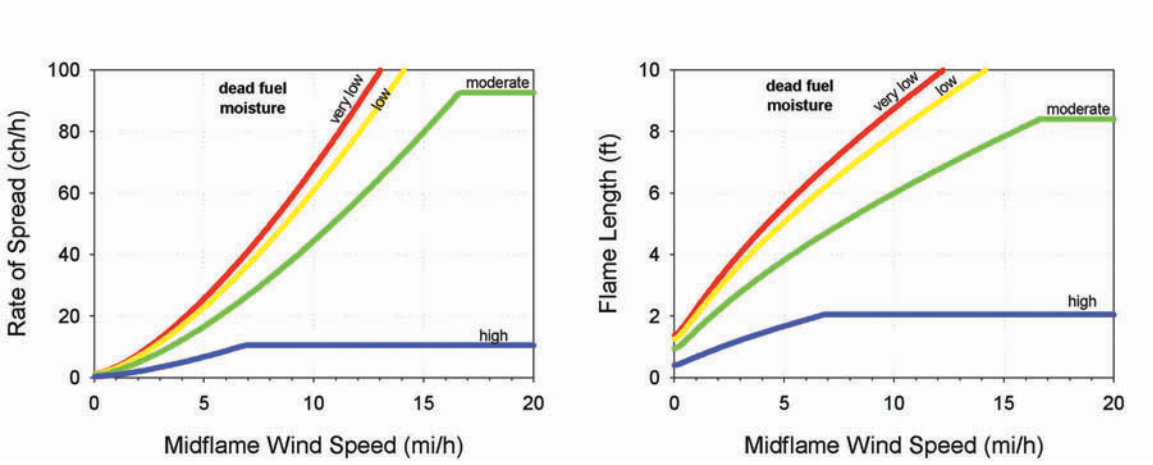
### *Moderate Load, Dry Climate Grass-Shrub (Dynamic)*





**Description:** The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate. Moisture of extinction is low.

| | |
|---|---|
| Fine fuel load (t/ac) | 2.1 |
| Characteristic SAV (ft-1) | 1827 |
| Packing ratio (dimensionless) | 0.00249 |
| Extinction moisture content (percent) | 15 |



## *GS3 (123)*

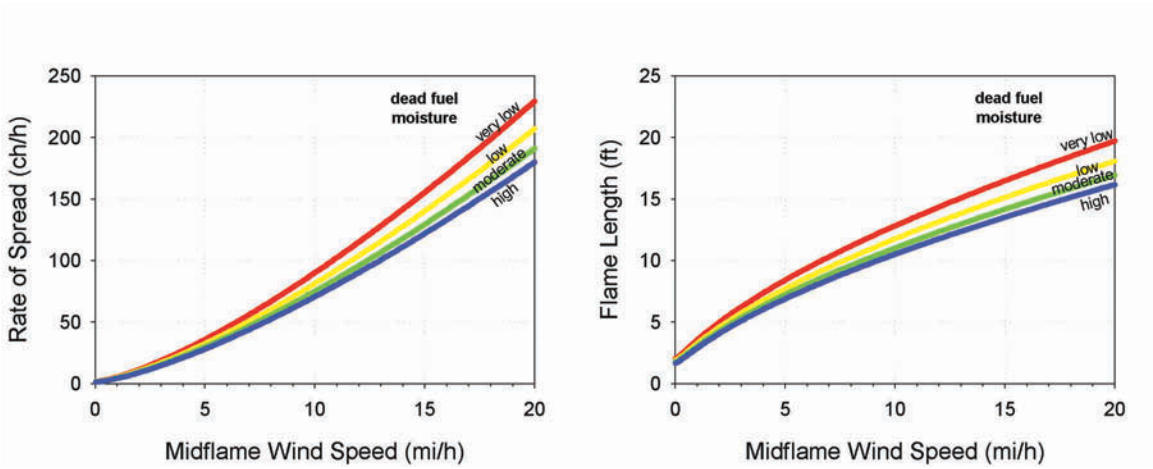
### *Moderate Load, Humid Climate Grass-Shrub (Dynamic)*





**Description:** The primary carrier of fire in GS3 is grass and shrubs combined. Moderate grass/shrub load, average grass/shrub depth less than 2 feet. Spread rate is high; flame length moderate. Moisture of extinction is high.

| | |
|---|---|
| Fine fuel load (t/ac) | 3.0 |
| Characteristic SAV (ft-1) | 1614 |
| Packing ratio (dimensionless) | 0.00259 |
| Extinction moisture content (percent) | 40 |



## *GS4 (124)*

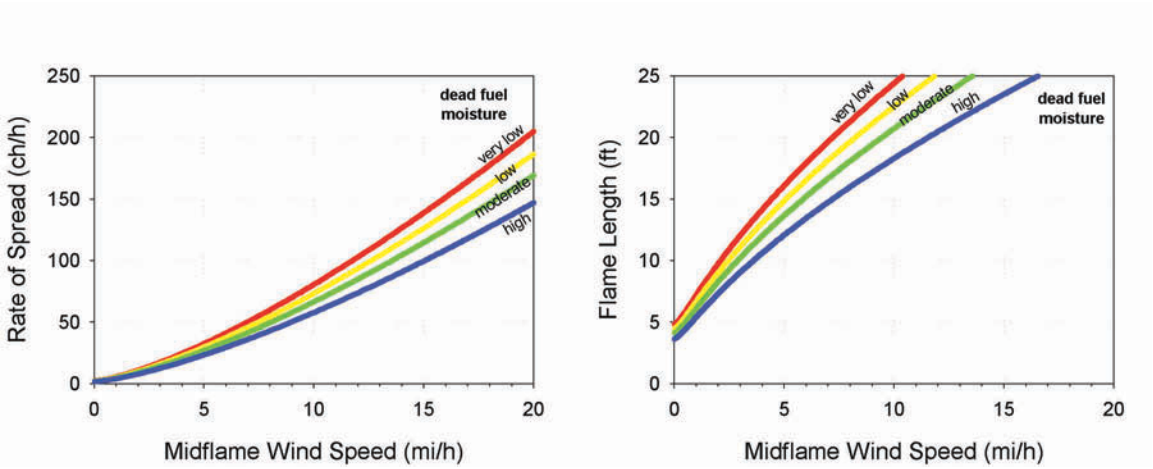
### *High Load, Humid Climate Grass-Shrub (Dynamic)*





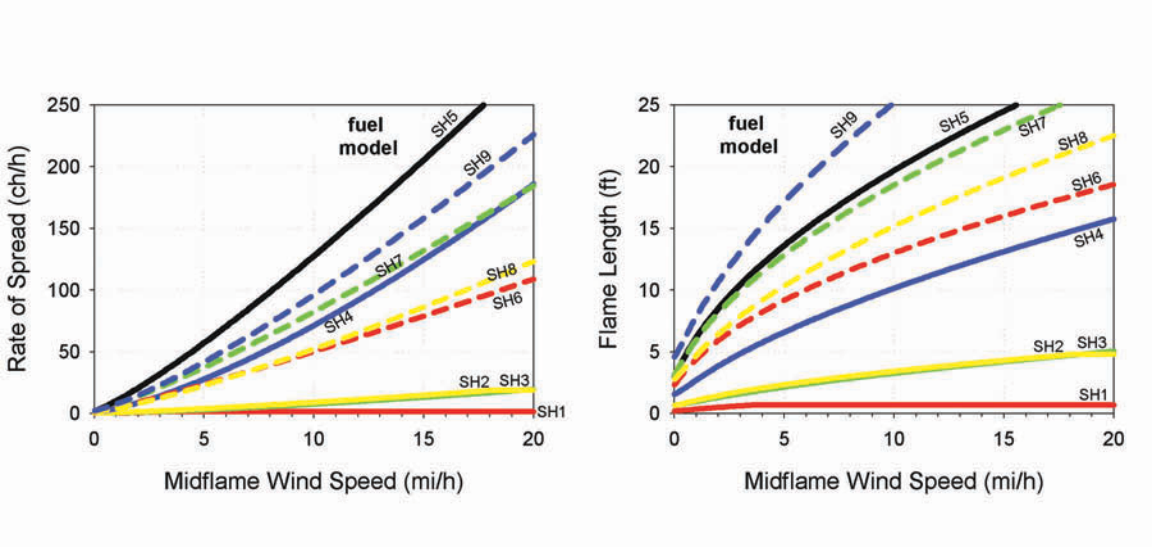
**Description:** The primary carrier of fire in GS4 is grass and shrubs combined. Heavy grass/shrub load, depth greater than 2 feet. Spread rate high; flame length very high. Moisture of extinction is high.

| | |
|---|---|
| Fine fuel load (t/ac) | 12.4 |
| Characteristic SAV (ft-1) | 1674 |
| Packing ratio (dimensionless) | 0.00874 |
| Extinction moisture content (percent) | 40 |



## Shrub Fuel Type Models (SH)

The primary carrier of fire in the SH fuel models is live and dead shrub twigs and foliage in combination with dead and down shrub litter. A small amount of herbaceous fuel may be present, especially in SH1 and SH9, which are dynamic models (their live herbaceous fuel load shifts from live to dead as a function of live herbaceous moisture content). The effect of live herbaceous moisture content on spread rate and flame length can be strong in those dynamic SH models.



## *SH1 (141)*

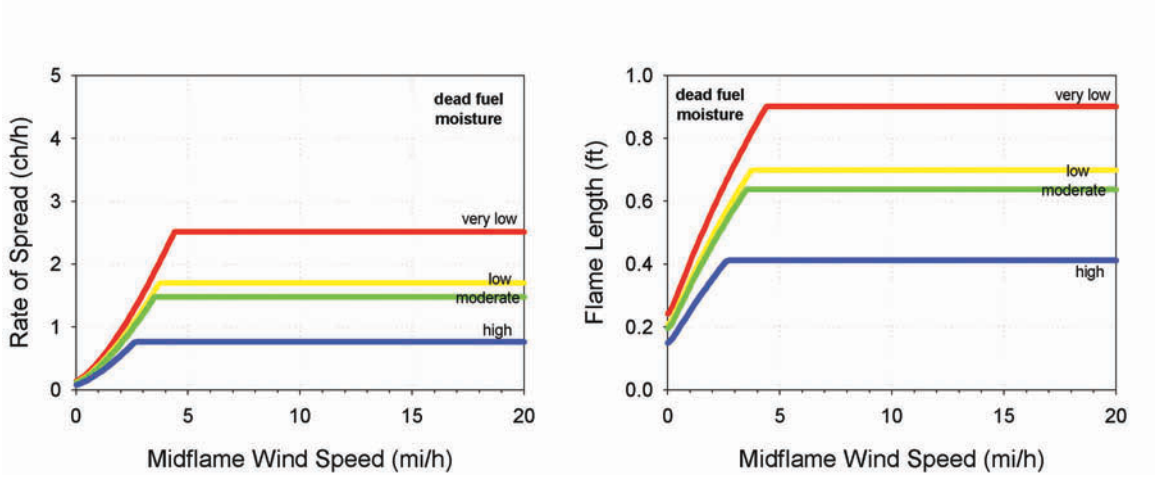
### *Low Load Dry Climate Shrub (Dynamic)*





**Description:** The primary carrier of fire in SH1 is woody shrubs and shrub litter. Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate is very low; flame length very low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.7 |
| Characteristic SAV (ft-1) | 1674 |
| Packing ratio (dimensionless) | 0.00280 |
| Extinction moisture content (percent) | 15 |



## *SH2 (142)*

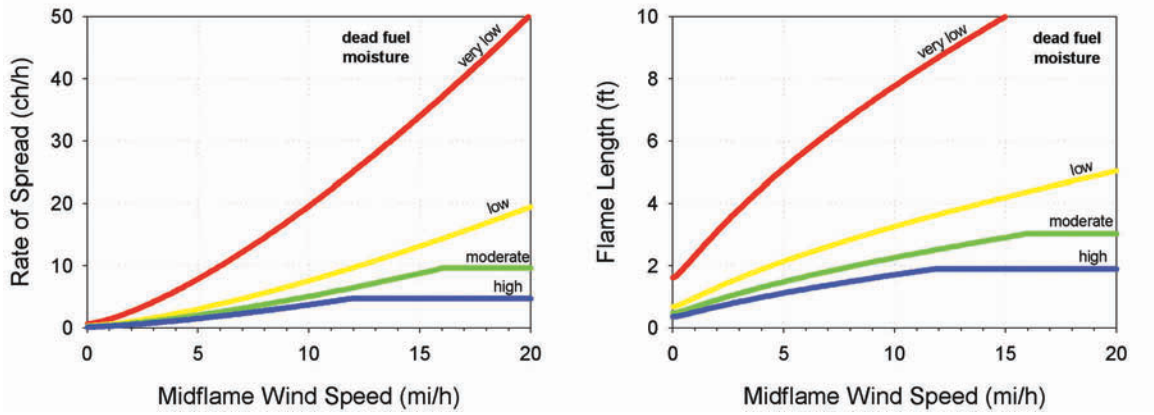
### *Moderate Load Dry Climate Shrub*





**Description:** The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate is low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 5.2 |
| Characteristic SAV (ft-1) | 1672 |
| Packing ratio (dimensionless) | 0.01198 |
| Extinction moisture content (percent) | 15 |



## *SH3 (143)*

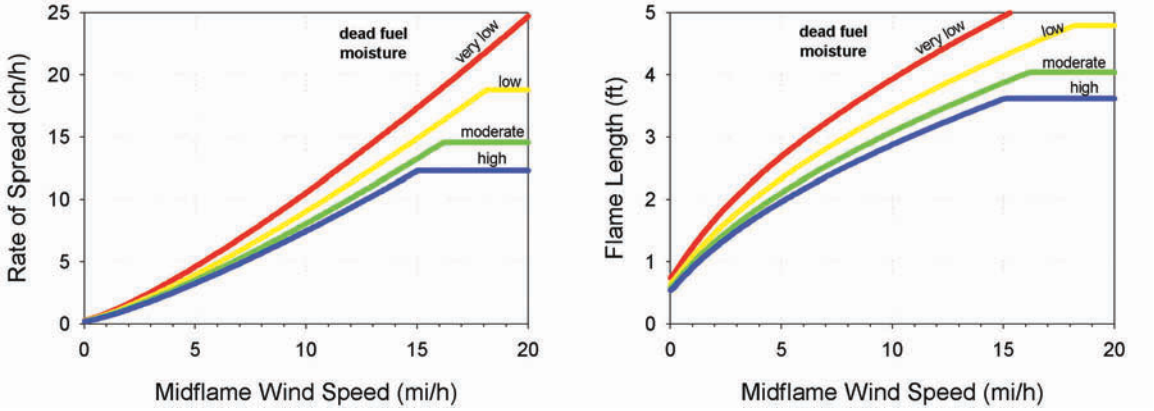
### *Moderate Load, Humid Climate Shrub*





**Description:** The primary carrier of fire in SH3 is woody shrubs and shrub litter. Moderate shrub load, possibly with pine overstory or herbaceous fuel, fuel bed depth 2 to 3 feet. Spread rate is low; flame length low.

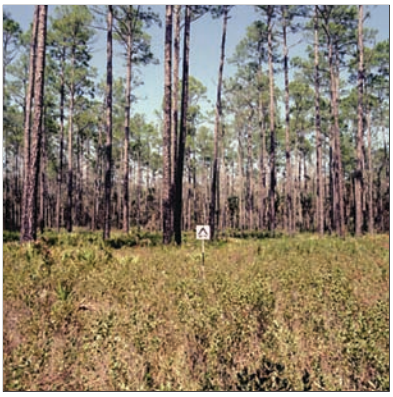
| | |
|---|---|
| Fine fuel load (t/ac) | 6.65 |
| Characteristic SAV (ft-1) | 1371 |
| Packing ratio (dimensionless) | 0.00577 |
| Extinction moisture content (percent) | 40 |



## *SH4 (144)*

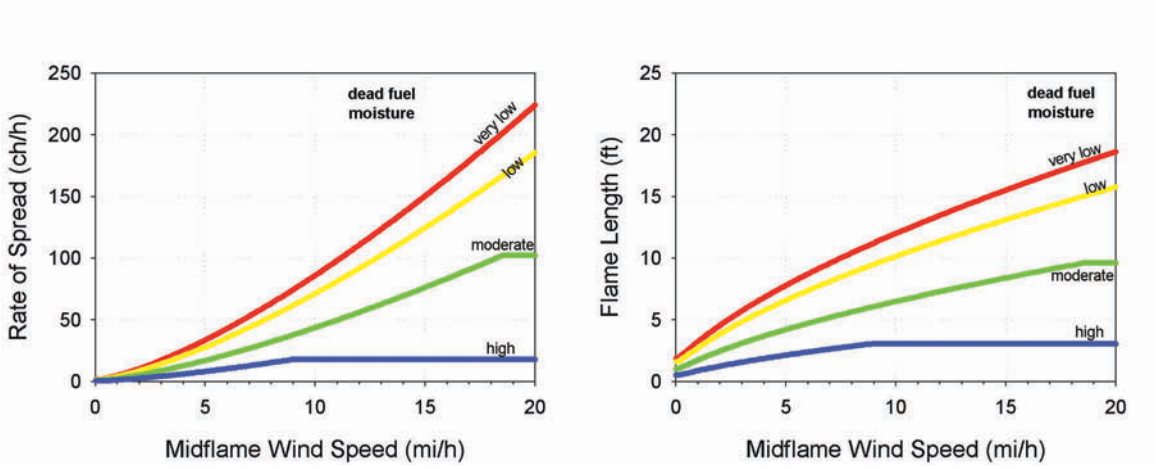
### *Low Load, Humid Climate Timber-Shrub*





**Description:** The primary carrier of fire in SH4 is woody shrubs and shrub litter. Low to moderate shrub and litter load, possibly with pine overstory, fuel bed depth about 3 feet. Spread rate is high; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 3.4 |
| Characteristic SAV (ft-1) | 1682 |
| Packing ratio (dimensionless) | 0.00227 |
| Extinction moisture content (percent) | 30 |



## *SH5 (145)*

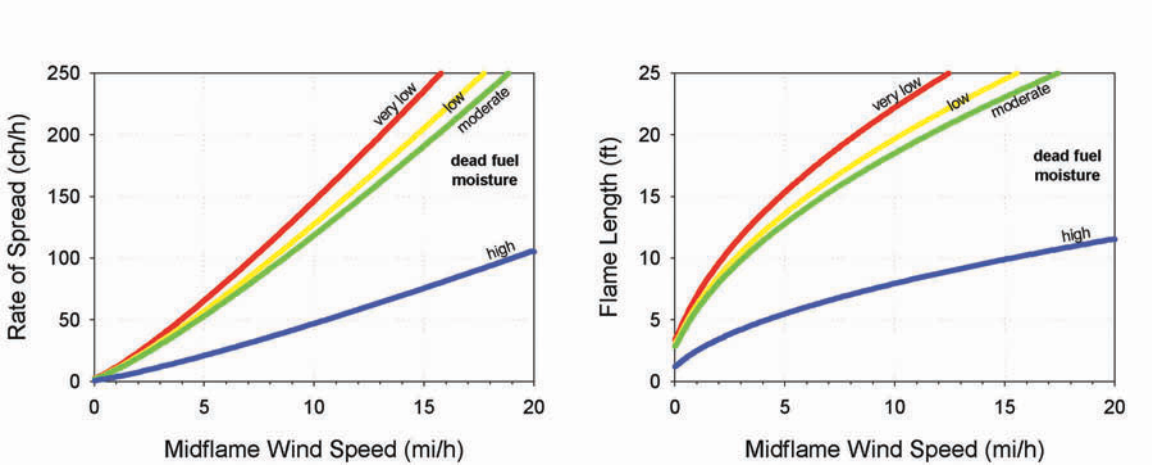
### *High Load, Dry Climate Shrub*





**Description:** The primary carrier of fire in SH5 is woody shrubs and shrub litter. Heavy shrub load, depth 4-6 feet. Spread rate very high; flame length very high. Moisture of extinction is high.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.5 |
| Characteristic SAV (ft-1) | 1252 |
| Packing ratio (dimensionless) | 0.00206 |
| Extinction moisture content (percent) | 15 |



## *SH6 (146)*

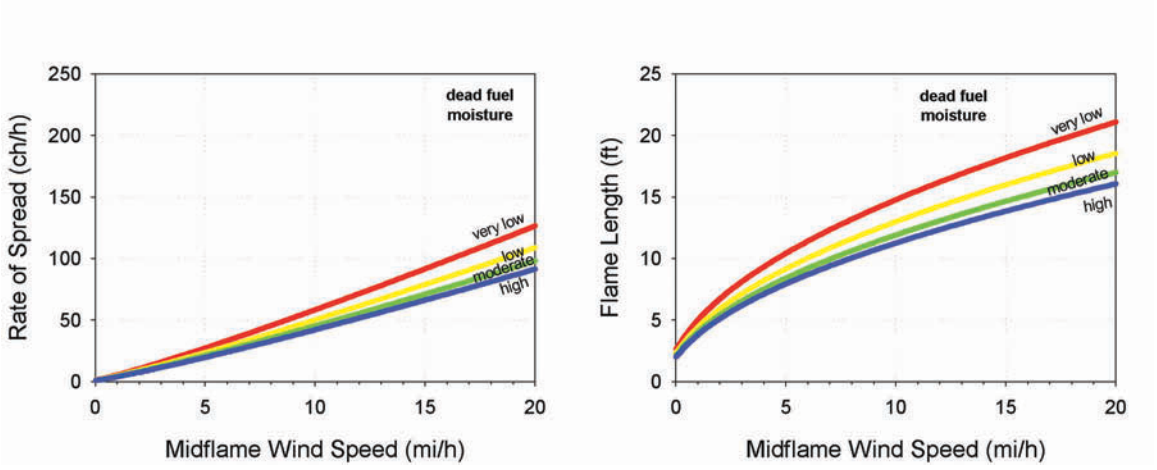
### *Low Load, Humid Climate Shrub*





**Description:** The primary carrier of fire in SH6 is woody shrubs and shrub litter. Dense shrubs, little or no herbaceous fuel, fuelbed depth about 2 feet. Spread rate is high; flame length high.

| | |
|---|---|
| Fine fuel load (t/ac) | 4.3 |
| Characteristic SAV (ft-1) | 1144 |
| Packing ratio (dimensionless) | 0.00412 |
| Extinction moisture content (percent) | 30 |



## *SH7 (147)*

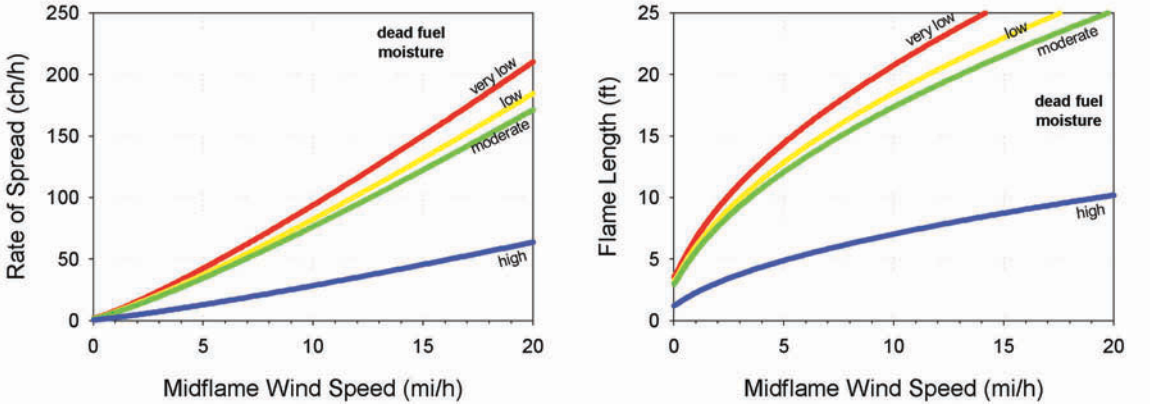
### *Very High Load, Dry Climate Shrub*





**Description:** The primary carrier of fire in SH7 is woody shrubs and shrub litter. Very heavy shrub load, depth 4 to 6 feet. Spread rate lower than SH7, but flame length similar. Spread rate is high; flame length very high.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.9 |
| Characteristic SAV (ft-1) | 1233 |
| Packing ratio (dimensionless) | 0.00344 |
| Extinction moisture content (percent) | 15 |



## *SH8 (148)*

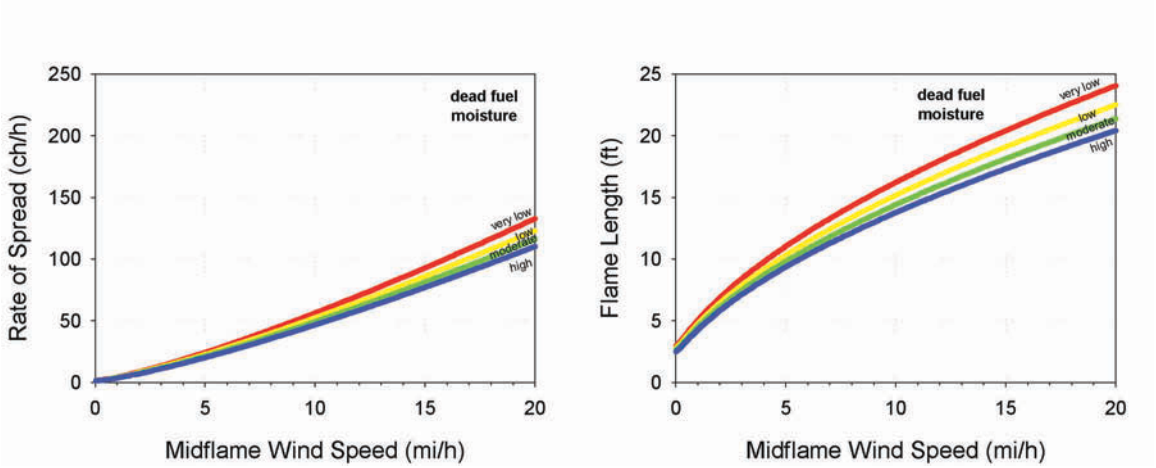
### *High Load, Humid Climate Shrub*





**Description:** The primary carrier of fire in SH8 is woody shrubs and shrub litter. Dense shrubs, little or no herbaceous fuel, fuelbed depth about 3 feet. Spread rate is high; flame length high.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.4 |
| Characteristic SAV (ft-1) | 1386 |
| Packing ratio (dimensionless) | 0.00509 |
| Extinction moisture content (percent) | 40 |



## *SH9 (149)*

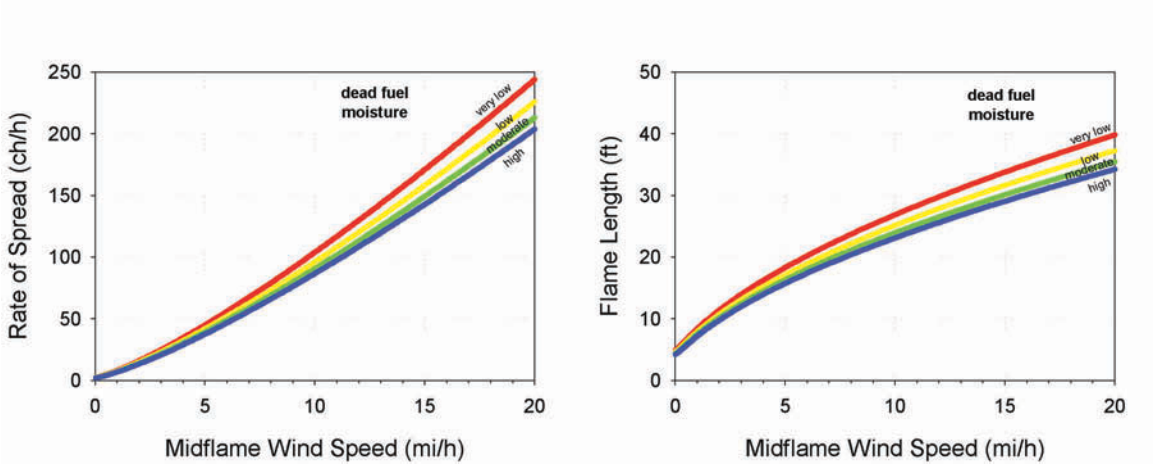
### *Very High Load, Humid Climate Shrub (Dynamic)*





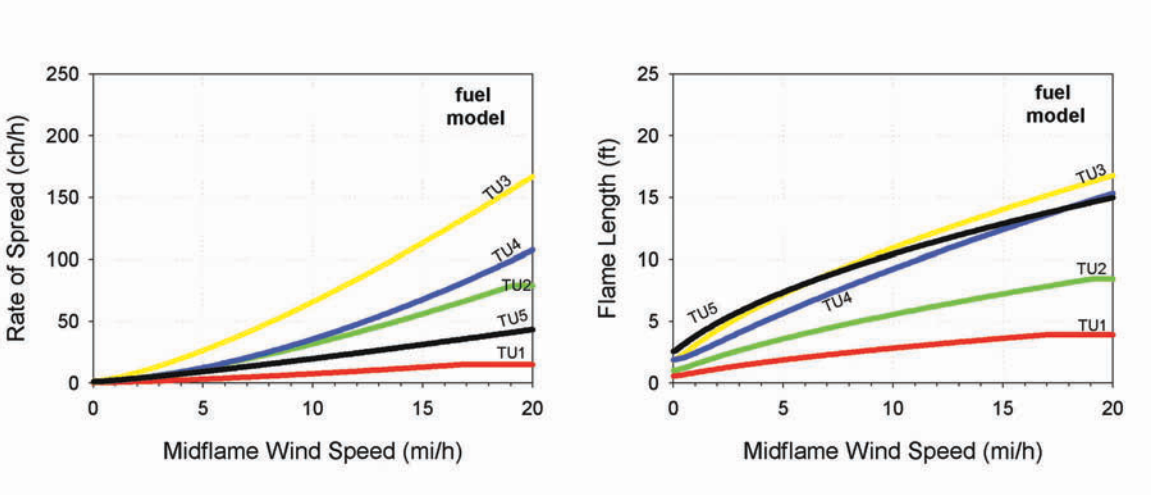
**Description:** The primary carrier of fire in SH9 is woody shrubs and shrub litter. Dense, finely branched shrubs with significant fine dead fuel, about 4 to 6 feet tall; some herbaceous fuel may be present. Spread rate is high, flame length very high.

| | |
|---|---|
| Fine fuel load (t/ac) | 13.05 |
| Characteristic SAV (ft-1) | 1378 |
| Packing ratio (dimensionless) | 0.00505 |
| Extinction moisture content (percent) | 40 |



## Timber-Understory Fuel Type Models (TU)

The primary carrier of fire in the TU fuel models is forest litter in combination with herbaceous or shrub fuels. TU1 and TU3 contain live herbaceous load and are dynamic, meaning that their live herbaceous fuel load is allocated between live and dead as a function of live herbaceous moisture content. The effect of live herbaceous moisture content on spread rate and intensity is strong and depends on the relative amount of grass and shrub load in the fuel model.



## *TU1 (161)*

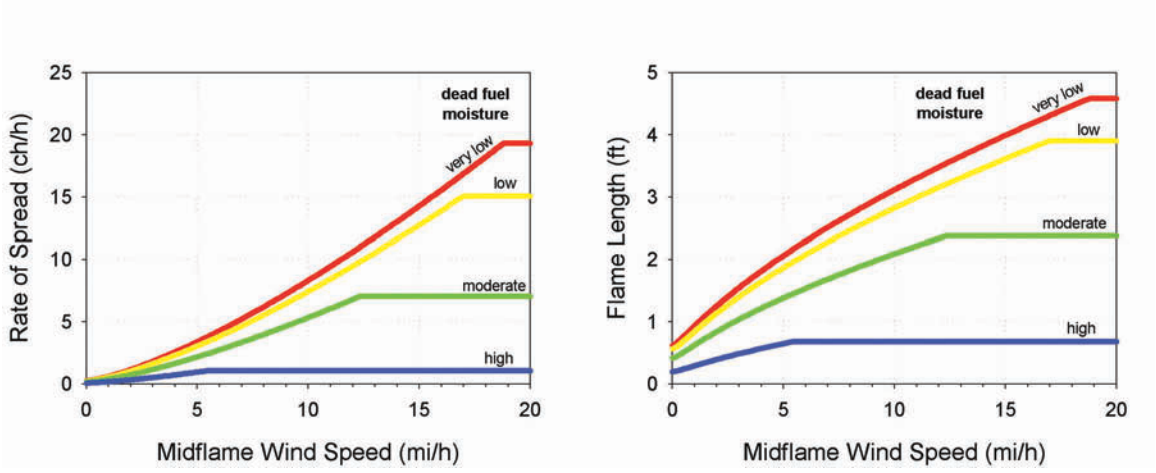
### *Low Load Dry Climate Timber-Grass-Shrub (Dynamic)*





**Description:** The primary carrier of fire in TU1 is low load of grass and/or shrub with litter. Spread rate is low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.3 |
| Characteristic SAV (ft-1) | 1606 |
| Packing ratio (dimensionless) | 0.00885 |
| Extinction moisture content (percent) | 20 |



## *TU2 (162)*

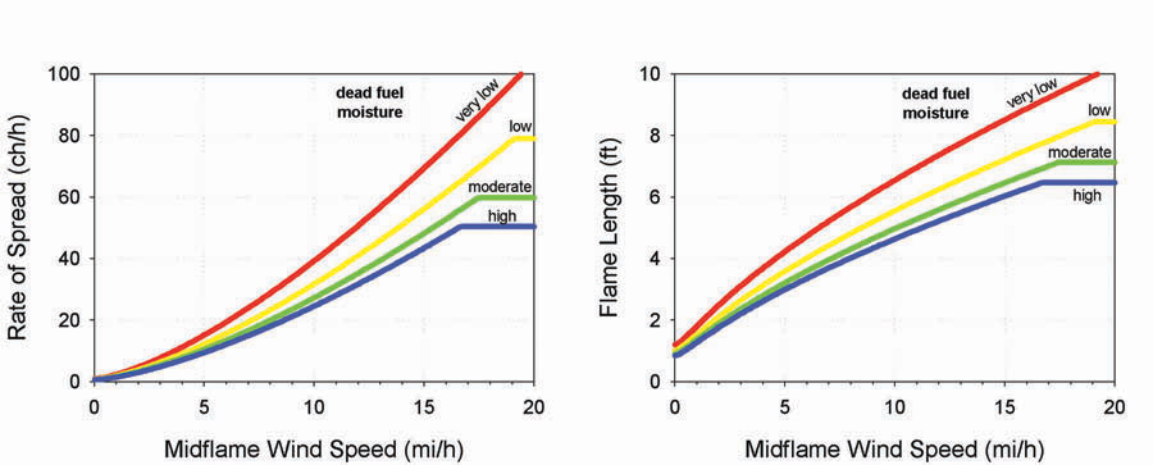
### *Moderate Load, Humid Climate Timber-Shrub*





**Description:** The primary carrier of fire in TU2 is moderate litter load with shrub component. High extinction moisture. Spread rate is moderate; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.15 |
| Characteristic SAV (ft-1) | 1767 |
| Packing ratio (dimensionless) | 0.00603 |
| Extinction moisture content (percent) | 30 |



## *TU3 (163)*

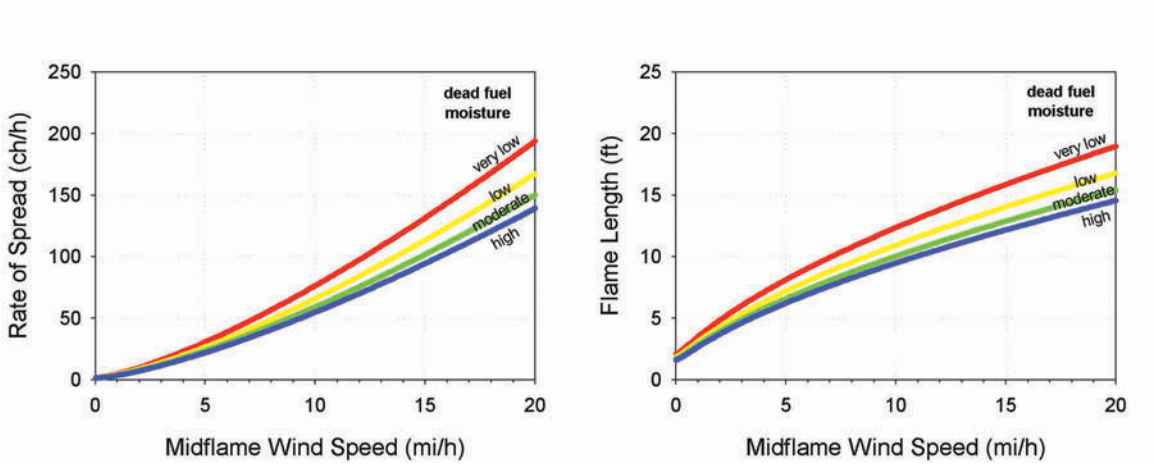
### *Moderate Load, Humid Climate Timber-Grass-Shrub (Dynamic)*





**Description:** The primary carrier of fire in TU3 is moderate forest litter with grass and shrub components. Extinction moisture is high. Spread rate is high; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 2.85 |
| Characteristic SAV (ft-1) | 1611 |
| Packing ratio (dimensionless) | 0.00359 |
| Extinction moisture content (percent) | 30 |



## *TU4 (164)*

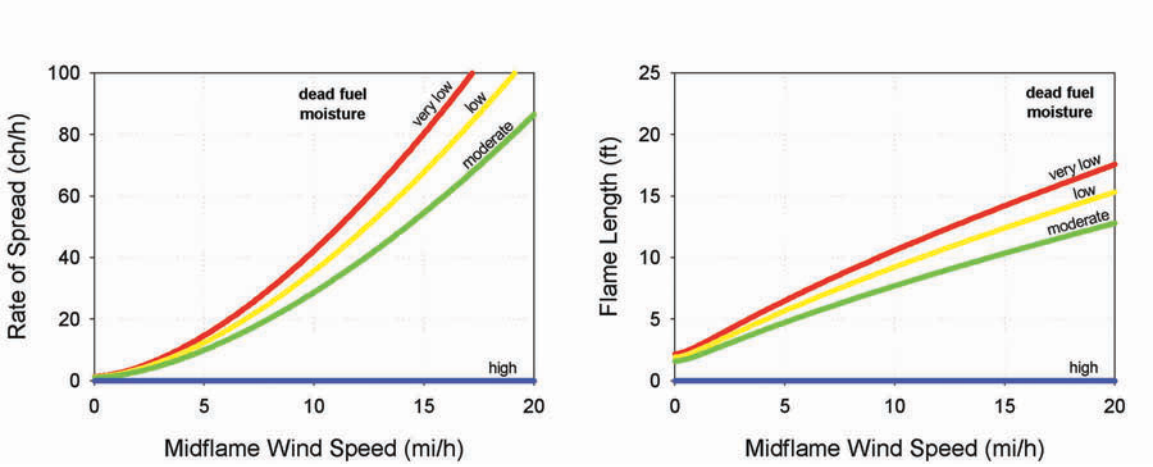
### *Dwarf Conifer With Understory*





**Description:** The primary carrier of fire in TU4 is short conifer trees with grass or moss understory. Spread rate is moderate; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.5 |
| Characteristic SAV (ft-1) | 2216 |
| Packing ratio (dimensionless) | 0.01865 |
| Extinction moisture content (percent) | 12 |



## *TU5 (165)*

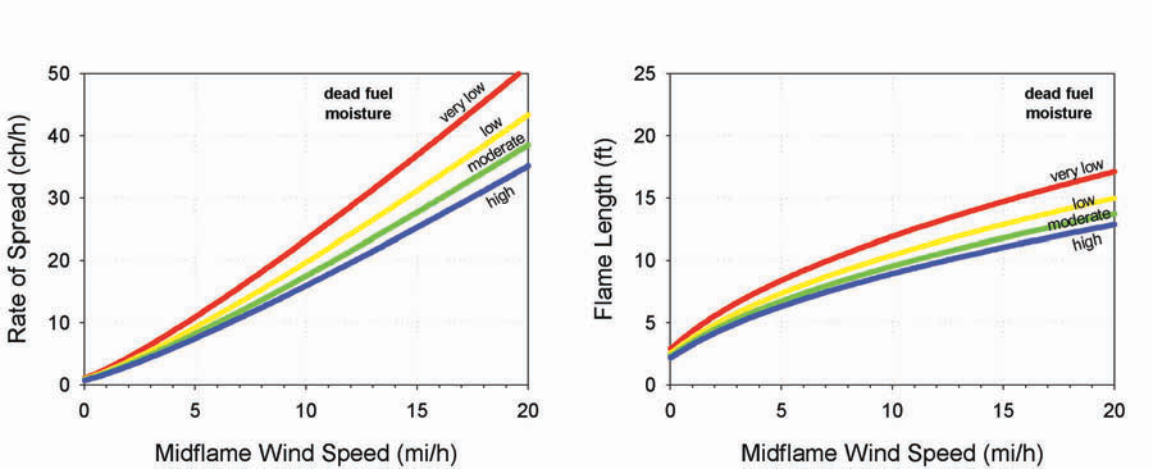
### *Very High Load, Dry Climate Timber-Shrub*





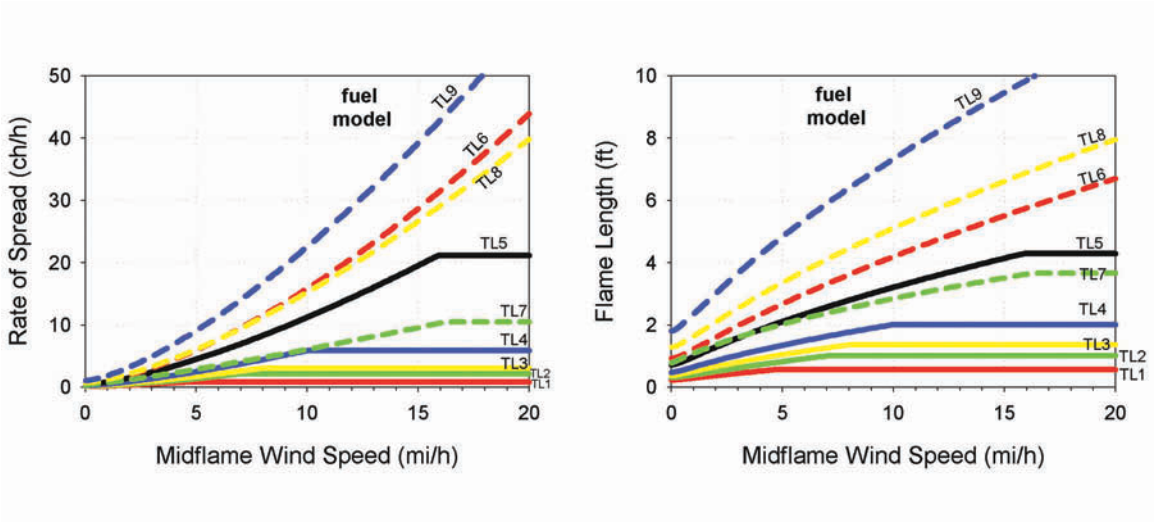
**Description:** The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 7.0 |
| Characteristic SAV (ft-1) | 1224 |
| Packing ratio (dimensionless) | 0.02009 |
| Extinction moisture content (percent) | 25 |



## Timber Litter Fuel Type Models (TL)

The primary carrier of fire in the TL fuel models is dead and down woody fuel. Live fuel, if present, has little effect on fire behavior.



## *TL1 (181)*

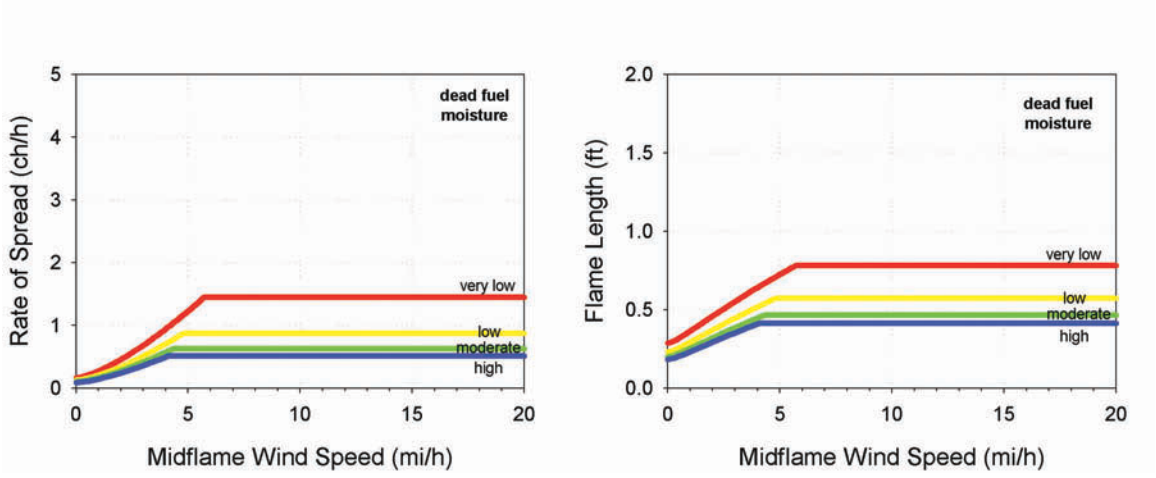
### *Low Load Compact Conifer Litter*





**Description:** The primary carrier of fire in TL1 is compact forest litter. Light to moderate load, fuels 1 to 2 inches deep. May be used to represent a recently burned forest. Spread rate is very low; flame length very low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.0 |
| Characteristic SAV (ft-1) | 1716 |
| Packing ratio (dimensionless) | 0.04878 |
| Extinction moisture content (percent) | 30 |



## *TL2 (182)*

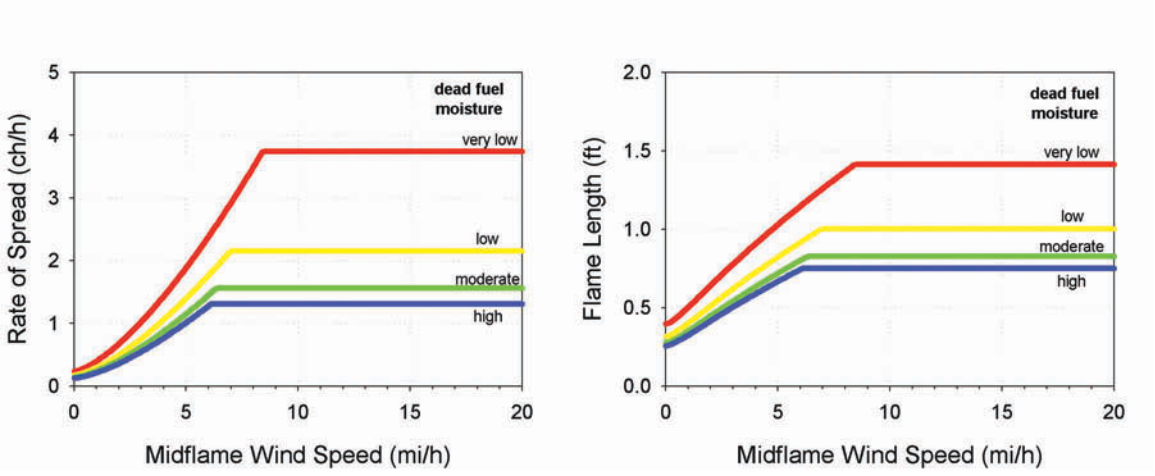
### *Low Load Broadleaf Litter*





**Description:** The primary carrier of fire in TL2 is broadleaf (hardwood) litter. Low load, compact broadleaf litter. Spread rate is very low; flame length very low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.4 |
| Characteristic SAV (ft-1) | 1806 |
| Packing ratio (dimensionless) | 0.04232 |
| Extinction moisture content (percent) | 25 |



## *TL3 (183)*

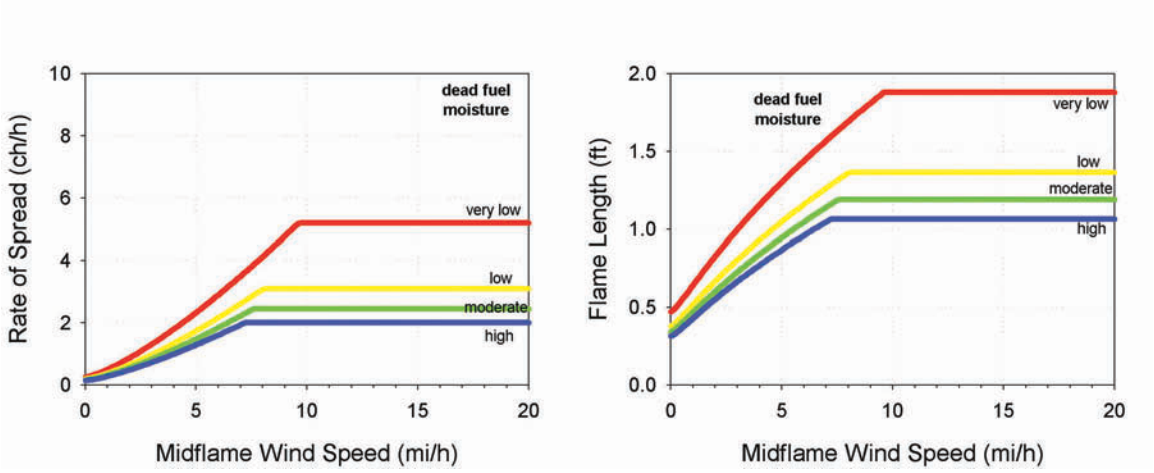
### *Moderate Load Conifer Litter*





**Description:** The primary carrier of fire in TL3 is moderate load conifer litter, light load of coarse fuels. Spread rate is very low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 0.50 |
| Characteristic SAV (ft-1) | 1532 |
| Packing ratio (dimensionless) | 0.02630 |
| Extinction moisture content (percent) | 20 |



## *TL4 (184)*

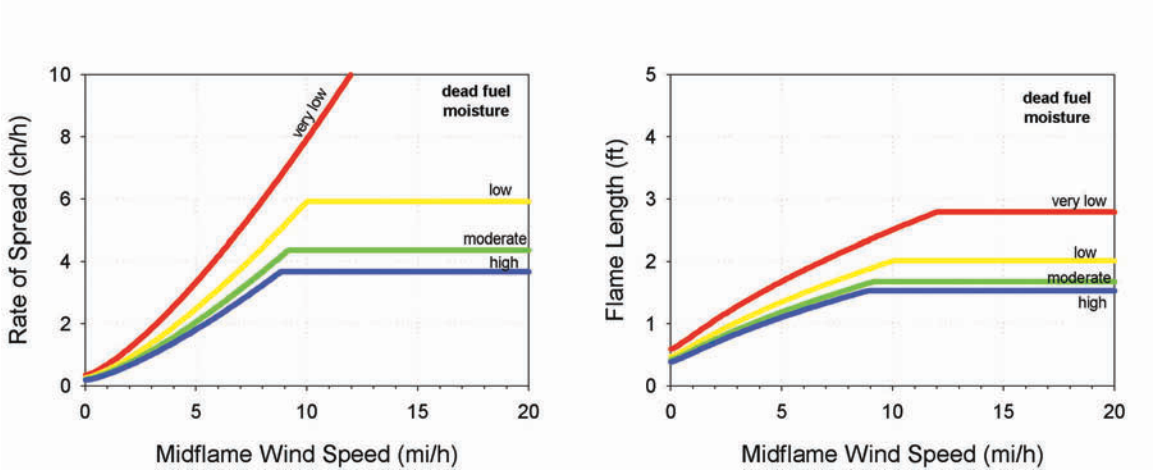
### *Small downed logs*





**Description:** The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels. Includes small diameter downed logs. Spread rate is low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 0.50 |
| Characteristic SAV (ft-1) | 1568 |
| Packing ratio (dimensionless) | 0.02224 |
| Extinction moisture content (percent) | 25 |



## *TL5 (185)*

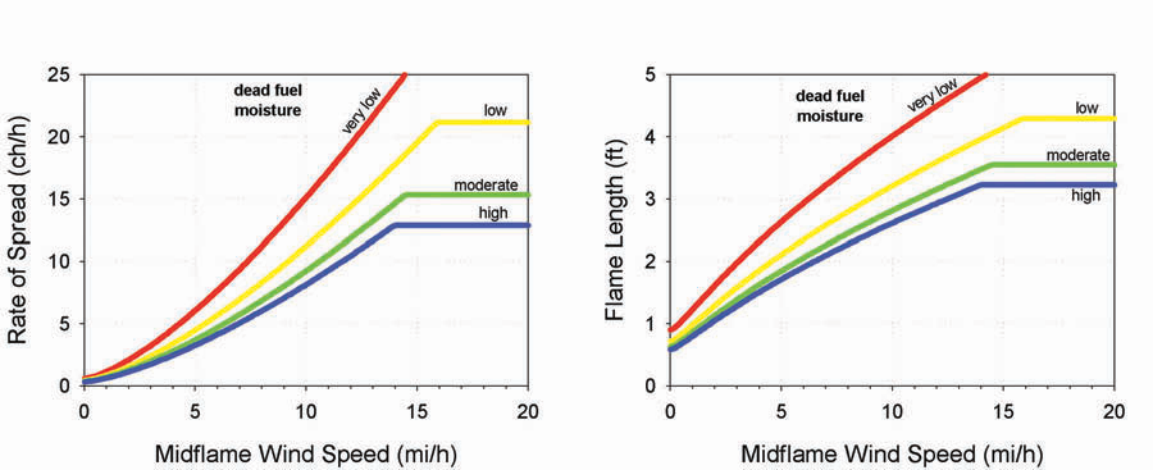
## *High Load Conifer Litter*





**Description:** The primary carrier of fire in TL5 is high load conifer litter; light slash or mortality fuel. Spread rate is low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.15 |
| Characteristic SAV (ft-1) | 1713 |
| Packing ratio (dimensionless) | 0.01925 |
| Extinction moisture content (percent) | 25 |



## *TL6 (186)*

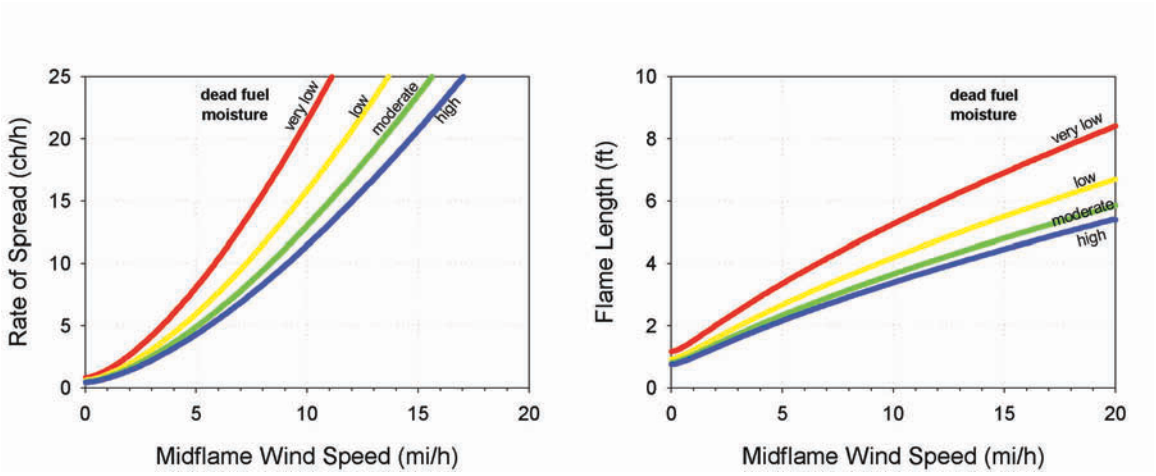
### *Moderate Load Broadleaf Litter*





**Description:** The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 2.4 |
| Characteristic SAV (ft-1) | 1936 |
| Packing ratio (dimensionless) | 0.02296 |
| Extinction moisture content (percent) | 25 |



## *TL7 (187)*

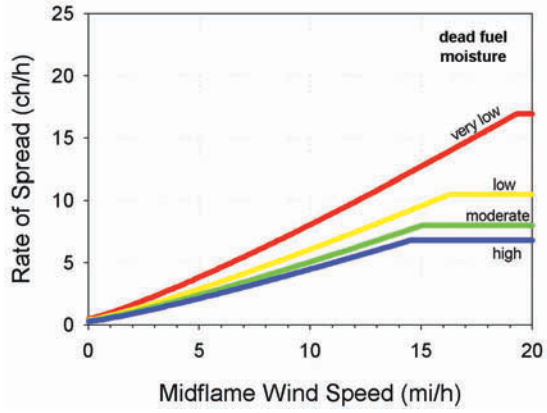
### *Large Downed Logs*

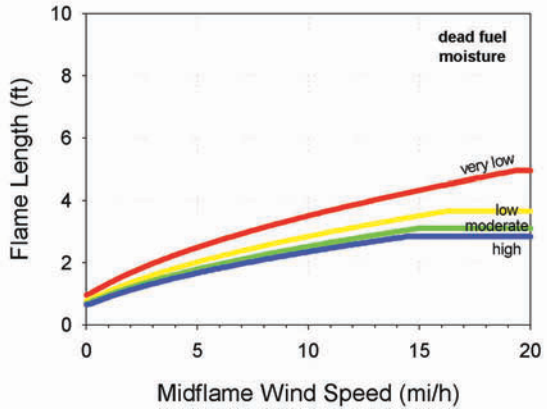




**Description:** The primary carrier of fire in TL7 is heavy load forest litter, includes larger diameter downed logs. Spread rate low; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 0.30 |
| Characteristic SAV (ft-1) | 1229 |
| Packing ratio (dimensionless) | 0.03515 |
| Extinction moisture content (percent) | 25 |



## *TL8 (188)*

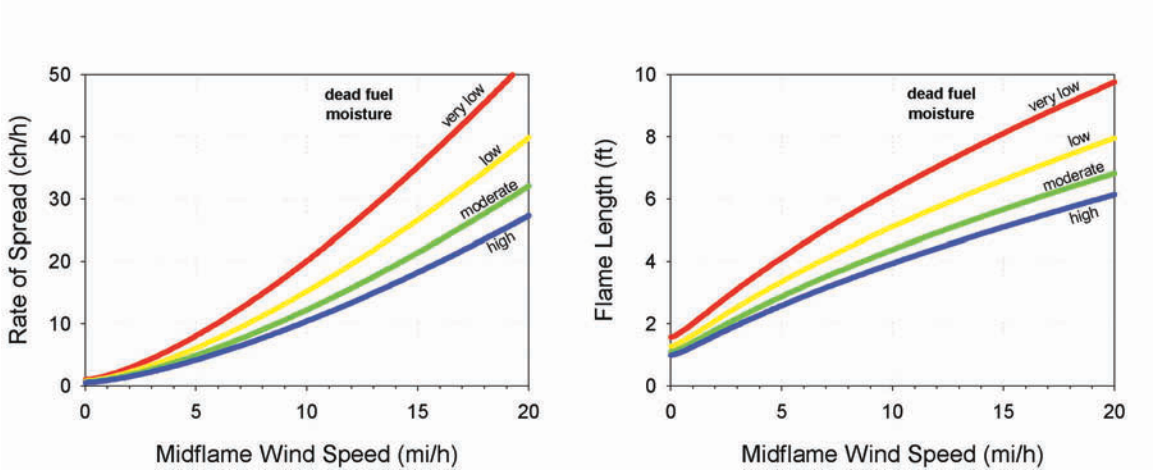
## *Long-Needle Litter*





**Description:** The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 5.8 |
| Characteristic SAV (ft-1) | 1770 |
| Packing ratio (dimensionless) | 0.03969 |
| Extinction moisture content (percent) | 35 |



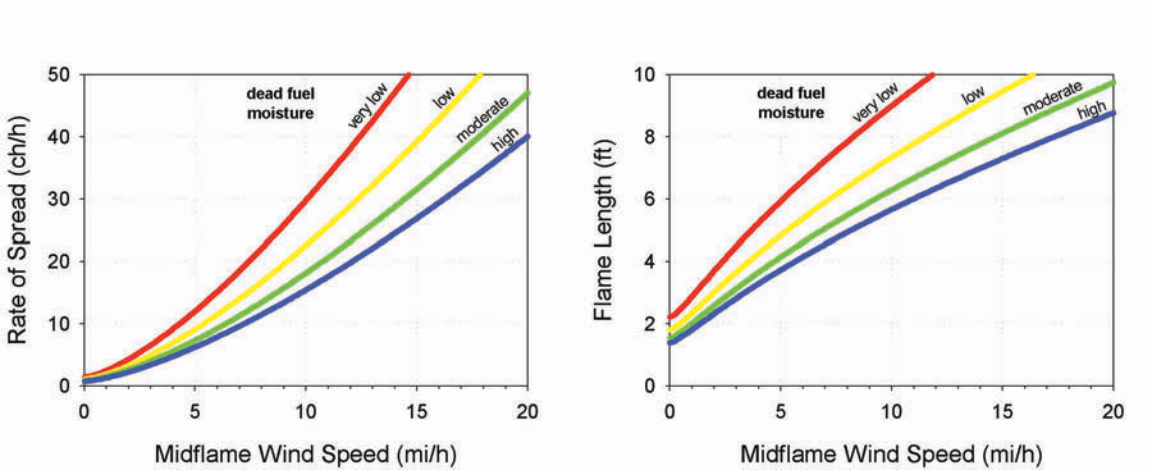
## *TL9 (189)*

### *Very High Load Broadleaf Litter*



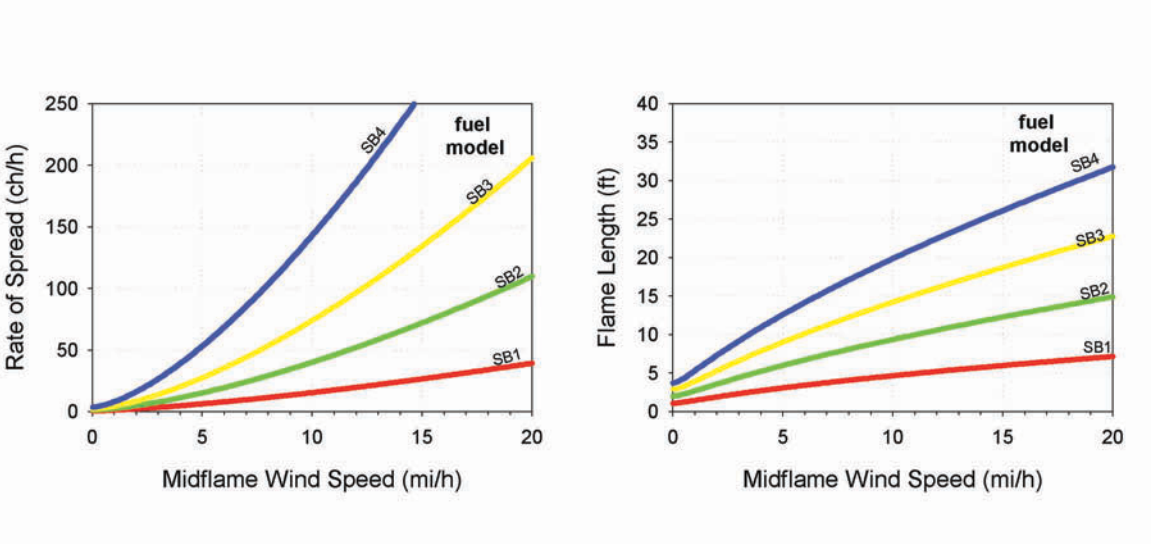
**Description:** The primary carrier of fire in TL9 is very high load, fluffy broadleaf litter. TL9 can also be used to represent heavy needle-drape. Spread rate is moderate; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 6.65 |
| Characteristic SAV (ft-1) | 1733 |
| Packing ratio (dimensionless) | 0.03372 |
| Extinction moisture content (percent) | 35 |



## Slash-Blowdown Fuel Type Models (SB)

The primary carrier of fire in the SB fuel models is activity fuel or blowdown. Forested areas with heavy mortality may be modeled with SB fuel models.



## *SB1 (201)*

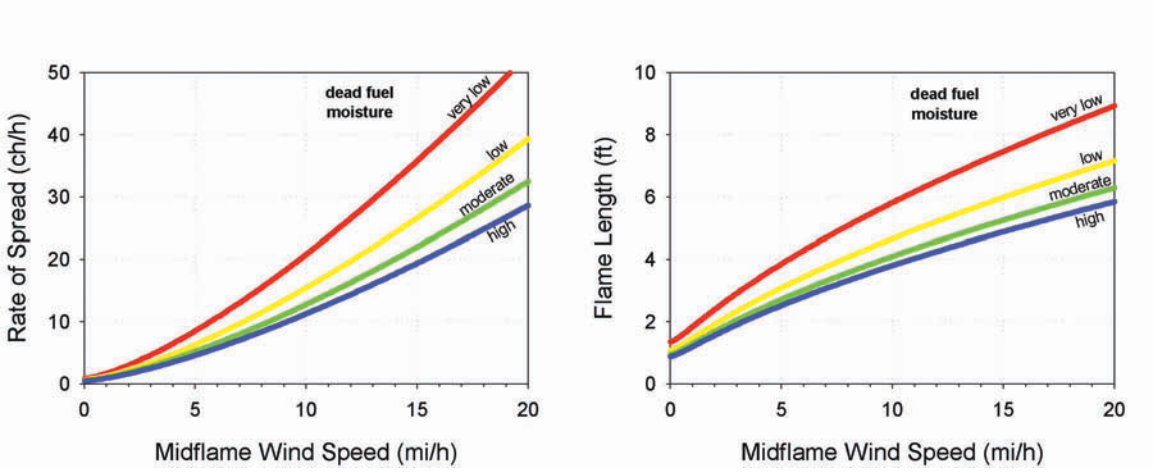
## *Low Load Activity Fuel*





**Description:** The primary carrier of fire in SB1 is light dead and down activity fuel. Fine fuel load is 10 to 20 t/ac, weighted toward fuels 1 to 3 inches diameter class, depth is less than 1 foot. Spread rate is moderate; flame length low.

| | |
|---|---|
| Fine fuel load (t/ac) | 1.50 |
| Characteristic SAV (ft-1) | 1653 |
| Packing ratio (dimensionless) | 0.02224 |
| Extinction moisture content (percent) | 25 |



## *SB2 (202)*

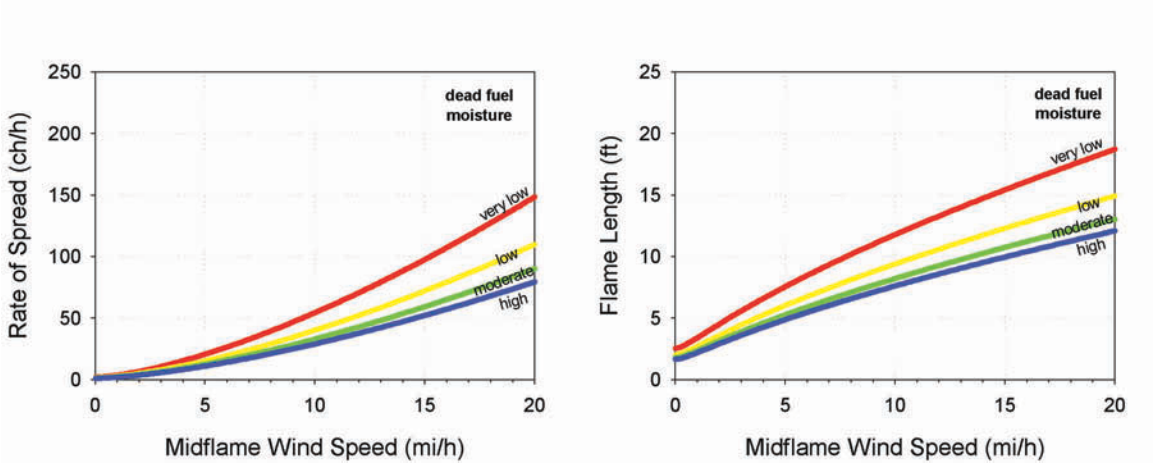
### *Moderate Load Activity Fuel or Low Load Blowdown*





**Description:** The primary carrier of fire in SB2 is moderate dead and down activity fuel or light blowdown. Fine fuel load is 7 to 12 t/ac, evenly distributed across 0 to 0.25, 0.25 to 1, and 1 to 3 inch diameter classes, depth is about 1 foot. Blowdown is scattered, with many trees still standing. Spread rate is moderate; flame length moderate.

| | |
|---|---|
| Fine fuel load (t/ac) | 4.5 |
| Characteristic SAV (ft-1) | 1884 |
| Packing ratio (dimensionless) | 0.01829 |
| Extinction moisture content (percent) | 25 |



## *SB3 (203)*

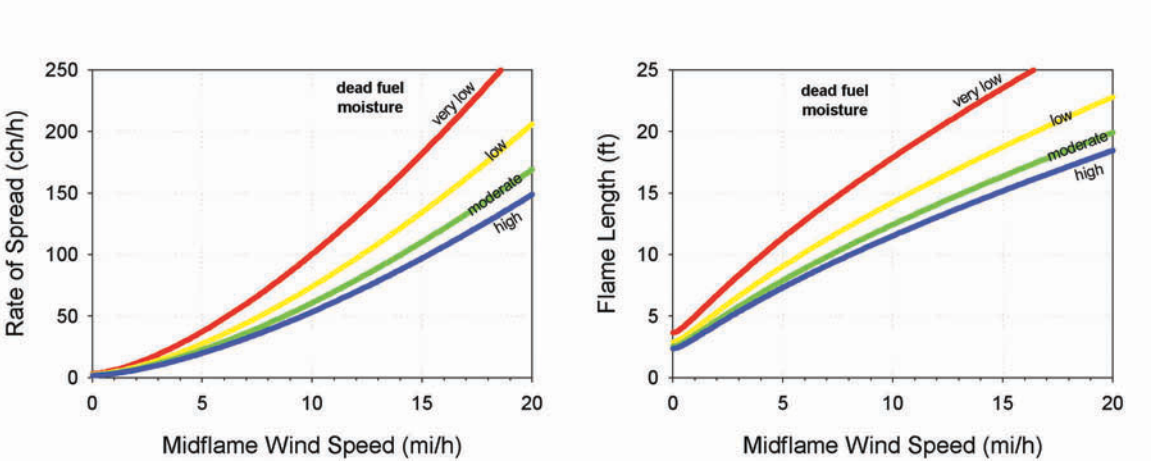
### *High Load Activity Fuel or Moderate Load Blowdown*





**Description:** The primary carrier of fire in SB3 is heavy dead and down activity fuel or moderate blowdown. Fine fuel load is 7 to 12 t/ac, weighted toward 0 to 0.25 inch diameter class, depth is more than 1 foot. Blowdown is moderate, trees compacted to near the ground. Spread rate is high; flame length high.

| | |
|---|---|
| Fine fuel load (t/ac) | 5.50 |
| Characteristic SAV (ft-1) | 1935 |
| Packing ratio (dimensionless) | 0.01345 |
| Extinction moisture content (percent) | 25 |



## *SB4 (204)*

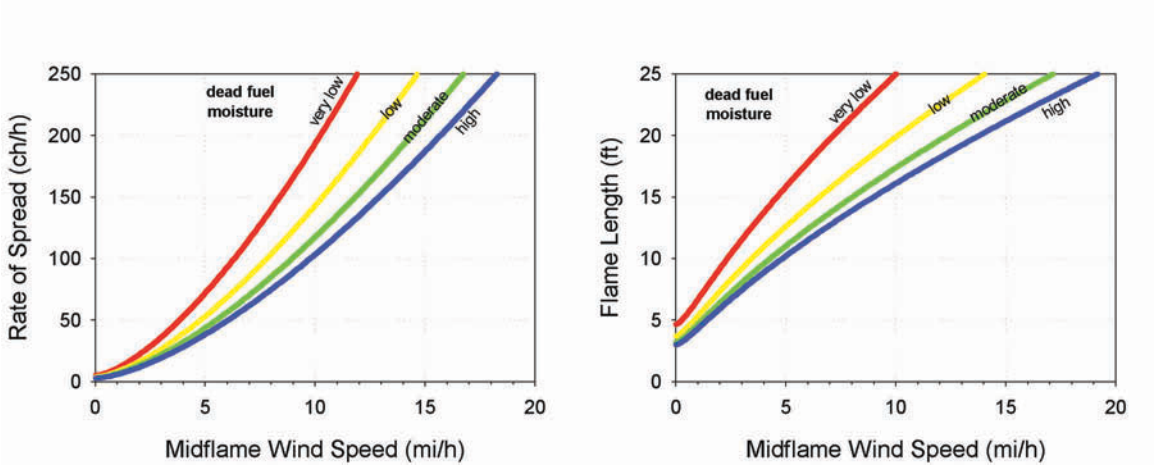
### *High Load Blowdown*





**Description:** The primary carrier of fire in SB4 is heavy blowdown fuel. Blowdown is total, fuelbed not compacted, most foliage and fine fuel still attached to blowdown. Spread rate very high; flame length very high.

| | |
|---|---|
| Fine fuel load (t/ac) | 5.25 |
| Characteristic SAV (ft-1) | 1907 |
| Packing ratio (dimensionless) | 0.00744 |
| Extinction moisture content (percent) | 25 |



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GREATER FLAGSTAFF FORESTS PARTNERSHIP

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001

March 11, 2011

Mike Williams
Supervisor, Kaibab National Forest
Earl Stewart
Supervisor, Coconino National Forest

**RE: Four Forest Restoration Initiative, 1st Phase Proposed Action**

Dear Mike and Earl:

Thank you for the opportunity to provide comments on the proposal to conduct restoration activities on ponderosa pine ecosystems within a 750,000-acre portion of the Coconino and Kaibab National Forests as part of the Four Forest Restoration Initiative (4FRI) (Letter of January 21, 2011, File Code: 1950). We applaud the Forest Service (FS) for this bold initiative and for willingness to work collaboratively on the planning of such a large and innovative project.

As you are aware, the Greater Flagstaff Forests Partnership (GFFP) has been working on forest restoration and community protection activities throughout the Greater Flagstaff landscape for more than 12 years. As such, several Partners from GFFP have been heavily engaged in the 4FRI since the inception of this historic landscape scale restoration project. Working directly with the FS 4FRI Team and, as members of the 4FRI Stakeholder Group, the GFFP has been greatly encouraged by the efficiency and depth of your approach to this dynamic effort. As members of the 4FRI, we have reviewed the letter that will be submitted on behalf of the Stakeholders to the FS regarding this Proposed Action (PA) and agree and concur with the comments provided in that letter under the eight headings of: 1) Detail; 2) Strategic Placement of Treatments; 3) Old Growth; 4) Managing with Fire; 5) Ecological Restoration; 6) Economics and Utilization; 7) Monitoring; and 8) Adaptive Management. We therefore reinforce those comments with this letter.

We also provide the following comments directly from the GFFP Board of Directors:

1) Based on the section of the PA (page 3) and on the FS 4FRI Team presentations made at the recent Public Workshops regarding treatment options or approaches for the PA, we are concerned regarding the limited number of treatment types as presented. We hope that there will be a variety of treatments that actually could be implemented within any one of the treatment options identified. GFFP looks forward to working with you to develop the treatment scenarios into more specific treatment options based upon site specific resource considerations.

1300 S. Milton Road, Suite 209 Flagstaff, AZ 86001 FAX 928-226-1387 admin@gffp.org www.gffp.org

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1 We want to ensure that the PA results in a diversity of thinning and fire treatments that provide the full natural range of variability of forest structure, composition and function necessary to meet all resource objectives and that will support natural fire regimes across the landscape.

2) We are encouraged by your discussion of "strategic placement of treatments would maximize the ability to reduce fire risk" in the PA section (page 3, paragraph 3). The GFFP believes that the Lake Mary Watershed (LMW) is a priority treatment area (municipal water supply source prioritized in the local CWPP). In utilizing a strategic placement of treatments approach, we recommend the LMW is prioritized as one of the first treatment implementation areas. GFFP would like to work with the FS, City of Flagstaff (a GFFP Partner) and other stakeholders to designate the LMW as a priority area and assist in designing a treatment approach and an aggressive timeline that reduces the potential negative effects of a severe fire on this critical watershed that so many citizens cherish and rely on.

2

3) As stated above relating to the 4FRI Stakeholder Group comment letter, the GFFP is concerned about a lack of specificity in the PA and during Public Workshop presentations about where, when and what type of treatment action will take place. Related issues are: determining where treatments, especially silvicultural and fire-based, fit into a trajectory of achieving restoration objectives outlined in the Desired Future Conditions (DFCs); how stakeholder "filters" (such as Candidate Areas or the Old Growth Protection and Large Tree Retention Strategy) may affect treatment placement and intensity; and how various other "filters" are applied and prioritized to potentially modify and refine proposed treatments at the project level. To that end, GFFP commits to working with the FS to develop a Landscape Restoration Matrix that can be incorporated into the final PA; one that could be used at the Treatment Area, Firescape or full Analysis Area level.

3

4) The GFFP worked with the FS and 4FRI Stakeholders in development and submission of the Collaborative Forest Landscape Restoration Program (CFLRP) proposal, which was ranked first nationwide and funded with $2M. We were surprised the CFLRP was not mentioned in the PA, as well as how the two projects fit together.

4

5) Lastly, we look towards implementing an effective adaptive management program. To this end, an essential component is an efficient, cost effective monitoring program that will directly inform management decisions. GFFP is committed to this process and will strive to work with the FS to provide a systematic and pragmatic approach that will ultimately improve project planning, reduce conflict and increase trust. It is our expectation that both the 4FRI Stakeholders and the FS commits the resources to this process. Without adaptive management in the forefront, the potential success of the 4FRI project will be compromised.

5

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Finally, we commend the FS on your efforts to date, and on your approach to such an ambitious project traveling an uncharted course. Your work to date has been excellent and we appreciate the collaborative engagement provided!.

We look forward to working with you on this PA throughout the NEPA process as appropriate to collaboratively develop an effective and socially acceptable landscape restoration plan and project. Then hopefully the hard work begins – implementation!

With Warm Regards,

Paul Summerfelt
President, GFFP Board of Directors

Enclosure: Landscape Restoration Matrix

cc: GFFP Board of Directors & Partnership Advisory Board
Henry Provincio & Paula Cote, 4FRI Team, USFS
Ethan Aumack & Steve Gatewood, Co-Chairs, 4FRI Steering Committee

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March 11, 2011

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001
Sent Via email to *4FRI_comments@fs.fed.us*

Henry Provencio,
4FRI Team Leader
Mike Williams
Supervisor, Kaibab National Forest
Earl Stewart
Supervisor, Coconino National Forest

**RE: Four Forest Restoration Initiative, 1st Phase Proposed Action**

Dear Sirs:

The Nature Conservancy appreciates the opportunity to provide comments on the Forest Service's proposed action for the first analysis area. In general, we are very supportive of the proposal, and support the 4FRI collaborative group through our participation in the steering committee, in several working groups, and recently through signing the Memorandum of Understanding between the USFS and 4FRI entities.

We support the ambitious efforts of the USFS to comprehensively and ecologically restore ponderosa pine forests across a large proportion of the 750,000-acre analysis area. The goals of the 4FRI are an excellent balance of restoring forests, reducing fuels that could be hazardous to communities, and creating jobs for Arizonans. We agree that the strategic placement of treatments affords an opportunity for managers to meet multiple objectives synergistically while optimizing the return on investment. We are very interested in continuing to provide scientific information to inform this process through inclusion of model outputs, historical range of variation data, and climate change and wildlife habitat analyses.

Because some uncertainty remains about how much change will continue to occur in different locations, we encourage the USFS to continue being adaptive in all areas of management, including: prioritization of treatments, scenarios analyzed in NEPA, design and implementation of prescriptions, using economic data in designing contracts, and evaluation of post-treatment data and its incorporation into subsequent actions. We will continue to work with the USFS in the design and implementation of processes that allow the agency to respond quickly to rapid change and uncertainty. We are very interested in seeing this project move forward with the use of mechanical thinning as a means to reintroduce natural fire regimes across a large landscape to increase the resilience of its forests.

During the public workshops, we have been impressed with the sheer volume and quality of data that have been presented to stakeholders on silvicultural treatment options, potential fire behavior due to fuel conditions, and wildlife objectives. We look forward to continued collaboration on how these data will be integrated with an improved understanding of values-at-risk in designing more detailed treatment scenarios (size and type) that optimize placement to meet multiple objectives while minimizing treatment costs. We think that many within the stakeholder group agree with the USFS that this objective is critically important to achieving 4FRI goals in a cost effective manner.

The Nature Conservancy is dedicated to continuing to work with the USFS and partners to find efficient ways to effectively analyze large portions of the analysis area to find ecologically appropriate solutions to restoration needs. We are confident that the combined capabilities of stakeholders and USFS will allow 4FRI to move forward with confidence toward implementation in the coming months and years. We look forward to the next steps.

Sincerely,

Tom Collazo

Tom Collazo

Associate State Director
For Conservation Programs

2011-0311-33

**Scott Hunt**
**<ScottHunt@azsf.gov>**
03/11/2011 04:50 PM

To "4FRI_comments@fs.fed.us" <4FRI_comments@fs.fed.us>
cc Kevin Boness <KevinBoness@azsf.gov>
bcc
Subject Comments from Arizona State Forestry Division

Arizona State Forestry's comments are attached in a .pdf file. Original hard copy will be mailed.

Thank you, Scott Hunt

---

Scott Hunt
State Forester
Arizona State Forestry Division
1110 W. Washington Ste 100
Phoenix, AZ 85007
602-771-1412 office
602-568-6628 cell
623-445-0282 fax
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2011-03-11-33

Janice K. Brewer
**Governor**

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**State Forester**

# Arizona State Forestry Division

**Office of the State Forester**
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March 11, 2011

Coconino National Forest
Attn: 4FRI
1824 S. Thompson Street
Flagstaff, AZ 86001

Dear Forest Supervisors Stewart and Williams:

The Arizona State Forestry Division welcomes the opportunity to provide comments on the Proposed Action ("PA") and Notice of Intent to Prepare an Environmental Impact Statement for the Coconino and Kaibab National Forests, Four Forest Restoration Initiative (4FRI), as released on January 21, 2011 and published in the *Federal Register* at 76 Fed. Reg. 4279 on January 25, 2011, respectively.

We support the overall approach that the Four National Forests (Apache-Sitgreaves, Coconino, Kaibab, and Tonto) are taking to restore the health and sustainability of forest lands in Arizona. The landscape scale approach will insure that implemented management strategies will not stop at individual forest boundaries and will benefit large scale watersheds, wildlife habitats and scenic landscapes.

We would encourage that the management strategies being developed consider an all lands approach taking into account adjoining ownerships that have a vested interest in the outcome. To further enhance this effort, we recommend that the recently developed Arizona Statewide Assessment and Strategy be used as a guiding document. This document was developed working closely with our partner organizations and stakeholders statewide.

The PA does not specifically address the need for forest industry, but we believe it is a critical component to the overall success of the 4FRI. We can offer our assistance and enlist the help of the Governor's Forest Health Council in partnering with the national forests to foster a sustainable forest industry. Our hope is for a forest industry that will encompass a suite of forest products that has the capacity to utilize a variety of tree diameters. We believe the Forest Service will need to develop longer term contracts to cultivate forest industry investment.

We applaud your goal of reducing the potential for catastrophic wildfires especially where it involves the wildland/urban interface. The landscape approach of 4FRI will be effective

over the long run in reducing fire threat and damage to life, property, infrastructure, and watersheds. This will also benefit federal, state, and local fire and emergency agencies in reducing fire suppression and post fire mitigation costs.

Finally, we ask that as treatment prescriptions are developed, that the emphasis be placed on the health of each stand of trees. Ideally, they should address a broad base of objectives and not focus on any one aspect that may change overtime in a dynamic forest environment.

We appreciate the great effort that your staff has put forth to collaborate with our agency as well as the other stakeholders, and look forward to the success of this project.

Sincerely,

Scott Hunt
State Forester

2011-03-11 -34

***IMPORTANT NOTICE: This document is a work in progress from the Steering Committee of the Four Forest Restoration Initiative (4FRI), and is in DRAFT form until approved by the 4FRI Stakeholder Group. Therefore, this information is subject to change and does not necessarily represent final language, a formal position, or a statement of policy from 4FRI.***

March 11, 2011

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001
4FRI_comments@fs.fed.us

Dear Forest Supervisors Stewart and Williams:

On behalf of the Four Forest Restoration Initiative Stakeholder Group ("Stakeholder Group") we welcome the opportunity to provide comments on the Proposed Action ("PA") and Notice of Intent to Prepare an Environmental Impact Statement for the Coconino and Kaibab national forests, Four Forest Restoration Initiative (4FRI), as released on January 21, 2011 and published in the *Federal Register* at 76 Fed. Reg. 4279on January 25, 20ll, respectively. The Stakeholder Group is excited to be a partner with the Forest Service during such an important and evolving period of forest management. We are encouraged to see the Forest Service conduct its National Environmental Policy Act ("NEPA") analysis at such a large scale with the goal of re-establishing forest structure, pattern and function to increase forest resiliency. We also realize that as the largest restoration pilot under the Collaborative Forest Landscape Restoration Act what happens in Arizona will have ramifications throughout the National Forest System.

We are dedicated to helping make this a successful landscape-scale restoration project. In 2010, the Stakeholder Group calculated the value of their time and in-kind donation of resources to be approximately $444,360.00. Working in collaboration with the Forest Ecosystem Restoration Analysis Project ("ForestERA") the Stakeholder Group provided the Forest Service with its vision of a Landscape Strategy for the Mogollon Rim. We now hope that we can work collaboratively to efficiently complete NEPA requirements and move into implementation of the 4FRI.

The comments included in this letter were reviewed and approved by the Stakeholder Group and represent an official communication of the Stakeholder Group.

1. **Detail.** We are concerned that the current PA does not provide sufficient detail about proposed management actions. According to the PA cover letter of January 21, 2011, stakeholder comments "will be used to refine the proposed action." The letter goes on to state that revisions will include, "detailed information such as: desired future conditions, what type of activities would occur, as well as where and when those activities would be expected to

occur. We will also provide a range of acres by treatment type." The detail that is identified in the cover letter and promised to be forthcoming is essential in order to provide the public with a meaningful understanding of the actions that are being proposed and to conduct a robust effects analysis. Although we understand that the PA is currently evolving and being refined—a new and valuable approach to NEPA--we feel it is important to be clear on your timeline of when the final, refined PA will be finished.

2. **Strategic Placement of Treatments.** We are pleased that the Forest Service intends to strategically place treatments to maximize the ability to reduce fire risk. Yet it is unclear what method will be used to identify and configure strategic treatments. The Stakeholder Group has proposed configuration by FireScape. Other methodologies exist to determine treatment configuration as well. More clarity is needed. In addition, we request more clarity with regard to how the strategic placement of treatments will interface with planned and unplanned ignitions.

3. **Old Growth.** The Stakeholder Group has clearly stated that no old-growth trees[1] (predating Euro-American settlement or currently exhibiting old growth structural characteristics) should be cut. Presently, the language in the PA states that treatments will be designed to manage for old trees. This does not provide sufficient assurance that old growth will be protected.

4. **Managing With Fire.** The PA is silent with regard to how unplanned ignitions will be used as a management tool. Safely restoring low-intensity fire to the landscape is a goal of the 4FRI. Greater detail is needed regarding how the Forest Service will manage planned and unplanned ignitions. See number 2 above.

5. **Ecological Restoration.** The Stakeholder Group believes ecological restoration should guide, and be the goal of the 4FRI. The project summary states that the goal of the project is to re-establish forest structure, pattern and function, which will lead to increased forest resiliency. It then suggests actions that are traditional silvicultural treatments without specifying how they will use ecological science to frame action and achieve desired ecological conditions. It does not explicitly tie the goal of the 4FRI to historic conditions, natural range of variability, or clarify how forest resiliency and function will be accomplished at the landscape scale. The Forest Service Handbook FSM 2000/Chapter 2020/Effective date 09/22/2008 provides foundational policy for using ecological restoration to manage National Forest System lands in a sustainable manner. Using the definition of ecological restoration[2] from the Handbook would make the goal of this project crystal clear and tie it to the legal framework that supports it.

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[1] Kaufmann, M. R., D. Binkley, P. Z. Fulé, M. Johnson, S. L. Stephens, and T. W. Swetnam. 2007. Defining old growth for fire-adapted forests of the western United States. Ecology and Society 12(2): 15. [online] URL: http://www.ecologyandsociety.org/vol12/iss2/art15/ABSTRACT. There are varying definitions of old-growth forests because of differences in environment

[2] Ecological restoration. The process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged, or destroyed. Restoration focuses on establishing the composition, structure, pattern and ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient, and healthy under current and future conditions.

6. **Economics and Utilization.** The PA is silent on the relationship of the 4FRI to economics and utilization. The Stakeholder Group believes that ecological restoration and economic utilization must be mutually supporting and that landscape-scale restoration cannot be accomplished without private sector harvest, utilization, and marketing. It is a fundamental vision of the 4FRI that landscape-scale restoration should support sustainable forest industries and vibrant rural communities. The stakeholders would like to see a commitment to this goal.

7. **Monitoring.** In order to develop a robust monitoring framework additional detail about the ranges of measurable forest variables for the various Desired Future Conditions will be necessary if the monitoring program is to have sufficient power to assess whether or not management objectives are being met.

   We want to reiterate our commitment to developing an implementable monitoring program that measures not only ecological response to treatment but also the social and economic outcomes of the 4FRI. We recognize that resources will be a limiting factor, but believe that multi-party monitoring is critical to achieving the goals of 4FRI.

   In addition to the need for a targeted and efficient monitoring program, we also would like to emphasize the tremendous opportunity provided by the 4FRI to increase our understanding of the ecology of these systems. Given the 4FRI's commitment to being a science-based endeavor we would ask that the Forest Service help cultivate an atmosphere that is conducive to research being conducted by a variety of partners.

8. **Adaptive Management.** We are encouraged by the Forest Service's commitment to use adaptive management, and we feel some of the critical components of adaptive management should be highlighted. Adaptive management requires explicit statement of goals and objectives, and a well-informed monitoring program that has the requisite power to detect management impacts rapidly enough to inform future management. Furthermore, adaptive management is a structured decision- making process that relies on clearly articulated triggers for management change. Finally, adaptive management requires a commitment to change management when monitoring data indicates that the thresholds identified by those triggers have been crossed.

We look forward to continuing to collaboratively develop this program with the Forest Service in the coming months.

Sincerely,

Ethan Aumack
Co-Chair

Steve Gatewood
Co-chair

2011-0312-35




**March 11, 2011**

# Old Growth Protection & Large Tree Retention Strategy

## Contents

I. Old Growth Protection & Large Tree Retention Strategy (OGP&LTRS) Overview ..... 4
II. OGP&LTRS Rationale: The Historical Debate Regarding Diameter Caps in the Southwest and the 4FRI's Large Tree Retention Policy ..... 6
III. Exception Process for Large Post-Settlement Tree Retention ..... 9
IV. Exceptions ..... 10
Seeps & Springs ..... 10
Riparian ..... 12
Wet Meadows ..... 14
Encroached Grasslands ..... 16
Aspen Forest & Woodland ..... 18
Ponderosa Pine/Gambel Oak Forest (Pine-Oak) ..... 20
Within Stand Openings ..... 22
Heavily Stocked Stands with High Basal Area Generated ..... 24
By a Preponderance of Large Young Trees ..... 24
V. Description of Desired Next Steps and Ongoing Collaborative Clarification of OGP&LTRS 25
VI. References ..... 26
Appendix 1 – Reservations ..... 34

## I. Old Growth Protection & Large Tree Retention Strategy (OGP&LTRS) Overview

The goals of the Four Forests Restoration Initiative (4FRI) are to restore healthy, diverse stands, supporting abundant populations of native plants and animals; to protect communities in forested landscapes from destructive wildland fire; and to support sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values. In short, we seek to re-establish largely self-regulating forested landscapes including their associated fire regimes through a process of ecological restoration that benefits communities, economies, ecosystems and biodiversity.

Ecological restoration will require thinning post-settlement ponderosa pine trees[1] in unnaturally dense stands. While there is broad agreement for reducing small diameter tree densities, where and how this should be done has often been the subject of social and scientific debate. The purpose of this document is to affirm recommendations of the 4FRI Stakeholder Group relating to the retention of large post-settlement and old growth trees—recommendations that are critical to moving beyond those debates—and to provide specific, science-based recommendations for incorporation into 4FRI restoration plans and projects.

**Retention of Old Growth and Large Post-settlement Trees**

"The Path Forward"—a foundational document of the 4FRI—calls for blanket old growth protection, regardless of tree size. It states that, "No old-growth trees (pre-dating Euro-American settlement) shall be cut." The document also includes broad recommendations for retaining large post-settlement trees with some carefully specified exceptions.

In southwestern ponderosa pine forests, old-growth trees are important to ecosystem structure and function. They increase genetic diversity on the landscape; old trees have greater genetic diversity than even-aged groups of young trees (Kolanoski 2002) and, thus, may have a better chance of adapting to changing climatic and environmental conditions, an ability they can pass on to their progeny. In addition, when not surrounded by large amounts of fuel, the thick bark of old-growth trees makes them largely resistant to low-intensity surface fire (Agee 1998). Old-growth trees also increase forest structural diversity, which, in turn, provides more wildlife habitat. For example, large trees provide additional structure for bats, which roost under slabs of bark; nest trees for northern goshawks and Mexican spotted owls; continuous canopy for tassel-eared squirrels; and foraging habitat for bark-gleaning birds (Bull and Hohmann 1994, Humes et al. 1999, Dodd et al. 2003). In addition, old trees often become long-lasting snags when they die, which benefits many species of cavity-nesting birds and mammals (Chambers and Mast 2005). Old, large trees also serve as long-term carbon stores (Harmon et al. 1990) and preserve a record of the past that can inform future research about insect outbreak, fire history, and climate change (Fulé et al. 1997, Soulé and Knapp 2006). Finally, old-growth trees enhance the

[1] Large and old growth tree recommendations offered in this document refer specifically to ponderosa pine trees.

aesthetics of forests (Brown and Daniel 1984) and, thus, increase public support for restoration projects. Old-growth trees are present on the landscape at similar or lower densities compared to presettlement times (Mast et al. 1999, Moore et al. 2004), depending on how many trees have been removed postsettlement by forest management practices (e.g., clearcut, thinning, seed tree, etc.). The three main threats to old-growth trees are high-severity wildfire, competition from mid- or under-story trees, and drought and subsequent bark beetle attacks (Kolb et al. 2007). Restoration treatments (thinning and prescribed burning) around old-growth trees can cause some mortality. However, this threat can be reduced through careful management (Hood 2010). In addition, restoration treatment should result in a reduced threat of wildfire, a release from competition, and increased tree growth (Fajardo et al. 2007, Fulé et al. 2007).

The Path Forward also calls for retaining large post-settlement trees (defined by the socio-political process as those greater than 16 inches diameter-at-breast height [dbh]) throughout the 4FRI landscape, except: (1) as necessary to meet community protection and public safety goals within the Community Protection Management Areas identified in the Analysis of Small Diameter Wood Supply in Northern Arizona and where stakeholder agreement identifies priority areas within approved CWPPs; and (2) when best available science and stakeholder agreement (as defined in the 4FRI Charter) identify sites where ecological restoration and biodiversity objectives cannot otherwise be met – specifically wet meadows, seeps, springs, riparian areas, encroached grasslands, aspen groves or oak stands, within-stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees.

We recognize that there are multiple causes of ecological degradation that may not be affected by mechanical thinning and different types of burning. The exceptions articulated in the following section are intended to be part of a more comprehensive and concurrent approach to treating causes (rather than just symptoms) of ecological decline. To that end, we are asking the Forests to work collaboratively on a comprehensive restoration assessment that identifies possible management actions to stem/reverse ecological decline. We believe this restoration assessment should focus on a wider range of forest resources than just timber and fire; such as hydrology, range, recreation, and wildlife. We ask the four National Forests to initiate this assessment with the 4FRI Stakeholders, upon release of the Draft EIS for the first project area.

The intention of the exception process is to increase landscape heterogeneity and conserve biodiversity. Thus we do not support implementing any exceptions where removing the trees would conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat. We also recognize there may be additional areas and/or circumstances where large trees need to be removed to achieve restoration. These circumstances should be identified through a site-specific, agreement-based, collaborative process as described in the 4FRI Charter.

## II. OGP&LTRS Rationale: The Historical Debate Regarding Diameter Caps in the Southwest and the 4FRI's Large Tree Retention Policy

**Introduction**

Diameter caps for tree cutting have been used in forest management efforts across the West. They have been and continue to be the subject of much debate. In this section of the Large Tree Retention Strategy document, two different perspectives on diameter caps are presented. Recognizing that the 4FRI Large Tree Retention and Old Growth Protection Strategy is not meant to serve as a strict diameter cap, these perspectives are offered here to illuminate elements of the historical debate that have led to the 4FRI's formulation of the existing Large Tree Retention and Old Growth Protection Strategy.

**Arguments in Favor of Diameter Caps**

There is a generally recognized need to retain larger trees and protect old growth in southwestern ponderosa pine forest restoration. Some proponents of large tree retention have suggested that a 16" diameter cap is both ecologically and socio-politically warranted given the scarcity of mature and old growth forest cover in the region; the need to quickly re-establish lost mature and old forest structure; the necessity of retaining trees larger than 16" dbh to recruit new trees into regionally-underrepresented VSS 5, 6 and "old growth" structural stages; and the regional rarity of trees larger than 16" (approximately 96% of ponderosa pine trees in northern Arizona and New Mexico are smaller than 16-inch dbh).

Such proponents have proposed diameter caps as a means to (1) prevent large-tree logging for production-oriented, uneven-aged silvicultural goals, (2) discourage large-tree logging to pay for small-tree thinning or other activities, (3) favor small-diameter-specific industries over large-tree-dependent ones, (4) avoid population-level effects to imperiled species and wildlife that are associated with larger live and dead trees and denser canopy, (5) mitigate unforeseen large tree mortality during and following restoration treatments, (6) mitigate unknown rates of future large tree mortality resulting from re-establishing natural fire regimes and future climates, (7) mitigate under-estimates of historical tree densities owing to evidence undercounting and loss to fire, logging and decay, (8) accommodate differing reference scales, choices of reference attributes, restoration objectives and desired degrees of precision or rates of change, (9) mitigate uncertainty about future national forest policy, timber and wildlife habitat management, and (10) facilitate a restoration approach that reduces immediate crown fire threat while incrementally moving the forest toward its natural range of variability through a combination of thinning and natural fire.

Diameter limits and exception-thresholds for tree cutting are a common strategy for achieving ecological objectives in western forest landscapes. In their recommendations to Congress and the President, the Eastside Forests Scientific Society Panel proposed a 20" diameter limit for trees younger than 150 years old to protect late-successional and old-growth dry forests of eastern Oregon and Washington. They cited the ecological importance and scarcity of large and old trees and the need to retain them to replenish regionally-depleted supplies of large and old trees, snags, logs and associated wildlife habitat. Those recommendations formed the basis for interim management direction amending nine national forest plans and establishing a 21" diameter limit in dry forests which in turn carried forward into an exception-threshold of 21"

diameter in legislation proposed to restore dry forests of eastern Oregon. The Sierra Nevada Framework set forth a 20" diameter limit for tree cutting to conserve late-seral forests across national forest land in the Sierra Nevada. Larger diameter limit and exception-thresholds in these examples reflect more productive forests and larger mean diameters than in southwestern forests. Diameter limits in Region 3 forest plans restrict large tree cutting in habitat for Mexican spotted owl and northern goshawk for their viability and in "old growth"; diameter-based "vegetative structural stages" guide management of those species' habitats.

**Arguments Against Diameter Caps**

Arbitrary diameter thresholds (or "caps") may assure that trees of a certain size are retained, but they do not guarantee that short- or long-term ecological restoration goals will be achieved. In fact, diameter caps can actually prevent attainment of ecological restoration objectives because they can have unintended consequences such as interfering with the restoration of herbaceous openings and, where unnaturally dense stands of larger, post-settlement trees predominate, caps can limit fuel reduction and, therefore, undermine the agency's ability to re-establish surface fire (Abella et al. 2006, Sanchez-Meador 2009). A diameter threshold also creates a "one-size-fits-all" guideline which can lead to treatments that are inconsistent with site-based conditions.

In general caps are arbitrarily chosen to achieve socio-political objectives that do not necessarily support comprehensive ecological restoration. Contemporary diameter caps, even as an informal agreement, have become the condition that allows fuel reduction and restoration to move forward without lengthy delays due to appeals and litigation. Examples of their arbitrary application include:

- In order to test restoration treatments in the Grand Canyon, a 5-inch cap was required by environmental advocates (Fulé 2006).
- For restoration to proceed in the White Mountains, a 16-inch cap was required (Abrams and Burns 2007).
- A 12-inch cap was employed to define forest biomass appropriate for generating renewable energy (Arizona Corporation Commission, 2006).
- On the Coconino National Forest, a 16-inch cap was imposed to allow restoration projects proposed by the Grand Canyon Forest Partnership to proceed (Friederici 2003).

Further evidence that caps undermine ecological restoration goals is reflected in a recent decision on the Marshall Fuel Reduction and Forest Restoration Project (USFS 2010). The Forest Service rejected an alternative that proposed a 16-inch diameter cap because, "A 16-inch cap would prevent the restoration of natural openings and more natural spatial distribution of clumps of trees important for wildlife habitat and forest health." When administrative and legal challenges to forest thinning and restoration projects prevail it is generally because of issues related to agency compliance with law and policy (Brown 2009)—not because there is a scientific basis for a diameter threshold.

Finally, a static diameter cap fails to account for the fact that trees grow, that restoration will occur over decades while those trees are growing, and that over time, retention of excess trees may undermine efforts to restore ecosystem resilience in the face of drier conditions associated with climate change (Glicksman 2009, Westerling et al. 2006).

**Conclusions**

Recognizing a need to move beyond the historical debate and move forward with landscape-scale restoration that is ecologically, socially, and economically viable, the 4FRI Collaborative has agreed that the 4FRI effort should implement large tree retention and old growth protection strategies that are not based on strict diameter limits, but are based upon a 16" diameter threshold that limits the cutting of trees larger than 16" to circumstances and criteria set forth in pre-defined exception categories that follow. In addition, we are committed to monitoring the outcomes of treatments that follow this guidance to determine if they achieve our ecological restoration goals. If they do not we are committed to adapting this policy to achieve better ecological outcomes.

It is our hope and expectation that this approach will balance the approaches and opinions expressed above, and will serve as a policy mechanism for supporting comprehensive ecosystem restoration while addressing stakeholders' needs for protecting old growth and large ponderosa pine trees.

## III. Exception Process for Large Post-Settlement Tree Retention

The following section outlines a problem statement, specific identifying circumstances, ecological objectives and selection criteria for instances in which large post-settlement trees may be cut to meet restoration objectives. At specific locations, large trees may need to be removed, felled, or girdled for purposes of ecological restoration and biodiversity conservation. The purpose of this section is to provide sufficient specificity to translate those exception categories—where stakeholder agreement exists to do so—into management actions and tree-marking guidelines. For eight of the nine exception categories programmatic recommendations describe the circumstances and criteria in which large post-settlement trees may need to be removed. For the "Heavily Stocked Stands with High Basal Area Generated by a Preponderance of Large Young Trees" (or "Large Young Tree") exception category, getting to a higher level of social and scientific agreement entails more complexity and challenges, so we propose the initiation of additional collaborative discussion and planning that we hope will bolster restoration efforts by increasing confidence and knowledge-sharing, maximizing agreement and minimizing disagreement.

## IV. Exceptions

### Seeps & Springs

**Suggested Tree Marking Exception Code**: "S"

**Identifiable Circumstance**

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock, where standing or running water is infrequent or absent and that exhibit vegetation and other biological diversity adapted to mesic soils.

Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water, wet or moist soils and that exhibit vegetation and other biological diversity adapted to mesic soils or aquatic environments (Feth and Hem 1963).

**Problem Statement**

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. Due to the absence of frequent fires in the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of these trees may constitute a relatively small part of an overall seep and spring restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore seeps and springs (Thompson et al. 2002).

**Ecological Objectives**

(1) Conserve and restore the biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted and aquatic native biological diversity depend.

**Criteria**

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of seeps & springs according to these criteria:

(1) Where large trees' roots are encroaching on mesic soils associated with a seep or spring, or such trees' drip lines are overlapping or nearly overlapping a seep or spring

such that its shading compromises the integrity of a spring's unique biophysical attributes, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said seep or spring in the past, leave an equivalent number of large replacement trees.

# Riparian

**Suggested Tree Marking Exception Code:** "R"

**Identifiable Circumstance**

Riparian areas occur along ephemeral or perennial streams or are located down-gradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

**Problem statement**

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted or aquatic biological diversity. Riparian areas and the streams, springs and seeps connected to them often harbor imperiled species and can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial wildlife. In the absence of frequent fires and in the presence of livestock grazing, water development projects and other factors, large post-settlement trees may have established and grown within riparian areas such that they compromise available soil moisture or light that support those unique biophysical conditions. However, it is likely to be a very rare circumstance that trees of any size will need to be removed from forested riparian zones.

Cutting of any trees within riparian areas should minimize impacts by following Best Management Practices (BMPs).

Whenever possible, large trees identified for cutting should be left onsite as snags or downed logs.

Removal of these trees may constitute a relatively small part of an overall riparian area restoration effort when compared to addressing fundamental causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore riparian areas.

**Ecological Objectives**

Conserve and restore the biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depend.

**Criteria**

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of riparian areas according to these criteria:

(1) Where large trees are growing (rooted) within a riparian area and compromising available soil moisture or light that support that area's unique biophysical conditions, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Notes: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said riparian in the past, leave an equivalent number of large replacement trees.

There may be additional areas and/or circumstances identified for riparian restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

## Wet Meadows

**Suggested Tree Marking Exception Code**: "WM"

**Identifiable Circumstance**

High-elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1% of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 ha of wet meadows occur on national forests in Arizona and New Mexico.

These areas may be referred to as riparian meadows, montane (or high-elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (*Carex* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (Salix) and alder (Alnus) species often occur in or adjacent to these meadows (Long 2000, 2002, Maschinski 2001, Medina and Steed 2002). High-elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

**Problem statement**

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations, most notably the lowering of their water tables due to stream downcutting, surface water diversions, or groundwater withdrawal (Neary and Medina 1996, Gage and Cooper 2008). In the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Removal of these trees may constitute a relatively small part of an overall wet meadow restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore wet meadows.

**Ecological Objectives**

Conserve and restore the biophysical conditions of wet meadows upon which terrestrial native biological diversity depend.

**Criteria**

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of wet meadows according to these criteria:

(1) Where large trees are growing (rooted) in a wet meadow, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said wet meadows in the past, leave an equivalent number of large replacement trees.

## Encroached Grasslands

**Suggested Tree Marking Exception Code**: "EG"

**Identifiable Circumstance**

Encroached grasslands are herbaceous ecosystems that have infrequent-to-no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils, which are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and to a lesser extent by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (Festuca arizonica) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands are the most naturally fragmented grasslands in the region, ranging from thousands of acres in size (e.g., in the White Mountains, Baker 1983) down to only a few acres. They generally occur in small (<100 ac.) to medium-sized (100 to 1000 ac.) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings.

Identification of grasslands in this region should use a combination of the Terrestrial Ecosystem Survey, Southwest Regional GAP Analysis, Brown and Lowe Vegetation Classification (Brown and Lowe 1982; TNC GIS Layer 2006) among other existing vegetation and soils data.

This exception category will require an iterative process of collaborative mapping, field verification, and refinement. There is debate about where and how much the grassland-forest mosaic shifts over time and space. There are also questions about whether some recently-burned areas are early seral forests or stable grasslands, whether or how they may be surrogates for historical grasslands, and if or how that should factor into the overall retention of forest cover. Recognizing the importance of montane grassland restoration, we encourage all parties to seek resolution to these issues on a case-by-case basis through field visits, literature review, and/or discussion.

**Problem statement**

Prior to European settlement, pine trees rarely established in grasslands because they were either outcompeted by production of cool-season grasses or killed by frequent fire (Finch 2004). In

the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, releasing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Allen 1984, Moore and Huffman 2004, Coop and Givnish 2007).Pine encroachment into grasslands has contributed to a significant loss of biodiversity (Stacey 1995) and wildlife habitat particularly for grassland-dependent species such as pronghorn. Plant diversity is particularly important in grassland ecosystems: grassland plots with greater specie diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994); this resilience will become even more important in a warming climate. Pine tree removal, restoration of fire, and complementary reductions in livestock grazing pressure are all necessary to restore structure and function of native grasslands.

**Ecological Objectives**

(1) Enhance, maintain, and restore naturally functioning grasslands.

(2) Ensure native grassland composition, increase native species diversity, improve resilience to drought.

(3) Restore natural fire regime.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be cut and/or removed to restore the unique biophysical attributes of grasslands according to these criteria:

(1) Where existing grasslands are being encroached, and large trees are interfering with overall restoration objectives, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: There may be additional areas and/or circumstances identified for grassland restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

## Aspen Forest & Woodland

**Suggested Tree Marking Exception Code:** "AF"

**Identifiable Circumstance**

Quaking aspen (*Populus tremuloides*) occurs in small patches throughout the 4FRI area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. Almost all of the aspen occurring within ponderosa pine forests of the 4FRI area exists as seral aspen, and regenerates after disturbance both through root sprouting and rarely from seed production (Quinn and Wu 2001). Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire 4FRI area and map layers are available from existing databases.

**Problem Statement**

Aspen occurs within ponderosa pine forests, and is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finch and Reynolds 1987, Griffis-Kyle and Beier 2003). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio and others 2005). However, aspen is currently declining at an alarming rate (Fairweather and others 2008).

The loss of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen-dominated lands to succeed to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing by livestock and introduced and native wild ungulates in the absence of natural predators like wolves (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1994, Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with 90% mortality occurring in low elevation aspen sites and over 60% mortality observed in mid-elevations. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather and others 2008) that have served as the "final straws" for already compromised stands.

Removal of encroaching pine trees constitutes part of an overall aspen restoration effort. Thinning alone without addressing other sources of degradation, such as excessive herbivory is unlikely to successfully restore aspen forests.

Some stakeholders expressed that considerable uncertainty exists around fire regimes for aspen in ponderosa pine, and that research questions remain unanswered around the prevalence of mixed-severity fire and its ecological role as a driving force for aspen stands at the top of its elevational range, and on steep slopes within this vegetation type.

**Ecological Objectives**

(1) Conserve and restore aspen forests and woodlands within 4FRI area by restoring appropriate fire regimes and decreasing competition from ponderosa pine.

(2) Protect regeneration, saplings, and juvenile trees from browsing.

**Criteria**

Large (>16"dbh) post-settlement trees may be cut in conifer-encroached seral aspen stands according to the following criteria:

(1) Where current post-settlement ponderosa pine tree numbers are above and beyond residual targets (identified using pre-settlement conifer tree evidences), and

(2) Where fire cannot be used safely and effectively to regenerate or maintain aspen, or

(3) Where site visitation and/or data collection and analysis indicates the need for encroachment mitigation, and

(4) Where removing large trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat

Note: There may be additional areas and/or circumstances identified for aspen restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

## Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

**Suggested Tree Marking Code**: "P-O"

**Identifiable Circumstance**

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak trees in locations throughout the 4FRI area in a habitat association referred to as PIPO/QUGA (USFS 1997, USDI FWS 1995). Specifically, any stand within the Pinus ponderosa series where ≥10% of stand basal area consists of Gambel oak (*Quercus gambelii*) ≥13 cm (5 in) diameter at root collar (drc) is considered to be pine-oak within the 4FRI area (USDI FWS 1995). In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Brown 1958, Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number of varying wildlife species (Neff and others 1979, Kruse 1992).

Gambel oak provides high quality wildlife habitat in its various growth forms, and is a desirable component of ponderosa pine forests (Neff and others 1979, Kruse 1992, Bernardos et al. 2004). Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI FWS1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular fuelwood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

**Problem Statement**

Although management on public lands with regard to oak has changed to better protect the species, illegal fuelwood cutting of Gambel oak and elk and livestock grazing negatively impact oak growth and regeneration (Harper et al. 1985, Clary and Tiedemann 1992, Rick Miller, 1993, unpublished report) and continues to result in the removal of rare, large diameter oak trees (Bernardos et al. 2004).

A literature review by Abella and Fule (2008) found that Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium-diameter stems (<8" dbh). Chambers (2002) found that Gambel oak on the Kaibab and Coconino National Forests was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 cm dbh) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 cm) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fule (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

**Ecological Objectives:**

(1) Maintain and restore all growth forms of Gambel oak, focusing on enhancing and maintaining larger, older oak trees.

(2) Restore frequent, low intensity surface fire to ponderosa pine-Gambel oak forests.

(3) Restore and maintain brushy thicket, pole and dispersed clump growth forms of Gambel oak by allowing natural self-thinning, thinning dense clumps, and/or burning.

(4) Protect Gambel oak growth forms from fuel wood cutting, damage during restoration treatments including thinning and post thinning slash burning.

**Criteria**

In pine-oak, which occurs when ≥10% of the stand basal area consists of Gambel oak >13 cm (5 in) diameter at root collar, large (>16 dbh) post-settlement ponderosa pine trees may be removed to conserve oaks according to these criteria:

*In MSO restricted habitat*:

(1) Within MSO habitat and designated critical habitat, the Recovery Plan for the Mexican spotted owl should be followed to improve key habitat components and primary biological factors, which includes Gambel oak, or

*Outside MSO restricted habitat*: where large post-settlement trees' drip lines or roots overlap with those of Gambel oak trees exhibiting drc of >12"; and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

# Within Stand Openings

**Suggested Tree Marking Exception Code**: "WSO"

**Identifiable Circumstance**

Within Stand Openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sanchez-Meador et al. 2009). Pre-settlement openings can be identified by the lack of stumps, stump holes, and other evidence of pre-settlement tree occupancy (Covington et al. 1997). These openings are most pronounced on sites with heavy textured (e.g., silt-clay loam) soils (Covington and Moore 1994). Current openings include fine scaled canopy gaps. It is not necessary that desired within stand openings and groups be located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees. The within stand opening criteria described here are distinct from and should not be considered as guidance relating to regeneration openings. The stakeholder group does not support the cutting of large trees to create regeneration openings.

**Problem Statement**

Within stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sanchez-Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997). These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within a stand opening as soon as herbaceous vegetation was removed by overgrazing (Sanchez-Meador et al. 2009). Contemporary within stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within stand heterogeneity.

**Ecological Objectives**

(1) Conserve and restore openings within stands to provide natural spatial heterogeneity for biological diversity.

(2) Break up fuel continuity to reduce the probability of torching and crowning.

(3) Restore natural heterogeneity within stands.

(4) Promote snow-pack accumulation and retention to benefit groundwater recharge and watershed processes at small scale.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to restore the unique biophysical attributes of within stand openings according to these criteria:

(1) When the presence of such trees would prevent the re-establishment of sufficient within stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives, and

(2) Where desired openings are tentatively identified as ≥0.05 acre (these openings should be established wherever possible by enlarging current within stand openings or where small diameter trees are predominant), and

(3) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: It is not necessary that within stand openings and groups be located in the same location that they were in before settlement. That is, trees might be retained in areas that were openings before settlement, and openings might be established in areas that had previously supported pre-settlement trees.

## Heavily Stocked Stands with High Basal Area Generated By a Preponderance of Large Young Trees

**Suggested Tree Marking Exception Code**: "LYT"

**Identifiable Circumstance**

The stakeholder group could not identify with sufficient clarity and agreement the identifiable circumstances under which large removal would take place. We aim to have this completed by early May 2011.

**Problem Statement**

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and BA would be desirable, large post-settlement pines may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. In stands where evidences indicate that higher tree density and BA would have occurred pre-settlement, only a few large pines may need to be removed. Many of these areas would support crown fire, and thus require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

**Ecological Objectives**

(1) Restore natural heterogeneity of forest, savannah and grasslands at the landscape scale.

(2) Restore natural heterogeneity within stands.

(3) Break up canopy fuel continuity to reduce the probability of torching and crowning and restore herbaceous fuel continuity to carry surface fire.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to meet restoration objectives according to these criteria:

(1) The stakeholder group could not identify with sufficient clarity and agreement the criteria under which large tree removal would take place. We aim to have this completed by early May 2011.

## V. Description of Desired Next Steps and Ongoing Collaborative Clarification of OGP&LTRS

Eight of the exception categories listed in this document have been clarified such that they can be operationalized "programmatically", that is, the process of mapping and selecting areas for exceptions is ready to be tested with real data in specific areas. This means that the stakeholder group considers the guidance offered for these exception categories sufficient to operationalize large tree retention/removal per these criteria across the 4FRI area. This process will require the participation of stakeholders and USFS team members to ensure that the suggested process in this document achieves the stated restoration objectives, and is not burdensome in its approach and mechanics.

The "Large Young Tree" exception category listed in this document will require additional collaborative analysis and clarification. Thus far, the group has discussed an opportunity and a need to carry these discussions forward with a combination of additional site visits to representative areas, analysis of USFS stand data, and further exploration of ForestERA remote sensing data that could inform our collective sense of the distribution and extent of areas exhibiting circumstances necessitating large tree removal, and an efficient means of analyzing data and selecting areas for treatment.

Recognizing the importance of finding additional clarity and agreement for these exception categories, the group intends to pursue additional field and data-centered explorations of these exception categories in 2011, working closely with the Forest Service to ensure that additional analysis occurs in a coordinated fashion, and that additional recommendations can be operationalized in a straightforward fashion. Analysis and visitation schedules are intended to be developed by March, 2011, and completed by May 6, 2011.

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**Appendix 1 – Reservations**

From Scott Harger, Coconino NRCD
From: Scott Harger [mailto:cannonbone@msn.com]
Sent: Friday, March 04, 2011 6:57 PM
To: Windy Greer
Subject: Re: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Dear Windy, and LTRS Sub-Group of the LSWG:

I appreciate the accelerated effort to push this document for timely delivery to the USFS.

I like the descriptions captured here for the large tree strategy overview and rationale for the document and the 8-of-9 exception categories whose language appear to be resolved. Except for some very turgid prose in section V that can be edited, I can support this draft as a partial or preliminary version, subject to review of the 9th exception. Otherwise, I can support approval of this final draft without conditions. I would also support it if "Problem Description" were changed to "Management Issue" or "Concerns driving the Exception" or something that doesn't suggest that habitats are problems.

Scott Harger
Range Conservationist
Coconino NRCD
Flagstaff, AZ
928.527.9050

From Scott Hunt, Arizona State Forester
From: Scott Hunt [mailto:ScottHunt@azsf.gov]
Sent: Friday, March 11, 2011 12:00 PM
To: Windy Greer; 'Ethan Aumack'; Ed Smith
Cc: Kevin Boness
Subject: RE: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Thank you Ed and Ethan for the dedicated work on this strategy. The State Forestry Division agrees with reservations on this large tree retention policy. The arguments against diameter caps that you provided in the policy capture most of our reservations. We have two additional items we wish to offer for consideration:

-In the category "Seeps and Springs" under criteria: there should be an allowance for removal of large trees a considerable distance from the seep or spring to help invigorate infiltration and flow. Distance will need to be determined by the effective area that benefits the seep or spring.

-We believe a consideration needs to given for stands that may have a healthy understory of regenerated ponderosa pine with an overstory of trees that are heavily infected with dwarf mistletoe. Objectives for

this type of stand may encourage and favor the vigorous, healthy understory. Removal of the larger trees that are infected would be required to meet the stand objectives.

We will look forward the opportunity to comment on the Larger Young Tree removal category when it is developed. Thanks again for all your time and effort.

Scott Hunt

2011-03-13 - 36

# The Friends of Anderson Mesa

To Conserve & Enhance Native Habitats & Wildlife

March 13, 2011

Coconino National Forest – Attn: 4 FRI
1824 South Thompson Street
Flagstaff, Arizona 86001

Mr. Earl Stewart, Forest Supervisor

This letter is sent in response to the document sent on January 21, 2011 regarding the Four Forest Restoration Initiative proposal for the Coconino, ( CNF) and Kaibab National Forest, (KNF)

It is gratifying to learn after 30 plus years that some of our members have interacted with the Forests in Arizona, that now, in 2011 the Forest Service, (Agency) is once again considering to address this key issue "head-on", an issue that has been talked and written about extensively for 50 years. From our interactions with "projects" as well as in the first forest planning process, tree density with its associated issues of watershed conditions, loss of meadows & grasslands by the encroachment of pine, loss of Aspen, lack of small / cleansing " good fire " and catastrophic fires, have been put forward by the Agency as very important issues that have plagued Region 3 for at least the past 50 years.

general

The first question that comes to mind when considering this topic from a historical perspective: Why Now ?

See 5

The question has nothing to do with the validity of the issue nor the need, by why now ? These issues were openly discussed in great detail in the first forest planning meetings, 1982 – 1986. Not much of substance to these issues was committed in Standards & Guidelines to address the issues.

Again in the early - mid 90's there again was a flurry of activity most noted by research papers published by a number of authors, including:

general

- Marlin Johnson,
- Wally Covington,
- Margret Moore,
- Wally Covington & Margret Moore
- Covington & Sackett
- Russell Graham; et al

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- James Brown; et al
- White

There were a large number of publications from R-3 including:

- Management Recommendations for the Northern Goshawk
- Sustaining Our Aspen Heritage Into the Twenty-fists Century
- Forest Health Restoration Initiative
- An Ecological Basis for Ecosystem Management
- Desired Future Conditions – Apache-Sitgreaves NF
- Changing Conditions in Southwestern Forests & Implications on Land Stewardship.
- Changes in Southwestern Forests: Stewardship Implications
- Land Management Considerations in Fire-Adapted Ecosystems
- Coarse Woody Debris: Managing Benefits & Fire Hazard in the Recovering Forest
- Managing Coarse Woody Debris in the Forests of the Rocky Mountains

general

All of which speaking to the issues of declining habitat quality: too many small trees, declining aspen, no natural fire, inadequate fuels: grasses, forbs and shrubs as well as Coarse Woody Debris to support / carry natural fires, rather conditions which promote catastrophic / stand-replacement crown fires.

general

Noting from all the above effort and information there are currently only two changes of direction in "pine management" specifically to those areas currently occupied by Mexican Spotted Owls or Goshawks. The Owl brought by a ruling under the Endangered Species Act and the Goshawk by the court.

general

Clearly The Agency has the responsibility and authority from its Organic Act and a long list of Laws the ability to put in place proper management for long term sustainability as well as to correct these issues. History shows the leadership of the Agency in Washington, in the Regional Office, ( R-3 ) and each of its Forests Line Officers did not have the Will to meet the major challenges at that time.

general / opinion

It is our hope the current Line Officers have the Will to "do it today" and not take the easy way out – and again "kick the can" down the road for another 20 - 30 years for someone else to deal with.

general

We applaud this current effort and hope the outcomes from this work are truly in the best interest of "the land" and all the native species which depend upon it to live.

general

The Second major questions with this proposal that the Agency must completely detail to the public are:

- How did this problem get so big ?
- If the current conditions are as bad as the Agency claims, these pieces did not simply pop-up overnight, clearly and factually it has taken years for these issues to get to these proportions, why were these issues not addressed years ago ?

See 5 EC

It is most troubling to understand how this problem got as big and bad as it has especially when the area of consideration has been under the full care-custody and control of the USDA Forest Service, in Arizona since 1910. Further troubling is the Agency has positioned itself with the Congress, Judiciary as well as the public, setting itself up as the "experts all things Forest Service" .

Which leads to the Third major question with this proposal is to Trust.

Why should the pubic Trust the Agency is proposing the proper / correct treatments which will:

- Correct the current problems ?, and
- Set in place proper management which will not allow "the land" to once again slip into an un-healthy and dangerous condition ?

General

For over 100 years the Agency has managed these lands with what the public has been told is the correct management. Now we learn that the past management was not correct, why should the public trust this proposal is correct action(s) to implement ?

The Fourth question is directed to Functioning of the Proposed Plan.

The shear size, scope, complexity dealing with Forest Health and the Health of all the interconnecting ecosystems as well as their Key Elements of Ponderosa Pine and tree density / encroachment it would seem most appropriate these would be addressed in the new Forest Plans currently under development.

1

We request the Agency please provide specificity to the following:

- Why is this a stand alone document and not incorporated into the forest plans currently in development ?
- Given there is going to be two major documents guiding the management of the Forest Reserves moving forward; this 4 Forest Effort and the current / future Forest Plans of each NF the 4 Forest Effort will cover:
  - how will the two be linked ?
  - how will they work together and not in opposition to one another ?
  - if not linked, and there is a conflict in management direction, which will have supremacy and which will be the secondary ?

Given this proposal is accurate, based on good site specific science and the right thing to do, its function will take 10's of Millions of dollars and 10's of years to complete. With the state of our current economy, Federal and State where is the adequate funding for this proposal going to come from ?

2

Historically the harvest of ponderosa pine went into the construction industry as "finish" material for doors, door jambs, base boards, window jambs & casings and furniture. Closure of the timber industry in AZ back in the late 1980's and early 90's forced the

customers who bought these AZ wood products to find other locations harvesting suitable wood species or moved their products to "wood-like" products.

There once was talk of an OSB plant somewhere between Williams and Springerville, what is the status of that industry in R-3 and is it part of this project ?

here was talk about using this material for co-generation of electrical power, what is the status of that industry in R-3 and is it part of this project ?

Without a viable timber industry in Arizona, with the major cost of building a state-of-the-art facility to process small diameter pine to take in the huge volume of pine biomass and turn it into "usable" products, simply where is all the pine biomass going to go ?

Understanding this is a Scoping Document and does not provide any of the real details, we are offering higher level – more general comments and questions which we hope the Agency will fully address in future documents.

The Fifth question has to do with; Just how many acres are going to be treated ?

The cover letter sent, in the first paragraph speaks to "…restoration activities within a 750,000 acre ponderosa pine ecosystem …." We feel it very important that the Agency provide a deeper level of detail so the pubic has a deeper level of knowledge of the proposal, to that we ask that more specificity be presented:

- What are the anticipated acres to be treated for each forest, and
- What is the estimated time-line for acres to be treated on each forest, year by year

Please we are fully aware that these numbers are not "cast in stone" and subject to all manner of regulation, funding and appeals.

The Sixth question is directed to: History, How Did We Get Here ?

Pages 1, 2 and the first paragraph of 3 give the reader a decent general description of what is wrong with the Ponderosa Ecosystem and its associated subsets of meadows, grasslands, PJ, mixed species, aspen & riparian systems.

What not seen is the What, When, Why, and How this vast area of Ponderosa pine and its smaller interdependent ecosystems ended up in the conditions found today.

The Agency must provide a much more detailed look at, "how did we get here ? "

- What were the "causes and associated effects" which brought the land to current conditions ?

That discussion then must be followed with a detailed explanation to :

- How should this "system function naturally" — 8 P/N-Dc

From the two above then the Agency must provide:

- Specificity / the Details on how the system will be managed into the future to:
  - Correct the current problems
  - Manage for long-term sustainability with the correct focus these problems will not happen again.

6

Without factual historical knowledge to "how did we get here ?" it is impossible for the public to:

- Understand the "total situation" thus allowing them to
- Provide accurate / germane comments to the Agencies proposed actions to "fix the Forest".

general / dup 4 5

For the Agency to make the simple one-line statements of:

- the forest has too many small trees
- the forest lacks natural - ground fires
- the Agency is going to fix the problem by removing small trees and setting small ground fires,

is misleading, fundamentally wrong and continues to ignore / overlook the reasons which the permitted activates which the Agency approved, promoted and directed management which created / resulted in the current conditions.

dup 3 5

Page 3 & 4 at the section Proposed Action, there is a list of 11 action statements;

- #1 through #4 speak to cutting of trees
- #5 speaks to prescribed burning
- #6 speaks to restoration of ephemeral channels
- #7 speaks to fencing riparian resources
- #8 through #11 speak to roads

7

Not seen is any mention of herbivore by non-native species, most notable being;

- Domestic livestock
- Elk

We must say again; The Agency has the responsibility to present to the public All the historical and current activities which set and continue to keep the current condition, current.

dup 3 5

Review and study of the above mentioned papers and publications there is a common thread:

- Reduction of "fine fuels" the grasses, forbs and shrubs by non-native grazing animals, which
- Reduced the fuel loading of coarse woody debris > 3 inches in diameter to a level which would not carry natural – ground fires, which
- Allowed the uncontrolled growth of pine and mixed species into:

dup 3 5

- Meadows,
- Grasslands,
- Open stands of mature pine, and

By extension the lack of natural fire has also effected the historical pattern of Chaparral and Pinion – Juniper systems where they also contain too many trees per acre and are lacking in the small plant community < 3 inches in diameter. general

It is very important that everyone in this discussion including those of the Agency clearly understand and acknowledge that "per-settlement" there we no native, large bodied bovine / herbivores in these Arizona ecosystems. There were no bison, bison habitat ended on the eastern boarder of New Mexico and Texas. There is some evidence that a species of elk did live in the far eastern portion of Arizona along the boarder with New Mexico, there population is thought to be very small due the few historical sightings by early trappers and travelers. Dup 95

As such the Region – 3 ecosystems evolved over time ***With-Out*** a big bodied herbivore, the large mammal species in these systems were and are deer and antelope. Domestic livestock were first introduced into Arizona by early travelers and settlers. Large numbers of cattle were introduced circa 1870's with second migration West promoted by the end of the Civil War and the development of the railroad. general

Elk were introduced 1914 to 1917 general

It must also be noted that Arizona is considered an arid climate, simply a desert. As such abundant, naturally occurring sources of open water is all but nonexistent. Open water is absolutely mandatory for survival of livestock and elk. Native species deer and antelope who co-evolved in this arid climate are reliant on forbs for their moisture. As a direct result of this mandatory requirement for open water for livestock, water development became the number one priority of the ranching industry. Secondary importance was fire control. Fire was a major determent to the livestock industry, in that it: general

- ❖ Consumed forage needed by their livestock
- ❖ Burned up fence posts, corrals, and buildings.

Each water development brought a corresponding larger area where livestock could graze / impact. Elk which were introduced after the livestock would find the modified habitat most satisfactory to support their needs. Today it is still the goal of the current forest plans to have a water development at least every mile, given a cow does not travel much more that one mile from water to graze, the goal of a water development every mile allows livestock and elk to graze ever acre of the Forest Reserves. general irrelevant to decision

Each of these non-native animals on the land today also need food to survive. That food is provided by the small plant community, IE: grasses, forbs and shrubs. Daily consumption for adult animals: general

- Cattle 26 pounds per day, which on average is composed of;
  - 60% grass
  - 18% forb
  - 22% shrub
- Elk 14 pounds per day, which on average is composed of;
  - 76% grass
  - 10% forb
  - 18% shrub

To better understand the impact of this consumption, taking data from the R-3 Forest and RO documents to the new Forest Plans show the actual use / Head Months for livestock on each Arizona forest to be and their associated tons consumed in 2005:

- Apache / Sitgreaves 92,988 HM = 36,265 tons
- Coconino 124,186 HM = 48,433 tons
- Coronado 177,800 HM = 69,342 tons
- Kaibab 103,583 HM = 40,397 tons
- Prescott 107,602 HM = 41,965 tons
- Tonto 47,028 HM = 18,341 tons
  - Total = 254,743 tons

general

Consumption by elk is a difficult task given the Game and Fish Department does not publish population numbers. Estimated elk populations offered were estimated from Department survey data and extrapolation from earlier Dept estimate formulas

- Apache / Sitgreaves 9,000 head = 31,590 tons
- Coconino 13,000 head = 45,630 tons
- Kaibab 5,000 head = 17,550 tons
- Tonto 3,500 head = 12,285 tons
  - Total = 107,055 tons

In 2005 it is estimated that non-native species consumed / removed 361,798 tons of the very material which "pre-settlement" provided for the issues seen / presented today, the lack of;

- Fine fuels to support / carry natural fire to;
  - Remove the small trees
  - Provide a natural fertilizer which produced a very high level of nitrogen in new growth in; grasses, forbs & shrubs, essential to native wildlife.
- Food and habitat for all manner of small animals & insects
- Adequate hiding cover for antelope fawns
- Protection for soil from;
  - Rain impact
  - Surface erosion both water and wind
- Lack of organic matter on the soil for
  - Organic material for;
    - the development of topsoil
    - Protection for seeds and young plants

general

Further documentation to the impacts of herbivore by domestic livestock can be found in works of:

- Thomas L. Fleischner, "Ecological Costs of Livestock Grazing in Western North America", Conservation Biology, Volume 8, No. 3, September 1994 pages 629-644.
- Debora L. Donahue, "Western Range Revisited", University of Oklahoma Press, 1999.

From the document sent there is no evidence the Agency has any plans to address the primary question of herbivore by non-native species. .

From the document sent it appears that once again the Agency is trying to avoid the primary question to the impacts of non-native herbivore on these ecosystems. Even though:

- Grazing by non-native species has been proven to be a primary cause to the problems in place today, and
- To date the Agency has not been able to produce one scientific field study from the ecosystems in this discussion which:
  - Shows the effects of herbivore by non-native species, and
  - Shows the appropriateness of non-native herbivore to long-term sustainability, and
  - Shows the capacity, capability or suitability for non-native herbivore.

From the document sent it appears the Agency is making much-to-do about real problems and yet is only going to treat the symptom, ( too many small trees ) with a "treatment – tree cutting" is nothing more than a Band-Aid on the problem and not putting forward a "cure" for the root cause of the problem.

The initial treatment will provide ample fuel for the first fire, a controlled fire designed to consume the tops and limbs of those trees cut.

The Real Question Is, What fuel will carry the second and subsequent future natural fires ? What actions is the Agency going to take specifically to reducing herbivore by non-native species to a level which will provide adequate "fine fuels" to successfully carry the second and subsequent future fires needed to cleanse and reinvigorate the Forest ?

Considering the works of Graham; et al and Brown; et al dealing with Coarse Woody Debris recommendations of leaving 5 to 20 tons per acre of material > 3 inches in diameter ( in contact with the soil ), there must also be a recommendation for the debris < 3 inches in diameter; The Mulch / organic litter from; Grasses, Forbs & Shrubs.

Review of the TES for the CNF & KNF finding an example of a "common soil" type supporting Ponderosa pine we find for the:

- CNF – 597.01 with 65% canopy cover produces:
  - Currently 275 pounds per acre
  - Potential at 0 canopy cover 2,650 pounds per acre

- KNF – 537 with 45% canopy cover produces:
  - Currently 250 pounds per acre
  - Potentially at 0 canopy cover 2,500 pounds per acre

Review of: Covington & Sackett ,1986 and White, 1985 we learn the estimated canopy cover for Ponderosa Pine Pre-Settlement was 17% and 22% respectively. Simple math shows us that:

- An average canopy cover could be 20%, and
- From that cover on the above soil types there could be production of herbaceous material; grass – forbs & shrubs of 1,800 pounds per acre per year.

general

Which historically was left on the land and as such "built up" over time providing all manner of positive attributes including fuel for fire, noting the fire frequency between 5 and 15 years its pretty easy to see there would be quite-a-bit of fine fuels to burn. For this calculation, given the native species; deer and antelope with primary dietary needs of forbs, the calculation of herbaceous material "left-on-the-land" was reduced to 1,500 pounds per acre per year;

- 5 years = 7,500 pounds per acre = 3.75 tons per acre
- 10 years = 15,000 #/ac = 7.5 t/ac
- 15 years = 22,500 #/ac = 11.25 t/ac

We are quite sure these numbers will be Shredded by the Agency Experts and we are quite sure they are not exact, the estimate is based on limited data, they are put forward as a very simple example to how much potential material < 3 inches in diameter that:

- Could be on the land
- Which is not on the land today because:
  - The land is not in optimal or historical condition
  - What forage is produced most of it is removed by herbivore of non-native species.

The last major issue that must be addressed in this document and process is Drought. The current forest plans for the CNF & KNF do not even have the word drought in them. Those plans were developed during a very wet period as noted by NOAA as the "Late 20th Century Wet Period" covering 1979 to 1995. Simply – Out of Sight, Out of Mind.

general
O/S

Today the moisture regime is 180 degrees opposite. Starting in 1996 is the "Early 21st Century Drought" ( as titled by NOAA ) which continues today. Moisture records from NOAA tell us of Exceptional Drought ratings:

- CNF the Flagstaff airport – 1996, 97, 2000, 02, 06 & 09
- KNF the Williams station – 1996, 01, 02 & 09

Review of stocking rates show that only in the 2002 were adjustments made to compensate for the dry weather. It is also interesting to note that in dry periods the permitte is given special permission to haul water for their livestock. O/S

Yet to be explained by anyone is how there is not enough surface runoff to provide water into stock tanks, given the existing very poor watershed / soil conditions ( lack of litter ) so the stockman must haul water to keep there cows alive, AND Yet there is somehow enough moisture to produce adequate volumes of forage to feed those same cows ? O/S

Should be noted that Exceptional Drought is the highest level of drought by NOAA.

Please don't try and tell the public that the Agency, be it the RO or each of the Forests or the Forests as a group have and use A Drought Policy. We have see "words on paper" but they have little value if any and the function of this "policy" is totally at the discretion of a line officer, to date, as best we tell there has been little if any reliance on science. O/S

How is it that the Agency can stand so strong on key elements of the historical, current and the future healthy forest of: general

- Canopy cover
- BA / Stems per acre
- Coarse Woody Debris > 3 inches in diameter
- Watershed conditions
- Needs of soils, small plants and wildlife
- Importance and need for natural fire

And yet stand mute too to the essential / key elements: duplicate of 10

- The need for material < 3 inches in diameter to carry fire and all the many other positive attributes it provides,
- The removal of the fine fuels; grass-forbs & shrubs by non-native species. The Agency is most willing to close roads and greatly restrict vast tracts of its lands to use by the Public in OHV travel in the name of habitat destruction, but is totally unwilling to address the factual habitat damage from cows & elk.
- And the primary driving force for all the above, Moisture and how to specifically deal with current and future management in periods / years of drought.

The Agency is not factually and functionally addressing Herbivore by non-natives and Drought with substantive changes in management, the Agency only proposing the removal of small trees and closing roads is only treating the results of historical and current management, not addressing the Cure for current – unhealthy – dangerous conditions. position

11 - GRMP

Again we reference history and R-3 publications, this time looking to the September 1993 edition of "Integrated Resource Management – The Road to Ecosystem Management – the Fourth Edition". It is our hope this document and process it promotes is followed by the Agency not only in the development of this project but in its day-to-day function.

Hopeful this project will be fully Integrated with and for all Resources.

We want to thank the Agency for providing us the opportunity to provide our questions and comments. We request this letter be answered with specificity to each point raised rather than just read by staff and put in the project file under " public comments ".

Indeed if there are any questions, the need for more information or perhaps a meeting to discuss this offering, please call me, 602-769-6111.

*YOU CANNOT SOLVE A PROBLEM BY USING THE SAME MINDSET THAT CREATED IT*
*Albert Einstein*

Rick Erman
Member

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03/14/2011 09:39 PM

To "Mary Lata" <mlata@fs.fed.us>
cc
Subject Re: comment due date

Mary, thank you, an enjoyably part of my "hobby" - wildlife conservation provides me a number of opportunities,
to meet good people who in there own way make a difference, and
to continue my education on topics I enjoy and have a passion for

general

thank you for finding someone to help with my education on canopy cover. over the weekend I dug through my stacks of papers and found references from: Covington & Sackett, White and Moore, speaking to tree canopy closure, pre-settlement ( as an average ) of 17% which I took the easy way for math at 20%. found a common soil type for the CNF & KNF in their TES's for Ponderosa. doing a little math came up with 1,800 #'s / acre / year potential.

general

I fully know that my logic, method and numbers will be shredded by the experts, my lack of formal training and field work makes me a very easy target. news flash !! nothing new in that. I have for some 354 years taken a number of un-popular positions and ask a Bunch of Hard Questions.

general

my point is someone must come up with a range of variation for how much fine fuels were on the ground pre-settlement to carry those natural fires, which fed the wildlife, protected the watershed and kept the small trees at bay. the reason for my attempt at numbers is to start an honest - meaningful conservation which will lead to valid Desired Conditions on the Forest Reserves in R-3. my numbers clearly show there is indeed a possible range of variation which is will beyond what we see today. the 1,800#'s produces 5 tons in 5 years and by logic/math 900#'s/year/acre at least 2.5 tons/acre.

someone in the Agency or Academia must have a realistic number for Debris - Litter - Mulch for the material < 3 inches, which would mimic the pre-settlement condition.

1- Request for Info

one last item if I might, attached is a short paper I would ask you to read at least the first five pages. I am quite sure your slammed working on the 4 Forest and my guess is a forest plan or two as well. I think those 5 pages will give you a pretty good idea of my direction.

2

Having said that I must defend myself and others in the Friends group, we are NOT anti cow or elk, we are not advocating the total removal of either species. we all feel there is a place for those uses on the Forest Reserves, it's the Agencies responsibility to "step-up" and face the facts if the real / true issue.

general

the Agency cannot have it both ways,
on one hand tell the public there are too many small tress & the habitat is unhealthy and we will solve the problem by cutting a Bunch of small trees, AND
stand mute to the root cause of the issue / problem,,,,,,, herbivore by non-native species

general

thanks again for the dialog

Rick

**From:** Mary Lata
**Sent:** Monday, March 14, 2011 5:03 PM
**To:** RICK ERMAN
**Cc:** Neil McCusker ; Paula Cote ; Henry Provencio
**Subject:** Re: comment due date

Rick - For details on canopy cover and VSS classes, I'm going to refer you to our Silviculturist, Neil McCusker.

It would, of course, depend on the 100 acres you're looking at, but you've already awknowledged that. Frustrating as it is, I believe a professor I had in college was right when he said that 90% of the time, when someone asks a question about the natural environment, the first answer is "it depends". For us, finding the appropriate level of detail/specificity is one of the more difficult tasks on a landscape of this size.

>><><<<><>>><><<
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**RICK ERMAN <ermanaz7746@msn.com>**

03/12/2011 10:33 AM

To "Mary Lata" <mlata@fs.fed.us>
cc
Subject Re: comment due date

Mary, thank you, very understandable

if I might I do have another general question, according to CNF - TES for a pine soil type 582.1 we see the canopy cover from pine is 65%, and general agreement is this % cover is way too high.

can you give me some idea to the goal of canopy cover, for the 4F or the new Forest Plans,,,,, say for a 10 / 100 Average plot after treatment and modest re-growth ?

more specifically if we were to be at a high elevation looking down on this site, with the desired conditions in place we would see on our 100 acres

X - acres of VSS 5's & 6's with ( I am going to guess at ) 80 to 100% canopy cover., and
Y - acres of VSS 3's & 4"s with ( again a guess ) 20 to 30% canopy cover, and
Z - acres of VSS 1's & 2's with little if any canopy cover thus rated at 0%

2011-0314-38

THE JOHN MUIR PROJECT of EARTH ISLAND INSTITUTE

P.O. Box 697
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Tel: 530-273-9290
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14 March 201

Coconino National Forest
Attn: 4FRI

To Whom It May Concern,

On behalf of the John Muir Project of Earth Island Institute, I am submitting the following scoping comments on the proposed "Four Forest Restoration Initiative". I have a Ph.D. in Ecology from UC Davis, with a research focus in forest and fire ecology in western U.S. conifer forests, which is also the focus of my published research over the past six years. I offer the following in the hopes of facilitating better use of science in forest management decisions:

1. **There is no question that high-intensity fire, at some level, was a natural part of historic fire regimes in dry ponderosa pine forests.**

The recent scientific literature has left no question that high-intensity fire was a natural part of the mix of historic, pre-suppression fire regimes in dry ponderosa pine (PP) forests in the western North America, including studies by Baker et al. (2007) (PP forests of Northern Rockies, SW Colorado, and northern New Mexico), Baker (2006) (PP forests of northern Arizona), Hessburg et al. (2007) (mixed-conifer, fir, and PP forests of eastern Cascades of Washington), Klenner et al. (2008) (PP forests of British Columbia), Minnich et al. (2000) (PP/JP forests of northern Baja California, Mexico), Leiberg (1900) (PP forests of eastern Oregon Cascades), and Pierce et al. (2004) (PP-dominated forests of Idaho). Please see my report, "The Myth of Catastrophic Wildfire", on JMP's website (www.johnmuirproject.org), for full citations for these studies, and studies cited below.

general statement

2. **The studies that provide data which can be used to determine a historic high-intensity fire rotation interval in dry ponderosa pine forests tend to indicate rotations of 300-400 years.**

Baker (2006), using a fire history reconstruction approach from plot data in PP forests of northern Arizona, concluded that historic high-intensity rotations were approximately 300-400 years. The data from Leiberg (1900) for PP forests in the eastern Oregon Cascades (summarized in my "Myth of Catastrophic Wildfire" report) indicates a pre-suppression high-intensity rotation of 300-400 years. Hessburg et al. (2007) found that approximately 1/3 of the eastern Cascades forests in Washington (much of it dominated by PP) was in an early-successional state due to recent, or relatively recent, high-intensity fire, historically. Minnich et al. (2000) found a 300-year high-intensity fire rotation in PP/JP dry forests of the Sierra San Pedro de Martir in Baja California, Mexico (these forests have never experienced logging or fire suppression). Given

growth rates in Cascades dry forests (Moeur et al. 2005), this roughly corresponds to a high-intensity rotation of, once again, 300-400 years.

3. **Current high-intensity fire rotations are likely longer than 300-400 years in dry ponderosa pine forests of the SW.**

Rhodes and Baker (2008), using Forest Service BAER severity data to estimate high-intensity rotations in various parts of the U.S. West, concluded that current high-intensity fire rotations in SW forests is about 625 years. An estimate could also be made using RdNBR satellite imagery, but this has not been done yet. Nevertheless, fire intensity estimates based on RdNBR tend to be similar to BAER estimates at landscape scales (see, e.g., Odion and Hanson 2006, Odion and Hanson 2008). Given the extremely long current rotations of high-intensity fire in SW forests at the landscape scale, there is no question that older forest is recruiting much faster (due to growth) than it is being affected by high-intensity fire (see Hanson et al. 2009 and Hanson et al. 2010 for a similar analysis in NW dry forests).

4. **Patches of high-intensity fire are very important ecologically, and support high levels of native biodiversity.**

The evidence on this point is too abundant to summarize here (please see my "Myth of Catastrophic Wildfire" report for details), but a couple of points bear mentioning in particular. First, Kotliar et al. (2007) concluded that a mix of fire intensities, including significant occurrence of high-intensity fire, benefitted bird diversity in SW forests. Here are some relevant quotes from Kotliar et al. (2007):

"Our results demonstrated that many species tolerate or capitalize on the ecological changes resulting from severe fires…"

"…there is increasing evidence that crown fires occurred historically even in montane forests…"

"Fire management that includes a broad range of natural variability (Allen et al. 2002), including areas of severe fire, is more likely to preserve a broad range of ecological functions than restoration objectives based on narrowly defined historic fire regimes (Schoennagel et al. 2004)."

Moreover, the presence of certain native species in SW forests tends to contradict the assumption that fires were exclusively low-intensity historically. For example, the Northern Three-toed Woodpecker is native to montane forests of Arizona and New Mexico, and not only the highest elevation forests. This species has habitat requirements very similar to those of the Black-backed Woodpecker, which requires large, recent high-intensity fire patches in mature forest. Further, while the Spotted Owl selects dense, old forest for nesting and roosting, we have now come to understand that it preferentially selects high-intensity fire areas (so long as they are not salvage logged, in which case the Owl avoids them) for foraging, likely due to the excellent habitat created for the Owl's small mammal prey in high-intensity patches (e.g., montane chaparral, as well as large snags, large downed logs, and variable-density pockets of natural conifer regeneration). See, for example, Bond et al. (2009). See also the following studies,

which are not cited in my "Myth of Catastrophic Wildfire" report", regarding Mexican Spotted Owl use of moderate- and high-intensity fire areas:

Bond, M.L., R.J. Gutiérrez, A.B. Franklin, W.S. LaHaye, C.A. May, and M.E. Seamans. 2002. Short-term effects of wildfires on spotted owl survival, site fidelity, mate fidelity, and reproductive success. *Wildlife Society Bulletin* 30:1022–1028.

Jenness, J. J., P. Beier, and J. L. Ganey. 2004. Associations between forest fire and Mexican spotted owls. *Forest Science* 50:765–772.

general

In a broad sense, the ecological importance of high-intensity fire patches, and the resulting habitat and natural processes, is discussed and summarized very well in a recent article by Swanson et al. (2010), which I have attached.

5. **Landscape-scale, or sub-regional, management actions in SW ponderosa pine (PP), or mixed-pine, forests designed to further reduce the occurrence of high-intensity fire can only be justified scientifically if baseline data (not assumptions) indicates that the current high-intensity rotations are significantly shorter than historic high-intensity rotations.**

As discussed above, the existing data that we have indicates that the current high-intensity rotations in SW forests may be longer (i.e., meaning less high-intensity fire) than the historic rotations, and current high-intensity rotations are so long that there is little question that older forest is recruiting much faster than it is being affected by high-intensity fire. Nevertheless, it is always beneficial to have more data, and if future data indicates that current high-intensity rotations have become significantly shorter than historic rotations, then, and only then, would management actions designed to reduce high-intensity fire occurrence be worthy of consideration, scientifically. In such a circumstance, this should include more broadly-applied prescribed fire, and prescribed fire should be the first priority as a management tool, given its importance not only in creating some of the important post-fire habitat features, but also in nutrient cycling. If, in this hypothetical scenario, prescribed fire alone cannot be used in some site-specific areas, then thinning of very small trees could be used first in such areas. However, it is very important to note here that the scientific evidence is quite clear that potential fire intensity can be very effectively reduced with an upper diameter limit of about 8 inches in diameter at breast height (Omi and Martinson 2002, Martinson and Omi 2003, Strom and Fule 2007). This is true regardless of the pre-thinning basal area density of the stands (Martinson and Omi 2003). There is no justification, ecologically, for thinning of trees up to 16 inches in diameter, or larger, and such action would only unnecessarily reduce forest canopy cover and reduce potential for natural recruitment of ecologically-vital large snags through competition mortality.

Rec. Alt 2

Having said this, I have seen very, very few cases in which prescribed fire cannot be used in lieu of thinning. The main reasons that prescribed fire is rejected, and thinning is favored, are: a) the obvious perverse economic incentives that influence Forest Service decisions; and b) unscientific protocols and policies that essentially require Forest Service managers to reject prescribed fire as an option if their modeling indicates that tree mortality would exceed arbitrarily-low thresholds,

Rec. Alt 3

usually around 5% mortality. If managers accept some mixed-intensity effects not only as acceptable, but also as a desired condition, then we could see significantly more prescribed fire, as well as Wildland Fire Use fires (now called Appropriate Management Response, i.e., managed lightning-caused fires).

Even if some site-specific case can be found where prescribed fire is unwarranted (perhaps adjacent to homes, for example), I recommend that the small-diameter thinning of trees up to 8 inches in diameter be done via a non-commercial service contract in which the thinned trees are not removed as commercial product—either for sawtimber or biomass. There are several options for the material, including piling and burning, mastication followed by burning, or removal for non-commercial use such as personal use permits for firewood or fence materials. None of these are perfect, of course, but they are all considerably better than the alternative, i.e., using a timber sale or commercial biomass sale to remove the trees. The perverse financial incentives involved tend to compromise the ecological goals, and unnecessary damage occurs—more trees and larger trees are removed than would otherwise occur, or would otherwise be recommended for removal. Moreover, if the biomass industry develops greater and greater economies of scale, due to an increase in subsidized projects on federal lands, then the industry will naturally push more and more for increased removal of wood products, and will take their case increasingly to Congress and the Administration. This will result in increased intensity of removal of small trees, increasing removal of mature trees, and increased spatial scope of removals across the forested landscape for biomass (we are already seeing biomass post-fire salvage sales, and old growth biomass sales in CA).

3

opinion

Finally, I should briefly address the issue of "uncharacteristic" wildfire. This is one of those situations where the question itself may be a problem. Generally, activists and managers are focused on the percentage of high-intensity effects in current fires, and the question they pose is whether the percentage of current high-intensity effects is likely higher now than it was historically (I have little doubt that the current high-intensity percentage is higher that is was historically, if for no other reason than because, in the era of ongoing fire suppression, it is easy to suppress low-intensity effects, and that necessarily bumps-up the proportion of high-intensity effects). For example, if the current high-intensity average percentage is, say, 25%, and the assumption or belief is that the historic percentage might have been 5-10% (in point of fact we have no direct data on this), then current fires are described as uncharacteristic. However, this is not the most ecologically relevant question because there was nearly an order of magnitude more fire overall (acres burned on average in a given year or decade) historically compared to now. The ecologically relevant question is: how much fire of low **and** high intensities, spatially, is occurring in a given year or decade now versus prior to fire suppression—i.e., what is the current spatiotemporal extent of low- and high-intensity fire versus the pre-suppression extent? This goes to the question of the amount of post-fire habitat created for the species that depend in whole or in part upon such habitat, as well as the extent of vital nutrient cycling across the landscape. From this standpoint, current fires may indeed be "uncharacteristic", but in the opposite direction from what most people assume.

general

6. **The scoping notice assumes, incorrectly, that there is a sound scientific basis for the Fire Regime Condition Class (FRCC) system.**

The scoping notice assumes that, with increasing time since fire—i.e., higher levels of missed fire return intervals relative to the natural, historic fire return intervals—fire intensity will substantially increase and high-intensity fire predominates in higher FRCC areas. The empirical data contradicts this assumption (Odion et al. 2004, Odion and Hanson 2006, Odion and Hanson 2008, Odion et al. 2010) (once again, please see my report, "The Myth of Catastrophic Wildfire" at JMP's website, www.johnmuirproject.org, for citations).

**7. Misleading recent studies.**

A couple of recent studies, Williams et al. (2010) (Proceedings of National Academy of Sciences) and Hurteau and Brooks (2011) (BioScience, Feb. 2011), have caused some confusion and require some clarification. Williams et al. (2010) discussed recent mortality from fire and insects, but defined "stand-replacing fire" as fire categorically mapped by the USFS as "moderate" and "high" (i.e., only excluding "low"). I am familiar with the thresholds used for this mapping, and the "moderate" category includes tree mortality down to as low as 20% of the basal area (far, far lower than "stand-replacing" mortality levels). Also, the authors of Williams et al. (2010) refer to "extensive" areas of beetle mortality, and reference (in the supplemental material for the study) a USFS website as the source of aerial tree mortality surveys, claiming that the high mortality areas represent over 50% tree mortality. I visited that website and it does not say that. It classifies such areas as having over 50% of foliage discolored, or over 50% of trees stressed, which is a long ways from 50% mortality. Further, Williams et al. (2010) ignore modeling indicating that SW forests will see LESS fire in future decades due to climate change (e.g., Krawchuk et al. 2009). Moreover, Williams et al. (2010) used a 1992 vegetation data base to classify vegetation, which was used to determined "trend" in fire severity since 1984. The problem is that areas that burned at high severity in the earlier years of this time series are frequently reclassified in the vegetation mapping data bases as meadow or brush, leading to an erroneously low estimate of the extent of high-severity fire in the early years relative to the later years—i.e., leading to a false appearance of an upward trend. Williams et al. (2010) also extrapolate the relatively dry years of the past decade to all future decades, ignoring the fact that 1976-1999 was the wettest period of the 20th century in SW forests (Haire and McGarigal 2010). Finally, with regard to both Williams et al. (2010) and Hurteau and Brooks (2011), both imply that high-intensity fire is causing type conversion to non-forest in the SW, but both either ignore recent data or present it misleadingly. For example, both Haire and McGarigal (2010) and Savage and Mast (2005) found substantial natural conifer regeneration following high-intensity fire in SW pine forests. Hurteau and Brooks (2011) misleadingly suggest that Savage and Mast (2005) found conversion to non-forest in several high-intensity fire areas. This is incorrect, as shown in Table 3 of Savage and Mast (2005).

Please mail me hard copies of any documents produced pursuant to this proposal, and feel free to contact me if you have any questions.

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RESEARCH ARTICLE

# Effects of landscape patterns of fire severity on regenerating ponderosa pine forests (*Pinus ponderosa*) in New Mexico and Arizona, USA

**Sandra L. Haire · Kevin McGarigal**

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**Abstract** Much of the current effort to restore southwestern ponderosa pine forests to historical conditions is predicated upon assumptions regarding the catastrophic effects of large fires that are now defining a new fire regime. To determine how spatial characteristics influence the process of ponderosa pine regeneration under this new regime, we mapped the spatial patterns of severity at areas that burned in 1960 (Saddle Mountain, AZ) and (La Mesa, NM) 1977 using pre- and post-fire aerial photography, and quantified characteristics of pine regeneration at sample plots in areas where all trees were killed by the fire event. We used generalized linear models to determine the relationship of ponderosa pine stem density to three spatial burn pattern metrics: (1) distance to nearest edge of lower severity; (2) neighborhood severity, measured at varying spatial scales, and (3) scaled seed dispersal kernel surfaces. Pine regeneration corresponded most closely with particular scales of measurement in both seed dispersal kernel and neighborhood severity. Spatial patterns of burning remained important to understanding regeneration even after consideration of subsequent disturbance and other environmental variables, with the exception of a few cases in which simpler models were equally well-supported by the data. Analysis of tree ages revealed slow progress in early post-fire years. Our observations suggest that populations spread in a moving front, as well as by remotely dispersed individuals. Based on our results, recent large fires cannot be summarily dismissed as catastrophic. We conclude that management should focus on the value and natural recovery of post-fire landscapes. Further, process centered restoration efforts could utilize our findings in formulating reference dynamics under a changing fire regime.

**Keywords** Spatial heterogeneity · Burn severity · Spatial scale · Forest recovery · Generalized linear models · Seed dispersal kernel · Forest age structure · Ecological restoration

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## Introduction

The recent increase in large fires in forests of the southwestern U.S. is considered a harbinger to catastrophic ecological effects (Covington 2000; Covington et al. 2001). For species that rely on legacy seed sources, such as ponderosa pine (*Pinus ponderosa*), spatial patterns of biological legacies are critical to recolonization of severely affected areas (Turner et al. 1997; Romme et al. 1998). Given variability in seed production, germination success, and time to achieve seed bearing age, species with limited dispersal capabilities may not successfully

re-establish in large openings before fire recurs (Turner et al. 1994; Frelich and Reich 1995; Romme et al. 1998; Allen et al. 2002). Historically (prior to ~1700), openings created by frequent fire in southwestern ponderosa pine forests were small, often less than 1 ha (Cooper 1960; White 1985), and landscape patterns of burning did not limit the occurrence and persistence of post-fire regeneration (Agee 1998). As a result, ponderosa pine forests exhibited an uneven-age structure over large areas which remained stable through time (Cooper 1960). In contrast, recent fires have left much larger openings, and a significant overall proportion of stand mortality (Westerling et al. 2006). However, the role of landscape patterns created by contemporary fires in longer-term recovery of ponderosa pine forests is unknown.

Seminal work in landscape ecology following the Yellowstone fires of 1988 provides a basic framework for exploring fire size and pattern (Turner et al. 1994) and their relationship to ecological processes, including succession (Turner et al. 1997). Landscape heterogeneity, associated with variable fire severity within burned areas, was a striking characteristic of the 1988 fires (Turner et al. 1994). More recent work has uncovered the persistent effects of landscape patterns on forest communities, as they evolve through time (Turner et al. 2003; Kashian et al. 2004).

Fires affect landscape pattern at many scales: across an entire region, within an area burned in a particular fire event, and within a burned patch (Turner et al. 1994). There is not a single, relevant spatial scale for understanding the effects of landscape pattern, but potentially important spatial scales can be identified for a specific process (Delcourt et al. 1983; Levin 1992). In particular, seed dispersal capabilities may define key spatial scales for regeneration of species such as ponderosa pine because their recovery relies on patchily distributed biological legacies (Franklin et al. 2000; Allen et al. 2002). Using statistical approaches, it is possible to identify scales at which spatial pattern best describes variation in response of the ecological process of interest (Wiens 1989).

Similarly, ecological processes operate at different temporal scales, and variables including reproductive age and disturbance interval can define an appropriate time frame for studying pattern-process relationships. Our previous work at two burns, Saddle Mountain, which occurred on the Kaibab Plateau, Arizona, USA in 1960 and La Mesa, which burned on the Pajarito Plateau, New Mexico, USA in 1977 indicated that diverse communities were present years after these large, severe fire events, including young forests (Haire and McGarigal 2008). In addition, observations at these sites were consistent with a wave-form model of succession (Frelich and Reich 1995), where species that rely on legacy seed sources outside of severely burned areas, such as ponderosa pine, gradually migrate into openings of varying size.

Our primary objective was to identify at what scale spatial patterns of severity influence ponderosa pine regeneration at La Mesa and Saddle Mountain. Therefore, we examined relationships across a range of spatial scales that encompassed variability in dispersal distances, potential long-distance dispersal, and seed production by young trees coming of cone-producing age (Clark and Ji 1995; Clark et al. 2001). We quantified the importance of spatial patterns in models that included several groups of variables: (1) subsequent burning, either prescribed or wildland fire events which can influence seedling survival (Moore et al. 2004); (2) physical environment (topographic variation including elevation) which creates a template of basic resources for germination and growth (Baird et al. 1999; Bonnet et al. 2005); and (3) the biotic environment, because it reflects neighborhood interactions that alter resource availability (Frelich 2002).

Lastly, our study sites afforded the rare opportunity to observe the longer-term formation of forest structure as it occurred across varying distances from surviving seed sources following severe fire. Therefore, our final objective was to describe the temporal progress of regeneration in post-fire years in a spatial context defined by patterns of severity under the new fire regime. We discuss the relevance of our findings to restoration efforts given the likelihood that expansive fires will continue to play a role in fire regimes of southwestern forests with predicted changes in climate (Pierce et al. 2004; Westerling et al. 2006).

## Methods

### Study areas

Fires at our two study sites, La Mesa and Saddle Mountain, encompassed a broad gradient in elevation

that includes several major community types: piñon-juniper (*P. edulis-Juniperus* spp.) woodland, ponderosa pine forest, and mixed conifer forest that varied in composition of ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and aspen (*Populus tremuloides*). La Mesa, thought to be human-caused, burned across the Pajarito Plateau of northern New Mexico (35°48′ N, 106°20′ W) in 1977; Saddle Mountain, a lightning-caused fire, occurred on the Kaibab Plateau in northern Arizona (36°20′ N, 111°59′ W) in 1960. Both sites were located on regional plateaus, but geologic histories were markedly different. Ash-flow tuffs, erupted from the Jemez Mountains, define the Pajarito Plateau; its alternating broad mesas and steep canyons drain eastward to White Rock Canyon of the Rio Grande (Reneau and McDonald 1996). In contrast, the Kaibab Plateau was formed from sedimentary rock layers deposited with shifts in sea level (Hopkins 1990). The topography creates dramatic relief; steep scarp slopes, or combs, are adjacent to narrow stream bottoms, with sheer walls on the south forming the Nankoweap Rim.

Climate patterns in the Southwest are influenced by the El Niño Southern Oscillation, in which wetter winter and spring months and dry summers of El Niño alternate with the drier winter and spring months and wetter summers that characterize La Niña (Swetnam and Betancourt 1998). In years following La Mesa and Saddle Mountain, climate was variable in the 1960s and 1970s, but the wettest period in the region in the twentieth century occurred from 1976 to 1999, with a major El Niño event in 1997/98; subsequently a shift to La Niña led to a severe drought in the early 2000s (NCDC 2006).

Because both fires burned in areas with active post-fire management programs, salvage logging, seeding of non-native grasses and planting of seedlings of ponderosa pine occurred in some places (C. Allen and D. Steffensen, pers. comm.). Subsequent wildland and prescribed fires have burned in portions of both study sites (National Park Service, unpubl. data; United States Forest Service, unpubl. data). Influences on land use and management at the two sites have included their status as traditional and current homelands to many Native American peoples. Currently, the Saddle Mountain burn is entirely within the Saddle Mountain Wilderness on the Kaibab National Forest, except for a small area in Grand Canyon National Park. La Mesa falls under several jurisdictions including Bandelier National Monument and the Dome Wilderness, the Santa Fe National Forest, and the Los Alamos National Laboratory, a United States Department of Energy facility.

## Quantifying burn spatial patterns

For both locations, we mapped high severity using aerial photography obtained within 4 years before and after the fire event. Areas where all trees were killed were labeled as high severity, and areas of surviving trees were labeled as lower severity, because they could have experienced low, moderate or mixed fire effects or could represent unburned islands within the fire perimeter. The minimum mapping unit for areas of surviving trees within high-severity patches was two live trees in close proximity to each other. We field-checked the maps for accurate representation of surviving trees, and modified the maps in a few cases. The origin of the forest opening (i.e., the high-severity patch) was corroborated in the field by presence of downed wood, stumps, or snags. Total area, composition, and patch size statistics for high and lower severity were calculated using Fragstats (McGarigal et al. 2002).

We derived three metrics to quantify spatial patterns of burning (Table 1, Fig. 1). First, the burn severity maps were used to calculate Euclidean distance (m) from each point (i.e., 10-m grid cell) within a high-severity patch to the nearest edge of lower severity. We defined the second metric, neighborhood severity, as the percent of the landscape that burned with high severity at different spatial scales (Fig. 1). We calculated neighborhood severity in circular windows of variable size centered at each grid cell; the window radius (100, 150, 200, 250, 300, and 400-m) defined a particular spatial scale of analysis.

The third spatial pattern metric extended the concept of a dispersal kernel, which describes the scatter of offspring about the parent plant in the form of a probability density function (Clark et al. 2003), to a landscape dispersal kernel (Fig. 1). In order to reflect abundance of seed sources as it varied across the study site, we used a map of ponderosa pine cover to weight the kernel. Cover was mapped at La Mesa using post-fire (1981/1983) aerial photography by

**Table 1** Variables included in model tests

| | Description |
|---|---|
| Spatial variables | |
| Distance to edge of lower severity (m) | Euclidean distance from each point (i.e., 10-m grid cell) in high-severity patch to lower-severity edge |
| Seed dispersal kernel[a] scales ($h$): 50, 60, 70, 80, 90, 100, 150, 200, 300, 400 | Kernel surface weighted by cover of ponderosa pine at the edge of high severity patches. Multiple scales ($h$) |
| Neighborhood severity (%) scales: 100, 150, 200, 250, 300, 400 m | Percent of the landscape around the sample point that is high severity (i.e., total tree mortality). Multiple scales defined by radius of moving window in meters |
| Physical variables | |
| Elevation (m) | Digital elevation model (http://nationalmap.gov/) |
| Topographic wetness index (TWI)[b] | Ratio of the slope to the specific catchment area (contributing area) based on digital elevation model |
| Radiation or heat load (MJ $cm^{-2}$ $year^{-1}$) | Potential annual direct incident radiation and heat load. Best derivation selected using AIC for each site, either aspect rotations folded about the north–south line such that NE = NW (radiation; La Mesa) or aspect folded about the NE-SW line (heat load; Saddle Mountain) |
| Topographic position | Classified relative to the local (plot context) condition: summit or mesa top, flat side-slope, shoulder, toe, or bottom |
| Disturbance variable | |
| Disturbance | Number of times an area burned subsequent to the La Mesa or Saddle Mountain fires. Based on records from the U.S. Forest Service and National Park Service |
| Biotic variables | |
| Ground cover (%) | Grass, forb, soil, rock, or organic: recorded along 2 50-m transects at 1-m intervals |
| Community characteristics: Total cover of resprouters (La Mesa); total cover of aspen (Saddle Mountain) | Cover of species which were predicted to interact with ponderosa pine regeneration: recorded along two 50-m transects at 1-m intervals |
| Ponderosa pine response variables | |
| Number of individuals $ha^{-1}$: regression response Age estimate (years): graphical analysis | In a variable-width belt along either side of the line transects: count of all ponderosa pine trees (seedlings, saplings, and adults). Age estimate based on whorl counts (see text for details) |

All possible combinations of variables were compared in zero-inflated negative binomial models using ΔAIC

[a] Programs written by B. W. Compton, University of Massachusetts, in APL + Win (version 6.0, APLNow, Brielle, New Jersey)

[b] TauDem: Copyright (C) 2004 David Tarboton, Utah State University (http://hydrology.neng.usu.edu/taudem/)

Allen (1989); values ranged from 0 to 95%. A comparable map for Saddle Mountain, which we developed from aerial photography, was scaled categorically: 1 (<25% cover), 2 (25–60% cover), 3 (>60% cover). We used a Gaussian kernel but varied the smoothing parameter ($h$ = 50, 60, 70, 80, 90, 100, 150, 200, 300, 400; Silverman 1986) to examine regeneration response across a range of different spatial scales (i.e., potential seed dispersal distance functions).

## Physical environment and disturbance predictor variables

We measured the physical environment of the study areas using both digital map and field data (Table 1). We used digital elevation maps to model topographic wetness (TWI) and to calculate models of potential annual direct incident radiation and heat load (McCune and Keon 2002). In addition, we used digital fire history maps available from local land managers to

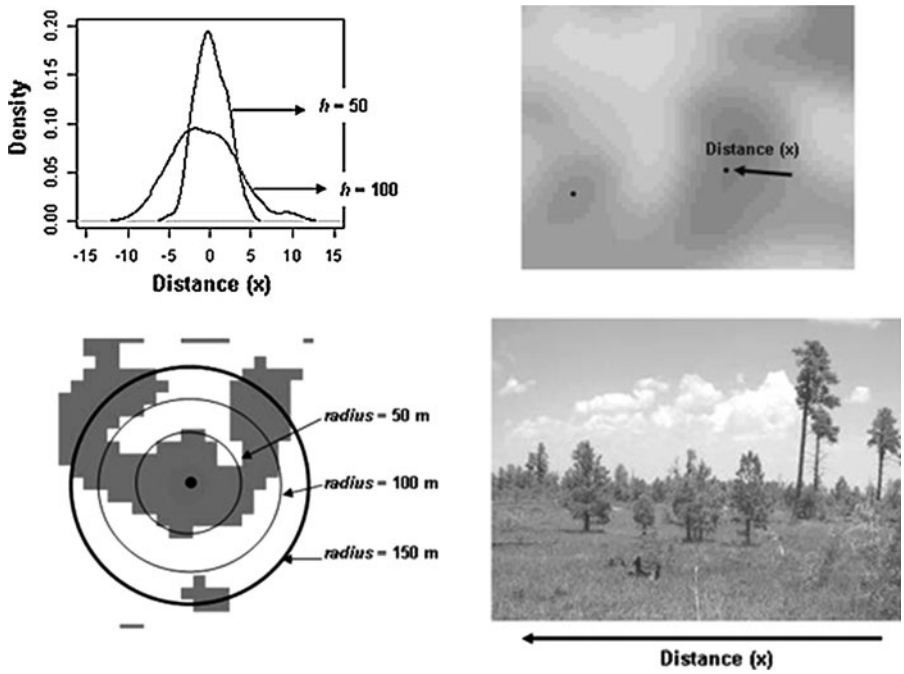



**Fig. 1** Illustrations of spatial pattern metrics. *Lower right* Young trees growing at varying distance ($x$) from legacy seed trees (see background of the right side of the photo). *Lower left* Neighborhood severity, measured around a sample plot location (*black dot*) in windows that vary in scale; *Upper left* Theoretical distributions of seed dispersal kernels, with scale defined by kernel shape ($h$). *Upper right* Seed dispersal kernel applied to the burn-severity map, where *white* to *light gray* values indicate higher values for seed source abundance and *darker shades* symbolize decreasing values as seed sources become more distant from sample plots (*black dot*) within high-severity patches

determine the number of times areas subsequently burned. All data were mapped at 10 m resolution. At each 50-m diameter field plot (see below), we classified topographic position relative to local condition as summit, side-slope, shoulder, toe, or bottom.

Field sample locations were randomly chosen from the set of maximum (Euclidean) distances along a center "line" within each high-severity patch. Locations where tree planting was documented were avoided. We surpassed our goal of $n = 50$ sample plots (based on the general rule of thumb: at least 10 samples per variable for building regression models with a maximum of 5 predictor variables) with a final total of 68 plots at La Mesa and 79 plots at Saddle Mountain (Fig. 2). Field work was completed between 16 May and 30 June 2005.

## Biotic environment and regeneration response variables

At each field plot, we recorded ground cover (grass, forb, rock, soil, or organic material) and cover of all woody species using point-intercept at 1-m intervals along two 50-m line transects positioned North-South and East-West. Aspen was abundant in the range of ponderosa pine at Saddle Mountain, while several species that tend to quickly resprout after fire were common at La Mesa (e.g. *Quercus* spp., *Robinia neomexicana*; Haire and McGarigal 2008). Because these species could affect resources for shade-intolerant pines, we included total cover of aspen and total cover of resprouters as variables in the analysis.

To determine tree density, we counted all individual ponderosa pine trees in a belt along either side of the 50-m transects. Width of the belt varied from 2 to 10 m with the goal of including some trees in more open locations, or to obtain a representative sample in locations where trees were dense. Ponderosa pine trees were aged by counting branch whorls on each tree trunk; whorl-counting has been employed for similar purpose in previous studies; for example, Shatford et al. (2007) aged coniferous trees in regenerating forests of the Pacific Northwest using whorl counts. Whorl-counting was quick and

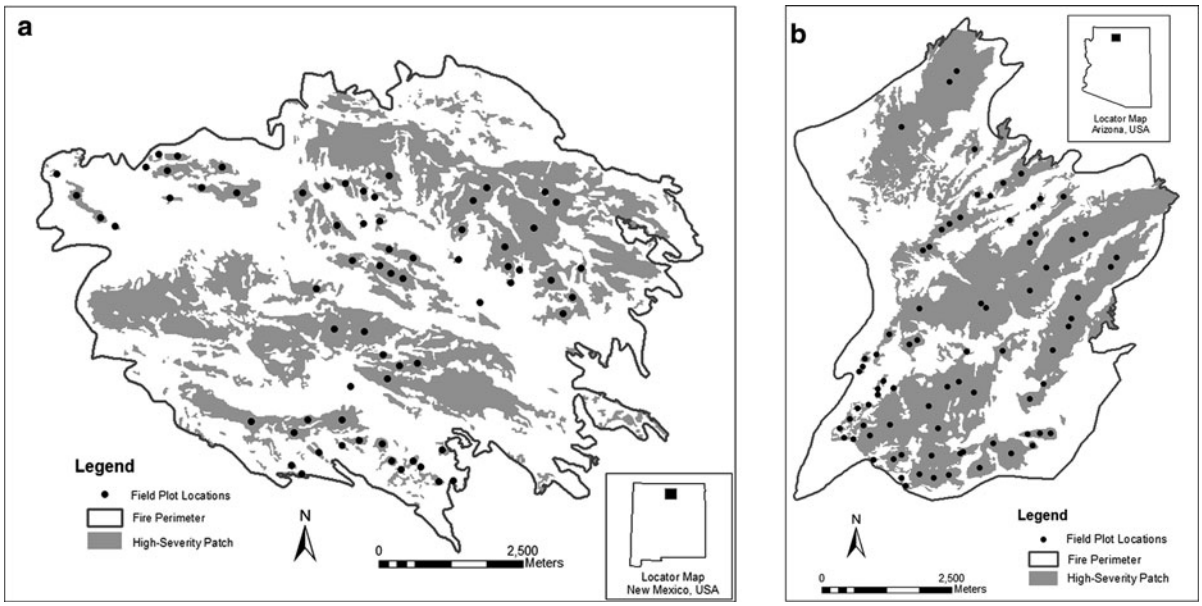



**Fig. 2** Severity maps of (**a**) La Mesa (New Mexico, USA) and (**b**) Saddle Mountain (Arizona, USA). *Gray patches* symbolize areas where all trees were killed (high severity) based on pre- and post-fire aerial photography. Field plot locations (*black dots*) were chosen randomly from the set of maximum (Euclidean) distances along a center ridge within each high-severity patch. Fire perimeters, provided by local land managers, represent the spatial extent of burning

efficient, given the open branch structure of ponderosa pine, and the relatively short stature of young trees. Trees were cored selectively (La Mesa, $n = 25$; Saddle Mountain, $n = 12$) to determine confidence in age estimates based on whorl counts.

## Statistical analysis

We developed separate regression models for each of three groups of predictor variables: disturbance, physical, biotic. Then, we formulated a combined model containing variables from each of the original three models. In models with multiple predictors, we examined all possible additive combinations of variables to determine the best final model. The response variable was ponderosa pine individuals $ha^{-1}$ calculated from tree counts within the belt transect. Two Saddle Mountain plots with extreme values for pine abundance were excluded from the analysis. Next, we added each of the spatial variables (seed dispersal kernel and neighborhood severity at each scale), in turn, to the disturbance model and to the best physical, biotic, and combined models.

We fit zero-inflated count models to the data (negative binomial with log link) using maximized likelihood. Zero-inflated models are two-component mixture models that are useful when count data have excess zero counts; the negative binomial adjusts for over dispersion due to extra variation in the count data (Zuur et al. 2009). We chose the zero-inflated models because log-likelihood statistics indicated major improvement in results when compared with Poisson, negative binomial, and zero-inflated Poisson models. In our model results, the sum of fitted densities evaluated at zero using zero-inflated negative binomial models was roughly equal to the observed number of zeros in the data (La Mesa, $n = 18 \pm 0.2$; Saddle Mountain, $n = 51 \pm 0.1$).

Pearson's correlation coefficient ($r$) and Lin's concordance correlation coefficient ($\rho$) were calculated to measure goodness of fit between predicted and observed non-zero values for each model. The first statistic indicates linear dependence between variables, and the latter reflects deviation in the linear relationship from a diagonal line (Lin 1989). We employed these statistics to provide a sense of the general correlation and predictive ability of model results, recognizing their limitations in reflecting true agreement in data sets with different degrees of heterogeneity (Atkinson and Nevill 1997).

Model selection was based on minimized Akaike's Information Criterion (AIC). The AIC considers the likelihood of observed data given a particular model (i.e. goodness of fit), but also includes an objective 'penalty' that increases with the number of parameters used (i.e. complexity; Ginzburg and Jensen 2004). We used commonly accepted rules of thumb for judging model improvement: models with $\Delta AIC \leq 2$ have substantial support (evidence), $4 \leq \Delta AIC \leq 7$ indicates considerably less support, and models with $\Delta AIC > 10$ have essentially no support (Burnham and Anderson 2004). To examine the relative contribution of spatial variables, and assess scales of importance, we plotted ΔAIC for each of the original models, with and without an added spatial variable.

Finally, we used age estimates of ponderosa pine trees, based on whorl counts, to analyze regeneration through time and across distance to edge of lower severity. To determine confidence in the whorl count estimates, we compared them with age estimates from tree ring counts using multi-response permutation procedures (Mielke and Berry 2001), and found no significant difference (La Mesa, $n = 25$, $\delta = 4.41$, $P = 0.73$; Saddle Mountain, $n = 12$, $\delta = 5.45$, $P = 0.21$). Using the tree age data, we constructed a data set containing the cumulative number of trees $ha^{-1}$ observed at each plot in each year after the fires. Tree density was plotted at several post-fire intervals across the range of distance to edge of lower severity, which enabled a graphical analysis of regeneration through time and space. All statistical analyses were conducted using R (R Development Core Team 2009) including the implementation of zero-inflated negative binomial models in the pscl package. For spatial analyses we used ArcInfo version 9.0 (Environmental Systems Research Institute, Redlands, California).

## Results

La Mesa and Saddle Mountain were similar in terms of fire size, but differed in composition and configuration of burn severity (Table 2). A large proportion of each burned landscape was high severity, but the high-severity patches varied widely in size. The La Mesa fire resulted in a more patchy landscape in comparison to Saddle Mountain. Saddle Mountain was approximately 70% as large as La Mesa; however, it contained only one quarter as many high-severity patches and a little more than half the number of lower-severity patches. The more homogeneous patterns that followed the Saddle Mountain fire were also apparent in the size of the largest high-severity patch. Both study landscapes had a large background matrix that burned at lower severity or did not burn at all, with many, small patches.

Analysis of ΔAIC for all additive combinations of physical and biotic variables resulted in fairly simple models at both sites (Tables 3, 4). Saddle Mountain especially stood out in this regard; best-supported physical and biotic models contained a single predictor, with two-parameter models in close competition. Elevation and TWI were important factors in physical models of regeneration at both sites, and neighborhood variables (i.e., resprouter cover and aspen cover) held their place in competing biotic models. In the best combined models, subsequent disturbance added important information at both sites, and physical and biotic predictors were retained.

The biotic model had the best fit for La Mesa; fit of all models was improved when a spatial variable was added based on $r$ and $\rho$ (Table 3). Saddle Mountain combined model was the best fit and the addition of a spatial variable likewise contributed to better fit (Table 4). Lower values of $\rho$ for Saddle Mountain

**Table 2** Landscape characteristics of the study areas calculated within fire perimeters

For patch size, the mean is followed by minimum and maximum values in parentheses

| Landscape characteristics | La Mesa | Saddle Mountain |
|---|---|---|
| Total area burned (ha) | 5,745 | 4,060 |
| High severity (%) | 34 | 48 |
| High-severity patches (*n*) | 190 | 45 |
| High-severity patch size (ha) | 10 (0.08, 634) | 43 (0.11, 947) |
| Lower-severity-patches (*n*) | 150 | 96 |
| Lower-severity-patch size (ha) | 25 (0.01, 3673) | 22 (0.01, 2047) |

**Table 3** The AIC and ΔAIC are given for competing physical, biotic, and combined models (ΔAIC ≤ 4) resulting from analysis of La Mesa data

| Model | | | AIC | ΔAIC | Pearson's $r$ | Lin's $\rho$ |
|---|---|---|---|---|---|---|
| Disturbance | | | | | | |
| Number of subsequent burns | | | 721.80 | NA | 0.37 (0.39; 0.54) | 0.19 (0.28; 0.36) |
| Physical model | | | | | | |
| Elevation | TWI | | 709.79 | 0.00 | 0.33 (0.50; 0.55) | 0.29 (0.38; 0.44) |
| Elevation | Topographic position | TWI heat load | 713.37 | 3.58 | | |
| Elevation | Topographic position | TWI | 713.64 | 3.85 | | |
| Biotic model | | | | | | |
| Organic ground cover | | | 708.57 | 2.24 | | |
| Organic ground cover | Resprouter cover | | 706.34 | 0.00 | 0.86 (0.88; 0.86) | 0.68 (0.82; 0.81) |
| Combined | | | | | | |
| Number of subsequent burns elevation | TWI | Organic ground cover | 701.32 | 1.83 | | |
| Elevation | TWI | Organic ground cover | 699.48 | 0.00 | 0.60 (0.73; 0.78) | 0.50 (0.53; 0.57) |

The best physical, biotic, and combined models, as well as the disturbance model, were used to test the benefit of adding a spatial variable (see Fig. 3). Pearson's correlation coefficient ($r$) and Lin's concordance correlation coefficient ($\rho$) are presented as goodness of fit measures for the best models. Given in parentheses are the values of these statistics for models with seed dispersal and neighborhood severity added at the best scale (kernel model; neighborhood severity model)

**Table 4** The AIC and ΔAIC are given for competing physical, biotic, and combined models (ΔAIC ≤ 4) using the data from Saddle Mountain

| Model | | AIC | ΔAIC | Pearson's $r$ | Lin's $\rho$ |
|---|---|---|---|---|---|
| Disturbance | | | | | |
| Number of subsequent burns | | 394.46 | NA | 0.36 (0.66; 0.82) | 0.06 (0.20; 0.24) |
| Physical | | | | | |
| Elevation | TWI | 389.38 | 2.00 | | |
| Elevation | Heat load | 387.62 | 0.24 | | |
| Elevation | | 387.38 | 0.00 | 0.51 (0.71; 0.76) | 0.11 (0.21; 0.20) |
| Biotic | | | | | |
| Rock ground cover | | 390.98 | 0.00 | 0.50 (0.67; 0.77) | 0.11 (0.19; 0.22) |
| Rock ground cover | Aspen cover | 392.85 | 1.86 | | |
| Combined | | | | | |
| Number of subsequent burns | Elevation | 382.31 | 1.98 | | |
| Rock ground cover | | | | | |
| Number of subsequent burns | Elevation | 380.33 | 0.00 | 0.66 (0.65; 0.81) | 0.20 (0.23; 0.23) |

The best physical, biotic, and combined models, as well as the disturbance model, were used to test the benefit of adding a spatial variable (see Fig. 4). Pearson's correlation coefficient ($r$) and Lin's concordance correlation coefficient ($\rho$) are presented as goodness of fit measures for the best models. Given in parentheses are the values of these statistics for models with seed dispersal and neighborhood severity added at the best scale (kernel model; neighborhood severity model)

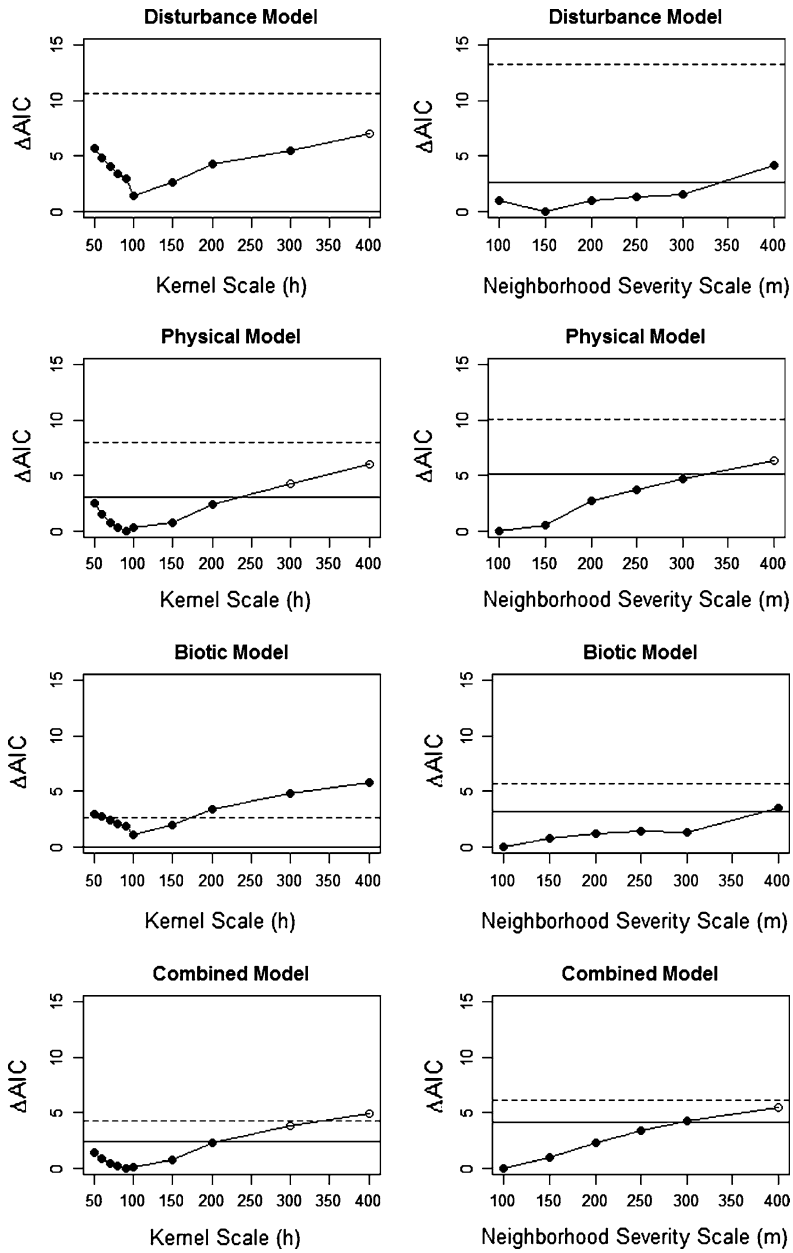



**Fig. 3** La Mesa model comparisons: ΔAIC values for disturbance, physical, biotic, and combined models without inclusion of a spatial variable are represented by a *dashed line* and ΔAIC with addition of distance to lower severity edge is shown as a *solid horizontal line*. The ΔAIC values for models where a seed dispersal kernel or neighborhood severity variable was added are shown as a *curved line*; significant scales ($P < 0.05$) are marked with a *filled circle*, non-significant scales with an *open circle*

models could reflect poor agreement, but evaluation of the influence of the small sample of non-zero values ($n = 26$) and influence of data homogeneity (Atkinson and Nevill 1997) would be necessary to further assess these results.

Particular scales in seed dispersal kernel and neighborhood severity models added significant information to disturbance, physical, biotic and combined models for La Mesa. Kernel scales where $h = 90$ or 100 provided the most improvement over original models, but several scales were significant ($P < 0.05$) in all models (Fig. 3). Biotic and combined models showed the least improvement through addition of a kernel variable. The best scale for neighborhood severity fell between 100 and 150 m; the full model at the best scale represented a major improvement over original models ($\Delta AIC \geq 6$).

La Mesa models containing distance to edge of lower severity were close competitors with the best seed dispersal kernel and neighborhood severity

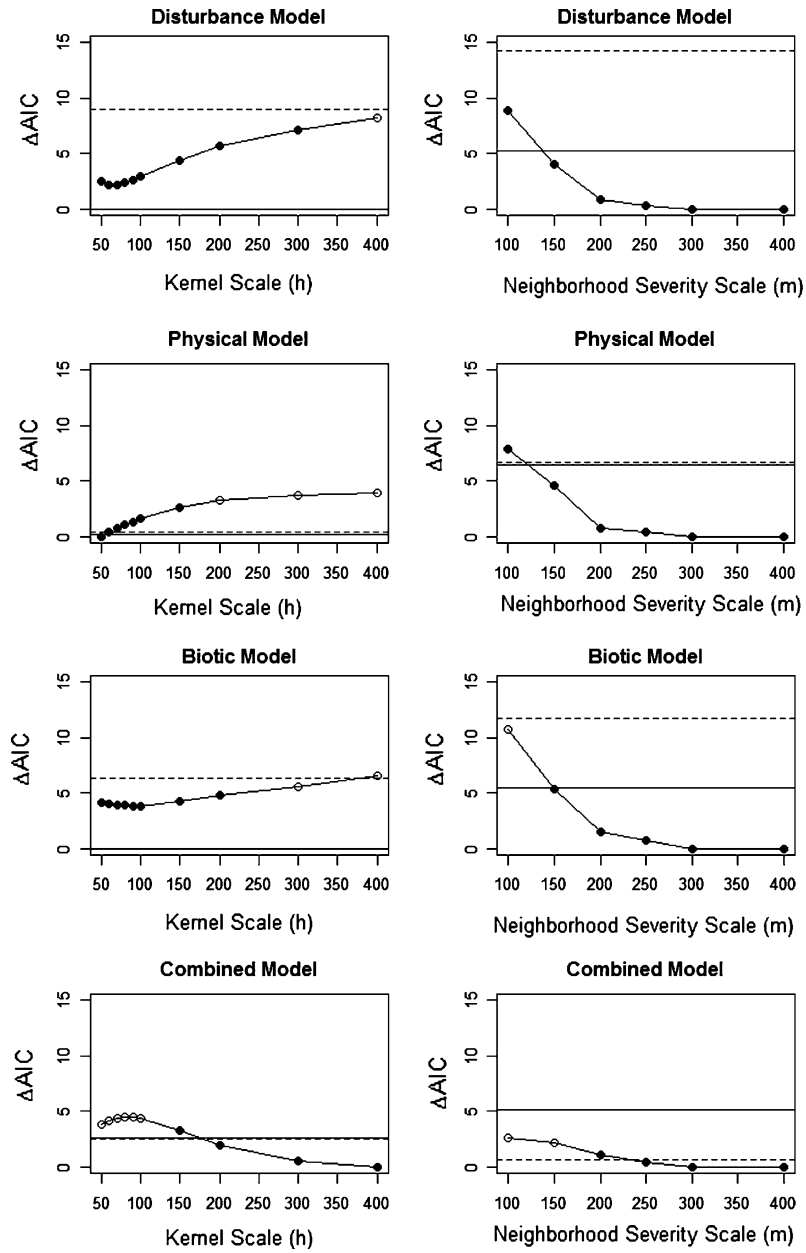



**Fig. 4** Saddle Mountain model comparisons: ΔAIC values for disturbance, physical, biotic, and combined models without inclusion of a spatial variable are represented by a *dashed line* and ΔAIC with addition of distance to lower severity edge is shown as a *solid horizontal line*. The ΔAIC values for models where a seed dispersal kernel or neighborhood severity variable was added are shown as a *curved line*; significant scales ($P < 0.05$) area marked with a *filled circle*, non-significant scales with an *open circle*

models, with one exception (Fig. 3). The distance model ΔAIC was approximately five units greater than the best physical-neighborhood severity model at 100 m; thus, the distance model was not well supported by the data. All other models with the distance variable were within three ΔAIC units of the best scaled variable model.

Saddle Mountain models also exhibited improvement when seed dispersal kernel or neighborhood severity predictors were added, with some exceptions (Fig. 4). The most model improvement was noted when the seed dispersal kernel at $h = 60$ was added to the disturbance model. Biotic, physical, and combined models showed little or no improvement at any kernel scale, even though kernel predictors were often significant ($P < 0.05$). Models with neighborhood severity, however, were generally better than original models at Saddle Mountain

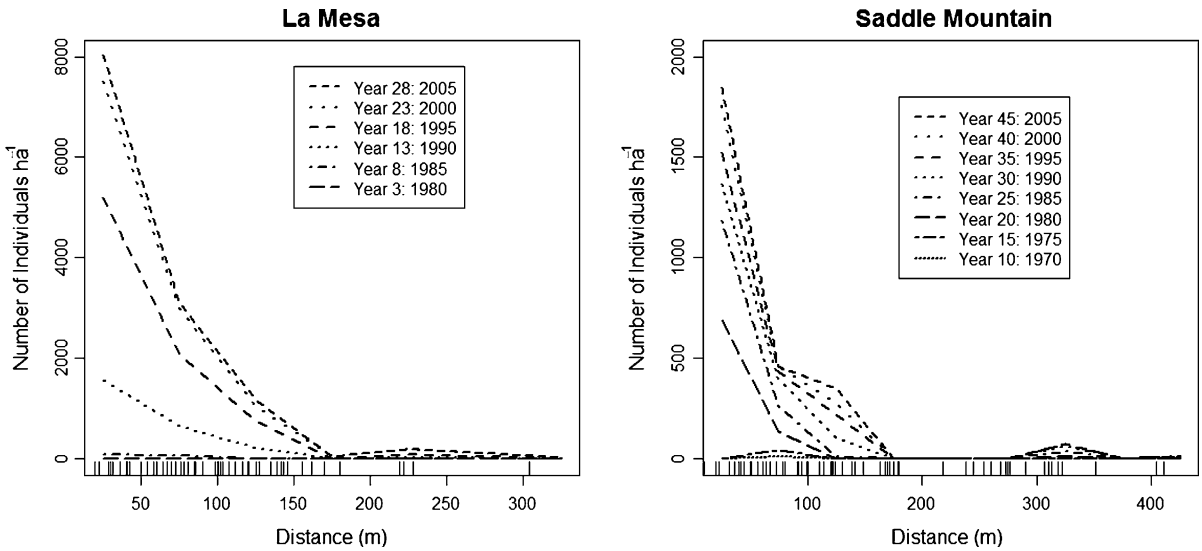



**Fig. 5** Cumulative regeneration (number of individuals ha$^{-1}$) through time, plotted across the gradient of distance to edge of lower severity at La Mesa (*left*) and Saddle Mountain (*right*). Observations were binned within 50-m distance intervals. *Vertical lines* along the *x*-axis represent locations of field plots. Post-fire years correspond to the descending sequence of *dashed lines*

(Fig. 4). Neighborhood severity scales that added the most information were 300–400 m. Combined models were an exception; ΔAIC was nearly the same with or without addition of a neighborhood severity predictor.

At Saddle Mountain, the addition of distance to edge of lower severity to original models resulted in ΔAIC values close to the best seed dispersal kernel models in most cases (Fig. 4). Biotic models containing a kernel variable showed marked improvement over the model with distance added; this was true across scales ($h = 50$–$100$; ΔAIC $\approx 4$). The addition of neighborhood severity consistently produced models that were better supported than those containing distance to lower severity edge.

Total productivity and density of trees differed between the two sites, with cumulative total number of trees at lowest distances much greater at La Mesa ($\sim$8,000 trees ha$^{-1}$ at La Mesa; $\sim$2,000 trees ha$^{-1}$ at Saddle Mountain; Fig. 5). However, some general trends were consistent at the two sites. First, at distances less than 100 m from potential seed sources, cumulative totals indicated that very little regeneration occurred in early post-fire years (year 1–8 at La Mesa, and year 1–15 at Saddle Mountain), but approximately 5–15 years after the first recorded regeneration at each site, more productive years occurred. Relatively large increases in tree density, shown in wide intervals between lines at lower distances, indicate that a majority of trees that survived to the 2005 field season germinated during this intermediate time frame (ca. 1985–1995 at La Mesa, and ca. 1975–1985 at Saddle Mountain). In more recent years, less growth was initiated at locations closer to edge, indicated by narrow intervals between dashed lines (Fig. 5).

Cumulative number of trees steadily declined across the range of distance to edge of lower severity, but some regeneration was recorded at distances from lower-severity edge greater than 200 m (Fig. 5). At La Mesa, regeneration occurred at three high distance locations (222, 228, and 304 m), and the first record of seedlings at these plots varied between year 11 and 18 post-fire (ca. 1988–1995). Out of 23 high-distance plots at Saddle Mountain, there were five locations (306, 310 [$n = 2$], 322, and 410 m) with regeneration. Earliest initiation of growth occurred about year 17 (ca. 1977), at 310 m from lower-severity edge. Density was low at all distances greater than 200 m ($\sim$11 to 26 individuals ha$^{-1}$).

## Discussion

Large fire events which now define a new fire regime in southwestern forests can encompass greater heterogeneity in spatial patterns than was common under a fire regime characterized by frequent, low-severity fires. At La Mesa and Saddle Mountain, high-severity patches ranged widely in size and shape, resulting in configurations of openings and seed sources that were probably similar to those of historical fires in some places, as well as situations that were unlikely historically (Agee 1998). The strong and persistent role of spatial patterning on ponderosa pine regeneration at our study sites suggests that an understanding of landscape heterogeneity will be critical to setting realistic and ecologically appropriate long-term restoration goals (Dellasala et al. 2004) under this new regime.

The three metrics of severity we used to quantify spatial pattern all contributed unique information in relation to other factors, but each provided a different slant on landscape heterogeneity. Distance from lower-severity edge assumed homogeneity within high-severity patches, but had the benefit of providing a simple description of spatial pattern that incorporates both patch size and shape. In some cases, the inherent scaling of the distance variable provided a measure of spatial heterogeneity that was at least as good as the other, explicitly scaled variables. The neighborhood severity metric reflected complexity in burn patterns because it is influenced by patchiness and edge effects. Both distance and neighborhood severity have the benefit of being very easy to calculate using a map of burn severity, thus facilitating testing of relationships at other sites. On the other hand, neither of these metrics addressed the influence of variations in species composition of legacy forests.

The landscape seed dispersal kernel incorporated variation in seed sources across broad elevational gradients and complex spatial patterns in burn severity that are often encompassed by large fires. The statistical importance of the kernel variable in models of ponderosa pine regeneration supports the theory that seed dispersal orders recolonization of disturbed sites, and is a primary scaling factor for succession after severe fire (Paine et al. 1998).

The extension of the traditional dispersal kernel to landscapes in which legacy seed sources are critical resources could provide a valuable enhancement to the classic models (e.g., Clark 1998). In a study of spatial patterns of post-fire ponderosa pine regeneration in South Dakota, USA, modeled seed availability was used to correct for variable seed inputs when determining the importance of environmental conditions (Bonnet et al. 2005). Analogous surfaces could be constructed for other species that are limited by seed dispersal ability such as white fir and Douglas-fir. For example, Shatford et al. (2007) described seedling density and distribution for several species across a gradient of forest types following fires in California and Oregon, USA. Interpretation of their results in relation to models of seed dispersal would enable a better understanding of regenerating and legacy forest dynamics.

Our results indicated that spatial patterns of burning interact with subsequent disturbance, the physical environment, and the biotic neighborhood in complex ways. For example, the original biotic models at both sites were comparable to those with the added kernel variable at the best scale (Figs. 3, 4). Available seed sources are only one component of successful regeneration; neighborhood conditions, defined by resprouters that come back quickly after fire, evidently played an equally important role in determining ponderosa pine distribution. This interpretation is consistent with the idea that resprouters "capture" a site in areas of fire-induced tree mortality in some places (Allen et al. 2002; Savage and Mast 2005). However, models that incorporate spatial and temporal dynamics are necessary to fully understand species interactions, especially in cases where species are expanding their range and distribution (Guisan et al. 2002).

Regeneration at both sites proceeded slowly and unevenly across the range of distance from lower-severity edge, and across post-fire time intervals. Other research has documented high numbers of seedlings in early post-fire periods (Bonnet et al. 2005), but according to our estimates, either few seedlings originated or few survived until approximately 5–10 years post-fire at either site. Years 5–15 were associated with high rates of establishment, followed by much lower rates in subsequent time intervals. These observations could be related to decreased resource availability with infilling of trees, and climate may have played a part as well (Savage et al. 1996).

General trends in post-fire climate did not point to clear association with progress of forest recovery. The periods of substantial regeneration at Saddle Mountain corresponded to the beginning of the generally wet years in the Southwest (ca. 1976), however regeneration slowed considerably before the drought of 2000–2004. Early post-fire years at La Mesa were also generally wet, but regeneration progress lagged nonetheless. It is possible that soil and other environmental conditions were too harsh for seedlings to establish immediately after these fire events. Changes in soils, for example, were dramatic in high-severity areas of the Cerro Grande fire that burned in New Mexico in 2000 (Kokaly et al. 2007). Our observations concur with the general theory that the rate of recovery of community composition slows with increasing distance from seed sources when disturbance intensity is high (Turner et al. 1998).

In addition to relatively slow migration of trees in a moving front, ponderosa pine populated areas at farther distances from the lower-severity edge through long-distance dispersal. As migrating trees and long-distance dispersers reach cone-bearing age, the result is a staggered arrangement of seed sources located apart from the original legacy trees (Clark and Ji 1995). Long-distance dispersal is an important mechanism for faster population spread where distances from legacy trees are great (Clark et al. 2001). The Gaussian model we employed approaches zero rapidly with distance, predicting spread of individuals from the frontier of the population (Clark et al. 1999). Theoretically, our data would be better fit with a fat-tailed kernel model that accommodates regeneration from long-distance dispersal.

## Implications for restoration and post-fire management

Recent large fires cannot be summarily dismissed as catastrophic (Beschta et al. 2004), in particular, when viewed over a longer term and at spatial scales of importance to regenerating ponderosa pine forests. Our findings indicated that significant reforestation had occurred at La Mesa and Saddle Mountain in some places. If the population front at La Mesa continued to progress at the rate we observed, young forests could inhabit distances over 200 m from edge of lower severity in approximately 15 years from the date of our observations, and could progress to the farthest occurring distances by 50 years post-fire. These estimates do not include the increased speed of reforestation that results from long-distance dispersers. Because our spatial methodologies differentiate this study from those using evidence from historical data and undisturbed sites, it is difficult to compare the forest structure we observed to reference conditions (Fulé et al. 1997; Moore et al. 1999). However, our observations at La Mesa and Saddle Mountain demonstrated that ponderosa pine forests with diverse density and age structure can naturally return after severe fire.

We encourage those concerned with restoration of areas burned in recent large fires to focus on the importance of naturally recovering post-fire landscapes (Turner et al. 2003) and post-fire management that enhances the capacity for natural recovery (Beschta et al. 2004). Areas disturbed by fire contain a wealth of valuable legacies, including large old trees of fire-resistant species, and large snags and logs that contribute to habitat refugia, movement of organisms and materials, and renewal of soils. Early successional habitats resulting from fire are valued for their diverse communities (Dellasala et al. 2004; Haire and McGarigal 2008) but are rare in many regions (Lindenmayer and Franklin 2002; DellaSala et al. 2004). Indeed, open habitats found in spatial heterogeneous post-fire landscapes make valuable contributions to biodiversity that cannot be replicated by rapid, uniform reforestation or extensive timber salvage (Lindenmayer and Franklin 2002).

As large fires define a contemporary fire regime in southwestern forests, the restoration paradigm will likewise require adjustments in its assumptions and key concepts (Choi 2007). Traditionally, ecological reference conditions for restoration have been solely defined by composition and structure (Fulé et al. 1997; Moore et al. 1999), but a definition that links key ecosystem processes (e.g., fire) to dynamic reference conditions has been proposed (Falk 2006). In process-centered restoration, the range of variation in fire regimes could potentially incorporate variability in spatial patterns and ecological response that may accompany non-equilibrial systems, including large fires (Wallington et al. 2005). Our findings regarding the spatial and temporal scales of reestablishment of ponderosa pine forests after large fires contribute to the on-going formulation of reference dynamics under a changing fire regime.

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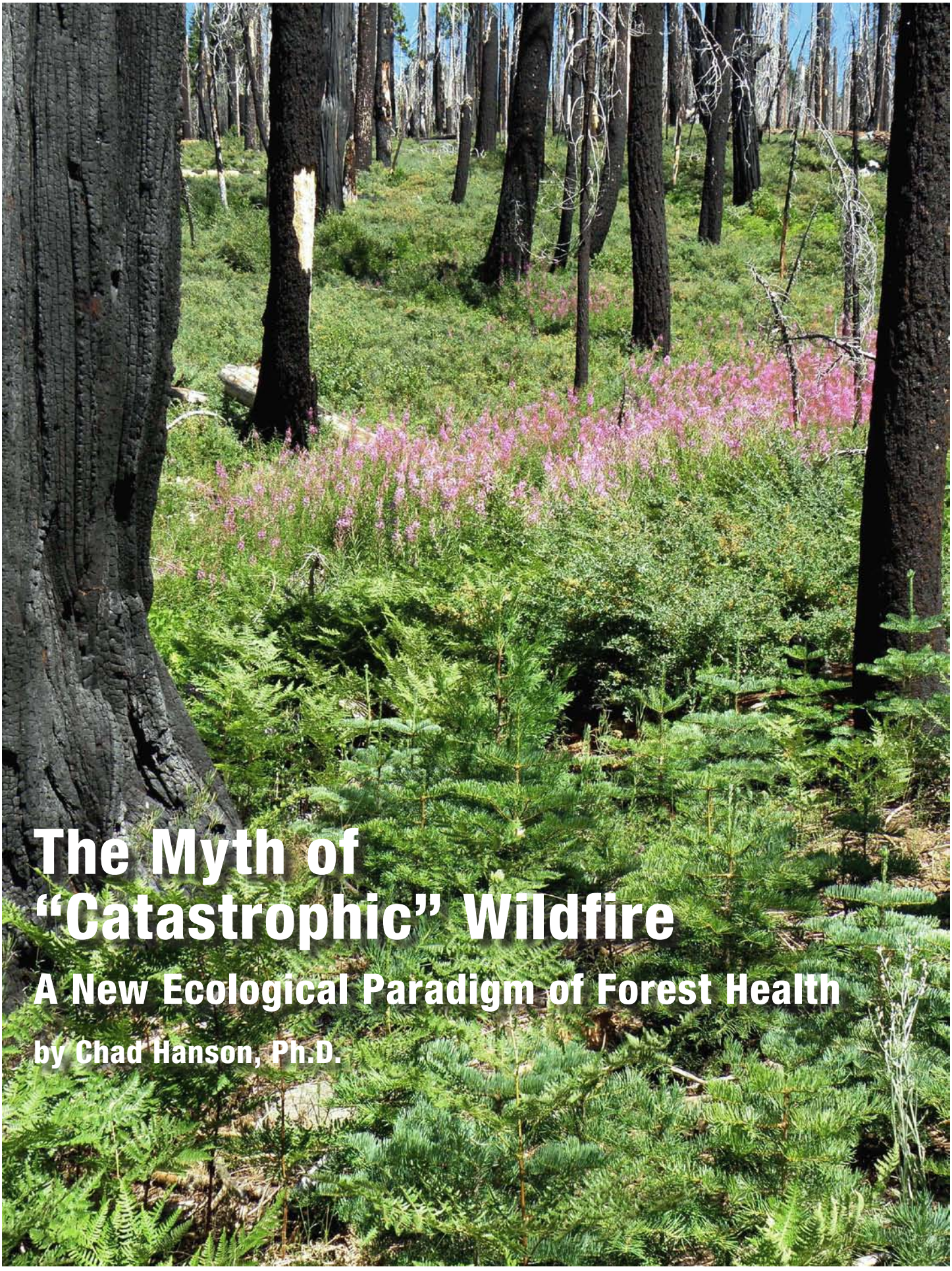
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# The Myth of "Catastrophic" Wildfire

## A New Ecological Paradigm of Forest Health

by Chad Hanson, Ph.D.

# Contents


**The Myth of "Catastrophic" Wildfire: A New Ecological Paradigm of Forest Health** **1**

Preface 1

Executive Summary 4

**Myths and Facts** **6**

Myth/Fact 1: Forest fire and home protection 6

Myth/Fact 2: Ecological effects of high-intensity fire 7

Myth/Fact 3: Forest fire intensity 12

Myth/Fact 4: Forest regeneration after high-intensity fire 13

Myth/Fact 5: Forest fire extent 14

Myth/Fact 6: Climate change and fire activity 17

Myth/Fact 7: Dead trees and forest health 19

Myth/Fact 8: Particulate emissions from high-intensity fire 20

Myth/Fact 9: Forest fire and carbon sequestration 20

Myth/Fact 10: "Thinning" and carbon sequestration 22

Myth/Fact 11: Biomass extraction from forests 23

**Summary: For Ecologically "Healthy Forests", We Need More Fire and Dead Trees, Not Less.** **24**

**References** **26**

**Photo Credits** **30**

**Recommended Citation** **30**

**Contact** **30**

**About the Author** **30**

# The Myth of "Catastrophic" Wildfire: A New Ecological Paradigm of Forest Health

By Chad Hanson, Ph.D.

## Preface

In the summer of 2002, I came across two loggers felling fire-killed trees in the Star fire area of the Eldorado National Forest in the Sierra Nevada. They had to briefly pause their activities in order to let my friends and I pass by on the narrow dirt road, and in the interim we began a conversation. One of the loggers pointed further down the road to a forest stand in which the fire burned less intensely. Most of the trees were alive and green. "I can see why people wouldn't want us to cut down a stand like that," he said, pointing to the green stand. "But what does it matter if we cut down an area like this?" he asked, referring to the heavily-burned area where high-intensity fire had occurred. "All of the trees have been killed. It's been destroyed. What sort of wildlife is going to live here?" he asked rhetorically.

I told the man that I didn't know the answer, and that his was a question that deserved some investigation. That conversation, and the curiosity it piqued in me, ultimately led me to graduate school to earn my Ph.D. in ecology, with a research focus on fire ecology in forest ecosystems. I found the answers to my questions to be as startling and counter-intuitive as they were undeniable, and increasingly I have wondered at the tremendous gap between the rapidly mounting scientific evidence and the widely held popular notions about wildland fire in our forests.

Every fire season in the western United States, we see on television the predictable images of 100-foot flames spreading through tree crowns, while grim-faced news anchors report how many acres of forest were "destroyed" by the latest "catastrophic" fire. The reaction is understandable. For decades, countless Smokey the Bear advertisements have told us that forest fires are bad and damaging. Until about 25 years ago, land management agencies, such as the U.S. Forest Service, genuinely believed that they could essentially eliminate fire from our forests if they had enough resources to suppress fires – and they sought to do just that.

By the late 20th century, however, forestry officials began to concede that, historically, frequent low-intensity fires were natural in our forests, slowly creeping along the forest floor after lightning ignitions, reducing fuel on the forest floor and naturally thinning-out brush and small trees. Though a begrudging acceptance of the benefits of low-intensity fire began to take hold, it was commonly assumed that areas of high-intensity fire, where tall flames killed most of the trees, were fundamentally the unnatural result of fuel accumulations from decades of fire suppression. Thus began the "catastrophic wildfire" paradigm, which divided fires into two categories: good fires and bad fires depending upon whether they burned at low-intensity or high-intensity, respectively.

A Forest Service public education brochure for the Sierra Nevada from 2004 captured the thinking underlying this paradigm. The brochure, entitled "Forests With A Future", portrayed high-intensity fires as an "eco-disaster" that "destroy wildlife habitat." No scientific studies were cited to support this characterization. Under the heading of "Good fires, bad fires", the brochure opined: "Fire is natural to the forest. But not the kind of fire that burns so hot, and shoots up so high, it destroys everything." The report blamed the perceived threat of high-intensity fire on a build-up of fuel from "fire suppression practices over the last century". It proposed a massive logging program on national forests, under the guise of "thinning", ostensibly to eliminate high-intensity fire from the landscape.

## The Myth of "Catastrophic" Wildfire

Ironically, in the "catastrophic wildfire" paradigm, land managers have requested, and received from Congress, increasingly more money for increasingly aggressive fire suppression tactics. The Forest Service justifies this by arguing that, except in rare cases, fires simply cannot be allowed to burn, since high-intensity fires will often occur. In these increasingly intensive fire suppression tactics, firefighters have frequently been placed in harm's way to stop fires the land management agencies assumed to be destructive and unnatural – often in remote areas, and all too often with fatal consequences for firefighters.

Simultaneously, land managers have requested, and received, increasingly more money for forest "thinning" operations under the guise of "fuel reduction". Land management agencies, such as the Forest Service, have used these funds to plan and implement thousands of commercial logging projects that remove mature trees, reasoning that they can thin more acres of forest if they sell many of the larger, fire-resistant trees – which are commercially valuable – to timber companies, using the sale of these trees to "offset" their costs. The Forest Service and other land agencies keep the revenues from these timber sales to enhance their budgets, creating a perverse incentive for more and more logging of larger and larger trees over increasingly vast expanses of the forested landscape. In this context, it did not take long for nearly everything to be described as "fuel" that must be removed. Live mature and old-growth trees have been, and are being, cut by the thousands, and dead trees are routinely sold to logging companies and removed, often leading to large areas being clearcut on public lands following wildland fires in the name of fuels reduction.

Commercial logging ostensibly to prevent "catastrophic fire" has been promoted heavily through a Bush-era policy known as the "Healthy Forests Initiative", which essentially defines a healthy forest as one in which the trees are all green, there are few if any dead trees or downed logs, and fire is acceptable so long as it doesn't kill any mature, commercially-valuable trees. This policy provides a compelling narrative to many, because it underscores and capitalizes upon deeply held cultural notions and perceptions about forests and fire. Once again, however, readily available ecological science was ignored.

And so, remarkably, under the "catastrophic wildfire" paradigm, the discredited policies of the past, including fire suppression and removal of mature, fire-resistant trees, has continued – even increased in many cases. Even as land managers and policy-makers lamented the mistakes of past management, essentially the same management has continued day after day, year after year.

Recently, however, a new paradigm has begun to emerge, informed by the latest ecological science. Over the past decade, a surge of scientific discovery has led researchers to fundamentally re-think previous assumptions about fire and forest health. In this new "forest ecology" paradigm, scientists have come to understand that high-intensity fires, or "stand-transforming fires", occurred naturally in most western U.S. conifer forests historically, and we have far less fire now than we did prior to fire suppression policies. Scientists have also come to understand that dead trees, especially large dead trees, or "snags", are not only the most ecologically valuable habitat features in the forest, but are also far too scarce, due to fire suppression and logging conducted under the guise of fuels reduction and forest health.

Most strikingly, recent scientific evidence has revealed that, contrary to previous assumptions, most current fires are predominantly low-intensity and moderate-intensity, and the relatively scarce high-intensity areas support the highest levels of native plant and wildlife biodiversity of any forest type in the western United States. Scientists now understand that, far from being "destroyed", these high-intensity patches are actually natural ecological treasures. High-intensity, or stand-transforming, fire creates ecologically-vital "snag forest habitat", which is rich with large snags, large downed logs, dense pockets of natural conifer regeneration, patches of native shrub habitat, or "montane chaparral", and large live trees.



Figure 1. Snag forest habitat in a mature mixed-conifer forest.

## The Myth of "Catastrophic" Wildfire

In snag forest habitat, countless species of flying insects are attracted to the wealth of flowering shrubs which propagate after stand-transforming fire – bees, dragonflies, butterflies, and flying beetles. Many colorful species of birds, such as the iridescent blue Mountain Bluebird, nest and forage in snag forest habitat to feed upon the flying insects. In order to feed upon the larvae of bark beetles and wood-boring beetles in fire-killed trees, woodpeckers colonize snag forest habitat shortly after the fire, excavating nest cavities in large snags. The woodpeckers make new nest holes each year, leaving the old ones to be used as nests by various species of songbirds. Many rare and imperiled bat species roost in old woodpecker cavities in large snags, and feed upon the flying insects at dusk. Small mammals, such as snowshoe hares and woodrats, create dens in the shrub patches and large downed logs, and raptors, such as the Spotted Owl, benefit from the increase in the abundance of their prey. Deer and elk browse upon the vigorous new plant growth that follows stand-transforming fire, and bears and wolves benefit from the increased abundance of their prey as well. A number of native wildlife species, such as the Black-backed Woodpecker, are essentially restricted to snag forest habitat for nesting and foraging. Without a continuous supply of this habitat, they won't survive.

Snag forest habitat is alive, and vibrant. It is colorful, and rich with varied sounds, given the sheer density of wildlife activity. It is the most rare, endangered, and ecologically important forest habitat in western U.S. forests, and the stand-transforming fires that create this habitat are not damaging the forest ecosystem. Rather, they are advancing ecological restoration. There is nothing "catastrophic" about wildland fire in these forests, especially where stand-transforming fire effects occur, creating snag forest habitat.

What is tragic, however, is the burning of homes in rural, forested areas. Our focus and our resources must be redirected to ensure protection of homes, rather than conducting pointless and destructive "fuels reduction" and "forest health" logging projects in remote forested areas based upon an outdated and unscientific management paradigm – a paradigm that financially benefits the timber industry and the budgets of land management agencies, but further deprives conifer forest ecosystems of the habitat features they need most to support imperiled species.

Fortunately, the means to protect homes from wildland fires are well understood, and fundamentally practical. The most recent science clearly shows that the only effective way to protect homes from fire is to reduce the combustibility of the home itself, by using fire-resistant roofing and siding and installing simple items like guards for rain gutters (which prevents dry needles and leaves from accumulating), as well as by creating "defensible space" through the thinning of brush and small trees within 100 feet of individual homes. If these simple measures are taken, the evidence clearly indicates that there is very little chance of homes burning, even in high-intensity fires (see, e.g., studies of Dr. Jack Cohen at www.firelab.org). Currently, however, only 3% of U.S. Forest Service fuels reduction projects are conducted adjacent to communities – and much of that 3% is well over 100 feet from homes.

We do not need to be afraid of the effects of fire in forest ecosystems of the western United States. Wildland fire is doing important and essential ecological work. It is keeping countless wildlife species alive. Our challenge, in the new and emerging paradigm, is to make certain that homes are protected so that we can allow wildland fire to do its vital and life-giving work in our forests. In short, we need to stop our futile battle against wildland fire and learn to live well with fire, reminding ourselves that western U.S. conifer ecosystems evolved with fire and are adapted to it. Excluding fire from these ecosystems is like trying to keep rain out of a rainforest.

## Executive Summary

Popular myths and misconceptions about the ecology of fire and dead trees in western U.S. conifer forests are numerous, and are strongly at odds with the recent scientific evidence, which indicates the following about these forest ecosystems:

- The only effective way to protect homes from wildland fire is to reduce the combustibility of the homes themselves, and reduce brush and very small trees within 100 feet of the homes. Commercial thinning projects that remove mature trees hundreds of yards – and often several miles – from the nearest home do not protect homes, and often put homes at greater risk by diverting scarce resources away from true home protection, by creating a false sense of security, and by removing large, fire-resistant trees and generating combustible logging "slash debris", which increases potential fire severity. Currently, less than 3% of U.S. Forest Service "fuels reduction" projects are near homes.
- Patches of high-intensity fire (where most or all trees are killed) support the highest levels of native biodiversity of any forest type in western U.S. conifer forests, including many rare and imperiled species that live only in high-intensity patches. Even Spotted Owls depend upon significant patches of high-intensity fire in their territories in order to maintain habitat for their small mammal prey base. These areas are ecological treasures.
- Current fires are mostly low- and moderate-intensity, and high-intensity fire comprises a relatively small proportion of the total area burned. Areas that have not burned in a long time are not burning more intensely.
- Vigorous natural regeneration of conifer seedlings occurs after high-intensity fire. Numerous large trees also survive, and their growth tends to increase substantially after the fire, which converts woody material on the forest floor into highly usable nutrients for tree growth. By contrast, after very long absence of these fires, forests can lose so much of their productivity that, ultimately, sites lose the ability to support forest at all.
- There is far less fire now than there was historically. There is also less high-intensity fire now than there was prior to fire suppression policies.
- Fires are not becoming more intense.

- Predictions vary about the effect of global warming and climate change on forest fire activity, but the most recent projections indicate reduced fire activity in most forests due to changes in combustible vegetation, and increased precipitation in many areas. Even scenarios for increased fire activity would not rectify the current deep deficit of fire in forest ecosystems.
- Ton for ton, dead trees ("snags") are far more important ecologically than live trees, and there are far too few large snags and logs to support native wildlife in most areas. Recent anecdotal reports of forest "destroyed" by beetles are wildly misleading and inaccurate.
- High-intensity fire burns cleaner than low-intensity, and produces fewer particulates.
- Current forests, including old-growth forests, are carbon sinks, meaning that they are absorbing more of the greenhouse gas CO2 than they are emitting. High-intensity wildland fire promotes high levels of carbon sequestration. Old-growth conifer forests cannot function as carbon sinks without fire. Without large, intense wildland fires to cycle nutrients and rejuvenate the productivity of the soil, forests can become carbon sources after about 600 years of age.
- Mechanical "thinning" decreases total carbon storage in conifer forests.
- Though timber interests have promoted increased logging by describing current forests as "overstocked", the scientific data indicates that, due to past logging, as well as exclusion of wildland fire, forests of today have much less total biomass than historic forests. However, "biomass" thinning is a growing threat to forests, and is now associated with post-fire logging, and logging of unburned old-growth trees.
- Ecologically "healthy forests" are those that have an abundance of low-, moderate-, and high-intensity fire effects, and an abundance of large snags. We need more, not less, fire and large dead trees and downed logs to keep our forest ecosystems healthy. "Thinning" projects designed to prevent high-intensity fire and reduce future large snag densities are not promoting "forest health", and post-fire "salvage" logging is profoundly destructive ecologically. Moreover, if fire suppression policies achieve their stated goal, many wildlife species that depend upon habitat created by high-intensity fire will be put at risk of extinction.

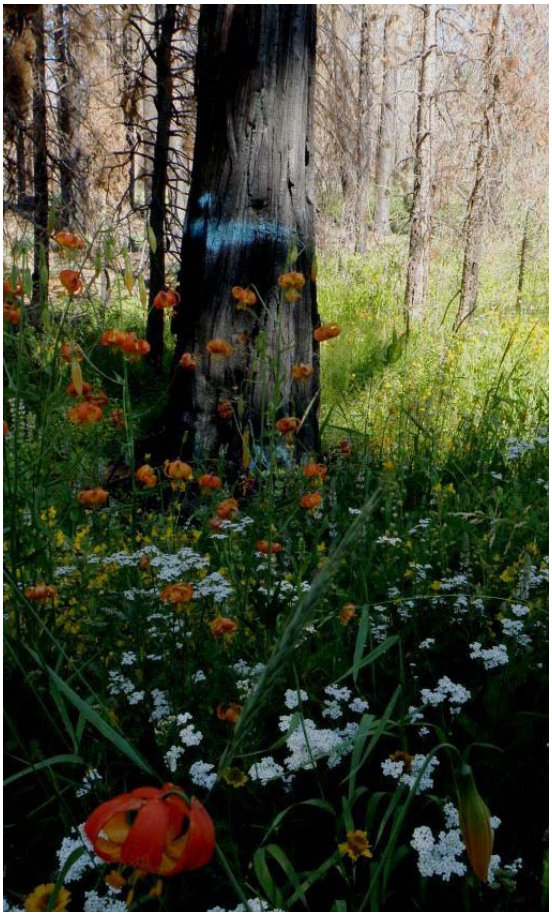


Fig. 2. Post-fire snag tree marked for logging.

## The Myth of "Catastrophic" Wildfire

Note: Fire studies often use the term "fire severity" to describe the proportion of trees killed, while "fire intensity" is used to describe the energy released by the fire. In this report, I use the term "fire intensity" in reference to the extent of tree mortality. I do this for two reasons. First, high-severity areas and high-intensity areas are generally the same in conifer forests. Second, the term "severity", like "catastrophic", is pejorative in nature, and objective scientific discourse should seek to use value-neutral terms.

## Myths and Facts

# MYTH 1

Forest "thinning" projects in the Wildland/Urban Interface (WUI) protect homes from wildland fire in forested communities.

# FACT 1

Commercial "thinning" logging projects do not protect homes.

The term "Wildland/Urban Interface", or "WUI", has been misleadingly used to justify commercial thinning logging projects – under the guise of home protection – miles from the nearest home. The scientific evidence is clear that the only effective way to protect structures from fire is to reduce the ignitability of the structure itself (e.g., fireproof roofing, leaf gutter guards) and the immediate surroundings within about 100 feet from each home, e.g., through thinning of brush and small trees adjacent to the homes (www.firelab.org–see studies by U.S. Forest Service fire scientist Dr. Jack Cohen). This area would be more properly described as the "Defensible Space Zone". Regardless, only 3% of Forest Service "fuels reduction" projects are conducted within the WUI, adjacent to communities – and much of that 3% is well over 100 feet from homes (Schoennagel et al. 2009).

Moreover, most "thinning" projects allow removal of many of the larger trees in order to make the projects economically attractive to logging companies, and to generate revenue for the public land management agencies, such as the U.S. Forest Service. Where this is done near homes, it can increase the danger of structures burning. The removal of larger, mature trees in thinning operations tends to increase, not decrease, fire intensity by: a) removing large, fire-resistant trees; b) creating many tons of logging "slash" debris – highly combustible branches and twigs from felled trees; c) reducing the cooling shade of the forest canopy, creating hotter, drier conditions on the forest floor; d) accelerating the growth of combustible brush by reducing the mature trees that create the forest canopy, thereby increasing sun exposure; and e) increasing mid-flame windspeeds (winds created by fire) by removing some of the mature trees and reducing the buffering effect they have on the winds associated with fires (Hanson and Odion 2006, Platt et al. 2006). The scientific evidence clearly indicates that, where it is important to reduce potential fire intensity (e.g., immediately adjacent to homes) this can be very effectively accomplished by thinning some brush and very small trees up to 8 to 10 inches in diameter (Omi and Martinson 2002, Martinson and Omi 2003, Strom and Fule 2007). Removal of mature trees is completely unnecessary.

A July 20, 2008 article by Heath Druzin and Rocky Barker in the Idaho Statesman documents an excellent example of effective home protection. The article describes the Idaho town of Secesh Meadows, which decided to get serious about creating defensible space by reducing brush immediately adjacent to the homes. A high-intensity wildland fire approached the town, but dropped down to a slow-moving low severity fire once it reached the populated area. The fire burned right through the town, right past front porches, and kept moving, but did not burn down a single home. As resources are being spent on counter-productive commercial thinning projects that are hundreds of yards, and sometimes several miles, from the nearest town, homes remain unprotected in rural forested areas. This is entirely preventable.

# MYTH 2

Low-intensity fire is natural and acceptable, but patches of high-intensity fire are ecologically destructive.

# FACT 2

High-intensity fire patches create habitat that supports some of the highest levels of native biodiversity of any forest type in western U.S. forests.

## Snag Forest Habitat

"Snag forest habitat", resulting from high-intensity fire patches (generally, stands with 75-80% or greater tree mortality from fire, exclusive of seedlings and saplings) that have not been salvage logged, is one of the most ecologically-important and biodiverse forest habitat types in western U.S. conifer forests (Lindenmayer and Franklin 2002, Noss et al. 2006, Hutto 2008). Noss et al. (2006) observed the following in reference to high severity fire patches: "Overall species diversity, measured as the number of species – at least of higher plants and vertebrates – is often highest following a natural stand-replacement disturbance…" Snag forest habitat is comprised of abundant standing fire-killed trees ("snags") of all sizes, especially larger trees, as well as patches of montane chaparral (dominated by flowering shrubs whose germination is facilitated by fire), dense pockets of natural conifer regeneration, large downed logs, numerous "fire-following" wildflowers, and widely-spaced large surviving trees. At the landscape level, high-intensity fire habitat (when it is left unlogged) is among the most underrepresented, and rarest, of forest habitat types. Noss et al. (2006) observed that "early-successional forests (naturally disturbed areas with a full array of legacies, ie not subject to post-fire logging) and forests experiencing natural regeneration (ie not seeded or replanted), are among the most scarce habitat conditions in many regions." The scarcity of this important natural habitat type is the result of fire suppression and post-fire logging.



Figure 3. Recent snag forest habitat in the Sierra Nevada.

Dr. Richard Hutto, one of the nation's top ornithologists, recently concluded the following, based upon the emerging scientific evidence: "Besides the growing body of evidence that large, infrequent events are ecologically significant and not out of the range of natural variation (Foster et al. 1998, Turner & Dale 1998), an evolutionary perspective also yields some insight into the 'naturalness' of severely burned forests… The dramatic positive response of so many plant and animal species to severe fire and the absence of such responses to low-severity fire in conifer forests throughout the U.S. West argue strongly against the idea that severe fire is unnatural. The biological uniqueness associated with severe fires could emerge only from a long evolutionary history between a severe-fire environment and the organisms that have become relatively restricted in distribution to such fires. The retention of those unique qualities associated with severely burned forest should, therefore, be of highest importance in management circles" (Hutto 2006).

There is strong consensus among ecologists that high-intensity fire, and resulting snag forest habitat, is something that must be preserved and facilitated, not prevented or destroyed. Lindenmayer et al. (2004) noted the following with regard to wildland fire: "…natural disturbances are key ecosystem processes rather than ecological disasters that require human repair. Recent ecological paradigms emphasize the dynamic, nonequilibrial nature of ecological systems in which disturbance is a normal feature… and how natural disturbance regimes and the maintenance of biodiversity and productivity are interrelated…" Smucker et al. (2005) concluded: "Because different bird species responded positively to different fire severities, our results suggest a need to manage public lands for the maintenance of all kinds of fires, not just the low-severity, understory burns…" Kotliar et al. (2007) observed that the results of their study "demonstrated that many species tolerate or capitalize on the ecological changes resulting from severe fires…", and concluded that: "Fire management that includes a broad range of natural variability (Allen et al. 2002), including areas of severe fire, is more likely to preserve a broad range of ecological functions than restoration objectives based on narrowly defined historic fire regimes (Schoennagel et al. 2004)."



Fig. 4. Some of the many species living in snag forest habitat.

## The Myth of "Catastrophic" Wildfire

Older, mature forests that burn at high-intensity are particularly important, since cavity-nesting species tend to select larger snags for nesting and denning. Hutto (1995) concluded that, because "the most suitable nest trees for cavity excavation are snags that are themselves old-growth elements, one might even suggest that many of the fire-dependent, cavity-nesting birds depend not only on forests that burn, but on older forests that burn." In burned forests, woodpeckers preferentially select larger snags for foraging (Hutto 1995, Hanson 2007, Hanson and North 2008). Scientists have recently recommended that forest managers should ensure the maintenance of moderate-and high-intensity fire patches to maintain populations of numerous native bird species associated with fire (Hutto 1995, Hutto 2006, Kotliar et al. 2002, Noss et al. 2006, Smucker et al. 2005, Hanson and North 2008, Hutto 2008).

Fire-induced heterogeneity, including a mix of low-, moderate-, and high-intensity patches, leads to higher post-fire understory plant species richness compared to homogeneous low-severity fire effects (Chang 1996, Rocca 2004). Mixed-intensity fire, meaning a heterogeneous mix of high-, moderate-, and low-intensity effects, facilitates reproduction of numerous native herbaceous and shrub species (Chang 1996, Rocca 2004), the germination of many of which is triggered by fire-induced heat, charcoal, or smoke (Biswell 1974, Chang 1996). These flowering plants, in turn, increase biodiversity of flying insects, such as bees and butterflies. In addition, fire-caused conifer mortality attracts bark beetles and wood-boring beetles, some species of which have evolved infrared receptors capable of detecting burned forests from over 161 km away (Altman and Sallabanks 2000, Hutto 1995). Other insect species are attracted by the smoke from fires (Smith 2000).

As a result, bird species richness and diversity increases in heavily burned patches, which generally occur within a mix of low- and moderate-intensity effects. Woodpeckers feed upon bark beetle and wood-boring beetle larvae in snags and excavate nest cavities in snags; Mountain Bluebirds and other secondary cavity-nesting species use nest holes created the previous year by woodpeckers; granivores such as the Red Crossbill feed upon seed release from cones following fire; shrub-dwelling species like the Blue Grouse nest and forage within shrub growth scattered throughout high-intensity patches; while aerial insectivores (animals that feed upon flying insects) such as the imperiled Olive-sided Flycatcher prey upon the native bark beetles that are abundant in snag patches (Altman and Sallabanks 2000, Hutto 1995). Likewise, mammalian species, such as the Sierra Nevada Snowshoe Hare, which is listed as a Forest Service Sensitive Species (USFS 2001), depend upon post-fire shrub habitat following intense fire (Smith 2000, USDA 2001). Populations of small mammals experience overall increases shortly after high-intensity fire, and amphibians are positively associated with the large woody material that gradually accumulates in the decades following such fire effects (Smith 2000). As well, ungulates, such as deer and elk, forage upon post-fire flora, and large predators frequently seek their prey in burned patches (Smith 2000). Studies have detected higher overall bird species richness in intensely burned versus unburned forest in the western United States (Bock and Lynch 1970, Hutto 1995, Raphael and White 1984, Siegel and Wilkerson 2005). In one snag forest area resulting from the Manter Fire of 2000 in the southern Sierra Nevada, a total of 111 bird species were observed (Siegel and Wilkerson 2005).

## The Myth of "Catastrophic" Wildfire

## Black-backed Woodpecker

There is perhaps no vertebrate species more strongly representative of the snag forest habitat type than the Black-backed Woodpecker (Picoides arcticus) (Hutto 1995, Hanson 2007, Hanson and North 2008, Hutto 2008). This species is a federally designated Management Indicator Species, acting as a bellwether for the viability of dozens of other species associated with snag forests (USDA 2004). One of only two woodpecker species globally with three toes instead of four, the Black-backed Woodpecker is able to deliver exceptionally hard blows due to added heel mobility resulting from the lack of a fourth toe and, as a consequence, it can reach beetle larvae that other woodpecker species cannot (Dixon and Saab 2000). One bird eats an astounding 13,500 beetle larvae per year (Hutto, unpublished data). From behind, the all-black coloring of this species confers excellent camouflage against the charred bark of a fire-killed tree, indicating a long evolutionary history with high-intensity fire (Hutto 1995). Though Black-backed Woodpeckers are occasionally, but rarely, seen outside of stand-replacement burns, forests outside of snag forest habitat are believed to be "sink" habitats which do not support them (Hutto 1995, Dixon and Saab 2000). In the northern Rocky Mountains, the Black-backed Woodpecker is largely restricted to recently severely burned conifer forest that is unlogged (Hutto 1995, Russell et al. 2007). The same has been found to be true in Sierra Nevada forests (Hanson 2007, Hanson and North 2008).



**Fig. 5. Black-backed Woodpeckers are just one of the many wildlife species threatened by the loss of snag forest habitat due to fire suppression and "salvage" logging.**

Black-backed Woodpeckers are strongly associated with large, unlogged high-intensity patches in areas that were mature/old-growth, closed-canopy forest prior to the fire (which ensures many large snags) (Hutto 1995, Saab et al. 2002, Saab et al. 2004, Russell et al. 2007, Hanson and North 2008, Hutto 2008, Vierling et al. 2008). Pre-fire thinning that reduces the density of mature trees can render habitat unsuitable for Black-backeds even if the area later experiences high-intensity fire, due to a reduction in the potential density of large snags caused by the earlier thinning (Hutto 2008). After approximately 5-6 years, when their bark beetle food source begins to decline and nest predators begin to recolonize the burn area, Black-backed Woodpeckers must find a new large, unlogged high-intensity patch in mature forest to maintain their populations (Hutto 1995, Saab et al. 2004). For these reasons, this species depends upon a continuously replenished supply of high-intensity burn areas (Hutto 1995).

## Spotted Owls and Fire



Fig. 6. Snag forest habitat increases the Spotted Owl's small mammal prey and provides foraging habitat for Spotted Owls.

Recent scientific evidence regarding spotted owls in northwestern California and in Oregon found that stable or positive trends in survival and reproduction depended upon significant patches (generally between one-third and two-thirds of the core area) of habitat consistent with high-intensity post-fire effects (e.g., native shrub patches, snags, and large downed logs) in their territories because this habitat is suitable for a key owl prey species, the Dusky-footed Woodrat (Franklin et al. 2000, Olson et al. 2004). This habitat is not mimicked by logging, which removes snags and prevents recruitment of large downed logs, and which seeks to reduce or eliminate shrub cover. Logging can reduce owl survival and reproduction by preventing occurrence of natural post-fire habitat heterogeneity in the spotted owl territories.

In a study conducted several years post-fire, Clark (2007) found that Northern spotted owls in southwestern Oregon were adversely affected by post-fire salvage logging, but his results show the opposite for unlogged moderately and intensely burned patches within the owls' territories. Specifically, he found that, in an area in which the spotted owl territories had been partially or predominantly salvage logged, occupancy decreased. For owls that had not been extirpated by salvage logging, the fire itself did not reduce productivity. Using radio-telemetry, Clark (2007) found that spotted owls used nesting, roosting, and foraging habitat (dense, old forest) that had burned at low-, moderate-, and high-intensity more frequently than would be expected based upon availability of these habitat strata on the landscape so long as these areas had not been salvage logged. The owls avoided salvage logged areas (and the few detections within salvage logged units were, on closer inspection by the author, generally found to be in unlogged retention areas within the logging units, such as stream buffers).



Fig. 7. A California Spotted Owl roosting in a burned area within the McNally fire, Sequoia National Forest.

Interestingly, over four years of study in three fire areas, only one Barred owl was found within burned forests, while many were found just outside the fire perimeter (Clark 2007). Barred owls prey upon Spotted owls and are considered to be a significant threat (Clark 2007). In addition, recent radio-telemetry research in the Sierra Nevada has found that, in post-fire forest (nearly all of which was unmanaged), California spotted owls selected low-intensity areas for roosting and selected high-intensity areas for foraging (Bond et al. 2009). One might think of dense, old forest as the owl's bedroom, and high-intensity fire patches as its kitchen. Recent scientific evidence indicates that there is far less high-intensity

fire in Northern Spotted Owl habitat than was previously assumed (Hanson et al. 2009, Hanson et al. 2010 in press in Conservation Biology). We do not yet fully know the potential adverse consequences of the ongoing fire deficit for Spotted Owls.

# MYTH 3

## Due to decades of fire suppression, and resulting fuel accumulation, most fires are currently dominated by high-intensity effects.

# FACT 3

## High-intensity fire is the exception, not the rule; and long-unburned areas are not burning more intensely.

Contrary to popular misconception, low- and moderate-intensity fire effects are heavily predominant in western conifer forests, and high-intensity effects comprise a minor portion of the overall area burned (Odion and Hanson 2008, Schwind 2008, Hanson et al. 2009). For example, in the Pacific Northwest since 1984, high-intensity effects occurred on only about 10-12% of the area burned, and on only about 12-15% of the total area burned in California (Schwind 2008).

Contrary to popular misconception, areas that have missed the greatest number of natural fire cycles, due to fire suppression, are burning mostly at low- and moderate-intensity and are not burning more intensely than areas that have missed fewer fire cycles (Odion et al. 2004, Odion and Hanson 2006, Odion and Hanson 2008). The notion that forested areas become increasingly likely to have high-intensity effects the longer they remain unburned is simply inaccurate. Instead, as the time period since the last fire increases, forests become more mature, and develop higher forest canopy cover. This reduces the amount of pyrogenic (combustible) shrubs, which need more sunlight, reducing overall high-intensity fire occurrence, based upon several decades of data from the Klamath mountains in California (Odion et al. 2009). It also reduces the amount of sunlight reaching the forest floor and understory. In such conditions, surface fuels stay moister during the fire season, due to the cooling shade of the forest canopy, and, due to reduced sunlight, forest stands begin to self-thin small trees and lower branches of large trees. This makes it more difficult for flames to spread into the forest canopy during wildland fire.

# MYTH 4

Where high-intensity patches occur, the forest will not regenerate naturally due to soil damage or lack of seed sources from surviving conifers.

# FACT 4

Forest growth and regeneration is vigorous after high-intensity fire, and fire-adapted forests need fire to maintain productivity. In the few places wherein post-fire conifer regeneration does not quickly occur, these areas provide important montane chaparral habitat, which has declined due to fire suppression.

The increase in available nutrients following fire, particularly higher-intensity fire, can lead to substantial growth pulses (Brown and Swetnam 1994 [Fig. 3], Mutch and Swetnam 1995 [Fig. 4]). This includes post-fire shrub growth, conifer regeneration, and growth release of surviving overstory trees. The conifer seedling/sapling regeneration is very vigorous in high-intensity patches (see, e.g., Donato et al. 2006, Hanson 2007b, Shatford et al. 2007). Ponderosa and sugar pines, which have declined in some western U.S. forests, appear to have a competitive advantage over fir and cedars in regrowth after high-intensity fire, as their post-fire proportions are higher than they were pre-fire, and pines tend to be tallest, fastest-growing conifer saplings in these areas (Hanson 2007b).

In the few places wherein post-fire conifer regeneration does not quickly occur, these areas provide important montane chaparral habitat, which has declined due to fire suppression (Nagel and Taylor 2005). As noted earlier, montane chaparral provides key habitat for a variety for shrub-dwelling species like the Snowshoe Hare and the Blue Grouse, which nests and forages within the shrub growth. The Dusky-footed Woodrat also inhabits these areas, which in turn provides food for the Spotted Owl. Likewise, ungulates, such as deer and elk, forage upon the shrubs, and their predators



Fig. 8. Natural conifer regeneration in a high-intensity patch of mixed-conifer forest.



Fig. 9. Natural conifer regeneration in an area of nearly 100% mortality from fire.

frequently seek prey in montane chaparral. Therefore, chaparral regeneration is another ecological benefit of high-intensity fire. On the whole, though, high-intensity fires are soon followed by vigorous forest regeneration.

By contrast, in the very long absence of large fires commonly thought of as "catastrophic", forests can lose so much of their productivity that, ultimately, sites lose the ability to support forest at all. Wardle et al. (2004) concluded the following: "Our results have several implications. First, they suggest that the decline of natural forests, which is often observed in the long-term absence of catastrophic disturbance [including wildland fires], may arise through increasing limitation by [phosphorus] and reduced performance of the decomposer subsystem… Second, the results show that the maximal biomass phase (and associated rates of ecosystem processes) attained after primary or secondary succession cannot be maintained in the long-term absence of major disturbances."

## MYTH 5

Fire is now burning at unprecedented levels.

## FACT 5

We are in a major fire deficit. There is now far less fire overall, and less high-intensity fire, than there was historically.

Fire extent in general remains heavily suppressed in western U.S. forests such that historic annual extent of burning was several times greater than the annual extent of burning under current conditions (Medler 2006, Stephens et al. 2007). Using more conservative estimates of historic fire extent (Baker and Ehle 2001), annual burning in forests prior to fire suppression was still several times higher than it is now. Western U.S. conifer forests remain in a serious "fire deficit" (Medler 2006). Even high-intensity effects are in deficit currently, relative to the extent of high-intensity fire prior to fire suppression and logging.

High-intensity fire was previously assumed to have been rare and of limited extent in most western U.S. conifer forests, largely because fire-scar studies documented frequent fire occurrence in most historic conifer forests, and it was assumed that frequent fire would have kept surface fuel levels low, preventing high-intensity fire. The problem, however, is that fire-scar records cannot detect occurrence of past high-intensity effects, wherein most trees were killed (Baker and Ehle 2001).

Historic data and recent reconstructions of historic fire regimes indicate that high-intensity fire was common in most conifer forests of western North America prior to fire suppression and logging, even in pine-dominated forests with frequent fire regimes "(Baker et al. 2007, Hessburg et al. 2007, Klenner et al. 2008, Whitlock et al. 2008, Baker et al. 2009). For example, a recent reconstruction of historic fire occurrence in a 1,587 ha (unmanaged) research natural area near Lassen Volcanic National Park found mid-elevation slopes to be dominated by moderate-intensity fire, mixed with some low- and high-intensity effects, while upper-elevation slopes were dominated by high-intensity fire (Beaty and Taylor 2001). Other research has found steep declines in montane chaparral within mixed conifer forest ecosystems in the Lake Tahoe Basin of the central and northern Sierra Nevada due to a decrease in high-intensity fire occurrence since the 19th century (Nagel and Taylor 2005).

In the late 19th century, John B. Leiberg and his team of United States Geological Survey researchers spent several years mapping forest conditions, including fire intensity in the central and northern Sierra Nevada. Leiberg recorded all high-intensity patches over 80 acres (32 ha) in size occurring in the previous 100 years

## The Myth of "Catastrophic" Wildfire

(Leiberg 1902). Using modern GIS vegetation and physiographic information, Hanson (2007a) compared fire locations to forest type and site conditions to examine patterns of high-intensity fire events, excluding areas that had been logged in the 19th century in order to eliminate the potentially confounding effect of logging slash debris (branches and twigs left behind by loggers). Hanson (2007a) used areas that Leiberg had mapped as having experienced 75-100% timber volume mortality.

Hanson (2007a) found that high-intensity fire was not rare in historic Sierra Nevada forests, as some have assumed. Over the course of the 19th century, within Leiberg's study area, encompassing the northern Sierra Nevada, approximately one-fourth to one-third of middle and upper elevation westside forests burned at high-intensity (75100% mortality) (Hanson 2007a). This equates to fire rotation intervals for high-intensity fire of roughly 400 to 300 years (i.e., for a fire rotation interval of 300 years, a given area would tend to burn at high severity once every 300 years on average). Available evidence indicates that current rates of high-intensity fire are considerably lower than this overall (Hanson 2007a). For example, the Final EIS for the 2004 Sierra Nevada Forest Plan Amendment indicates that, on average, there are about 15,000 acres of high-intensity fire occurring per year in Sierra Nevada forests (entire Sierra Nevada included) (USDA 2004). Given the size of the forested area in the Sierra Nevada, about 13 million acres (Franklin and Fites-Kaufman 1996), this equates to a high-intensity fire rotation interval of more than 800 years in current forests (longer rotation intervals correspond to less high-intensity fire).

Nor were pre-fire-suppression high-intensity patches all small, as has often been assumed. In fact, in unlogged areas mapped by Leiberg (1902), some aggregate patches of high-intensity effects were 20,000 to 30,000 acres in size, or larger (Leiberg 1902, Hanson 2007a (Fig. 3.1)), greater than any current high-intensity patches.

The findings of Hanson (2007a) are consistent with those of Beaty and Taylor (2001), whose reconstruction of historic fire regimes in unmanaged forests just north of Leiberg's study area found that, despite relatively frequent low-intensity fire occurrence, moderate- high-intensity fire were common and historically in these forests. Specifically, Beaty and Taylor (2001) found that approximately 15% of montane forests 1370-1770 m in elevation burned at high intensity over a 43-year period from 1883 to 1926 (Beaty and Taylor 2001). This equates to a high-intensity rotation interval of about 300 years. Bekker and Taylor (2001) found historic high-intensity fire rotations of 200 to 250 years in eastside mixed-conifer/fir forests types north of Leiberg's study area (California Cascades region). High-intensity rotation intervals of several hundred years in length, and much more frequent lower-intensity fire, indicates forests in which individual fires would, on average, tend to burn predominantly at low-and moderate-intensity, but would have the potential to burn at high-intensity under certain weather and fuel loading conditions. A high-intensity fire rotation of about 300 years was also found in the mixed-conifer and Jeffrey pine forests of the Sierra San Pedro de Martir in Baja California – forests that have never been subjected to fire suppression and have not been logged (Minnich et al. 2000).

Historic U.S. Geological Survey data gathered by Leiberg (1900b) provides further evidence of an active role for high-intensity fire prior to fire suppression. Leiberg (1900b) gathered comprehensive data on high-intensity fire occurrence for the period 1855-1900 in the Oregon Klamath region, presenting data on high-intensity (75-100% timber volume mortality) acres and acres logged for each township. Excluding the townships with any evidence of logging (in order to eliminate any confounding effects of logging), there were 12,700 acres of high-intensity fire in 72,580 acres of unmanaged forest over a 45-year period prior to fire suppression (Leiberg 1900b). This equates to a high-intensity rotation of 257 years. The high-intensity rotation within the Eastern Oregon Cascades physiographic province (Moeur et al. 2005) prior to fire suppression and logging was 165 years overall, and was 322 years for forests with more than 85% ponderosa pine (Leiberg 1900b), indicating far more high-intensity fire than is occurring currently (889-year high-intensity rotation in mature forests from 1984 to 2005) (Hanson et al. 2009, Hanson et al. 2010 in press in Conservation Biology).

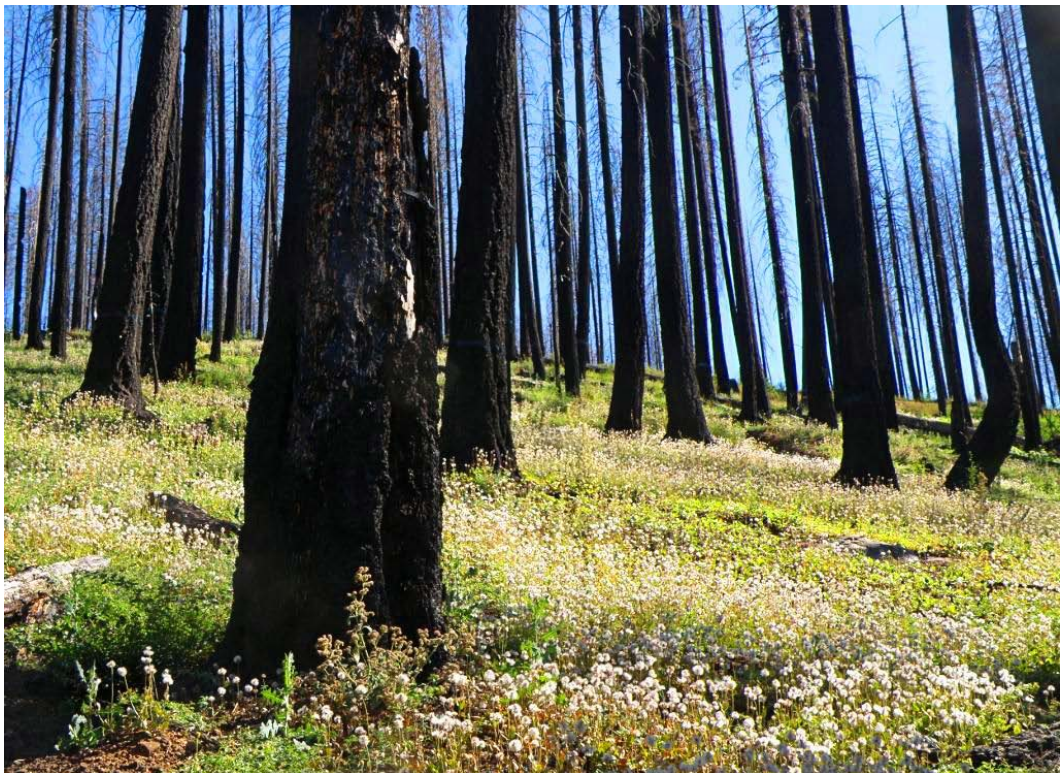


Fig. 10. A recent snag forest patch in the Sierra Nevada.

Taylor and Skinner (1998), in a reconstruction of historic fire occurrence in a 3,878-acre study area in the Klamath Mountains of California, found that 14% of the area burned at high intensity 1850-1950, though they defined high-intensity very narrowly as areas in which fewer than 4 trees per acre survived the fire. Moderate-intensity effects occurred on 27% of the area, where moderate intensity was defined as only 4-8 surviving trees per acre (Taylor and Skinner 1998), which would be categorized as high-intensity in current fire intensity assessments. If all areas in which there were 8 or fewer surviving trees per acre are included in a calculation of a high-intensity rotation, the high-intensity rotation would be approximately 244 years. Their study area was just south of the Oregon/California border at elevations ranging from about 2,100 to 5,200 feet in elevation within Douglas-fir, Douglas-fir/pine, and mixed-conifer forests (Taylor and Skinner 1998). Wills and Stuart (1994) reconstructed fire history in three representative study sites in the Klamath National Forest of California, using fire-scar and tree age class data. They found that the historic, pre-fire suppression interval between high-intensity fire events was approximately 170 to 200 years in the first study site, about 100 years in the second study site, and was intermediate between these two in the third study site. Their study area was in forests dominated by Douglas-fir, sugar pine and tanoak at approximately 3,000 feet in elevation on slopes averaging 56% within the Salmon River Ranger District (Wills and Stuart 1994). In contrast, the estimate of the current high-intensity rotation in Klamath forests, using satellite imagery data for 1984-2005, is about 600 years (Hanson et al. 2009, Hanson et al. 2010 in press in Conservation Biology).

The high-intensity rotation prior to fire suppression (1800-1900) was found to be 385 years in mid-elevation conifer forests of the western Cascades of Oregon (Morrison and Swanson 1990), indicating several times more high-intensity fire than is occurring currently in mature forests of the western Oregon Cascades (Moeur et al. 2005).

## The Myth of "Catastrophic" Wildfire

Within forests dominated by fir, spruce, and lodgepole pine in Montana prior to fire suppression and the arrival of settlers, high-intensity rotations were 289 years in one area (Leiberg 1904a) and 190 years in another (Leiberg 1904b). In Montana's Bitterroot Forest Reserve (now called the Bitterroot National Forest) prior to fire suppression and the arrival of settlers, out of 2,462,464 acres of fir, spruce, and lodgepole pine forest, 2,270,000 acres burned at high intensity over the course of 140 years prior to fire suppression and the arrival of settlers, equating to a high-intensity fire rotation of 152 years (Leiberg 1900a). Of the 1,149,696 acres of ponderosa pine forest, roughly 25-30% burned at high-intensity over this same time period (Leiberg 1900a), equating to a high-intensity rotation of roughly 450-500 years. In the Bitterroot Reserve as a whole, the historic high-intensity fire rotation was 200-300 years. The current high-intensity rotation for the forests of the northern Rockies is 500 years, using interagency Burned Area Emergency Rehabilitation (BAER) fire intensity data (Rhodes and Baker 2008). This indicates considerably less high-intensity fire now than there was historically.

Even in dry ponderosa pine forests of the southwestern U.S., high-intensity fire naturally occurred prior to fire suppression and logging, with stand age plot data indicating historic high-intensity rotations of 300-400 years during the 1800s (Baker 2006). The current high-intensity rotation is about 625 years in southwestern U.S. forests (Rhodes and Baker 2008). Based on charcoal sediments, researchers have also determined that high-intensity fire was common in low-elevation ponderosa pine forests from about 1000 to 1400 A.D., contradicting the assumption that current high-intensity fire in such forests is uncharacteristic or unprecedented (Pierce et al. 2004, Whitlock et al. 2004).

Overall, the data indicate that there was about 2-4 times more high-intensity fire historically in western U.S. conifer forests than there is currently. This fire deficit translates to serious deficits in ecologically-vital snag forest habitat, and this is greatly exacerbated by the fact that much of the snag forest habitat that is created by fire is lost to post-fire "salvage" logging.

## MYTH 6

Climate change and global warming will necessarily cause increased fire activity and intensity.

## FACT 6

Current predictions vary, and may differ greatly from region to region. The most recent projections indicate that, in most forested regions of the North America, reduced fire activity is likely to occur, due to vegetation changes that will result in less combustible fuel, and due to increased precipitation in many areas.

Westerling et al. (2006) speculated that climate change may lead to more intense fires, but more recent studies refute this assumption. A comprehensive analysis of high-severity fire since 1984 by the U.S. Geological Survey in California, Oregon and Washington found no increasing fire intensity trend (Schwind 2008). Other research since then has supported that finding for an area in Yosemite National Park (Collins et al. 2009) and within the dry conifer forests of the Klamath and eastern Cascade Mountains in California, Oregon, and Washington (Hanson et al. 2010). Miller et al. (2008) reported an increasing fire intensity trend in Sierra Nevada forests since 1984. However, Miller et al. (2008) was based upon only 60% of the available fire data, and used recent vegetation data to exclude shrub habitat. The results of Hanson et al. 2009 (in review), which was based upon complete fire data, indicate that this method excludes relatively more high-intensity fire in conifer forest within the earlier years of the data set, creating the appearance of an increasing trend where none exists. This implies

that recent high-intensity patches generally still visually appear to be conifer forest to those updating Cal-Veg mapping from remote sensing imagery, while older high-intensity patches frequently do not, likely due to greater post-fire snag attrition and maturation of montane chaparral. Another recent study inexplicably claimed that fires would become "more severe" and that there would be "increased proportions of high-severity fire" by 2020-2049 in Yosemite National Park, California, despite the fact that the study explicitly found that the high-intensity fire proportion would remain at 16% from the present through 2020-2049 (Lutz et al. 2009 [Table 1]).

Some previous climate modeling predicted increases in the annual area burned in most forested areas of the western U.S., but predicted decreases in some areas, such as California and Nevada (McKenzie et al. 2004). Increased temperatures are predicted to occur generally, but precipitation, including summer precipitation, is expected to increase as well in most areas (McKenzie et al. 2004). Moisture-related variables, e.g., humidity and precipitation, may be more important than temperature in predicting future fire occurrence (Parisien and Moritz 2009). Actual data from weather stations over the past several decades generally shows increases in precipitation, especially summer precipitation (which can significantly dampen wildland fire), in states comprising the western U.S. (Mote 2003, WRCC 2009), and in Canada's boreal forests (Girardin et al. 2009). Some studies (e.g., Spracklen et al. 2009) still predict some increase in overall fire occurrence but do so by assuming that increases in spring/summer precipitation will be only 1/8 to ¼ of the increases that have actually been occurring over the past 100 years (Mote 2003). Even if some forested areas become hotter and drier, as opposed to warmer and wetter, they may experience decreased, not increased, fire activity due to a reduction in the most combustible vegetation (Parisien and Moritz 2009). This is supported by charcoal and pollen deposits, which allow scientists to correlate past climate to fire activity since the last Ice Age. The evidence indicates that hotter, drier conditions sometimes led to reduced fire effects, and cooler, wetter conditions did not necessarily lead to reduced fire effects (Gavin et al. 2007 [Fig. 6], Parisien and Mortiz 2009). Often, the periods with the largest temperature increases were associated with decreased, not increased, fire occurrence (Marlon et al. 2009 in press in Proceedings of the National Academy of Sciences). The most current research predicts decreased fire activity in most western U.S. conifer forest regions (Krawchuk et al. 2009 [see Fig. 3 of that study]). Westerling et al. (2006) found that, since the 1970s, the total area affected by fire (all intensities included) in western U.S. forests has increased marginally, though it is unclear how much of this is the result of more recent fire management policies allowing more fires to burn in remote areas. Given the massive fire deficit we are in, as discussed above, even if there is some increase in the average annual area affected by fire, we would still have far less fire than we did prior to fire suppression policies, and would remain in an unnatural fire deficit.

## The Myth of "Catastrophic" Wildfire

# MYTH 7

Our forests are "unhealthy" because there are too many dead trees.

# FACT 7

There are far too few large dead trees to maintain ecologically healthy forests.

Due in large part to the combined effects of fire suppression and post-fire logging, large snags (dead trees) are currently in severe deficit, contrary to popular belief. For example, recent U.S. Forest Service Forest Inventory and Analysis (FIA) data, using 3,542 fixed plots throughout California, shows that there are less than 2 large snags per acre in all forested areas (Christensen et al. 2008). The Sierra Nevada Forest Plan Amendment recommends having at least 3-6 large snags per acre to provide minimum habitat for the needs of the many wildlife species that depend upon large snags for nesting and foraging (USDA 2001, 2004). Some species need even higher densities of large snags, such as the California Spotted Owl, which prefers to have at least 20 square feet per acre of basal area in large snags (about 6-8 large snags per acre) to maintain habitat for its small mammal prey (Verner et al. 1992). Other species require much higher densities of large snags, such as the Hairy Woodpecker and Black-backed Woodpecker (Hanson 2007a, Hanson and North 2008).



Fig. 11. Black-backed Woodpeckers (center of image) foraging on a large snag.

A study published recently in Science (van Mantgem et al. 2009) found increasing tree mortality in old-growth forest plots, speculating that it is a result of climate change, as opposed to fire suppression. However, the study did not find higher mortality rates in the large, old trees within those plots. Moreover, the study was based on only 76 plots across the western United States (van Mantgem et al. 2009). Two recent U.S. Forest Service Forest Inventory and Analysis (FIA) reports (one for CA and one for OR), each of which used thousands of plots, found that current large snag densities are harmfully low (generally only 1-3 per acre, and less than 1 per acre

in eastern Oregon), and management activities should be undertaken to increase large snag densities to prevent harm to wildlife populations (Christensen et al. 2008, Donnegan et al. 2008).

Some recent anecdotal accounts of forest "destroyed" by, or "lost" to, bark beetles across 1.5 million acres of lodgepole pine forests in Colorado are highly misleading and inaccurate. In fact, the beetles only kill a portion of the trees, creating vitally-important snags that benefit wildlife; the largest area found to have 100% tree mortality is only one acre in size (Rocca and Romme 2009). The surviving trees dramatically increase their growth rates following beetle mortality (Romme et al. 1986). Conifer mortality from bark beetles – which are native species in these forests – is a natural and necessary ecological phenomenon that generally occurs every few decades, and which occurred at large scales in western U.S. conifer forests historically as well (Romme et al. 1986, Shinneman and Baker 1997). Prior to the arrival of settlers and the onset of fire suppression, such events were well documented to have occurred across entire landscapes, and were found to play an important role in the natural ecological succession of conifer species as stands matured and aged (Leiberg 1900a, 1904a, 1904b). The recent areas of tree mortality in the Rockies are neither unprecedented nor unnatural (Romme et al. 2006).

Given the overall deficit of large snags, and the serious adverse consequences of this for myriad wildlife species, natural events that create additional snags should be welcomed, not viewed as a problem to be avoided.

## MYTH 8

### High-intensity fire creates far more particulate emissions.

## FACT 8

### High-intensity fire burns cleaner, and produces fewer particulate emissions.

Contrary to popular assumption, high-intensity forest fires produce relatively lower particulate emissions (due to high efficiency of flaming combustion) while low-intensity forest fires produce high particulate emissions, due to the inefficiency of smoldering combustion (Ward and Hardy 1991, Reid et al. 2005). For a given ton of fuel consumed, low-severity fires produce 3-4 times more particulate matter than high-intensity fires (Ward and Hardy 1991, Reid et al. 2005).

## MYTH 9

### Western U.S. conifer forests are becoming carbon sources due to increased fire.

## FACT 9

### Western U.S. conifer forests are major carbon sinks, where logging has been reduced.

Despite some speculation that western U.S. conifer forests could become carbon sources (Westerling et al. 2006, van Mantgem et al. 2009), the empirical data show the opposite to be true. Studies using very large data sets (several thousand plots), found that western U.S. forests, and old growth forests, are functioning as net carbon sinks (net sequestration of carbon, thus reducing greenhouse gases) and are expected to continue to do so long into the future (Donnegan et al. 2008, Luyssaert et al. 2008). Oregon's forests, which were a substantial carbon source when logging levels on national forests were higher, are now a significant carbon sink (Turner et al. 2007). After accounting for emissions from wildland fire, net carbon sequestration in Oregon's forests is now so great, due to dramatically decreased logging levels on public lands, that it offsets 41% of the state's total

emissions from fossil fuel burning (Turner et al. 2007). A recent study found that carbon sequestration would be maximized by ending all logging on U.S. public lands nationwide (Depro et al. 2008). In the continental United States, CO2 emissions from wildland fire are only about 5% of the amount resulting from human fossil fuel consumption, carbon sequestration from growth is about 25 times larger than carbon emissions from fire (Wiedinmyer and Neff 2007), and emissions from fire are offset by post-fire growth and carbon uptake. In a field-based study of four very large fires in two exceptionally large fire years (2002-2003) within the eastern Cascades of Oregon, researchers found that only 1-3% of the mass of living trees was consumed in the fires, and all four fires combined produced only about 2.5% of the statewide carbon emissions during the same two-year period (Meigs et al. 2009).



Fig. 12. Large surviving trees in a moderate/high-intensity patch wherein all small and medium-sized trees were killed.

Moreover, the increase in available nutrients following fire (Schlesinger 1997), particularly higher-intensity fire, can lead to substantial growth pulses (Brown and Swetnam 1994 [Fig. 3 of that study], Mutch and Swetnam 1995 [Fig. 4 of that study]), which results in carbon sequestration. This includes post-fire shrub growth, conifer regeneration, and growth release of surviving overstory trees. The shrub growth and conifer seedling/sapling regeneration alone – which are very vigorous in high-intensity patches (see, e.g., Hanson 2007b, Shatford et al. 2007) – can add many tons of sequestered carbon within just several years post-fire. In a comprehensive analysis of all fires over 15 years (1980-1995) in boreal forests in Canada and Alaska, it was determined that it took an average of only 9 years after fire for forests to once again become net carbon sinks (Hicke et al. 2003). Unlike boreal forests, in most other western U.S. conifer forests, high-intensity effects do not typically equate to 100% conifer mortality, and the largest several conifers per acre, which can comprise the majority of the carbon stocks, tend to survive in a given stand, in most cases. Relatively moderate post-fire growth increases (from nutrient cycling) in these large surviving overstory trees can increase carbon stocks rapidly, and will tend to reduce the time it takes for a postfire area to once again become a net carbon sink, relative to fires in which there is zero tree survival. The magnitude of this effect in mixed-conifer forests warrants careful study. Generally, the existing data indicate abundant natural conifer regeneration after high-intensity fire in western U.S. conifer forests (see, e.g., Hanson 2007b, Shatford et al. 2007).

Researchers recently found that the highest carbon sequestration levels were in forests that had previously experienced considerable occurrence of high-intensity fire (Keith et al. 2009). They concluded the following: "Fire can kill but not combust all of the material in trees, leading to much of the biomass carbon changing from the living biomass pool to the standing dead and fallen dead biomass pools… The dead biomass then decays as the stand grows… Slow decomposition rates can therefore result in large total carbon stocks of dead biomass and regrowing living biomass." (Keith et al. 2009). The authors noted that the results of their study, which was conducted in Australia, are broadly applicable to other temperate forests globally, including U.S. conifer forests. Conversely, as forest stands become ancient, in the long absence of high-intensity fire effects, they can transition from carbon sinks (net carbon sequestration) to carbon sources (net carbon emission) after about 600 years of age (Luyssaert et al. 2008, S. Luyssaert 2009 pers. comm.).

## The Myth of "Catastrophic" Wildfire

# MYTH 10

Forest "thinning" operations will increase carbon sequestration by reducing fire effects.

# FACT 10

Commercial logging, including mechanical "thinning", reduces forest carbon storage.

One recent modeling study found that the areas with moderate/high-intensity wildland fire only (i.e., with no thinning), and areas with prescribed fire only, had greater overall carbon stocks over the course of a century than the forest thinning options (Hurteau and North 2009 [Fig. 1]). In addition, by the end of the century the moderate/high-intensity wildland fire scenario produces considerably fewer carbon emissions when compared to the thinning/prescribed-fire scenarios (about 38 tons C per ha [Fig. 1(a)] versus about 56 or 50 tons C per ha [Fig. 1(d) and (f)]; see also Fig. 2) (Hurteau and North 2009). It should also be noted that nearly half of the carbon from thinned trees becomes surface fuel and is burned, and another quarter is lost as mill residue, which is often burned as fuel (Ingerson 2007). Ultimately, only a minor portion of trees that are logged become wood products, and this carbon is not stored in this form for long, as softwood lumber has a half-life of less than 40 years (Smith et al. 2005), and is obviously not assimilated back into the forest ecosystem.

If Hurteau and North (2009) had used more realistic assumptions for their modeling, the difference between fire-only and thinning would have been even greater. For example, they assumed virtually no mortality from wildland fire in the mechanically thinned areas (Figs. 1(c) and 1(e)), while actual areas thinned similarly (i.e., removal of some mature trees as well as small trees) often tend to burn at moderate- and high-intensity, due to residual slash debris, increases in brush growth due to canopy cover reduction, and drying of surface fuels due to a reduction in the cooling shade created by the forest canopy (see, e.g., Hanson and Odion 2006, Platt et al. 2006). Conversely, Hurteau and North (2009) assumed unrealistically high mortality (moderate/high-intensity) in the fire-only area (Fig. 1(a)). Forests, even those that have not burned in several decades, are burning mostly at low and moderate intensity (Odion and Hanson 2008, Schwind 2008), not high intensity.

Another recent modeling study found that mechanical thinning, whether for wood products or biofuels, generally reduced overall carbon storage in forests relative to fire-only (Mitchell et al. 2009). The study concluded that thinning was not an effective way to maintain or increase carbon storage. Had this study taken into account post-fire growth increases due to nutrient cycling (as discussed above), the differences between fire-only and thinning would have been even greater. Further, this study assumed, unrealistically, that thinning consistently reduces fire intensity, which is inconsistent with the scientific data (Hanson and Odion 2006, Platt et al. 2006).

Further, even if we assume for the sake of argument that thinning will reduce potential fire intensity, Rhodes and Baker (2008) found that, due to post-thinning vegetation regrowth, as well as the extremely low rate of occurrence of high-intensity fire currently, an area would have to be mechanically thinned every 20 years for about 720 years to have a mere 50% chance of encountering high-intensity fire and reducing its intensity. Not only would the adverse impacts of such repeated thinning on soils, watersheds, and wildlife be profound, but such constant thinning would permanently suppress carbon storage levels.

# MYTH 11

"Biomass" thinning is benign or beneficial in our forests; such thinning can reduce fire intensity and only removes some of the small trees.

# FACT 11

Further reducing snag forest habitat created by high-intensity fire patches – habitat that is already in short supply – would be ecologically devastating to the many wildlife species dependent upon that habitat. Biomass logging also: a) reduces carbon sequestration; b) increasingly seeks to remove old-growth trees; c) is generally tied to larger timber sales; and d) tends to remove all or nearly all of the smaller trees, regardless of species.



Fig. 13. Understory vegetation in a recent snag forest patch.

The living and dead plant material in a forest is called biomass. This includes everything from the small diameter branches, trees, and shrubs up to the old-growth trees. Today we are seeing increasing aggressive calls – mostly from the timber industry and their political allies – to remove biomass from the forest ostensibly to reduce fire effects. This biomass logging removes trees from the forest to be burned in energy production facilities. However, as discussed above, we remain in a major fire deficit, and snag forest habitat, created by patches of high-intensity wildland fire, is one of the rarest and most endangered habitat types in western U.S. conifer forests; and it is also one of the most ecologically important and biodiverse forest habitat types. Forest management policies designed to further reduce this imperiled habitat would further exacerbate its current deficit, which is already critical. At present, many snag forest wildlife species have been federally listed in one or more regions as "Sensitive Species" or "Species at Risk" – meaning there is a significant concern about the viability of their populations – due to lack of habitat, greatly reduced populations, and/or declining populations. Such species include the Black-backed Woodpecker, the Olive-sided Flycatcher, and the Sierra Nevada Snowshoe Hare. Further degrading and reducing the habitat for such species would create a risk of extinction.

Biomass logging proponents also claim that this type of thinning should be used to maintain or increase carbon sequestration, supposedly by reducing fire effects. However, as discussed above, thinning does not maintain or increase carbon sequestration. The scientific evidence shows that thinning reduces overall carbon sequestration, and increases carbon emissions, relative to areas experiencing wildland fire and no thinning; and carbon sequestration is maximized by halting logging completely.

Though timber interests have promoted increased logging by describing current forests as "overstocked", the scientific data indicates that, due to past logging, as well as exclusion of wildland fire, forests of today have much less biomass than historic forests (Bouldin 1999, Fellows and Goulden 2008). Carbon sequestration is maximized where logging is absent and wildland fire is present (Turner et al. 2007, Depro et al. 2008, Keith et al. 2009). Peak biomass levels have been found in areas that have experienced high-intensity wildland fire – the total biomass being comprised of the fire-killed trees and downed logs, as well as the regenerating post-fire stand of trees (Keith et al. 2009). Small diameter trees and downed woody material on the forest floor play a key role in maintaining forest productivity, and carbon stocks, because this woody material is most easily combusted in a wildland fire, creating a rich supply of available nutrients in the ash (Schlesinger 1997). For this reason, biomass thinning not only reduces carbon sequestration in the short-term, it also diminishes the forest's productive capacity, and carbon sequestration potential, in the longer-term.

Moreover, typically biomass logging is just one portion of larger timber sales. First the larger trees are removed for lumber, then the smaller trees are removed as biomass for energy production; thus biomass logging and logging of mature trees are inextricably linked. Small trees are not merely "thinned". Rather, nearly all of the small trees, including pines and oaks, are removed, eliminating an entire forest regeneration cohort. Moreover, the U.S. Forest Service and private timberland owners are increasingly proposing large post-fire salvage logging projects for biomass production, especially when the lumber market is weak. Entire snag forest ecosystems could be wiped out to produce kilowatts. Further, there have been a growing number of accounts of old-growth trees being proposed for biomass logging. For example, the 2008 Flea project on the west side of the Plumas National Forest proposed removal of old-growth hardwoods up to 30 inches in diameter (over 8 feet in girth) for biomass energy production; and hundreds of acres of old-growth juniper were clearcut in 2008 on U.S. Bureau of Land Management lands in northeastern California to supply a biomass plant near Susanville (Tom Knudson, Sacramento Bee, Sept. 21, 2008).

Further, due to clear carbon accounting errors that ignore emissions from biofuel logging, as well as due to perverse economic incentives favoring biofuel production in climate legislation/rules, recent evidence published in Science indicates that, unless the faulty system is changed, the majority of the world's natural forests could be displaced for biofuel production, releasing as much greenhouse gas as is currently emitted from global fossil fuel consumption (Searchinger et al. 2009). Alarmingly, due to these carbon accounting errors and perverse incentives, this massive loss and degradation of natural forests, and the resulting doubling of current greenhouse gas emissions, would be mistakenly assessed as a 50% "cut" in greenhouse gas emissions – a dangerous fiction that threatens the world's forest ecosystems (Searchinger et al. 2009).

## Summary: For Ecologically "Healthy Forests", We Need More Fire and Dead Trees, Not Less.

In light of the foregoing, the term "catastrophic wildfire" is not scientifically credible; rather, it is a term based upon misinformation, as well as cultural fears and misconceptions about fire. There is a major deficiency of wildland fire – including high-intensity fire – and large snags in conifer forests. Yet forest management is still bent upon suppressing fire, reducing snag densities, and eliminating post-fire habitat, which is greatly worsening the current deficits. If this management pattern continues, it could threaten populations of numerous native wildlife species, many of which are already rare and/or declining (Hutto 1995, Altman and Sallabanks 2000, Hutto 2006, Hutto 2008, Hanson and North 2008). Current forest management direction continues to be disconnected from the current scientific data, and remains heavily focused on mechanical thinning projects ostensibly to reduce future tree mortality from competition and wildland fire. This situation is made worse by

management direction under the "Healthy Forests Initiative" on public lands, which makes the scientifically-outdated assumption that wildland fire and snag densities should be further reduced, and recommends logging operations to accomplish its stated goals. Current forest management also remains focused on post-fire "salvage" logging. Scientifically, however, there is probably no forest management activity more clearly and profoundly destructive to wildlife and biodiversity than post-fire "salvage" logging. Hutto (2006) concluded the following: "The ecological cost of salvage logging speaks for itself, and the message is powerful. I am hard pressed to find any other example in wildlife biology where the effect of a particular land-use activity is as close to 100% negative as the typical postfire salvage-logging operation tends to be." Lindenmayer et al. (2004), writing in the journal Science, observed that, "…[post-fire] salvage harvesting removes critical habitat for species, such as cavity-nesting mammals, woodpeckers, invertebrates like highly specialized beetle taxa that depend on burned wood, and bryoflora closely associated with recently charred logs…" Hutto and Gallo (2006) found a major adverse impact to the cavity-nesting bird community as a result of post-fire logging. In response to legislation proposed in Congress that would expedite post-fire logging on national forest lands, nearly 600 of the nation's top scientists signed a letter of objection, dated August 1, 2006. The scientists wrote the following: "When we, as scientists, see policies being developed that run counter to the lessons of science, we feel compelled to speak up. Proposed post-disturbance legislation… crafted as a response to recent fires and other disturbances, is misguided because it distorts or ignores recent scientific advances. Under the labels of 'recovery' and 'restoration', these bills would speed up logging and replanting after natural disturbances… such activity would actually slow the natural recovery of forests and of streams and the creatures within them… no substantive evidence supports the idea that fire-adapted forests might be improved by logging after a fire."

Based upon the scientific evidence summarized above, a new ecological paradigm has emerged – one that recognizes: a) historic conifer forests generally had a mix of low-, moderate-, and high-intensity effects; b) current forests have an unhealthy deficiency in wildland fire and large snags; and c) forest management activities should be undertaken to increase occurrence of mixed-intensity wildland fire and increase the density of large dead trees in order to maintain ecologically healthy forests.

Of course, as the new forest ecology paradigm is increasingly reflected in actual forest management policies in the coming years, it is important to ensure that homes are adequately protected. Resources must be focused on creating defensible space within 100 feet of homes in forested areas, and reducing the combustibility of the homes themselves. So-called "fuels reduction" projects far from homes are diverting important resources from home protection, and are creating a false sense of security in forested communities. By focusing our attention on ensuring public safety, we can also facilitate the restoration of the natural role of wildland fire in our forest ecosystems.

Those who benefit from the perpetuation of the "catastrophic wildfire" myth – chiefly the timber industry and their Congressional allies, as well as the federal land management agencies that pad their budgets through timber sale revenue – seek to convince the public that we need to fear the effects of fire in our forests. They would have us continue to spend billions of dollars not only subsidizing logging projects across millions of acres of mature and old-growth forest on public lands, but also funding increasingly aggressive fire suppression policies, while weakening federal environmental laws to expedite such programs. Fire-dependent wildlife species would be put at a growing risk of extinction.

The emerging forest ecology paradigm, in contrast, does not require these costly and destructive programs. It recognizes that wildland fire is doing important and beneficial ecological work in our forests. Moreover, within the forest ecology paradigm, policies are focused on ensuring that rural human communities adapt to wildland fire so that homes are protected. Both our forests and our communities will be healthier for the change.

## The Myth of "Catastrophic" Wildfire

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# The forgotten stage of forest succession: early-successional ecosystems on forest sites

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# The forgotten stage of forest succession: early-successional ecosystems on forest sites

**Mark E Swanson[1*], Jerry F Franklin[2], Robert L Beschta[3], Charles M Crisafulli[4], Dominick A DellaSala[5], Richard L Hutto[6], David B Lindenmayer[7], and Frederick J Swanson[8]**

**Early-successional forest ecosystems that develop after stand-replacing or partial disturbances are diverse in species, processes, and structure. Post-disturbance ecosystems are also often rich in biological legacies, including surviving organisms and organically derived structures, such as woody debris. These legacies and post-disturbance plant communities provide resources that attract and sustain high species diversity, including numerous early-successional obligates, such as certain woodpeckers and arthropods. Early succession is the only period when tree canopies do not dominate the forest site, and so this stage can be characterized by high productivity of plant species (including herbs and shrubs), complex food webs, large nutrient fluxes, and high structural and spatial complexity. Different disturbances contrast markedly in terms of biological legacies, and this will influence the resultant physical and biological conditions, thus affecting successional pathways. Management activities, such as post-disturbance logging and dense tree planting, can reduce the richness within and the duration of early-successional ecosystems. Where maintenance of biodiversity is an objective, the importance and value of these natural early-successional ecosystems are underappreciated.**

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Severe natural disturbances – such as wildfires, windstorms, and insect epidemics – are characteristic of many forest ecosystems and can produce a "stand-replacement" event, by killing all or most of the dominant trees therein (Figure 1). Typically, limited biomass is actually consumed or removed in such events, but many trees and other organisms experience mortality, leaving behind important biological legacies (structures inherited from the pre-disturbance ecosystem; Franklin *et al.* 2000), including standing dead trees and downed boles (tree trunks; Franklin *et al.* 2000). Such legacies provide diverse physical/biological properties and suitable microclimatic conditions for many species. Thereafter, species-diverse plant communities develop because substantial amounts of previously limited resources (light, moisture, and nutrients) become available. These emerging plant communities create additional habitat complexity and provide various energetic resources for terrestrial and aquatic organisms.

The ecological importance of early-successional forest ecosystems (ESFEs) has received little attention, except as a transitional phase, before resumption of tree dominance. In forestry, this period is often called the "cohort re-establishment" or "stand initiation" stage, with attention obviously focused on tree regeneration and the re-establishment of closed forest canopies (Franklin *et al.* 2002). Ecological studies have focused primarily on plant-community development and the needs of selected animal (mostly game) species, and not on the diverse ecological roles of ESFEs.

Here, we highlight important features of ESFEs, including their role in sustaining ecosystem processes and biodiversity, so that they may be appropriately considered by resource managers and scientists, and included within management/research programs dedicated to maintaining these functions, particularly at larger spatio-temporal scales. Most published examples focus on sites in western North America, but ESFEs are important elsewhere (Angelstam 1998; DeGraaf *et al.* 2003). We also discuss how traditional forestry practices, such as clearcutting, tree planting, and post-disturbance logging, can affect early-successional communities.

## In a nutshell:

- Naturally occurring, early-successional ecosystems on forest sites have distinctive characteristics, including high species diversity, as well as complex food webs and ecosystem processes
- This high species diversity is made up of survivors, opportunists, and habitat specialists that require the distinctive conditions present there
- Organic structures, such as live and dead trees, create habitat for surviving and colonizing organisms on many types of recently disturbed sites
- Traditional forestry activities (eg clearcutting or post-disturbance logging) reduce the species richness and key ecological processes associated with early-successional ecosystems; other activities, such as tree planting, can limit the duration (eg by plantation establishment) of this important successional stage

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***Figure 1.*** *Stand-replacement disturbance events in forests create large areas free of tree dominance and rich in physical and biological resources, including legacies of the pre-disturbance ecosystem.*

## Early-successional ecosystems on forest sites

Initial conditions after stand-replacing forest disturbances vary generically, depending on the type of disturbance; this includes the types of physical and biological legacies available. For example, aboveground vegetation may be limited immediately after the disturbance, as in the case of severe wildfires or volcanic eruptions. Conversely, intact understory communities may persist where forests have been blown down by severe windstorms. Spatial heterogeneity in conditions is characteristic, given that disturbances vary greatly in the amount of damage they cause (Turner *et al.* 1998). For instance, severe wildfires frequently include substantial areas of unburned as well as low to medium levels of mortality, creating variability in shade, litterfall, soil moisture, seed distribution, and other factors.

We define ESFEs as those ecosystems that occupy potentially forested sites in time and space between a stand-replacement disturbance and re-establishment of a closed forest canopy. These ecosystems undergo compositional and structural changes (succession) during their occupancy of a site. Changes begin immediately post-disturbance, as a result of the activities of surviving organisms (eg plants, animals, and fungi), including plant growth and seed production. Developmental processes are enriched by colonization of flora and fauna from outside the disturbed area. Successional change is often characterized by progressive dominance of annual and perennial herbs, shrubs, and trees, although all of these species are typically represented throughout the entire sequence of forest stand development (or sere; Halpern 1988).

The ESFE developmental stage ends with re-establishment of tree cover that is sufficiently dense to suppress and often eliminate many smaller shade-intolerant plants (Franklin *et al.* 2002). Consequently, the duration of ESFEs varies inversely with rapidity of tree regeneration and growth, which, in turn, depend on such variables as tree propagule availability, conditions affecting seedling or sprout establishment, and site productivity. ESFE longevity after natural disturbances is therefore highly variable.

Development of a closed forest canopy may require a century or more in areas with limited seed sources, harsh environmental conditions, severe shrub competition (in some instances), or combinations thereof (Hemstrom and Franklin 1982). For example, tree canopy closure after wildfire in the Douglas fir region of western North America often requires several decades (Poage *et al.* 2009), but can occur much more rapidly when canopy seedbanks are abundant (eg Larson and Franklin 2005). Closed forest canopies may develop quickly in forests dominated by trees with strong sprouting ability (eg many angiosperms) or when windstorms "release" understories of shade-tolerant tree seedling banks by removing all or most of the overstory (Foster *et al.* 1997).

## Attributes of early-successional ecosystems

After severe disturbances, forest sites are characterized by open, non-tree-dominated environments, but have high levels of structural complexity and spatial heterogeneity and retain legacy materials.

### *Environmental conditions*

Removal of the overstory forest canopy during disturbances dramatically alters the site's microclimate, including light regimes. These changes lead to increased exposure to sunlight, more extreme temperatures (ground and air), higher wind velocities, and lower levels of relative humidity and moisture in litter and surface soil. Shifts in these environmental metrics favor some species, while creating suboptimal or intolerable conditions for others. For example, post-disturbance plant community composition, cover, and physiognomy are altered as shade-tolerant understory herbs are largely displaced by shade-intolerant and drought-tolerant species. New substrates deposited by floods or volcanic eruptions may lack nutrients, provide additional water-holding capacity, or have high albedo, all of which favor shifts in plant communities.

### *Survivors*

Organisms (in a variety of forms) that survive severe disturbances are extremely important for repopulating and

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restoring ecosystem functions in the post-disturbance landscape. Even in severely disturbed areas, organisms may survive as individuals (mature or immature) or as reproductive structures (eg spores, seeds, rootstocks, and eggs), which become in situ propagule sources. For example, after the 1980 volcanic eruption of Mount St Helens (Washington State), most pre-eruption flora and many fauna (especially aquatic and burrowing terrestrial species) survived within the blast zone through several different mechanisms (Dale *et al.* 2005).

Surviving organisms are also often vital for the prompt re-establishment of important ecosystem functions, such as conservation of nutrients and stabilization of substrates. For instance, the important role of resprouting vegetation in curbing massive losses of nitrogen was demonstrated by experimentally clearcutting and applying herbicides in a watershed at Hubbard Brook Experimental Forest (Bormann and Likens 1979).

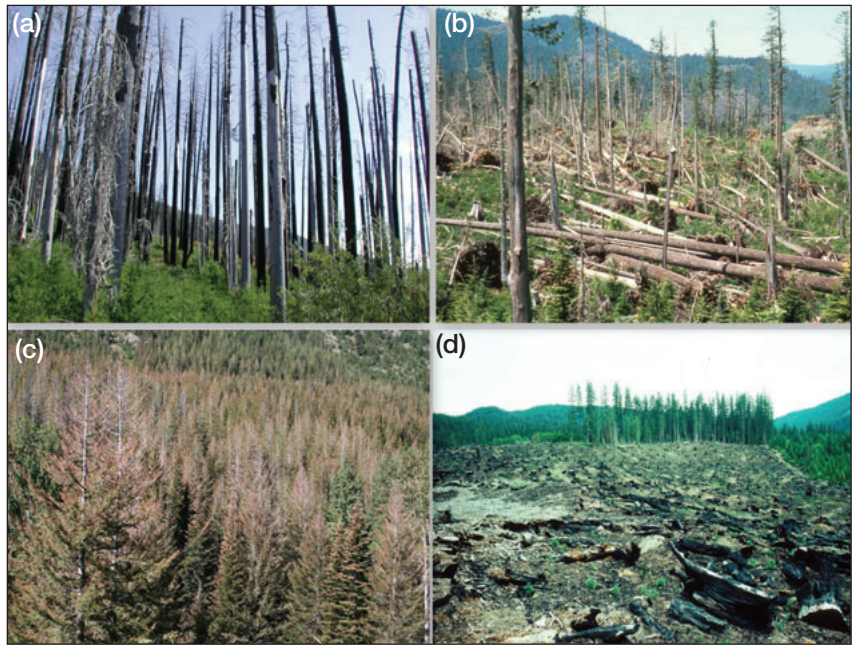



***Figure 2.*** *Different types of disturbances produce different types of biological legacies, including living organisms and structures: (a) standing dead trees (snags) are dominant structural legacies after severe wildfires; (b) downed tree trunks and nearly intact understory communities are characteristic legacies after major windstorms; (c) standing dead trees are also dominant structural legacies after heavy insect infestations; and (d) clearcuts typically eliminate most aboveground structural legacies. Values for each metric are shown in Table 1 and are described in detail in the text.*

### *Structural complexity*

The structural complexity of ESFEs depends initially on legacies, the general nature of which varies with the type of disturbance (Table 1; Figure 2); for example, snags and shrubs originating from belowground perennating (ie resprouting) parts or seeds are dominant legacies after wildfires, whereas downed boles and largely intact understories are typical post-disturbance characteristics of windstorms.

Woody legacies, such as snags and downed boles, play numerous roles in structuring and facilitating the development of the recovering ecosystem – providing habitat for survivors and colonists, moderating the physical environment, enriching aquatic systems in the disturbed area (Jones and Daniels 2008), and providing long-term sources of energy and nutrients (Harmon *et al.* 1986). Although subject to decomposition, these legacies can persist for many decades and sometimes even centuries.

**Table 1. Different types of intense disturbances generate different types of biological legacies**

| | *Disturbance* | | | | |
|---|---|---|---|---|---|
| *Biological legacies* | *Wildfire* | *Wind* | *Insect* | *Volcano* | *Clearcut* |
| Live trees | Infrequent | Variable | Variable (depends on stand composition) | Infrequent – confined to margins | Infrequent or absent |
| Snags | Abundant | Variable | Abundant | Abundant (spatially variable) | Infrequent or absent |
| Downed woody debris | Variable, but typically abundant | Abundant | Variable, but eventually abundant | Abundant (spatially variable) | Infrequent |
| Undisturbed understory | Infrequent | Abundant | Abundant | Infrequent – confined to disturbance margins | Infrequent |
| Spatial heterogeneity of recovery | High | Variable | High | High | Variable – usually low |
| Time in early-successional condition | Variable | Variable | Long | Variable – usually long | Variable – usually short |

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***Figure 3.*** *Plant communities with well-developed shrub and perennial herb species are characteristic of early-successional communities on forest sites and provide diverse food resources. Twenty-five years after the Mount St Helens eruption in 1980, this community, which was within the blast zone, includes well-developed shrubs (eg* Sorbus *and* Vaccinium *spp), trees, and perennial herbs (eg* Epilobium angustifolium*).*

Structural complexity is further enhanced by the establishment and development of a variety of plant species, which often include perennial herbs and shrubs characteristic of open environments, as well as individual trees (Figure 3). The diversity of plant morphologies (maximum height, crown width, etc) increases structural richness, so that this associated flora contributes to both horizontal and vertical heterogeneity.

### *Spatial heterogeneity*

Spatial heterogeneity is evident in early-successional ecosystems and has multiple causes: (1) natural variability in the geophysical template (topography and lithology) of the affected landscape; (2) variability in conditions in the pre-disturbance forest ecosystem; (3) variability in the intensity of the disturbance event; and (4) variability in rates and patterns of subsequent developmental processes in the ESFE. The first two sources relate to existing geophysical and biological patterns within the disturbed area. Land formations and patterns of geomorphic processes are certainly key geophysical elements (Swanson *et al.* 1988). The presence of surface water, such as streams and ponds, can be particularly influential in facilitating survival and re-establishment of biota.

Natural disturbances create heterogeneous environments at multiple spatial scales (Heinselmann 1973), because disturbances do not cause damage uniformly. Disturbances such as wildfires and windstorms are variable in intensity (eg "spotting", or initiation of new flame fronts by wind-thrown firebrands, during fire events). Alternatively, geographic variation in environmental conditions and topography (Swanson *et al.* 1988) influences the intensity of the disturbance and results in heterogeneity at multiple scales. Variability in the structure and composition of the pre-disturbance forest also creates spatial and temporal variability (Wardell-Johnson and Horowitz 1996). Some of these patterns may be transient, such as residual snowbanks protecting tree regeneration after the aforementioned Mount St Helens eruption (Dale *et al.* 2005).

Post-disturbance developmental processes also lead to spatial heterogeneity. For example, varying distances to sources of tree seed result in different rates and densities of tree re-establishment (Turner *et al.* 1998). Structural legacies can greatly influence the rates at which wind- or waterborne organic (including propagules) and inorganic materials are deposited. Finally, animal activity can strongly influence patterns of revegetation, as illustrated by the multiple effects that gophers (*Thomomys* spp) can have on post-disturbance landscapes (Crisafulli *et al.* 2005b) or the way ungulate browsing may impede tree regeneration (Hessl and Graumlich 2002).

## ■ Biological diversity

ESFEs in temperate forest seres show great diversity in the abundance of plant and animal species (Fontaine *et al.* 2009). Species composition may consist of a mix of forest survivors, opportunists, or ruderals (plants that grow on disturbed or poor-quality lands), and habitat specialists that co-exist in the resource-rich ESFE environment (Figure 3). Most forest understory flora can survive disturbances as established plants, perennating rootstocks, or seeds. In one study, in western North America, over 95% of understory species survived the combined disturbance of logging and burning of an old-growth Douglas-fir–western hemlock stand (Halpern 1988). Some important early-successional species (eg *Rubus* spp [blackberry; raspberry], *Ribes* spp [gooseberry], and *Ceanothus* spp [buckbrush]) may persist as long-lived seedbanks.

Opportunistic herbaceous species are often conspicuous dominants early in the development of ESFEs (Figure 4). Many of these weedy species (particularly annuals) decline quickly, although other opportunists will persist as part of the plant community until overtopped by slower growing shrubs or trees. Consequently, diverse plant communities of herbs, shrubs, and young trees emerge in ESFEs; this, combined with the structural legacies from the pre-disturbance ecosystem, often results in high levels of structural richness (Figure 3).

Many animals, including habitat specialists and species typically absent from the eventual tree-dominated com-

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munities, thrive under the conditions found in ESFEs. For some species, this is the only successional stage that can provide suitable foraging or nesting habitat. As an example, many butterflies and moths (Lepidoptera) found in forested regions depend on the high diversity and quality of plant forage in ESFEs (eg Miller and Hammond 2007), whereas jewel beetles (Coleoptera: Buprestideae) depend on abundant coarse woody debris. Also, a number of ground-dwelling beetle species occur as habitat specialists in early-successional communities (Heyborne *et al.* 2003).



***Figure 4.*** *Early-successional communities are often dominated by annual herbaceous species for the first few years after disturbance; these are quickly displaced by perennial herbaceous species and shrubs.*

Many vertebrates also respond positively to ESFEs, which may provide the only suitable habitat at a regional scale for some species. Ectothermic animals, such as reptiles (eg Rittenhouse *et al.* 2007), generally respond favorably to sunnier and drier conditions, colonizing early-successional habitat or increasing in abundance if present as survivors. Many amphibians also thrive in ESFEs, provided resources such as water bodies and key structures (eg logs) are available. The diversity and abundance of amphibians in the area affected by the 1980 Mount St Helens eruption is illustrative (Crisafulli *et al.* 2005a); eleven of 15 amphibian species survived the event, and some (eg western toad, *Bufo boreas*) have since had exceptional breeding success.

The broad array of birds using the abundant and varied food sources (eg fruits, nectar, herbivorous insects) and nesting habitat in ESFEs includes many raptors and neotropical migrants, often making bird diversity highest during the ESFE stage of succession (Klaus *et al.* in press). Some species are habitat specialists that directly utilize the legacy of recently killed trees; for instance, black-backed woodpeckers (*Picoides arcticus*) are almost completely restricted to early post-fire conditions (Hutto 2008). Mountain bluebirds (*Sialia currucoides*) and several other woodpecker species also favor structurally rich, early-successional habitats (Figure 5). Observed population declines of many avian species in eastern North America – which, in some cases, have proceeded to a point of conservation concern – are linked to conversion of early-successional habitat to closed forest (Litvaitis 1993).

Small mammal communities in ESFEs typically show high levels of diversity as well, including some obvious habitat specialists. The eastern chestnut mouse (*Pseudomys gracilicaudatus*), for example, inhabits early-successional environments in coastal eastern Australia for 2–5 years after a wildfire, and then declines dramatically until these environments are burned again (Fox 1990). Populations of mesopredators (medium-sized predators, such as raccoons [*Procyon lotor*] and fox species) benefit from the abundance of small vertebrate prey items characteristic of ESFEs. Likewise, some species of large mammals are well known to favor ESFEs (Nyberg and Janz 1990). Utilizing the diverse and luxuriant forage characteristically present in these ecosystems, ungulates, such as members of the Cervidae, in turn serve to benefit large predators (eg wolves [*Canis lupus*]) as well as scavengers, making ESFEs important elements within those species' typically extensive home ranges. Omnivores, such as bears (*Ursus* spp), also rely on the diversity of food sources often present in ESFEs.

## Food web diversity

ESFEs are exceptional in the diversity and complexity of food webs they support. Simply stated, a diverse plant community produces many food sources. Food resources for herbivores (grasses, shrubs, forbs) – as well as nectar, seeds, and shrub-borne fruit (eg produced by *Rubus* and *Vaccinium* spp [huckleberry]) – can reach high levels before site dominance by trees. In the temperate Northern Hemisphere, biologically important berry production is maximized in slowly reforesting ESFEs. Resource production in early-successional patches may even augment the richness of adjacent undisturbed forests, as in the case of fluxes of key prey species (Sakai and Noon 1997).

Aquatic biologists have, perhaps, best appreciated the greater complexity of food chains in early-successional versus closed forest environments (Bisson *et al.* 2003). In established forest stands, trees strongly dominate the physical and biological conditions in nearby small streams by controlling light and temperature, stabilizing channels, providing woody debris, and, importantly, offering allochthonous inputs (organic matter originating outside the aquatic ecosystem) – the primary energy and nutrient source for such ecosystems (Vannote *et al.* 1980).

Stand-replacement disturbances remove forest constraints on conditions and processes, and shift streams to an early-

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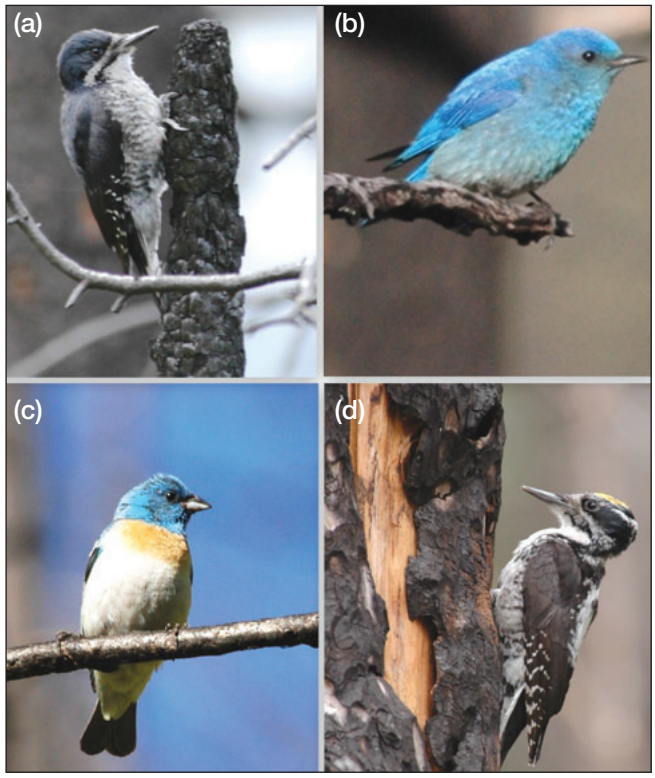



***Figure 5.*** *Bird diversity is typically high in early-successional communities on forest sites and includes many habitat specialists: (a) black-backed woodpeckers* (Picoides arcticus) *are almost entirely restricted to early post-fire habitat; (b) mountain bluebirds* (Sialia currucoides) *favor early-successional ecosystems; (c) lazuli buntings* (Passerina amoena) *and (d) three-toed woodpeckers* (Picoides tridactylus) *have similar requirements.*

successional context (Minshall 2003; Figure 6). This greatly diversifies the types and timing of allochthonous inputs, as well as increases primary productivity. Allochthonous inputs are shifted from primarily tree-derived litter (coniferous-based in many systems) to material from a range of flowering herbs, shrubs, and trees, as well as from conifers. Consequently, litter inputs are highly variable in quality (eg decomposability) and delivery time, as compared with litterfall contributed primarily by evergreen conifer species. Also, inputs to post-disturbance streams often include material with a high nitrogen content, such as litter from the early-successional genera *Alnus* and *Ceanothus* (Hibbs *et al.* 1994).

Greater algal production may increase the diversity and abundance of aquatic invertebrate populations, which, in turn, become prey for fish and other organisms. However, increases in sediment production associated with disturbances can negate some benefits to aquatic processes and organisms (Gregory *et al.* 1987).

## Processes in ESFEs

Ecosystem processes in ESFEs can be more diverse than those in closed forest systems, where the primary productivity of trees is dominant and organic matter is processed primarily through detrital food webs. Development of more diverse, and perhaps more "balanced", trophic pathways is possible when a disturbance opens a previously closed forest canopy. The contrast is probably greatest in forests dominated by a single tree type, such as evergreen conifers, as opposed to more diverse forests, such as mixed evergreen associations.

### *Recharging nutrient pools*

ESFEs provide major opportunities for recharge of nutrient pools, such as additions to the nitrogen pool by leguminous (eg *Lupinus*) and some non-leguminous early-successional (eg *Alnus* and *Ceanothus*) plant species. These genera are commonly absent from late-successional forests, but are well represented in ESFEs. Nitrogenous additions from these sources are particularly important where the disturbance – eg a wildfire – has volatilized a substantial amount of the existing nitrogen pool.

Mineralization rates of organic material are typically accelerated (sometimes profoundly) after disturbances, as a result of warmer growing season temperatures. Diversified litter inputs in ESFEs, including a greater proportion of easily decomposed litter from herbs and deciduous shrubs, also result in more rapid mineralization. Finally, successional changes in the fungal and microbial communities can also hasten decomposition processes. As noted, these changes will be most profound in forest ecosystems dominated by a single species, including evergreen conifers or hard-leaved, evergreen hardwoods (such as the ash-type eucalypt forests of southeastern Australia).

In aquatic ecosystems that experience fire in adjacent forests, greater post-disturbance light and nutrient availability enhance primary productivity within the water body, causing shifts in food webs from the level of primary producers up through high-level consumers, such as fish (Spencer *et al.* 2003).

### *Modifying hydrologic and geomorphic regimes*

Hydrologic regimes associated with ESFEs contrast greatly with those characterizing closed forest cover. For example, transpiration and interception are dramatically reduced and recover only gradually as forest canopies redevelop. Increases in normally low summer flows and annual water yields may occur immediately after a disturbance, as compared with levels in the dense young forests that may subsequently develop (Jones and Post 2004). The opposite may be true in systems where condensation of cloud or fog on tree crowns is an important component of the hydrologic cycle. ESFEs may also contribute to increased discharge peak runoff flows in hydrologic events of smaller magnitude (Harr 1986), but appear to have little effect on the magnitude of peak flows during large runoff events (Grant *et al.* 2008). From an ecological perspective, this may have a positive outcome, however, because floods restructure and rejuvenate many riparian communities (Gregory *et al.* 1991).


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Rates and patterns of geomorphic processes, such as erosion and nutrient leaching losses, are also different between ESFEs and later successional stages. Tree death results in a loss of root strength that is critical for stabilizing soils and deeper rock layers on mountain slopes (Perry *et al.* 2008). Erosion and landslides may occur at higher rates in ESFEs, contributing to the variability of sediment budgets in watersheds (Reeves *et al.* 1995) and creating long-lasting substrates for ruderals. While enhancing erosion processes, ESFEs also provide materials and processes that counteract this effect, such as woody debris, which retain sediments and organic materials, and surviving vegetation, which stabilizes slopes and nutrient stores (eg Bormann and Likens 1979).



J Halofsky

***Figure 6.*** *Streams within early-successional forest ecosystems contrast with forest-dominated reaches in many ecosystem attributes, including physical parameters (temperature and insolation), structure, plant and animal composition, and ecosystem processes, such as primary productivity.*

## Land management implications

Incorporating ESFE attributes into forest policy and management is highly desirable, given the numerous advantages provided by these ecosystems. Many species and ecological processes are strongly favored by conditions that develop after stand-replacement disturbances. Rapid, artificially accelerated "recovery" of disturbed forest areas (eg via dense planting) to closed forest conditions has serious implications for many species. Clearly the term "recovery" has a different meaning for such early-successional specialists or obligates.

To fulfill their full ecological potential, ESFEs require their full complement of biological legacies (eg dead trees and logs) and sufficient time for early-successional vegetation to mature. Where land managers are interested in conservation of the biota and maintenance of ecological processes associated with such communities, forest policy and practices need to support the maintenance of structurally rich ESFEs in managed landscapes. Natural disturbance events will provide major opportunities for these ecosystems, and managers can build on those opportunities by avoiding actions that (1) eliminate biological legacies, (2) shorten the duration of the ESFEs, and (3) interfere with stand-development processes. Such activities include intensive post-disturbance logging, aggressive reforestation, and elimination of native plants with herbicides.

In particular, post-disturbance logging removes key structural legacies, and damages recolonizing vegetation, soils, and aquatic elements of disturbed areas (Foster and Orwig 2006; Lindenmayer *et al.* 2008). Where socioeconomic considerations necessitate post-disturbance logging, variable retention harvesting (retention of snags, logs, live trees, and other structures through harvest) can maintain structural complexity in logged areas (Eklund *et al.* 2009).

Prompt, dense reforestation can have negative consequences for biodiversity and processes associated with ESFEs, by dramatically shortening their duration. Such efforts reduce spatial and compositional variability characteristic of natural tree-regeneration processes, promote structural uniformity, and initiate intense competitive processes that eliminate elements of biodiversity that might otherwise persist. Artificial reforestation can also reduce genetic diversity by favoring dominance by fewer tree species/genotypes, and may make the system more prone to subsequent, high-severity disturbances (Thompson *et al.* 2007). The elimination of shrubs and broad-leaved trees through herbicide application can alter synergistic relationships, such as the belowground mycorrhizal processes provided by certain shrub species (eg *Arctostaphylos* spp).

Naturally regenerated ESFEs are likely to be better adapted to the present-day climate and may be more adaptable to future climate change. The diverse genotypes in naturally regenerated ESFEs are likely to provide greater resilience to environmental stresses than nursery-grown, planted trees of the same species. Given that climate change is also resulting in altered behavior of pests and pathogens (Dale *et al.* 2001), encouraging greater tree species diversity may also increase ecosystem resilience.

Clearcutting has been proposed as a technique to create ESFEs, but this can provide only highly abridged and simplified ESFE conditions. First, traditional clearcuts leave few biological legacies (eg Lindenmayer and McCarthy 2002), limiting habitat and biodiversity potential. Second, clearcuts are often quickly and densely reforested, and often involve the use of herbicides to limit competition with desired tree species. Clearcuts can provide some early-successional functionality (eg serving as nurseries or post-breeding habitat for many bird species in the southern US; Faaborg 2002), but this service is often truncated by prompt reforestation.

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Management plans should provide for the maintenance of areas of naturally developing ESFEs as part of a diverse landscape. This should be in reasonable proportion to *historical* occurrences of different successional stages, as based on region-specific historical ecology. Major disturbance events provide managers with opportunities to incorporate a greater diversity of species and processes in forest landscapes and to enhance landscape heterogeneity. Some aspects of ESFEs can be incorporated into areas managed for production forestry as well, such as through variable retention harvest methods, the incorporation of natural tree regeneration, and extending the duration of herb/shrub communities in some portions of a stand by deliberately maintaining low tree stocking levels.

Finally, we suggest that adjustments in language are needed. Ecologists and managers often refer to "recovery" when discussing post-disturbance ecosystems, inferring that early seral conditions are undesirable and need to be restored to closed canopy conditions as quickly as possible. Emphasizing recovery as the management goal fails to acknowledge the essential ecological roles played by early-successional ecosystems on forest sites. It should also be considered that climate change and other factors may not permit "recovery" to pre-disturbance conditions.

## Conclusions

Twentieth-century forest management objectives were centered on wood production and, later, on conservation and development of late-successional forests. Rapid regeneration of dense timber stands was frequently seen as a way to address both of these divergent objectives. Recognizing the ecological value of early-successional ecosystems on forest sites extends the ecological concerns associated with old growth to another "rich" period in a forest sere. This represents an important development in the evolution of holistic management of forest ecosystems, whereby large landscapes are managed for diverse seral stages.

ESFEs provide a distinctive mix of physical, chemical, and biological conditions, are diverse in species and processes, and are poorly represented and undervalued in traditional forest management. Forest policy and practice must give serious attention to sustaining substantial areas of ESFEs and their biological legacies. Similarly, scientists need to initiate research on the structure, composition, and function of ESFEs in different regions and under different disturbance regimes, as well as on the historical extent of these systems, to serve as a reference for conservation planning.

## Acknowledgements

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39

**CENTER FOR BIOLOGICAL DIVERSITY**

**SIERRA CLUB GRAND CANYON CHAPTER**

March 14, 2011

Henry Provencio
4FRI Team Leader
Coconino National Forest
1814 S. Thompson Street
Flagstaff, AZ 86001

**Re: Four Forests Restoration Initiative Proposed Action**

Dear Mr. Provencio,

general

The Grand Canyon Chapter of the Sierra Club and Center for Biological Diversity hereby submit Scoping Comments regarding the Four Forest Restoration Initiative as published in the Federal Register on January 25, 2011. Due to statements made by the Forest Service in public meetings, it is our understanding that the comment period closes on March 14, 2011 as opposed to the March 11th date printed in the Federal Register Notice. It is also our understanding that the Forest Service will develop another, more detailed Proposed Action based on comments received on this one. We support that approach, and we will continue to submit comments on the Proposed Action as new iterations are developed and details become clearer.

1

We support the Forest Service's stated goal of focusing management of Mogollon Plateau ponderosa pine forests on ecological restoration. Since European settlement in the middle to late 1800s pervasive changes have homogenized ponderosa pine forests in the Southwest. Logging has decreased the number of old and large trees. Livestock grazing and fire suppression have promoted unnaturally dense stands of small trees. This condition threatens the remaining large trees and ecological systems through competition and by fueling increasingly extensive crown fires. Alteration of stand structures and species compositions has in turn altered natural processes. Understory grasses and forbs have decreased in abundance and diversity, replaced by deep mats of pine needles. Nutrient cycling dynamics have been disrupted and overall biodiversity levels decreased. Old-growth ponderosa pine forests have become rare and meadows have shrunk due to tree encroachment. Some vertebrate animal species, such as the Northern Goshawk and Mexican Spotted Owl have declined in abundance due to habitat alterations. Others, such as wolves, jaguar, grizzly bear and Merriam's elk have been extirpated or driven extinct. Non-native species have displaced native species and road construction has fragmented

general

forest habitats. An increase in number, size, and severity of stand-replacing fires threatens both human and ecological communities. The aftermath of such fires includes short term amplification of erosion and flooding. Landscape scars created by total canopy destruction may persist as grasslands, shrublands or small tree thickets for decades to centuries. If the current trajectories of anthropogenically driven change continue, serious ecological damage to ponderosa pine ecosystems will accumulate and, with global climate change, likely accelerate. These worrisome trends have long been evident to forest scientists and ecologists and have led to a broad scientific, social, and political consensus that restoration of southwestern ponderosa pine forest ecosystems is necessary and urgent to conserve the ecological systems upon which native biological diversity and human society commonly depend.

general

Ecological restoration in northern Arizona ponderosa pine forests is a corrective step to safely re-establish and conserve self-regulating ecological systems and their full suite of native biological diversity. We recognize that doing so involves a comprehensive program that strategically integrates community protection, ecological restoration, fire management and biodiversity protection in a landscape context. A central outcome of these efforts is to facilitate the safe management and re-establishment of ecologically beneficial fire regimes at landscape scales. Strategically located and sequenced treatments that conserve large trees and reduce small tree densities will facilitate the re-establishment of natural frequent surface fire regimes and the conservation of native species, including populations of canopy dependent wildlife species, within treatments and adjacent landscapes. Because fire regimes naturally track variability in climate, and because fire plays a keystone ecological role shaping forest structure and composition, ecological restoration that leads to the re-establishment of more natural fire regimes at landscape scales will allow forest changes to track climate changes over time. Coupled with other restorative management, strategically reducing small tree densities and re-establishing frequent fire regimes will also increase the resilience and persistence of ponderosa pine forest ecosystems and biological diversity therein by reducing the potential for and extent of rapid, widespread forest dieback amidst anticipated global climate change. The correction and release of heretofore heavily managed forest ecosystems into a self-regulating, disturbance-maintained condition in wildlands is both in conceptual and applied terms fundamentally different than industrial forestry management models such as and including sustained yield management. The release of heretofore heavily managed forest ecosystems into a self-regulating, disturbance-maintained condition will yield ecological benefits including resilience, heterogeneity, adaptation, carbon sequestration and conservation of native biological diversity in the coming century of global climate change.

general

It is toward these ends that we support the Forest Service's stated goal of focusing management of Mogollon Plateau ponderosa pine forests on ecological restoration. Our understanding is that the Forest Service will use comments received in this round of scoping to revise and re-issue its proposed action with greater specificity. We strongly encourage the Forest Service to take that step, and additional scoping steps as necessary to develop a proposed action that is sufficiently specific to facilitate meaningful public comment, issue identification and alternative development. While we support the Forest Service stated desire to focus management on ecosystem restoration, the Proposed Action does not contain enough information to determine

general / duplicated in Comment 2

a site-specific outcome. It is unclear from the Proposed Action, the public presentations and information on proposed treatment approaches what impacts will occur to forest structure; information regarding residual tree densities, diameters, basal areas, canopy densities, soild, watershed and wildlife are necessary to determine possible impacts of the proposed action.

As a part of the public scoping process a number of significant issues have emerged which will need to be addressed.

### 1. Issue Number One: NEPA Requires Site-specific Analysis

The scale of the project being proposed would normally be analyzed in a programmatic document to be followed by tiered, site-specific analysis for treatment at smaller scales. The process as currently proposed requires a site specific analysis across 750,000 acres, covering activities over a 10 year period. As discussed in the following comments, we are being asked to comment on a Proposed Action that does not provide enough information regarding treatments and potential post treatment impacts. For example, the proposed action and public meetings have failed to provide information necessary for the public to understand even basic post-treatment stand structure characteristics (tree densities, size class distributions, canopy cover) in treatments proposed by the Forest Service. The significance of the lack of specifics and analysis detail for the Proposed Action is that the process, as currently proposed, will limit the public's ability to raise issues based on an evaluation of a detailed proposed action; this in turn precludes those issues from being addressed through the development of alternatives in the planning process. Thus, this lack of specificity in the Proposed Action undermines the entire NEPA process; it is our understanding based on statements made by Forest Service personnel in meetings that these comments will be used to develop a second, more specific proposed action that will also be scoped. We strongly encourage the Forest Service to take that step, and additional scoping steps as necessary to develop a proposed action that is sufficiently specific to facilitate meaningful public comment, issue identification and alternative development. 2

We remain concerned that a programmatic EIS followed by tiered, site-specific actions would best serve the 4FRI project, and that the scale of the Proposed Action may preclude satisfying NEPA's site-specific requirements. *See* Salmon River Concerned Citizens v. Robertson, 32 F.3d 1346 (9th Cir. 1994) (SRCC) (because the government made clear it would prepare site-specific EAs and "tier" back to the programmatic EIS, the court upheld the EIS.); Marble Mountain Audubon Society v. Rice, 914 F.2d 179, 182 (9th Cir. 1990) (unless the programmatic documents address site-specific impacts, they must be addressed in individual NEPA documents tiered to broader planning documents); Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1380 (9th Cir. 1998) ("Nor is it appropriate to defer consideration 3

of cumulative impacts to a future date"). *See also* Pit River Tribe v. U.S. Forest Service, 469 F.3d 768, 784 (9th Cir. 2006); Nat'l Parks Conservation Ass'n v. Babbitt, 241 F.3d 722 (9th Cir. 2001) (NPCA); (NEPA analysis must be conducted "before a decision that may have a significant adverse impact on the environment is made."); 40 C.F.R. 1500.1(b), 1502.5, 1506.1.

The court in *City of Tenakee Springs v. Block* provides a definition of a programmatic EIS: "A programmatic environmental impact statement is a broad-based, long range plan that discusses the overall environmental impacts of a proposed action."[1] Tiering refers to the process of preparing a broad statement and subsequently narrowing the focus of the NEPA analysis.[2] The first tier in the programmatic EIS "'should focus on broad issues such as mode choice, general location and area-wide air quality and land use implications of alternative transportation systems.'" The programmatic EIS should reflect the "broad environmental consequences…" and be forward looking.[3] The second tier includes the site-specific EISs.[4] As a practical matter, this sort of NEPA vehicle seems well-suited to necessarily hierarchical planning, implementation and monitoring needs of the Four Forests Restoration Initiative.

We are also concerned that entire 4FRI effort spanning a 2.4 million acre focal area could be legitimately construed as a single proposed action warranting analysis in one singular programmatic EIS, and that a programmatic EIS, under the letter of the law, is in fact the proper NEPA vehicle for the effort. In *Kleppe v. Sierra Club*, the U.S. Supreme Court stated the principle that if the government agency has not made a certain proposal, normally a dissatisfied group of citizens cannot force the agency to combine several truly separate projects into a single

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[1] *City of Tenakee Springs v. Block*, 778 F. 2d 1402, 1403 n.1 (9th Cir. 1985) (citing *Nat'l Wildlife Fed. v. U.S. Forest Serv.*, 592 F. Supp. 931, 940 n. 17 (D. Or. 1984)), *amended on other grounds, Nat'l Wildlife Fed. v. U.S. Forest Serv.*, 643 F. Supp. 653 (D. Or. 1984), *order vacated in part, appeal dismissed in part, Nat'l Wildlife Fed. v. U.S. Forest Serv.*, 801 F.2d 360 (9th Cir. 1986).

[2] 40 C.F.R. §§ 1502.20, 1508.28.

[3] *See Nat'l Wildlife Fed. v. Appalachian Reg'l Comm'n*, 677 F.2d 883, 888 (finding that a programmatic EIS was not required for a large scale highway project that had already been partially completed and project specific EISs were being conducted) citing *Kleppe*, 427 U.S. at 413).

[4] 40 C.F.R. § 1508.28.

environmental impact statement. The reverse of that same principle is that when an agency has made a comprehensive proposal, it has no choice but to evaluate the entire proposal in the EIS. *Kleppe v. Sierra Club*, 427 U.S. at 409. In addition to using the CEQ regulation's definition of "connected" action, the Ninth Circuit applies an "independent utility" test to determine if actions are "connected." *Wetland Action Network v. United States Army Corps of Eng'rs,* 222 F.3d 1105, 1118 (9th Cir. 2000). When one of the projects may reasonably be completed without the other, the two projects have independent utility and are not 'connected' for NEPA purposes. *Native Ecosystems Council v. Dombeck,* 304 F.3d 886, 894 (9th Cir. 2002). The thrust of the test is whether the connected actions, those that are necessary for independent utility, must be considered as part of the logical end.

The phrase "independent utility" is applied in the Ninth Circuit to mean "utility such that the agency might reasonably consider constructing only the segment in question." *Thomas,* 753 F.2d at 760. The court provides some further insight in *Trout Unlimited v. Morton,* 509 F.2d 1276 (9th Cir. 1974), stating that an EIS must address subsequent phases of development when "[t]he dependency is such that it would be irrational, or at least unwise, to undertake the first phase if subsequent phases were not also undertaken." *Id.* at 1285, quoted in *Thomas,* 753 F.2d at 759. This discussion could go on, but certainly, in the case of the "Four Forests Restoration Initiative," including only one phase involving only two of those four forests in a single EIS could be reasonably construed as "irrational," at least when viewed through the lens of the law. Again, we maintain that a Programmatic Environmental Impact Statement would remedy this potential problem. 14

**2. Issue: The Proposed Action Should Describe the Affirmative Goal of Safely Restoring Natural Fire Regimes and How Strategically Placed Treatments Deployed Within Firescapes Will Facilitate the Management of Planned and Unplanned Ignitions**

The proposed action should describe the project in the context of Federal Wildland Fire Policy and its goals of facilitating public and firefighter safety and maximizing fire's natural role in wildland ecosystems. 15

> "Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fire is based on ecological, social, and legal consequences of fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected dictate the appropriate management response to fire."

1995/2001 Federal Wildland Fire Management Policy. The proposed action should discuss the affirmative goal of restoring fire as a critical natural process rather than focusing on the negative goal of avoiding undesirable fires. The proposed action should discuss and present the idea of firescapes and strategically placed treatments in the context of safely managing planned and unplanned ignitions, including restoring fire as a critical natural process.

In the former case, the proposed action should describe Firescapes as a geographic context within which to plan and deploy strategically placed treatments that can facilitate safely managing planned and unplanned ignitions. We refer the Forest Service to the definition and description of Firescapes in the 4FRI Stakeholders' Landscape Strategy document; we suggest the Forest Service use this definition and description to provide additional clarity and specificity to the purpose of Firescapes as an geographic context for planning and deploying strategically placed treatments in a way that serves fire management goals.

In the latter case, the proposed action should provide additional detail on the relationship between strategically placed treatments and fire management. Specifically, the proposed action should describe how restoration treatments can be strategically designed, located and sequenced to efficiently and safely facilitate operational fire management, community protection, and landscape-scale restoration of ecologically beneficial fire regimes at landscape scales. Toward that end, some key questions that the Forest Service should be seeking to answer in the proposed action and subsequent analyses are:

- Where and under what conditions can natural ignitions be managed for resource benefit under current Fire Management Plans?
- Where can treatments be located to facilitate containment and management of planned or unplanned ignitions within firescapes or subsets thereof?
- How can treatments be positioned and sequenced to most efficiently reduce the potential for landscape-scale crown fire?

Treatment units should be distributed in the project area with spatial patterns of crown fire spread in mind. Overlapping patterns of fuel treatment that reduce horizontal fuel continuity can fragment severe fire behavior and effects into smaller patches if they disrupt heading fire behavior and increase the area burned by fires exhibiting flanking behavior as they move upslope (Finney 2001). Slope aspects facing away from frontal or diurnal winds are a lesser priority for treatments because backing fires likely to occur on those sites are the most likely to exhibit mild intensity and cause low-severity effects to vegetation and soil with attendant benefits to ecosystem resources and fire worker safety.

The direction of fire spread (backing, flanking, heading) is an important aspect of fire behavior because fire interacts with weather, topography and vegetation to "back" and "flank"

around certain fuel and topographic conditions or "head" through others as it moves across the landscape (Graham et al. 2004). Steep slopes can facilitate wind-driven convection currents that drive radiant heat upward and bring flames nearer to adjacent unburned vegetation, pre-heating fuels and amplifying fire intensity as it moves upslope (Whelan 1995). As a result, severe fire effects typically concentrate at upper slope positions and on ridges, whereas such effects are relatively rare on the lee side of slopes that do not directly receive frontal wind (Finney 2001).

For starters, we suggest the Forest Service consider targeting treatments in fire suppressed VSS 3 stands that are (1) within ¼ mile of roads, (2) that exhibit active or passive crown fire behavior under 95th percentile conditions, and that (3) occur in patches of 50 acres or larger. We also urge the Forest Service to carefully review rationale and analyses employed in the 4FRI Landscape Strategy; the analyses unpinning that document reflect careful thinking about linking restoration and fire management goals in a landscape context. The Forest Service should explicitly include thinning with fire, either in single or multiple, repeated events, within the range of treatment options. Acres precluded from mechanical treatment should not automatically be excluded from fire use; rather, the planning document should consider thinned and non-thinned areas together within a landscape matrix that can safely accommodate natural fires with beneficial ecological effects.

Another approach to strategic location of fuel treatments is to identify landscape features that are currently resilient to fire disturbance and use those sites as anchor points for compartmentalization of the project area for long-term fire management oriented to use of unplanned ignitions for resource benefits. Such sites may include natural openings, meadows, relatively open ridges, riparian areas, patches of mature forest with relatively shaded and cool microclimates, and sites where fuel reduction work already has been completed. Such locations can facilitate appropriate fire management responses including confinement and containment strategies as alternatives to full control, as well as provide safe areas for workers to ignite prescribed fires for hazardous fuel reduction and ecological process restoration. Identification of such sites does not necessarily equate to actively treating them. Landscape features that are currently fire resilient, as well as proposed fuel treatment areas, should be spatially mapped and distinguished in analysis of the proposed action.

The Forest Service also can prioritize active fuel management in areas where relatively little resource investment may create relatively fire resilient stand conditions. This may include low-productivity sites with little encroachment of small trees (e.g., dry southerly aspects) and relatively open stands that are currently dominated by large conifers. Targeting work in these areas will maximize the area treated and the effectiveness of treatments with available funds and personnel, and thereby provide the greatest opportunity to quickly reduce fuels and restore ecosystem function at larger spatial scales.

### 3. Issue : Tree-mortality and Other Structural Changes Resulting From Fire Use

The EIS must describe tree mortality and other structural changes resulting from restoration treatments and from fire management following treatments on an ongoing basis. That is, the forest structure resulting from thinning, or the forest structure today in areas that will go unthinned, will change over time by virtue of fire effects. The EIS needs to characterize those ongoing changes and incorporate them into forest modeling. Losses of canopy, large trees, small trees and resulting recruitment of logs and snags will affect long-term forest dynamics, stand development and wildlife habitat suitability. We urge the Forest Service to exhibit caution in so doing: Post-treatment large tree mortality have exceeded planning targets at several restoration sites in northern Arizona.

### 4. Issue: Limiting Vegetative Structural Stage Distribution and Canopy Cover Requirements to the Group Scale Would Violate NFMA and Harm Canopy-dependent Species

Pursuant to NFMA, "the Forest Service must demonstrate that a site-specific project would be consistent with the land and resource management plan of the entire forest." *Neighbors of Cuddy Mountain v. U.S. Forest Service*, 137 F.3d 1372, 1377 (9th Cir. 1998), *citing* 16 U.S.C. § 1604(i); 36 C.F.R. § 219.10(e). In 1996, the Forest Service amended all Forest Plan in the Southwest Region, including the CNF Plan, to provide additional standards and guidelines for northern goshawks. The Forest Service must demonstrate that the project will comply with the mandatory standards and guidelines for the northern goshawk.

The existing amended forest plans, including the Coconino Forest Plan, incorporate the *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992), which define northern goshawk habitat through the structural habitat attributes of 14 of the hawk's prey species. In two environmental impact statements that based action alternatives on the recommendations, the Forest Service established a habitat-proxy relationship of specifically quantified attributes of ponderosa forest structure and viability of northern goshawk and 14 other vertebrate species that comprise its prey base (USDA 1996, 2006).

Appendix C to the 1996 Record of Decision for the northern goshawk plan amendments sets forth the mandatory standards and guidelines for ecosystem management within Northern goshawk habitats, and these standards and guidelines have been incorporated into the CNF Plan. *See* CNF Plan at 65-7 through 65-11. These standards and guidelines apply to all forested lands that are outside the protected areas for the Mexican Spotted Owl. CNF Plan at 65-7. The standards and guidelines for northern goshawks include, but are not limited to:

(1) The Forest Service must survey the management analysis area prior to any habitat modifying activities, including a ½ mile beyond the proposed project boundary. The

Forest Service must use the R3 survey protocol in order to get complete coverage of the management analysis area, and must complete at least one year of surveys.

(2) The Forest Service must establish and delineate on a map, a post-fledgling family area that includes 6 nesting areas per pair of nesting goshawks for known nest sites, old nest sites, areas where there is historic data of past nest sites, and where there have been repeated sightings. A post-fledgling family area (PFA) must be approximately 600 acres in size, and must include the nest sites and habitat most likely to be used by the fledglings during their early development. The 6 identified nest sites should each be approximately 30 acres in size, requiring a minimum total of 180 acres of nest areas within each PFA.

(3) The Forest Service must manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels;

(4) The Forest Service must manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape;

(5) The Forest Service must sustain a mosaic of vegetation densities, age classes and species composition across the landscape;

(6) The Forest Service must provide foods and cover for goshawk prey;

(7) The Forest Service must limit human activity in nesting areas and near PFAs during the breeding season, which extends from March 1 to September 30;

(8) The Forest Service must manage the ground surface layer to maintain satisfactory soil conditions i.e., minimize soil compaction and maintain hydrologic and nutrient cycles;

(9) The required habitat structures, such as tree size, snags, dead and down material, etc., are to be evaluated at (a) the ecosystem management area level, (b) the mid-scale such as drainage, *and* (c) the small scale of site.

(10) For areas outside of PFAs, the required distribution of vegetation structural stages is 10% VSS1, 10% VSS2, 20% VSS3, 20% VSS4, 20% VSS5, and 20% VSS6. (Actual percentages may vary + or – up to 3%).

(11) Snags are to be 18 inches or larger dbh and 30 feet or larger in height, downed logs are to be 12 inches in diameter and at least 8 feet long, and woody debris must be 3 inches or larger on the forest floor.

(12) For areas outside PFAs, canopy cover for Ponderosa pine forest is to average 40+% for VSS4, 5, and 6.

(13) Within PFAs, the canopy cover for Ponderosa pine forest is to average 50+% for VSS4, 5, and 6.

(14) Within nesting areas, the area must contain only mature to old forest (VSS5 and 6) having a canopy cover between 50-70% with mid-aged VSS6 trees 200-300 years old.

(15) Road densities are to be managed at the lowest level possible, and where timber harvesting is prescribed to achieve desired forest conditions, the Forest Service is to use small, skid trails in lieu of roads.

12 In public meetings Forest Service personnel have stated that they plan to apply canopy requirements of the standards and guidelines relating to VSS 4, 5, and 6 only at the tree-group level. The Forest Service cannot arbitrarily relegate standards and guidelines to tree groups because the standards and guidelines apply to all forested lands outside protected areas for the Mexican Spotted Owl. CNF Plan at 65-7.

13 The Arizona Game and Fish Department has stated that application of canopy cover guidelines at small tree group scales instead of at larger forest stand scales in mature and old growth ponderosa forest has the potential to significantly reduce the amount of forest cover within treated areas, with detrimental consequences to goshawk and its prey.[5] For example, assuming a residual canopy cover within groups of 50 percent, and if groups occupy 50 percent of the stand, canopy cover at the stand scale will be 25 percent, far below required minimums.

To prevent this outcome across project areas, the *Management Recommendations* and the amended forest plans incorporating them clearly require maintenance of canopy cover at stand

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[5] See notes of Arizona Game and Fish Deptartment Region II Commission Briefing, July 27, 2007, attached to these comments for convenience. In it, the Department explains, "the Management Recommendations for the Northern Goshawk in the Southwestern United States (GTR-RM-217) defines northern goshawk habitat through the structural habitat attributes of 14 of the hawk's prey species. The canopy cover data described for these prey species, and for the northern goshawk, were measured at the stand level – not the tree group level. By changing the canopy cover targets from the stand level to the group level, the Department is concerned that the Forest Service may not be meeting the habitat requirements for those 14 wildlife species, and also may not be meeting the habitat requirements for the northern goshawk per the 1996 Forest Plan Amendment."

scales in older ponderosa forest. As listed above, minimum canopy cover values within and outside of PFAs and nesting areas in VSS 4, 5 and 6 are plainly among the required habitat structures in the standards and guidelines, and "required habitat structures… are to be evaluated at (a) the ecosystem management area level, (b) the mid-scale such as drainage, *and* (c) the small scale of site." Further, the required habitat structures explicitly apply to Nest Areas, Post-fledging Family Areas (PFA) and Foraging Areas, all of which occur at scales larger than the group level. The described stand structures are to occur across 30 acres for nest areas, 420 acres for PFAs and 5,400 acres for foraging areas. Additional desired conditions for each forest type are also described in terms of stand (not group) characteristics.

Restricting minimum canopy cover requirements to groups and excluding inter-space from canopy tallies within VSS 4, 5 and 6 also conflicts the plain language of the *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds et al. 1992), which the existing amended forest plans, including the Coconino Forest Plan, incorporate. That document plainly states that, "Vegetation structural stage (VSS) is a method of describing the growth stages of a stand of living trees. It is based on tree size (DBH) and total canopy cover." (Appendix 5, MRNG), where VSS is "A generalized description of forest growth and aging stages based on the majority of the trees in the specific diameter distribution of the stand." (Glossary of Terms, MRNG).

The Forest Service needs to explain how using a silvicultural tool designed for the stand level can accurately be used to create groups and canopy restricted to the group scale. Achieving structural stages at only the group level could allow a significantly higher number of canopy openings with smaller numbers of trees between those openings. Using Vegetative Structural Stage (VSS) data to determine canopy or forest structure at the group level could present a false picture of stand conditions and associated canopy.

The goshawk prey species analysis underpinning the MRNGs was based on the prey species' use of small to large contiguous patch sizes with varying canopy densities. Prey species' home ranges vary in size from half an acre to miles. In providing habitat for prey species, the goal of the MRNG was to result in a mosaic of interspersed vegetative structural stages in large landscape units. (Page 30, MRNG, RM-217) Measuring structural stages and the associated canopy densities at the group level only is inconsistent with the science underpinning the MRNGs, the 1996 ROD, and will likely have deleterious effects on northern goshawk and its prey species by failing to provide adequate canopy cover in VSS 4, 5 and 6 at multiple scales. The consequence of such effects cannot be downplayed in the context of the proposed project: its scale could entail population-level impacts to the goshawk and its prey species. Notably, the latest report of the Kaibab National Forest on management indicator species habitat and population trends (USDA 2010) states that the source population of northern goshawk on the

Kaibab Plateau is in decline, and the species is "at risk of extirpation or extinction in Arizona." The Forest Service must ensure that the project will not adversely affect goshawk or contribute to a trend toward listing under the Endangered Species Act.

In public meetings the Forest Service personnel have also stated that the MRNG did not specify the levels of analysis to take place regarding impacts to canopy. However, the June 1996 Regional forest plan amendments, which provide the binding standards and guidelines for logging within goshawk habitat, state the following: "Distribution of habitat structures (tree size and age classes, tree groups of different densities, snags, dead and down woody material, etc.) should be evaluated at the ecosystem management level, at the mid-scale such as drainage, and at the small scale of site." (Record of Decision for amendment of forest plans, p.92).

This multi-leveled approach is critical. For instance, a goshawk PFA may not meet the desired VSS distribution and may not be adequately represented at the VSS 1 level, however, the larger analysis area may have a surplus of VSS 1. When determining dense canopy cover in older age classes, a multi-level approach gives a more accurate picture of over all forest structure. While the Coconino and South Kaibab National Forests may be able to achieve the larger tree group and dense canopy requirements at the group scale, they are less likely to be achieved at the stand and landscape scales. Such an analysis would indicate the need to manage for a mature forest component.

**5. Issue: Old Growth**

In addition to specific requirements for northern goshawks, the 1996 Forest Plan Amendment for the Southwest Region also includes mandatory standards for old growth habitat. Each national forest, including the CNF, must allocate no less than 20 percent of each forested "ecosystem management area" to old growth habitat. CNF Plan at 70-1. In order to properly determine old growth habitat, the Forest Service must refer to a specific table included in the both the 1996 Plan Amendment and CNF Plan, which sets forth the detailed, minimum numeric criteria for various forest types, including the size, age, and number of live and dead trees, down trees, and canopy cover. CNF Plan at 70-2.

Forested sites must meet or exceed these numeric structural attributes in order to be considered old growth habitat. CNF Plan at 70-1. In addition, the CNF Plan requires the Forest Service to analyze old growth habitat at multiple scales – (1) the ecosystem management area; (2) one scale above the ecosystem management area; and (3) one scale below the ecosystem management area. CNF Plan at 70-1; *see also* New Goshawk Guidelines, p. 11 ("all forest plans require analysis of old growth at multiple scales"). The amount of old growth that can be provided and maintained must be evaluated at the ecosystem management level and be based on forest type, site capability, and disturbance regimes. CNF Plan at 70-1.

Old Growth is essential to many species inhabiting the Coconino and Kaibab National Forest because it provides habitat attributes not found in younger forests. These include large, old trees, large standing dead trees, vertical and horizontal structural diversity, nesting cavities, broken tops, and fire resistant "plated" bark structure. In addition to these important habitat characteristics, old growth provides a host of ecological services including overall watershed function, clean water, soil retention, and storage of greenhouse gasses.

general

The Proposed Action notes the Forest Plan direction to "Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape." The revised proposed action should clearly state that no old growth trees will be cut and should designate old growth to its maximal possible extent across the landscape.

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### 6. Issue: Treatment Openings

The Proposed Action does not adequately define within stand openings, interspaces and regeneration openings. All of these terms refer to conditions that describe openings in the canopy, but have very different management goals. We support the restoration of a more natural forest structure that includes fine-scale openings (generally 0.05 to 1.0 acres) interspersing groups of trees.

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### 7. Issue: Invasive Plants

Domestic livestock, as well as logging, prescribed fire, and other practices that disturb soils, spread alien weedy species in ponderosa forests (Johnson et al. 1994). Livestock act as vectors for seed travel, disturb the soil, and reduce the competitive and reproductive capacities of native species. Exotic weeds can displace native species, in part, because native grasses are not adapted to frequent and close grazing (Mack and Thompson 1982, Belsky and Blumenthal 1997). In some portions of the planning area, although the locations relative to active grazing allotments is not disclosed, aggressive alien weeds such as cheatgrass (*Bromus tectorum*) and spotted knapweed (*Centaurea maculosa*) have displaced native species. EA at 164. The potential for significant cumulative impacts of noxious weed spread in the project area is high because McGlone and others (2009) showed that cheatgrass abundance and distribution increased 90-fold above a pre-treatment baseline as a result of forest treatments similar to the proposed action.

general

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The presence of cheatgrass has important long-term implications for native plant communities. Melgoza and co-workers (1990) studied cheatgrass soil resource acquisition after fire and note its competitive success owing to its ability suppress the water uptake and

general

productivity of native species for extended periods of time. They further note that cheatgrass dominance is enhanced by its high tolerance to grazing (also see Mack 1981).

Cheatgrass is well adapted to fire and often dominates plant communities after disturbance (Young et al. 1969). Its annual life-form coupled with the abilities to germinate readily over a wide range of moisture and temperature conditions, to quickly establish an extensive root system, and to grow early in the spring contribute to its successful colonization (Melgoza et al. 1990). Some native species also exhibit this trait, but greenhouse and field studies show that cheatgrass effectively competes with seedlings of perennial species (Hull 1963, Harris 1967, Evans et al. 1970, Harris and Wilson 1970). In addition, Melgoza and others (1990) show that cheatgrass successfully competes with the native species that survive fire, despite these plants being well-established adult individuals able to reach deeper levels in the soil. This competitive ability of cheatgrass contributes to its post-fire dominance.

general

**8. Issue: Domestic Livestock Grazing**

The Forest Service must adequately consider the cumulative impacts of all past, present and reasonably foreseeable projects within and near the project area. 40 C.F.R. § 1508.27(b)(7); *see also id.* § 1508.7 ("Cumulative impact" defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action," and recognizing that cumulative actions "can result from individually minor but collectively significant actions taking place over a period of time."); *id.* § 1508.25(a)(2) (in considering the proper scope for analysis, the Forest Service must consider "cumulative actions," which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same analysis). If several actions may have a cumulative environmental effect, the environmental consequences must be disclosed in an EIS. *See Blue Mountains Biodiversity Project*, 161 F.3d at 1214.

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general

There is a substantial body of scientific literature that identifies livestock grazing as a major factor in the alteration of historic fire regimes and a contributor to fire hazard (Arnold 1950, Cooper 1960, Madany and West 1983, Mitchell and Freeman 1993, Rummell 1951, Savage and Swetnam 1994). This is true for five reasons.

general

First, livestock grazing removes the grasses that compete with tree seedlings for water and nutrients. This favors the establishment of deep rooted trees and allows them to dominate affected sites. Studies of ungrazed sites in several ponderosa pine dominated ecosystems found that in the absence of livestock grazing, and in the absence of fire, open ponderosa pine forests with a minimum of understory pine seedling establishment was documented (Madany and West 1983, Rummell 1951).

general

Second, most tree species require bare soil for successful germination and, grazing that removes the grassy understory and creates bare disturbed soil conditions that favors tree establishment. This has led to excessive tree-stocking density in many locations (Belsky and Blumenthal 1997). general

Third, grazing removes fine fuels such as grasses that otherwise may help to carry the light intensity fires that once burned at regular intervals in the planning area. This has permitted young saplings and trees to become established and be recruited into the forest stand (Arnold 1950, Savage and Swetnam 1994). general

Fourth, by permitting a large number of small saplings to become established, competition for water among existing living trees is increased making trees more vulnerable to insects and other pathogens (Hessburg et al 1994). Under extreme drought such trees are actually more flammable than a dead tree since internal water content is often less than kiln-dried lumber. Flammable resins found in living, drought-stressed trees may explode into flames upon contact with fire. general

Fifth, by contributing to the spread and persistence of easily ignited weedy species like cheatgrass, livestock production has created far more acres of highly flammable plant communities (Belsky and Gelbard 2000, Billings 1990, Mack 1981). general

**9. Issue: Stand Density Index**

The Forest Service needs to describe in detail how the Stand Density Index (SDI) will be used in developing treatment approaches described in the Proposed Action and public meetings. SDI was designed for use in even-aged management scenarios. The Proposed Action is planning on restoring an uneven-aged forest structure. How the use of SDI relates to ecological restoration goals remains unclear. 20

**10. Issue: Threatened and Endangered Species**

Section 7 of the Endangered Species Act ("ESA") requires the Forest Service, in consultation with the U.S. Fish and Wildlife Service ("FWS"), to insure that any action authorized, funded, or carried out by the agency is not likely to (1) jeopardize the continued existence of any threatened or endangered species or (2) result in the destruction or adverse modification of the critical habitat of such species. 16 U.S.C. § 1536(a)(2). "Action" is broadly defined to include all activities or programs of any kind authorized, funded, or carried out by general

federal agencies, including actions directly or indirectly causing modifications to the land, water, or air; and actions intended to conserve listed species or their habitat. 50 C.F.R. § 402.02.

Section 7(a)(2) of the ESA requires all federal agencies to "insure" that any action they undertake or authorize is "not likely to jeopardize the continued existence of any endangered species or threatened species"; this is the duty to "insure no jeopardy." *Id.* § 1536(a)(2). This duty is one of the ESA's clearest cornerstones for the conservation of listed species. As the Supreme Court has acknowledged, "[o]ne would be hard pressed to find a statutory provision whose terms were any plainer than those in § 7 of the [ESA]." *TVA*, 437 U.S. at 173.

The ESA's implementing regulations set forth a specific process, fulfillment of which is the only means by which an action agency ensures that its affirmative duties under Section 7(a)(2) are satisfied. 50 C.F.R. § 402.14(a); *Sierra Club v. Babbitt*, 65 F.3d 1502, 1504-05 (9th Cir. 1995). By this process, each federal agency must review its "actions" at "the earliest possible time" to determine whether any action "may affect" listed species or critical habitat in the "action area." 50 C.F.R. § 402.14. The definition of agency "action" is broad and includes "actions directly or indirectly causing modifications to the land, water, or air." 50 C.F.R. § 402.02. The "action area" is defined to mean all areas that would be "affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." *Id.* The term "may affect" is also broadly construed to include "[a]ny possible effect, whether beneficial, benign, adverse, or of an undetermined character". 51 Fed. Reg. at 19926. If a "may affect" determination is made, "formal consultation" is required.[6]

In formal consultation, after evaluating all relevant information, FWS prepares a "biological opinion" ("BiOp"), which considers the current status of the species, the environmental baseline, and the effects of the proposed action, and concludes "whether the action, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species… ." *Id.* § 402.14(g)(2)-(4). The BiOp is the heart of the Section 7 consultation

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[6] The process leading up to formal consultation is called "informal consultation." 50 C.F.R. § 402.02.

process, and results in either a "likely to jeopardize" or a "no jeopardy" conclusion. 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(h)(3). To "jeopardize" to mean "engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. § 402.02. This requires FWS to consider "both recovery and survival impacts." *Nat'l Wildlife Fed'n v. Nat'l Marine Fisheries Serv.*, 524 F.3d 917, 931 (9th Cir. 2008).

If "jeopardy" is likely, FWS must prescribe in the BiOp "reasonable and prudent alternatives" to avoid that result. 50 C.F.R. § 402.14(i)(1)(ii). If FWS concludes that the project is not likely to jeopardize listed species, it must provide an "incidental take statement" ("ITS") with the BiOp that specifies the amount or extent of such incidental take, the "reasonable and prudent measures" that FWS considers necessary or appropriate to minimize such take, and the "terms and conditions" that must be complied with by the action agency or any applicant to implement any reasonable and prudent measures, as well as other details. *Nat'l Wildlife Fed'n v. Nat'l Marine Fish. Serv.*, 481 F.3d 1224, 1230 (9th Cir. 2007); 16 U.S.C. § 1536(b)(4); 50 C.F.R. § 402.14(i).

Section 7(a)(1) of the ESA directs all federal agencies to consult with the Secretary and "utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species … ." 16 U.S.C. § 1536(a)(1). Thus, pursuant to Section 7(a)(1) of the ESA, the Forest Service must undertake formal consultations with the U.S. Fish and Wildlife Service to ensure that the proposed action "insure" that the project is "not likely to jeopardize the continued existence of any endangered species or threatened species"; this is the duty to "insure no jeopardy."

As the Forest Service is aware, the species most likely to be impacted by the Proposed Action is Mexican spotted owl. As the Forest Service is also aware, the Forest Service has been, on an ongoing basis, violating the mandatory terms and conditions set forth in the 2005 biological opinion concerning the implementation of the Forest Plans in the Southwest Region, including mandatory monitoring requirements for the Mexican spotted owl, in violation of the ESA. 16 U.S.C. § 1536(b)(4)(C)(iv); 50 C.F.R. §§ 402.14(i)(1)(iv), and 402.14(i)(3). Due to these monitoring failures, the Forest Service is also failing to insure that it has not exceeded the incidental take allowances for these species. Through its failure to comply with the monitoring requirements that are included within the terms and conditions of the 2005 biological opinion[7], and through its failure to insure that it has not exceeded the incidental take limits for these listed species, the Forest Service is thereby failing to insure that the Coconino Forest Plan and projects that implement the plan are not likely to jeopardize the continued existence of Mexican spotted owl, or result in the destruction or adverse modification of critical habitat. 16 U.S.C. § 1536(a)(2). The Forest Service has also failed to complete consultation with FWS regarding impacts of the Coconino Forest Plan on the owl and its critical habitat, in violation of the ESA. 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.16.

general

Because the Forest Service is in ongoing violation of the 2005 programmatic biological opinion's terms and conditions for the Mexican spotted owl, among other species, any take of these species – incidental or otherwise – is no longer covered by the programmatic biological opinion and would be in violation of Section 9 of the ESA. *See* 16 U.S.C. 1536(o)(2); 16 U.S.C. 1538. Therefore, until the Forest Service has completed its reinitiated consultation with the U.S. Fish and Wildlife Service regarding impacts of implementing Land and Resource Management Plans in the region on Mexican spotted owls and other species, any projects implementing those

21

[7] The Forest Service typically monitored only 20-25% of PACs during 2005-07. Moreover, PACs have been monitored for owl occupancy but not owl reproduction. The Forest Service states in the annual report that personnel and funding levels are not adequate to meet the monitoring requirements set out in Term and Condition 3.1. As a result, in many cases, monitoring has not been accomplished. In addition, the Forest Service claims in the report that the incidental take issued by the biological opinion is difficult to understand at the Forest level.

Plans, including the Proposed Action, must avoid take of Mexican spotted owl to avoid violating Section 7(d) and 9 of the ESA. 16 U.S.C. § 1538(a)(1); 16 U.S.C. 1536(d); 50 C.F.R. § 17.31(a).

**11. Issue: Soils**

The proposed action should identify soil types on which mechanical treatments, piling and pile burning should be prohibited owing to vulnerability to soil disturbance. It should also include mandatory procedures for preventing soil erosion during mechanical treatments. We are not at all convinced that best management practices will prevent unacceptably detrimental soil conditions where ground-based log skidding occurs. The EIS should relate slope steepness to soil erosion hazard or soil structure throughout the project area; it should disclose exactly where ground-based skidding and mechanical treatments may and should not occur. The Forest Service should evaluate soil erosion hazard at multiple scales, using watersheds and sub-watersheds to delineate between those scales. 22

**12. Issue: Non-forested land allocations**

The proposed action and public meetings have described savannahs, grassland and other ecological communities that may or not be Management Areas set forth in governing Land and Resource Management Plans. The Forest Service needs to describe the scientific and policy basis for those delineations. The Forest Service also needs to describe how treatments proposed therein comply with the standards and guidelines for northern goshawk and Mexican spotted owl. 23

**13. Issue: General Restoration Objectives**

The only way to restore and develop old growth as a natural process at the landscape scale is to preserve the old growth components that currently exist. This can best be accomplished by retaining old growth components such as yellow pines and large trees at the individual and group levels while identifying stands that as a whole generally exhibit old growth characteristics. The goal is to provide as much old growth as can be sustained in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time. While old growth is a term generally used to describe ecosystem function, it is also increasingly used by the public, academics and even some land managers to describe individual trees with the characteristics described below in "A."

(A) Retain old growth trees regardless of size, as old growth is a function of age, not size. Old growth is not a definitive age. Ponderosa pines begin to develop the thick yellow bark characteristic of an old growth tree between 120 and 150 years of age. As they 24-1

age, the yellow-red bark also develops wide, large plates. In addition to bark characteristics, an old growth ponderosa pine tree typically exhibits complex structural attributes such as full crowns, flattened tops and large limbs. These trees are sometimes referred to as yellow pines, presettlement trees or mature trees. (Note that "The Path Forward" dated March 19, 2010, a document guiding the Four Forests Restoration Initiative uses the following language: **"8.No old growth trees (predating Euro-American settlement) shall be cut.")**

(B) When creating openings, protect old growth trees by removing excess competition from small, young trees. Initially, removal should focus on, but not be restricted to, trees 12 inches in diameter and smaller. Such a focus is warranted given the high density and high percentage of the forest landscape these trees occupy. According to the USDA, more than 82 percent of ponderosa pine trees in Region Three are smaller than 11 inches in diameter. (USDA, 1999 & 2007) Thinning should occur within groups, as well as in identified openings between groups. 24/2

(C) Reduce the fire risk to old growth trees by removing small, younger trees, as well as some mid-aged trees, (VSS 4: 12 to 18 dbh) from within the drip lines of individual trees. Given the lack of trees larger than 16 inches in diameter, thinning should focus on trees smaller than 16 inches in diameter. Approximately 96 percent of the trees in Region Three are smaller than 15 inches in diameter (USDA, 1999 & 2007). This would reduce ladder fuels, lowering the potential for crown fires. It would also encourage the growth of an understory community. 24/3

(D) When developing future old growth stands and managing for mature age classes, larger diameter trees, in VSS 4, 5 and 6 should be retained to replace the structure and function of old growth trees that were removed by logging. 24/4

(E) To provide for an unevenaged structure, within old growth stands, retain groups of young and mid-aged trees to provide for multiple age classes and enhance structural diversity. Thin variably within retained groups, removing ladder fuels and avoiding even spacing. 24/5

(F) Identify and retain areas that would be best left unthinned as wildlife cover and for travel corridors. 24/6

(G) Preserve all snags. Downed logs with a diameter greater than **10"** will be preserved. 24/7

(H) Use prescribed fire and the management of natural ignitions to reduce ground fuels and to reintroduce fire to the ecosystem. 24/8

(I) Defer Livestock grazing, after the initial fire treatment to allow for understory recovery and change grazing management to allow for function of natural processes. 24/9

(J) Decrease road densities to enhance stand integrity by reclaiming old skid trails and log landings. 24/10

### 14. Issue: Large and Old Tree Retention

Our goal is to restore the forest's ecological integrity, which would include composition, structure and function. We are seeking to restore the natural range of variability with a distribution of tree ages, sizes and spatial structures, but not precise structural conditions that existed at some designated point in time. Reconstructed historic reference conditions should be used as general guides, rather than rigid restoration prescriptions. The Sierra Club and Center for Biological Diversity support a conservative approach, which seeks to determine the minimum amount of mechanical intervention and structural manipulation necessary to restore natural processes such as fire. Restoration is not a single event, but a process that occurs over time.

general

The Sierra Club and Center for Biological Diversity support a 16" diameter limit for tree cutting. We also support a 16" diameter threshold for exceptions for large tree retention during ecological restoration. The exception-threshold is not a strict diameter limit; rather, it limits the cutting of young trees larger than 16" diameter to circumstances and criteria set forth in exception categories in the 4FRI Large Tree Retention Strategy. In those cases, we support leaving those large, young trees on site to as logs, snags and for soil stabilization.

48-25

There is a generally recognized need to retain larger trees and protect old growth in southwestern ponderosa pine forest restoration. Some proponents of large tree retention have suggested that a 16" diameter cap is both ecologically and socio-politically warranted given the scarcity of mature and old growth forest cover in the region; the need to quickly re-establish lost mature and old forest structure; the necessity of retaining trees larger than 16" dbh to recruit new trees into regionally-underrepresented VSS 5, 6 and "old growth" structural stages; and the regional rarity of trees larger than 16" (approximately 96% of ponderosa pine trees in northern Arizona and New Mexico are smaller than 16-inch dbh). Such proponents have proposed diameter caps as a means to (1) prevent large-tree logging for production-oriented, uneven-aged silvicultural goals, (2) discourage large-tree logging to pay for small-tree thinning or other activities, (3) favor small-diameter-specific industries over large-tree-dependent ones, (4) avoid population-level effects to imperiled species and wildlife that are associated with larger live and dead trees and denser canopy, (5) mitigate unforeseen large tree mortality during and following restoration treatments, (6) mitigate unknown rates of future large tree mortality resulting from re-establishing natural fire regimes and future climates, (7) mitigate under-estimates of historical tree densities owing to evidence undercounting and loss to fire, logging and decay, (8) accommodate differing reference scales, choices of reference attributes, restoration objectives and desired degrees of precision or rates of change, (9) mitigate uncertainty about future national forest policy, timber and wildlife habitat management, and (10) facilitate a restoration approach

general

that reduces immediate crown fire threat while incrementally moving the forest toward its natural range of variability through a combination of thinning and natural fire.

Diameter limits and exception-thresholds for tree cutting are a common strategy for achieving ecological objectives in western forest landscapes. In their recommendations to Congress and the President, the Eastside Forests Scientific Society Panel proposed a 20" diameter limit for trees younger than 150 years old to protect late-successional and old-growth dry forests of eastern Oregon and Washington. They cited the ecological importance and scarcity of large and old trees and the need to retain them to replenish regionally-depleted supplies of large and old trees, snags, logs and associated wildlife habitat. Those recommendations formed the basis for interim management direction amending nine national forest plans and establishing a 21" diameter limit in dry forests which in turn carried forward into an exception-threshold of 21" diameter in legislation proposed to restore dry forests of eastern Oregon. The Sierra Nevada Framework set forth a 20" diameter limit for tree cutting to conserve late-seral forests across national forest land in the Sierra Nevada. Larger diameter limit and exception-thresholds in these examples reflect more productive forests and larger mean diameters than in southwestern forests. Diameter limits in Region 3 forest plans restrict large tree cutting in habitat for Mexican spotted owl and northern goshawk for their viability and in "old growth"; diameter-based "vegetative structural stages" guide management of those species' habitats.

general

Stems larger than 16" dbh comprise only approximately three percent (3%) of live ponderosa pines in Arizona and New Mexico, according to Forest Inventory and Analysis (FIA) data (USDA 1999, USDA 2007). The same data indicate that more than eighty-two percent (82%) of ponderosa pine trees in Region 3 are currently smaller than 11" dbh; approximately ninety-six percent (96%) of ponderosa pines are smaller than 15-inches dbh; and less than one-tenth of one percent (.01%) of pines are larger than 21" dbh. Large snags, which provide critical wildlife habitat, comprise less than three percent (3%) of total snags on the landscape, and average about one large snag per eight acres (Nowicki and George 2004). Clearly, the size distribution of trees in the southwest is heavily skewed toward small-diameter trees and is dramatically different than historical conditions (Fulé et al. 1997). Given the extreme rarity of large-diameter trees and the overabundance of small trees, trees larger than 16" dbh should generally be retained in ecological restoration treatments (Allen et al. 2002).

general

A variety of factors other than logging threaten the remaining large trees in southwestern ponderosa forests. Prescribed fire treatments can damage tree roots and cause high levels of mortality among large trees (Sackett et al. 1996). Burning of pine stands with high surface fuel loading also can result in tree mortality (Hunter 2007), and fire treatments may leave trees susceptible to bark beetle infestation (Wallin et al. 2003). Additionally, large tree mortality has unintentionally resulted from mechanical thinning projects (Hunter 2007). Large snags and downed logs, which provide critical habitat for cavity-nesting birds, bats, small mammals, reptiles, amphibians and insects, are often destroyed by fuel reduction treatments (Hunter 2007).

Any gains in new snags and downed logs as a result of vegetation treatments generally do not offset their loss at a landscape scale (Randall-Parker and Miller 2002). Hence, the continued existence of large trees and snags for purposes of old-growth function and adapted ecological processes is by no means assured. Considering their scarcity, as well as the unique services they provide, large trees should be preserved whenever possible. Because large trees are the most difficult of all forest structural elements to replace, logging them constitutes an irreversible environmental impact that is scientifically controversial in regards to its efficacy in fire hazard reduction and forest restoration (Covington 2000, Cortner 2003).

general

Conservation of trees larger than 16-inches diameter is central to restoration of ecosystem structure, composition and function. Cutting and removal of large-diameter trees consistently proves to be a deal-breaker for many stakeholders, and we suggest that adopting a diameter cap will expedite fuel reduction and forest restoration treatments. Please refer to the series of Forest Service reports on *Small-Diameter Success Stories* (Livingston 2004, 2006, 2008) demonstrating social consensus and market opportunities for stewardship activities, including the White Mountains Stewardship Project, focused on small-diameter thinning as a vital element of hazardous fuels reduction and ecological restoration.

49-26

Ponderosa pine forests historically contained a percentage of trees that were saplings, poles, and blackjack sized trees. To account for this, a diversity of tree sizes will be retained both within tree groups as well as across the restoration treatment area. Removing all of the smaller trees would result in oversimplification of the forest's structure and distribution of trees by age class. Our goal is to restore a natural range of variability based on soils, slope and aspect.

general

(A) Utilize and enhance existing forest structure by retaining the largest trees and groups of larger trees with interlocking crowns. Retain co-dominants in the larger diameter groups present on a site to maintain greater canopy retention with the goal of creating groups that function more like pre-disturbance groups. The diameter range of the largest trees existing on a site will vary with past treatments, site location and site productivity.

(B) Larger diameter trees, in VSS 4, 5, and 6 should be retained to replace the structure and function of old growth trees that were removed by logging. This would also apply to the larger trees in smaller structural stages.

duplicate 24/4

(C) When creating openings focus on the removal of small, young trees (12" dbh) from the spaces and openings between groups. According to the USDA, more than 82 percent of ponderosa pine trees in Region Three are smaller than 11 inches in diameter. (USDA, 1999 & 2007) This would reduce ladder fuels, lowering the potential for crown fires. It would also encourage the growth of an understory community.

duplicate 24/2

(D) Thin variably within retained groups, removing ladder fuels and avoiding even spacing. The goal is to emulate old growth group structure. duplicate of 24/5

(E) Openings within and between groups that were created by the logging of presettlement trees, or larger trees established close to disruption of the natural fire regime should not be considered openings to be maintained over time. However, given the high number of these logging created openings, their impacts should be considered when evaluating the creation of new openings. This should apply to all spatial scales. 49-27

(F) Identify and retain areas that would be best left unthinned as wildlife cover areas and for travel corridors. Retain trees with nests in them, and surrounding trees providing associated habitat, wind protection or shading. duplicate of 24/6

(G) Preserve all snags. Downed logs with a diameter greater than **10"** should be preserved. duplicate of 24/7

(H) Use prescribed fire and management of natural ignitions to reduce ground fuels and to reintroduce fire to the ecosystem.

(I) Defer livestock grazing after the initial fire treatment to allow for understory recovery and change grazing management to allow for function of natural processes. duplicate of 24/8

(J) Decrease road densities to enhance stand integrity by reclaiming old skid trails and log landings. duplicate of 24/9 duplicate of 24/10

Thank you for the opportunity to comment.

Respectfully,


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# Management Recommendations for the Northern Goshawk in the Southwestern United States



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Present forest conditions – loss of a herbaceous and shrubby understory, reductions in the amount of older forests, and increased areas of dense tree regeneration – reflect the extent of human influence on these forests. These changes may also be affecting goshawk populations. Information on goshawk nesting habitat and foraging behavior, and the food and habitats of selected goshawk prey, was therefore synthesized to develop a set of management objectives, desired forest conditions, and management recommendations. Key objectives of the guidelines are to provide (1) nesting, post-fledging, and foraging areas for goshawks, and (2) habitat to support abundant populations of 14 primary goshawk prey. Thinning trees in the understory, creating small openings in the forest, and prescribed fires should help produce and maintain the desired forest conditions. Other habitat elements critical for maintaining both goshawk and prey populations include abundant snags and large downed logs, woody debris, interspersion of different tree sizes across the landscape, and the majority of a goshawk's home range in older-aged forests. These guidelines should also benefit forest health, soil productivity, and the habitats of other old-growth-dependent plants and animals.

USDA Forest Service
General Technical Report RM-217

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# Management Recommendations for the Northern Goshawk in the Southwestern United States

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# Table of Contents


**Executive Summary** ..... 1
The Northern Goshawk Scientific Committee ..... 1
Components of the Nesting Home Range .... 3
Goshawk Prey ..... 4
Present Forest Conditions ..... 5
Management Recommendations ..... 6
Related Benefits of Achieving Desired Forest Conditions ..... 8

**Introduction** ..... 9

**Background** ..... 10

**Goshawk Populations and Prey Species** ..... 11
Factors Limiting Goshawk Populations ..... 11
Diet Breadth and Population Stability ..... 12
Prey Species ..... 12

**Conservation of the Northern Goshawk: Approach** ..... 13
Nest Area ..... 13
Post-fledging Family Area (PFA) ..... 13
Foraging Area ..... 14

**Synthesis of Desired Forest Conditions** ..... 15
Nest Area ..... 15
Post-fledging Family Area (PFA) ..... 15
Foraging Area ..... 16

**Present Forest Conditions** ..... 20

**Management Recommendations for the Home Range** ..... 21
Nest Area ..... 21
Post-fledging Family Area (PFA) ..... 22
Foraging Area ..... 26

**Related Benefits of Achieving Desired Forest Conditions** ..... 30
Landscape Ecology ..... 30
Species Associated with Old-Growth ..... 30
Susceptibility to Catastrophic Crown Fire ... 30
Large Snags and Downed Logs ..... 31
Forest Productivity ..... 31
Maintenance of Mycorrhizal Communities .. 31
Forest Products ..... 32
Forage Production ..... 32

**Research Needs** ..... 32

**Acknowledgements** ..... 33

**References** ..... 35

**Appendix 1. Description of ponderosa pine, mixed-species, and spruce-fir forest cover types** ..... 49
Ponderosa Pine Forest Cover Type ..... 49
Mixed-Species Forest Cover Type ..... 50
Engelmann Spruce-Subalpine Fir (Spruce-fir) Forest Cover Type ..... 50

**Appendix 2. Vertebrates in the diets of nesting northern goshawks from various locations in North America** .... 51

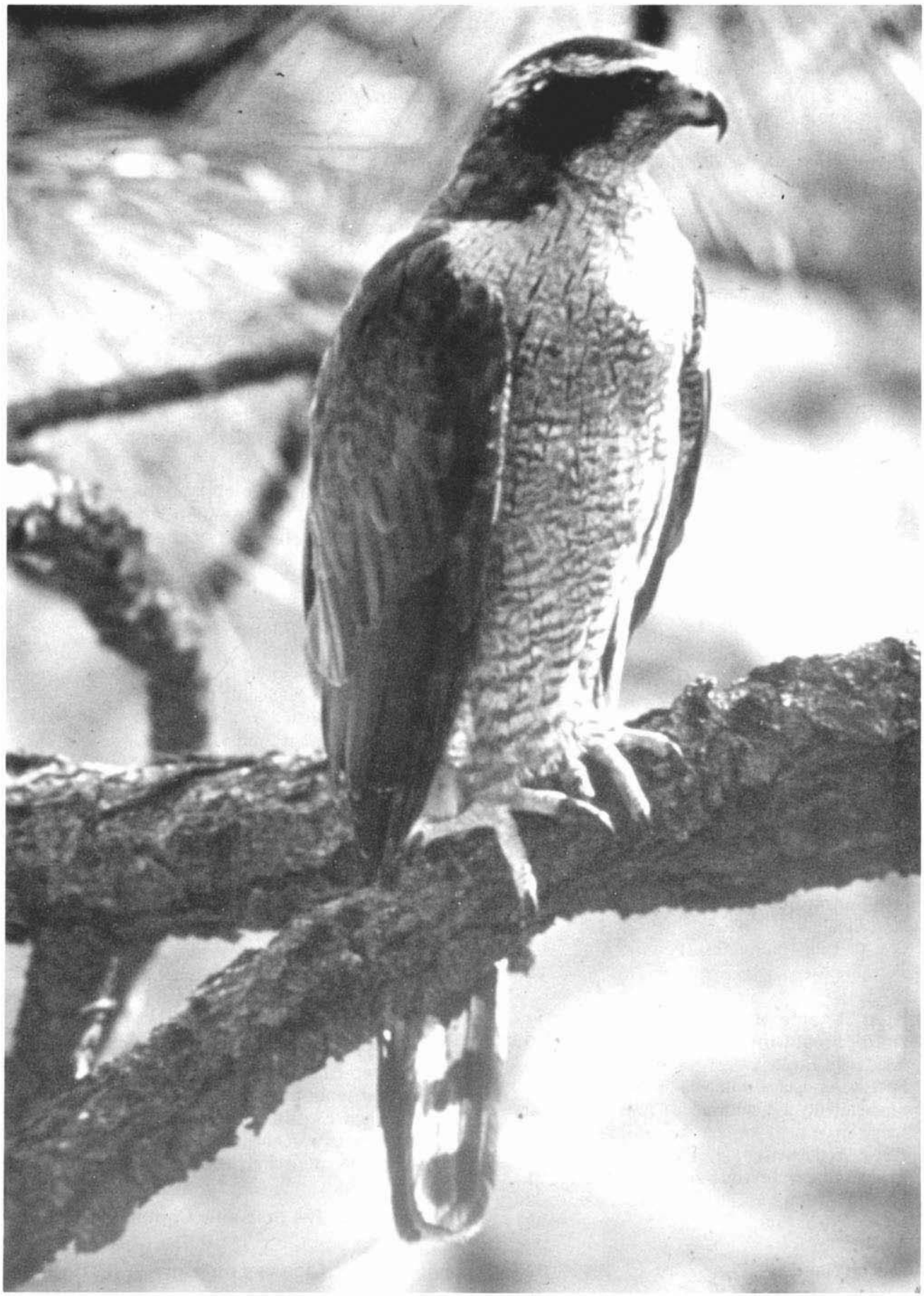
**Appendix 3. Natural history, habitat, and management recommendations for selected goshawk prey species** ..... 53
American Robin ..... 53
Band-tailed Pigeon ..... 54
Blue Grouse ..... 56
Chipmunks ..... 58
Cottontails ..... 60
Hairy Woodpecker ..... 62
Mantled Ground Squirrel ..... 64
Mourning Dove ..... 65
Northern Flicker ..... 67
Red-Naped Sapsucker ..... 68
Red Squirrel ..... 69
Steller's Jay ..... 72
Tassel-Eared Squirrel ..... 74
Williamson's Sapsucker ..... 76

**Appendix 4. Forest Health** ..... 79
Dwarf Mistletoe ..... 79
Root Diseases ..... 79
Western Spruce Budworm ..... 79
Bark Beetles ..... 79

**Appendix 5. Vegetation structural stage determination and management options** ..... 81
Vegetation Structural Stage Determination . 81
Management Options for Developing Vegetation Structural Stages ..... 81

**Appendix 6. The Scientific Committee** ... 85

**Appendix 7. Glossary of Terms** ..... 87



# Executive Summary

The northern goshawk (*Accipiter gentilis atricapillus*) (hereafter called the "goshawk") is the largest North American member of the genus *Accipiter*, which includes both the sharp-shinned hawk (*Accipiter striatus*) and the Cooper's hawk (*Accipiter cooperii*). It breeds in coniferous, deciduous, and mixed forests throughout much of North America.

The goshawk is a forest habitat generalist that uses a variety of forest types, forest ages, structural conditions, and successional stages. It preys on small- to medium-sized birds and mammals (robins and chipmunks to grouse and hares), which it captures on the ground, in trees, or in the air. A single goshawk may consume one-to-two prey per day.

The principal forest types occupied by the goshawk in the Southwest are ponderosa pine, mixed-species, and spruce-fir. There is a concern that populations and reproduction of the goshawk are declining in these forests and elsewhere in the western United States. These declines may be associated with forest changes caused by timber harvesting. However, fire suppression, livestock grazing, drought, and toxic chemicals may be involved. Because of the concerns over the effects of timber harvesting, the goshawk was listed as a "sensitive species" by the Southwestern Region of the Forest Service, U.S. Department of Agriculture in 1982.

## The Northern Goshawk Scientific Committee

The Northern Goshawk Scientific Committee (GSC) was established by the Regional Forester of the Southwestern Region in the fall of 1990. Its charter was to develop a credible management strategy to conserve the goshawk in the southwestern United States. This report describes the process used, findings, and recommendations of the scientific committee. In developing the recommendations, we used available information on goshawk biology, behavior, diet, and habitat. Information about goshawk foraging habitat was augmented with information on the habitat and foods of its main prey species. From this the GSC developed a set of "desired forest conditions" that, in their best estimate, will sustain goshawk populations in the Southwestern Region.

Because information on goshawk biology is limited, and our ability to produce and sustain certain forest conditions over long periods is unknown, the development of the "desired forest conditions" for the goshawk and its prey required certain assumptions:

1) goshawks and their prey populations are limited by the availability of their foods and habitats,
2) the availability of abundant, sustainable prey populations reduces the probability that food is limiting,
3) extreme fluctuations of goshawk populations caused by changes in the abundance of one or more prey will be dampened when a wider variety of prey species are available,
4) the foods and habitats of goshawk prey in southwestern forests are similar in adjacent regions, and
5) the forest attributes and age-classes of southwestern forests described herein can be sustained with scientific management.

These assumptions reveal areas where research is needed on goshawk and forest ecology.

The following are key concepts fundamental to the GSC recommendations:

- Forests within goshawk nesting home ranges should be an interspersed mosaic of structural stages -- young to old forests -- to increase the diversity of habitat for goshawks and their many prey species. Six vegetation structural stages (VSS) were used to describe regeneration, growth, and development of forests in the Southwest (Fig. 1). The proportions of the VSS and their interspersion in the forest is how the GSC described the forest mosaic.
- The extent to which southwestern forests were modified by Native Americans before European settlement is not well known. Since European settlement, management practices (such as timber harvesting, livestock grazing, and fire control) have changed the structure and species composition of forests. Today, much forested area consists of dense "thickets" of small-diameter trees (Fig. 2). Forests containing these thickets are prone to catastrophic, tree-killing fire, and insect and disease outbreaks. Because of inter-tree competition for moisture, nutrients, and light, these thickets will not mature into large trees. To accelerate the

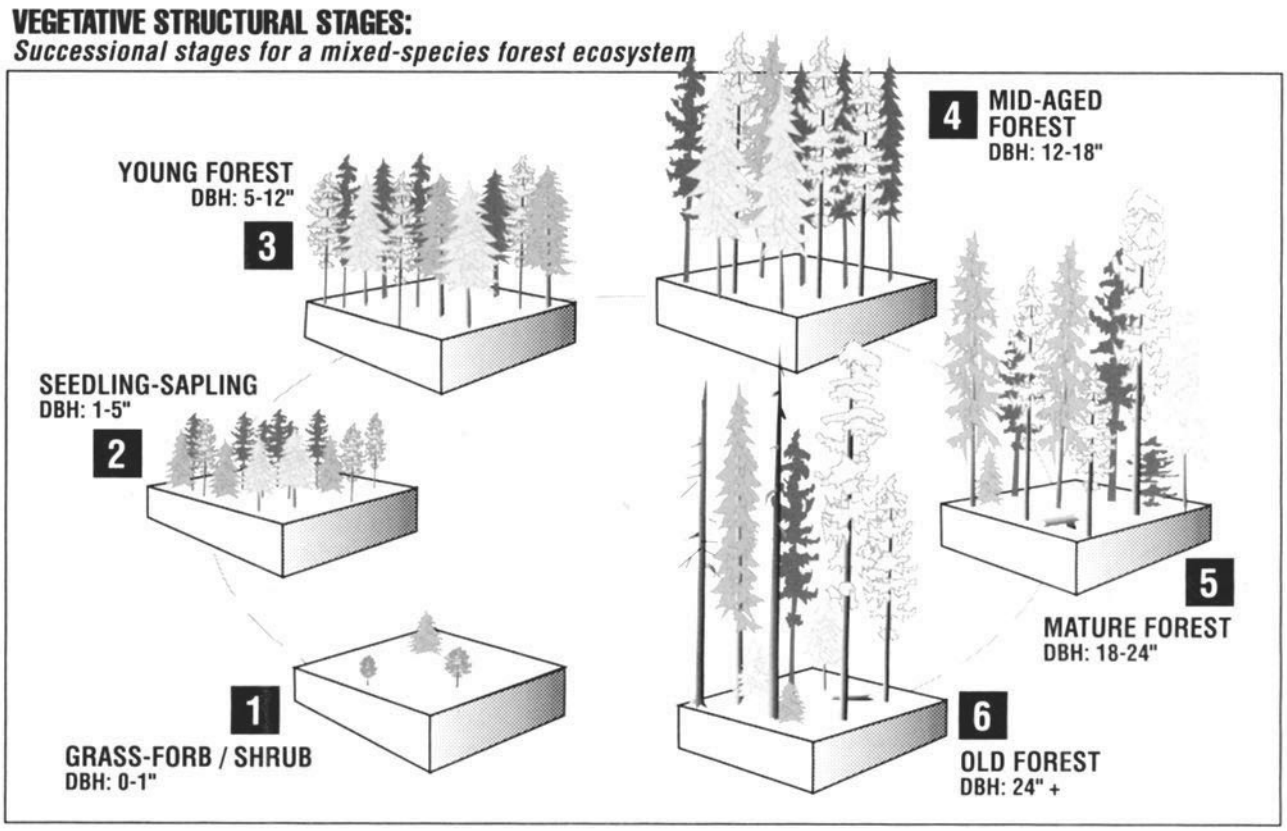



**Figure 1. Forest vegetation structural stages and their associated diameter breast height (DBH) ranges.**



**Figure 2. Dense "thicket" of small-diameter trees.**

development of mature forests and large trees, tree cutting and prescribed fire should be used to thin forest stands, concentrating growth on the remaining trees.

- Large trees, snags, and large downed logs provide important habitats for many plants and animals, and provide organic matter to the soil resource. Every acre of a goshawk nesting home range should contain a few large trees in clumps that are never removed. These trees live out their lives, die (become snags), fall, and decompose.
- Forest regeneration, growth, and development varies among locations because site specific productivity differs greatly throughout the Southwest. Therefore, no single management prescription is likely to develop or sustain the desired forest conditions on all sites within a landscape. In fact, the desired forest conditions may not be attainable on sites with low productivity, and may be easily attained on sites with high productivity.

## Components of the Nesting Home Range

Three components of a goshawk's nesting home range (about 6,000 acres) were identified: nest area, post fledging-family area (PFA), and foraging area. The size of these home range components has been determined from behavioral and radio-telemetry studies of goshawks.

The **nest area** (approximately 30 acres), which may include more than one nest, is typically located on a northerly aspect in a drainage or canyon, and is often near a stream. Nest areas contain one or more stands of large, old trees with a dense canopy cover (Fig. 3). A goshawk pair occupies its nest area from early March until late September. The nest area is the center of all movements and behaviors associated with breeding from courtship through fledging. Most goshawks have two to four alternate nest areas within their home range; alternate nest areas may be used in different years, and some may be used for decades.

The **post fledging-family area** (PFA) (approximately 420 acres) surrounds the nest area. Because of its size, it typically includes a variety of forest types and conditions. The PFA appears to correspond to the territory (defended area) of a



Figure 3. Nest areas contain one or more stands of large, old trees with a dense canopy.

goshawk pair, and represents an area of concentrated use by the family from the time the young leave the nest until they are no longer dependent on the adults for food (up to two months). These areas are important for fledglings; they provide hiding cover and prey on which to develop hunting skills. PFAs have patches of dense trees, developed herbaceous and/or shrubby understories, and habitat attributes (snags, downed logs, small openings) that are critical for many goshawk prey (Fig. 4).

The **foraging area** is approximately 5,400 acres in size, and surrounds the PFA. Hunting goshawks evidently use available habitats opportunistically. This opportunism suggests that the choice of foraging habitat by goshawks may be as closely tied to prey availability as to habitat structure and composition. Goshawks hunt from tree perches by scanning lower portions of the forest (ground, lower canopy) for prey. Because of visual limitations in dense forest environments, an open understory enhances detection and capture of prey (Fig. 5). Raptor (hawks, falcons, owls) populations are often limited by availability and abundance of their prey. The recommendations presented here are based on information available on how foraging goshawks use their habitat, and was supplemented with information on the habitats, foods, and cover of important goshawk prey.

## Goshawk Prey

A comparison of goshawk diets from disparate areas within North America showed that, while as many as 50 species are eaten, about 20 are common in the diets. Fourteen species were important in the diet of southwestern goshawks. Information on the distribution, habitat, special habitat needs, home range size, and populations of these 14 prey species were gleaned from the literature. A synthesis of this information provided a set of "desired forest conditions" that would result in sustainable populations of each prey. Because no single prey species is likely to be abundant enough to support goshawks, especially during the winter and extreme environmental fluctuations (periods of drought), habitats for and populations of all 14 prey are necessary.

Selected goshawk prey include squirrels, rabbits, woodpeckers, jays, and grouse. Specific habitat attributes used by these species include: snags,



**Figure 4. PFAs have patches of dense trees, developed herbaceous and/or shrubby understories, and habitat attributes (snags, downed logs, small openings) that are critical for many goshawk prey.**



**Figure 5. Because of visual limitations in dense forest environments, an open understory enhances detection and capture of prey by goshawks.**

downed logs, woody debris, large trees, openings, herbaceous and shrubby understories, and an intermixture of various forest vegetative structural stages. Prey populations within goshawk foraging areas will be abundant and sustainable when:

1) the specific habitat attributes are provided,
2) forests contain large trees and have relatively open tree understories,
3) forest openings are small (1/3 - 2 acres) to medium (2-4 acres) in size,
4) patches of dense, mid-aged forests are scattered throughout, and
5) the majority of forests are in the "mid-aged," "mature," and "old" structural stages.

## Present Forest Conditions

Southwestern forests have been altered from pre-settlement conditions by fire suppression, timber harvesting, livestock grazing, mining, and recreational uses. Prior to fire suppression in the western United States, ponderosa pine forests were burned by low-intensity surface fires at 2- to 15-year intervals. Fires burned at lesser frequencies in mixed-species forests (5-22 years). These fires maintained forests that were relatively open and dominated by mature trees by regularly burning and killing small trees. In spruce-fir forests, fire intervals were much longer (60-400 years) and fires were often catastrophic, stand-replacing events.

Habitat changes resulting from fire suppression in ponderosa pine and mixed-species, and to a lesser extent spruce-fir forests, are:

1) the replacement of open, single-storied stands by dense multistoried stands through tree regeneration,
2) loss of natural openings by tree invasion, and
3) changes in the abundance and composition of plant species in both the understory and overstory due to plant succession.

Accumulated fuels and dense forest conditions resulting from fire suppression have also increased the potential loss of goshawk habitat through catastrophic wildfire and epidemic infestations of insects and diseases. Increased shading from the dense regeneration has also reduced herbaceous and shrubby understories that provide important foods and cover for goshawk prey. Livestock and wildlife

browsing and grazing have accentuated this loss. In addition to these changes, timber harvesting, which began in the 1800s, has focused on large trees, resulting in few remaining mature and old forests and associated habitat attributes.

## Management Recommendations

The present conditions in southwestern ponderosa pine and mixed-species forests reflect the extent of human interference with natural processes. Given the improbability of returning to the previous frequencies of natural disturbances, some active management (mainly thinning and prescribed fire) will be necessary to produce and maintain the desired conditions for sustaining goshawks and their prey. In some spruce-fir forests, natural processes are still functioning and little or no management may be necessary to maintain the desired conditions.

These recommendations were specifically designed to provide breeding season habitat for the goshawk and its prey. It is not known whether goshawks in the Southwest winter on their nesting home ranges; if they do winter there, then these recommendations will provide habitat and food year-round.

### Nest Areas (30 acres each)

Three suitable nest areas should be maintained per home range. In addition, three replacement nest areas per home range should be in a development phase, using intermediate treatment and prescribed fire. Suitable areas may be lost because of insect epidemics, catastrophic fire, or other factors. Nest areas are typified by one or more stands of mature or old trees and dense forest canopies. No adverse management activities should occur at any time in suitable nest areas. Desired forest conditions for the nest stands and management recommendations for maintaining and developing nest stands within nest areas are presented in Tables 1 and 2.

### Post Fledging-Family Areas (PFA) (420 acres)

The PFA contains a variety of forest conditions and prey habitat attributes. Interspersed small openings, snags, downed logs, and woody debris are critical PFA attributes. To sustain the desired canopy cover, size of trees, and the specified portions of different forest ages within the PFA, regeneration of 10 percent of the PFA may be required every 20 years. Other management tools, such as prescribed fire and removing understory trees, are suggested for sustaining other critical elements of goshawk habitat (Table 2).

Small openings in the forest are desired habitat for some prey species and are required for forest regeneration (Fig. 6). If forested openings are 1.0 acre or greater in Ponderosa pine and mixed species, then 3 to 6 large mature and/or reserve old trees per acre should be left in groups. If spruce-fir forest openings are 0.5 acres or greater, a group of 6 reserve trees are required per 0.5 acres. Reserve trees are not necessary in smaller openings; this component can be met in adjacent forested areas. Ponderosa pine and other seral conifers can be planted, and, depending on forest type, aspen and oak regeneration are encouraged. Snags, downed logs, and woody debris should be present throughout the PFA.

All management activities in the PFA should be limited to the period from October through February. Prescribed burning is the preferred method for management of woody debris. Thinning from below (removing understory trees) is preferred for maintaining desired forest structures, and a variable spacing of trees is preferred for developing groups of trees with interlocking crowns. Road densities should be minimized, and permanent skid trails should be used in lieu of permanent roads. Forage utilization should average 20 percent by weight and should not exceed 40 percent in any area to maintain grass and forb layer. Browse utilization should average 40 percent by weight (Table 2). These recommendations are designed to provide foods (leafy material, berries) and cover for goshawk prey.

### Foraging Area (5,400 acres)

Both the desired conditions and the management recommendations for the foraging area are similar to the PFA. The distribution and proportion of vegetative structural stages and the requirements for habitat attributes such as reserve trees, snags, and downed logs are the same as the PFA. Because the foraging area need not provide hiding cover for fledgling goshawks, a more open canopy is preferred -- 40 percent in the mid-aged forests and 40 to 60 percent in the mature and old forests, depending on the forest type. Openings (up to 4 acres), for herbaceous and shrubby understory development and tree regeneration, are desired in ponderosa pine and mixed-species forests; smaller openings are desired in spruce-fir forests (Table 1). Specific management recommendations to obtain the desired conditions for the foraging area are identical to the PFA (Table 2).

**Table 1. Desired forest conditions in three forest types for sustaining northern goshawks and their principal prey species in the Southwest.**

| Attribute | Home-Range Components | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nest Area[a] | Post Fledging-Family Area | | | Foraging Area | | |
| | | Ponderosa Pine | Mixed-Species | Spruce-fir | Ponderosa Pine | Mixed-Species | Spruce-fir |
| VSS distribution[b] | | | | | | | |
| grass/forb/shrub VSS 1 (%) | 0[c] | 10[c] | 10[c] | 10[c] | 10[c] | 10[c] | 10[c] |
| seedling-sapling VSS 2 (%) | 0 | 10 | 10 | 10 | 10 | 10 | 10 |
| young forest VSS 3 (%) | 0 | 20 | 20 | 20 | 20 | 20 | 20 |
| mid-aged forest VSS 4 (%) | 0 | 20 | 20 | 20 | 20 | 20 | 20 |
| mature forest VSS 5 (%) | 100 | 20 | 20 | 20 | 20 | 20 | 20 |
| old forest VSS 6 (%) | 100 | 20 | 20 | 20 | 20 | 20 | 20 |
| Canopy cover | | | | | | | |
| mid-aged forest VSS 4[c] | NA[d] | 1/3 60+<br>2/3 50+ | 60+ | 60+ | 40+ | 1/3 60+<br>2/3 40+ | 1/3 60+<br>2/3 40+ |
| mature forest VSS 5 (%) | 50-70+ | 50+ | 60+ | 70+ | 40+ | 50+ | 60+ |
| old forest VSS 6 (%) | 50-70+ | 50+ | 60+ | 70+ | 40+ | 60+ | 60+ |
| Years to mid-aged VSS 6 | 200-300 | 200-250 | 200-300 | 200-300 | 200-250 | 200-300 | 200-300 |
| Opening size | | | | | | | |
| maximum size (acre) | NA | 2 | 2 | 1 | 4 | 4 | 1 |
| width--maximum (ft) | NA | 200 | 150 | 125 | 200 | 200 | 125 |
| Reserve trees[e] | | | | | | | |
| number of groups/acre | A[f] | 1 | 1 | 2[h] | 1 | 1 | 2[h] |
| number (per group) | NA | 3-5 | 6 | 6 | 3-5 | 6 | 6 |
| opening threshold[g] (acres) | NA | >1 | >1 | >0.5 | >1 | >1 | >0.5 |
| Snags (no/acre) | NR[i] | 2 | 3 | 3 | 2 | 3 | 3 |
| Downed logs (acre) | NR | 3 | 5 | 5 | 3 | 5 | 5 |
| Woody debris (tons/acre) | NR | 5-7 | 10-15 | 10-15 | 5-7 | 10-15 | 10-15 |

[a] *Suitable nest areas only; attribute values may vary by forest type.*
[b] *VSS; Vegetation Structural Stages, a forest description based on the tree diameter distribution within a stand. For example, if the majority of the stems of a stand (based on basal area) were located in the 12-18 inch diameter class, the stand would be classified as a VSS 4. General diameter limits are: VSS 1= 0-1" DBH; VSS 2= 1-5" DBH; VSS 3= 5-12" DBH; VSS 4= 12-18" DBH; VSS 5= 18-24" DBH; VSS 6 = 24"+ DBH. DBH = Diameter at Breast Height (4.5 ft.).*
[c] *Proportion of the area.*
[d] *NA; not applicable.*
[e] *Reserve trees; standing trees left after harvesting that will be allowed to become snags and downed logs.*
[f] *A; applicable, clumpiness, or groups of large trees is also desirable.*
[g] *When threshold size is exceeded, reserve trees are necessary.*
[h] *One group per 0.5 acres.*
[i] *NR; not required, but presence of these features are not detrimental.*

**Table 2. Management recommendations for sustaining habitat for northern goshawks and its principal prey species in the Southwest.**

| Attribute | Home Range Components[a] | | |
|---|---|---|---|
| | Nest Area | PFA | Foraging Area |
| Number of areas | 6 | 1 | 1 |
| Suitable[a] | 3 | NA | NA |
| Replacement[a] | 3 | NA | NA |
| Size (acre) | 30 (Total =180) | 420 | 5,400 |
| Management season[b] | Oct-Feb | Oct-Feb | Year-long |
| Regeneration of forest | | | |
| Conifer | None | Yes | Yes |
| Aspen & Oak | None | Yes | Yes |
| Planting | None | Yes | Yes |
| Thinning from below[a] | Non-uniform spacing | Non-uniform spacing | Non-uniform spacing |
| Transportation system | | | |
| Road | Minimum density | Minimum density | Minimum density |
| Skid trails | Permanent | Permanent | Permanent |
| Forage utilization[a] (%) | 20/40[c] | 20/40[c] | 20/40[c] |
| Woody debris treatment | | In Order of Preference | |
| Prescribed burning[a,d] | 1 | 1 | 1 |
| Lopping & Scattering[a] | 2 | 2 | 2 |
| Hand piling[a] | 3 | 3 | 3 |
| Machine grapple piling[a] | None | 3 | 3 |
| Dozer piling[a] | None | 4 | 4 |

[a] *Refer to glossary of terms.*
[b] *For PFAs surrounding active nest areas, months in which management activities are allowed.*
[c] *Average forage utilization (percent by weight) in herbaceous layer/shrub layer; utilization should not exceed 40% of grasses and forbs and 60% of shrubs.*
[d] *Not applicable in spruce-fir forest type.*



**Figure 6. Small openings in the forest are desired habitat for some goshawk prey species and are required for forest regeneration.**

## Related Benefits of Achieving Desired Forest Conditions

A large-scale, geographic approach is necessary when managing forests for a wide-ranging species such as the goshawk. An inherent danger in managing large areas for a single species is that other resources, including other wildlife species, may be harmed in the process. In developing these guidelines, the GSC used a landscape ecology approach that provides habitats and food chains for a broad variety of wildlife species. The approach also provides forage and timber, and benefits forest health. Vegetation management -- albeit in a manner that mimics the effects of natural forest disturbances -- is an integral part of these recommendations. It is a helpful tool for developing and maintaining desired forest conditions for goshawks and their prey.

Recurring fires, productive soils, forest productivity and health, eugenics, woody debris, large snags and downed logs, microorganisms, invertebrates and vertebrates-- all elements of functioning forest ecosystems -- are provided for when the desired future conditions are achieved. Managing forests at the landscape scale shifts the focus from more traditional single-species and stand-level management to management of ecosystems. As a result, the management recommendations for the northern goshawk in the southwestern United States are recommendations for maintaining biodiversity, with healthy forests relatively safe from catastrophic fires and pests. These recommendations offer a design that can be adapted for sustaining productive forests at the landscape level.

# Introduction

The northern goshawk (*Accipiter gentilis atricapillus*) was listed as a "sensitive species" by the Southwestern Region of the USDA Forest Service in 1982 (USDA Forest Service 1991). Information is available to identify and manage the nesting habitat of this forest hawk in numerous studies throughout the subspecies' range. Nesting habitat, however, comprises only a minor fraction of a home range of a pair of goshawks. Diets of the goshawk have also been described, and studies have shown that the home range of nesting pairs can be as large as 10 square miles (Table 3). In spite of this, little information exists on the forest types, ages, and conditions in which goshawks prefer to hunt. Thus, for the great majority of a pair's home range, little information is available to identify and manage its habitat.

This report describes the process used, findings, and recommendations of the scientific committee. In developing the recommendations, available information on goshawk biology, behavior, diet, and habitat was used. To augment what is known about goshawk foraging habitat, information on the habitat and foods of its main prey species was employed. This information was synthesized to develop a set of "desired forest conditions" that, in our best estimate, will sustain goshawk populations in the Southwestern Region.

The development of the set of desired forest conditions for the goshawk and its prey required certain assumptions:

1) biotic and abiotic factors limiting goshawk populations,
2) the numerical relationship between goshawk and prey populations,
3) the extent to which the foods and habitat of prey species in forests outside the Southwest are applicable to the Southwest, and
4) our ability to produce and sustain a long-term (250 years or more) intermixture of openings, trees, stands, and forests ranging in age from newly regenerated to old.

The following assumptions reveal areas where research is needed on goshawk and forest ecology:

1) goshawk and their prey populations are limited by the availability of their foods and habitats,
2) the availability of abundant, sustainable prey populations reduces the probability that food is limiting goshawk populations,
3) extreme fluctuations of goshawk populations caused by changes in the abundance of one or more prey will be dampened when a wider variety of prey species are available,
4) foods and habitats of goshawk prey in southwestern forests are similar in adjacent regions, and
5) the forest attributes and age-classes of southwestern forests described herein can be sustained with management.

As new research information becomes available, and as our understanding of the goshawk and its habitat use and preferences increase, these management recommendations will be refined.

**Table 3. Estimates of mean home range size among northern and European goshawks.**

| Species | Acres | Explanation | Source |
|---|---|---|---|
| Northern goshawk | 524 | plots of sight records | Craighead and Craighead 1956 |
| | 4890 | 1.6 mile radius of foraging | Eng and Gullion 1962 |
| | 6086 | 1.7 mile 1/2 x distance between nests | Reynolds 1983 |
| | 5203 | 95% harmonic mean radio-telemetry | Kennedy 1990 |
| | 4752 | 95% harmonic mean radio-telemetry | Austin in prep. |
| European goshawk | 6177 | 16 pairs/154 square miles | Kramer 1955 |
| | 7907 | 14 pairs/174 square miles | van Beusekom 1972 |
| | 7413 | 1 pair over many years | Brull 1964 |
| | 4928[1] | radio-telemetry, woodland, augmented[2] | Kenward and Widen 1989 |
| | 10880 | radio-telemetry, woodland, augmented[2] | Kenward and Widen 1989 |
| | 14080 | radio-telemetry, boreal coniferous forest | Kenward and Widen 1989 |

[1] *This home range was determined during the winter.*

[2] *Goshawk home ranges were augmented with live prey.*

# Background

There is concern that goshawk populations and reproduction may be declining in the Southwestern Region and elsewhere in western North America (Herron et al. 1985, Bloom et al. 1986, Kennedy 1989, Crocker-Bedford 1990, Patla 1990, Zinn and Tibbitts 1990, Reiser 1991). It has been suggested that population declines are associated with tree harvests, but other factors (toxic chemicals, drought, lack of fire, disease, and tree harvest on prey species) could be involved, perhaps synergistically (Snyder et al. 1973, Reynolds 1989, Smith et al. 1991).

The principal forest types occupied by the goshawk in the Southwestern Region are ponderosa pine (about 74% of the non-reserved forested area), mixed-species (about 23%), and spruce-fir (about 3%) (Appendix 1, Table 1; page 49). These southwestern forests, especially the ponderosa pine and mixed-species forest types, have undergone structural and compositional changes during the past 100 years due to livestock grazing, extensive tree harvests, and suppression of historically frequent surface fires (Rasmussen 1941, Cooper 1960, Moir and Dieterich 1988, Covington and Moore 1991). Given:

1) the suspected declines in goshawk productivity and populations,
2) the extent to which southwestern forests have changed in the past century, and
3) the lack of an understanding of how goshawk habitat is affected by forest management activities.

Then, the identification and conservation of goshawk habitat is prudent to prevent population declines or isolation of individuals and subpopulations.

At this time, because of the limited number of known breeding individuals, the identification and conservation of every goshawk home range is important.

The goshawk is the largest North American member of the genus *Accipiter*, which includes both the sharp-shinned hawk (*A. striatus*) and the Cooper's hawk (*A. cooperii*) (Storer 1966, Wattel 1973, Reynolds and Wight 1978, Reynolds and Meslow 1984). Both adult and juvenile goshawks are about the same size as a red-tailed hawk (*Buteo jamaicensis*). The adult goshawk plumage is blue-gray on the back and wings, while the breast has fine gray streaks and black feather shafts on a background of dull white or gray. Juvenile goshawks have brown backs and wings, while the under parts have drop-shaped chocolate colored markings on a rich cream-colored background (Brown and Amadon 1968, Wattel 1973).

Like other members of the genus *Accipiter*, the goshawk is a bird of coniferous, deciduous, or mixed forests. Special morphological adaptations that give members of the genus the necessary maneuverability to hunt in forests include short, rounded wings and a long tail. The goshawk preys on small to medium birds and mammals--from robins and chipmunks to grouse and hares--which it captures on the ground or in the air. A single goshawk requires about 4.2 to 5.3 ounces of food per day or the equivalent of about 1 or 2 birds per day (Brown and Amadon 1968).

The northern goshawk is holarctic in distribution. In North America it occurs primarily in boreal forests, but it also occurs far to the south in montane forests of the western United States and Mexico. The most widespread subspecies (*A. g. atricapillus*) occurs from the northeastern United States across the boreal forests of Canada to Alaska, and southward through the upland forests of western United States. Two other weakly differentiated subspecies are recognized in North America: *A. g. laingi* in forests on islands and along the coast of extreme northwestern United States and Canada to southeast Alaska, and *A. g. apache* in montane areas in extreme southern portions of Arizona and New Mexico to northern Mexico (Wattel 1973, Hubbard 1978). The goshawk is partly migratory in the northern portion of its range; in winters of food shortages, large southward migrations occur (Mueller and Berger 1967). At high elevations in montane areas, some goshawks descend to lower elevations into woodlands, riparian areas, and scrublands during winter (Kennedy unpublished data, Reynolds pers. obs.). There is evidence that some goshawks in the Southwest winter on or near their nesting home range (Kennedy unpublished data, Reynolds unpublished data).

In North America, the goshawk is a forest habitat generalist, occurring in all major forest types (coniferous, deciduous, and mixed). These forests, because of natural and man-caused disturbances (fires, diseases, insects, logging), contain a wide variety of forest ages and successional stages. The extent, however, to which goshawks use these different forest conditions is poorly known (Reynolds 1989). However, because of its relatively large body size and wing span, the goshawk seldom uses young, dense forests (Fischer 1986). In these habitats, there are few large trees in which the goshawk can place its large nest, and there is insufficient space in and below the canopy to facilitate flight and capture of prey.

Goshawk nesting habitat has been the focus of considerable research throughout its range. In general, nest sites have large trees, dense canopies,

and, in the southern portion of the hawk's range, are typically on slopes with northerly aspects (Bartelt 1974, McGowan 1975, Hennessy 1978, Shuster 1980, Reynolds et al. 1982, Saunders 1982, Moore and Henny 1983, Hall 1984, Speiser and Bosakowski 1987, Crocker-Bedford and Chaney 1988, Kennedy 1988, Hayward and Escano 1989). Tree species composition of nesting habitat is highly variable among nest sites within a region as well as across the subspecies' range.

Although goshawks are wide-ranging predators of more than 50 species of forest birds and mammals (Appendix 2, page 51), little is known about the structure and composition of habitats used by foraging goshawks (Schnell 1958, Reynolds and Meslow 1984, Reynolds 1989, Mannan and Boal 1990, Kennedy 1991). There is some evidence, however, that foraging goshawks use habitat opportunistically. First, because large forest areas vary spatially in composition and structure, goshawks are more often than not confronted with a mosaic of forest types and conditions in their daily foraging movements. Second, areas, dominated by different but homogenous forest types or ages (e.g., Douglas-fir, ponderosa pine; mature, young) have successfully supported nesting pairs. Third, direct observations of foraging goshawks show that they do indeed hunt in many forest types and conditions (Fischer 1986; Kenward and Widen 1989; Widen 1989; Kennedy unpublished data; Reynolds pers. obs., Reiser pers. obs.). Thus, the wide variation in habitats occupied by goshawks suggests that foraging habitat may be as closely tied to prey availability as to habitat structure or composition (Reynolds 1989, Kenward and Widen 1989,).

If goshawk populations have declined in the Southwest as a result of timber harvest, then nest-site protection -- the only component of goshawk home ranges protected in the Southwest since the early 1980s (Reiser 1991) -- may be insufficient for maintaining goshawk populations. In addition to habitat loss, goshawk declines could be related to decreases in prey populations, which in turn may be associated with changes in the composition and/or structure of the forests resulting from fire suppression, tree harvests, and livestock grazing. If goshawk populations are a barometer of their prey populations, then forest management should feature prey habitats as well as the habitats of the predator.

# Goshawk Populations and Prey Species

## Factors Limiting Goshawk Populations

For some raptor species, the idea that breeding density is limited, rather than undergoing random fluctuations, is based on four main findings:

1) many raptor populations are stable in numbers and distribution for long periods of time (Newton 1989, 1991);
2) surplus non-breeding adults are present in many populations and breed only when a territory with suitable habitat becomes available (Newton 1979, Village 1983, Bowman and Bird 1986);
3) some populations extirpated by deforestation over large areas have returned along with forest reestablishment (Rowan 1921, 1922, Newton 1979, Ratcliffe 1980); and
4) in areas where nest sites are not limiting, nesting pairs are regularly spaced, suggesting that food resources are being protected by exclusive territories (Ratcliffe 1972, Tubbs 1974, Newton 1988, 1991, Reiser and Ward unpub. data).

Two important resources, food and nesting habitat, are frequently the principal factors limiting raptor densities (Newton 1979, 1989, 1991, Village 1990).

Evidence that raptor populations can be limited by a shortage of nest sites (snags, cliffs, large trees) includes:

1) raptors are absent or rare in areas in which nest sites are rare; and
2) where nest sites are limiting, raptor populations have been increased when artificial nest sites were provided (Cave 1968, Reese 1970, Rhodes 1972, Hammerstrom et al. 1973, Village 1983, Newton 1989).

In areas where nest sites are readily available, raptor densities are often limited by food abundance (Village 1990, Newton 1991). Two lines of evidence of food limits to populations include:

1) raptor populations are stable where their prey populations are stable (e.g., sparrowhawks and kestrels) (Newton et al. 1986, Newton 1989, Village 1990); and
2) raptor populations fluctuate when and

where their prey populations fluctuate (McGowan 1975, Newton 1989, 1991, Grant et al. 1991).

Furthermore, the density of raptors during winter and the following nesting season can be influenced by winter food availability (Newton 1979, Village 1990).

## Diet Breadth and Population Stability

The composition and abundance of species in the diet of a goshawk population may determine population stability. In Alaska, goshawks feed on relatively few species, and diets are dominated by the snowshoe hare (*Lepus americanus*) (McGowan 1975). A 10-year cycle in Alaskan snowshoe hare abundance (Keith 1963) was reflected in similar cycles in the number of active goshawk nests and the production of nestlings (McGowan 1975). For example, near Fairbanks, hare populations peaked in 1971 but declined in 1972 and 1973. In 1971 high hare numbers were associated with high goshawk nesting success -- a mean of 2.5 nestlings per nest. However, the mean number fledged in both 1972 and 1973 decreased to 1.8 nestlings per nest. Furthermore, the number of nests in McGowan's study area was 7 in 1971 and 1 in 1974 (McGowan 1975).

In the conterminous United States, there is no evidence that goshawk populations undergo extensive fluctuations. This is probably because:

1) no single prey species in these areas is abundant enough to dominate goshawk diets, and
2) the more southerly hawks feed on a wider variety of prey (Reynolds and Meslow 1984, Kennedy 1991).

Thus, even though one or more prey species may undergo population fluctuations, the effects of these fluctuations are more likely to be buffered by populations of other prey species that are not simultaneously affected.

## Prey Species

Goshawks are predators of forest birds and mammals. Diets varied moderately among studies of nesting goshawks in California, New York, Oregon, New Mexico, and Arizona (Schnell 1958, Reynolds and Meslow 1984, Mannan and Boal 1990, Kennedy 1991) (Appendix 2, page 51). This dietary variation likely reflected differences in the composition, abundance, and availability of birds and mammals in the forests of these states. Goshawk diets can change seasonally or annually reflecting:

1) differences in the timing or extent of migration, hibernation, or periods of inactivity among prey species,
2) the eruptive and cyclic nature of populations of some prey, and
3) differences in food preferences among individual goshawks.

Despite differences in goshawk diets over wide geographic areas, some prey species tend to be consistently common in their diets. When combined, these commonly-eaten prey totaled more than three quarters of the individuals consumed (Schnell 1958, Meng 1959, Reynolds and Meslow 1984, Mannan and Boals 1990, Kennedy 1991) (Appendix 2, page 51). In addition, most of these species were of relatively large body size and therefore contributed disproportionately to the total biomass consumed by goshawks.

A comparison of goshawk diets identified 14 prey species (or groups of similar species) that are particularly important to goshawks in the Southwest (Table 4). Information on the distribution, habitat, special habitat needs, home range, and population density of these selected prey species were gleaned from the literature (Appendix 3, page 53). This information was used to identify a set of "desired forest conditions" needed to provide abundant and sustainable populations of each of these species. Our rationale was to supplement the limited information on goshawk foraging habitat preferences by identifying the forest type(s), composition(s), and structure(s) in which each of 14 selected prey attain sustainable and abundant populations.

The majority of the important prey species reside mainly on the ground and in the lower portions of the tree canopy. Therefore, much of the goshawk's hunting activity (prey searching and pursuit) is oriented towards these forest layers (Reynolds and Meslow 1984). Consequently, in areas that have tall

**Table 4. Selected northern goshawk prey in the Southwest.**

| Birds | Mammals |
|---|---|
| American robin | Chipmunks (*Tamias* spp.) |
| Band-tailed pigeon | Cottontails (*Sylvilagus* spp.) |
| Blue grouse[1] | Mantled ground squirrel |
| Hairy woodpecker | Red squirrel |
| Mourning dove | Tassel-eared squirrel |
| Northern flicker | |
| Red-naped sapsucker | |
| Steller's jay | |
| Williamson's sapsucker | |

[1] *Not presently known from northern goshawk diet studies in the Southwest, but likely to occur when studies are expanded or extended into specific geographic areas.*

and very dense understories, goshawk populations may effectively be diminished because:

1) impaired ability of goshawks to visually scan for prey,
2) restricted flight access to prey, and/or
3) greater escape cover for prey.

# Conservation of the Northern Goshawk: Approach

To identify, describe, and ultimately manage goshawk habitat in the Southwestern Region, three critical spatial components of a goshawk's nesting home range were identified: nest area, post-fledging family area (PFA), and foraging area.

The description of goshawk habitat in each of these components is based on the biology and ecology of goshawks and their main prey species. In contrast to our knowledge of the summer nesting biology of the goshawk, almost nothing is known of its winter ecology. Therefore, the habitat descriptions herein focus on the nesting home range and habitat. However, there is limited radio-telemetry evidence that adult goshawks in New Mexico winter on or near their nesting home ranges (Kennedy unpub. data, Reynolds pers. obs.). If this proves true for goshawks in the Southwest in general, then providing nesting habitat will also provide some winter habitat needs.

## Nest Area

Nest areas are easily identified by their unique vegetation structure. Nest areas include one or more forest stands, several nests, and several landform characteristics. Nest areas are occupied by breeding goshawks from early March until late September, and are the focus of all movements and activities associated with nesting (Reynolds 1983). Boundaries of nest areas were determined by observing the behavior of the adults, the movements and behavior of newly fledged young, and the locations of prey plucking areas and roosts (Reynolds et al. 1982). The size (20-25 acres) and shape of nest areas depend on topography and the availability of patches of dense, large trees (Reynolds 1983).

Suitable nesting habitat is critical in the reproductive biology of goshawks. Nest areas are often used more than one year, and some are used intermittently for decades (Reynolds 1983, Crocker-Bedford 1990). Many pairs of goshawks have two to four alternate nest areas within their home range. All previously occupied nest areas may be critical for maintaining nesting populations because they contain the habitat elements that attracted the goshawks originally. Additionally, replacement nest areas are required because goshawk nest stands are subject to loss from catastrophic events and natural decline.

Goshawk nest stands have a relatively high tree canopy cover and a high density of large trees (Bartelt 1974, McGowan 1975, Hennessy 1978, Shuster 1980, Reynolds et al. 1982, Saunders 1982, Moore and Henny 1983, Hall 1984, Speiser and Bosakowski 1987, Crocker-Bedford and Chaney 1988, Kennedy 1988, Hayward and Escano 1989) (Table 5). Most nest stands are either on slopes with northerly exposures (NW to NE) or in drainages or canyon bottoms protected by such slopes. Studies suggest that the dense vegetation in these stands provide relatively mild and stable micro-environments, as well as protection from predators of goshawks (other goshawks, great-horned owls, red-tailed hawks, coyotes, bobcats, raccoons, humans) (Reynolds et al. 1982, Moore and Henny 1983). Information on tree height, diameter, and canopy closure of goshawk nest areas in interior ponderosa pine and mixed-species forests is provided by Reynolds et al. (1982), Moore and Henny (1983), Crocker-Bedford and Chaney (1988), Kennedy (1988), and Patla (1990).

The structure of the vegetation within nest areas is associated with the forest type, and tree age, size, and density, and the developmental history of the stand. Within the Southwestern Region, nest areas occur within a range of forest growth-site potentials (Table 5). Nest areas in locations with low growth potential will have smaller (diameter and height) trees than locations with high potential. Table 5 presents **minimum** attributes required for goshawks on locations with "low" and "high" site productivity.

## Post-fledging Family Area (PFA)

In a radio-telemetry study of the post-fledging behavior of goshawks, Kennedy (1989, 1990) described an area used by the adults and young from the time the young leave the nest until they are no longer dependent on the adults for food. This "post-fledging family area (PFA)" surrounds the nest area and, although it generally includes a variety of forest conditions, the vegetation structure resembles that found within nest stands. PFAs vary in size from

Table 5. Structural attributes for suitable northern goshawk nest stands in the Southwest[1].

| Forest Cover Type[2] | Piñon-Juniper | Interior Ponderosa Pine | | Mixed-Species | | Aspen | Engelmann Spruce-Subalpine Fir |
|---|---|---|---|---|---|---|---|
| Site Index[3] | | <55 | ≥55 | <50 | ≥50 | | |
| Trees/Acre[4] | 60-100 | 40 | 30 | 45 | 35 | 20 | 35 |
| Mean DBH/DRC (in.)[5] | 12 | 16 | 22 | 15 | 20 | 16 | 20 |
| Age (yrs.)[5] | 200+ | 200+ | 200+ | 200+ | 200+ | 80+ | 150+ |
| Total BA (sq. ft/acre)[6] | 60 | 120 | 140 | 110 | 130 | 50 | 140 |
| Overstory canopy cover (%) | 60+ | 50+ | 60+ | 50+ | 60+ | 60+ | 70+ |
| VSS[7] | 5A-6 | 5B-6 | 5B-6 | 5B-6 | 5B-6 | 5B-6 | 5B-6 |

[1] *The entire nest area may not support all of these structural attributes.*

[2] *Forest cover types, SAF codes (Eyre 1980); Ponderosa pine 237; Mixed-species 209, 210, 211, 216; Aspen 217; Engelmann spruce-Subalpine fir 206; Piñon-juniper 239.*

[3] *Site Index (SI) = base age of 100 years; SI used for interior ponderosa pine = ponderosa pine; SI used for mixed-species = Douglas-fir.*

[4] *Number of live trees in the main canopy.*

[5] *Arithmetic average of the ages of dominant and codominate trees in the stand; DBH = diameter at breast height; DRC = diameter at root crown.*

[6] *BA = basal area.*

[7] *VSS = Vegetation Structural Stage.*

300 to 600 acres (mean = 415 acres) and may correspond to the territory (a defended area) of a pair of goshawks (Kennedy 1989). PFAs provide the young hawks with cover from predators, and sufficient prey to develop hunting skills and feed themselves in the weeks before juvenile dispersal. Thus, forests in the PFAs should contain overstories with a canopy cover greater than 50%, and well-developed understories and habitat attributes (e.g., snags, nest trees, foods) critical in the life-histories of goshawk prey species.

## Foraging Area

It is difficult to identify and describe goshawk foraging habitat because of the size of the home range and the dearth of information on what habitats are preferred.

As in most raptors, there are differences in the duties of the goshawk sexes during nesting: males hunt for the family while females stay close to the nests -- first to incubate eggs, then to brood and protect young. Information on nesting home range size and habitats used while foraging must therefore primarily come from studies of foraging males. The extent to which the foraging areas of adjacent pairs overlap is unknown.

Goshawks prey on birds and mammals in the larger body-size classes available to forest-dwelling hawks (Storer 1966, Reynolds and Meslow 1984). Generally speaking, because larger species of vertebrates have less dense populations than smaller species, predators of large prey must hunt over large areas in order to meet their energy requirements (Schoener 1983). This body size/home range size relationship is demonstrated in the North American *Accipiter*: the smallest, the sharp-shinned hawk, feeds on small birds and has nesting home ranges of about 1,200 acres; the Cooper's hawk, which feeds on birds and mammals of intermediate size, has home ranges of about 4,000 acres; and the northern goshawk, the largest *Accipiter*, has ranges of about 5,000-6,000 acres (Reynolds 1983, Kennedy 1989) (Table 3).

The size of nesting home ranges of goshawks has been estimated by:

1) repeatedly observing adult males leaving their nest areas above the forest canopy and noting the distance and direction traveled (Reynolds 1983);
2) Assuming home ranges are circular and using one-half the mean distance between nests as the radius of the home range (Newton et al. 1977, Reynolds 1983);
3) plotting the locations where some prey species were trapped and marked and whose remains were subsequently found at goshawk nests (Eng and Gullion 1962); and
4) monitoring the movements of adults using radio-telemetry (Kennedy 1991,

Austin in prep).

Radio-telemetry is the most accurate of these estimates, but radio-tracking of such a wide-ranging bird in mountainous terrain is most difficult. The task is made more difficult because goshawks, as well as other *Accipiters*, are short-sit-and-wait-short-flight predators (Fischer 1986, Kenward 1982, Kennedy 1991). That is, goshawks search their immediate surroundings for prey from a tree-perch for a short period (seconds) and then make a short flight to a new perch (Kenward 1982, Widen 1985). This searching behavior is an adaptation to living in forests where the area searched from a single perch is limited. Because of visual limitations, perches are changed frequently. Goshawks move rapidly through their home range in this manner, making it difficult to triangulate on radio-marked hawks.

Limited radio-telemetry evidence suggests that goshawks prefer mature forests for foraging. For example, Fischer (1986) found that a radio-tagged male in Utah preferentially foraged in "mature" Douglas-fir/white fir stands. Widen (1989), studying radio-marked goshawks (*A. g. gentilis*) in winter in intensively managed conifer forests in Sweden, found that both sexes of goshawks preferentially foraged in forests greater than 60 years of age. Application of this information in management recommendations is limited because of the small sample size in Utah, and uncertainties as to the similarities in foraging behavior of European and North American goshawks.

Additional information on the composition and structure of goshawk foraging habitat was gleaned from information on the habitat requirements of goshawk prey species. This approach is justified because:

1) raptor populations are often limited by prey populations, and
2) choice of foraging habitat by goshawks is predicated, at least in part, on habitats where prey are abundant and accessible.

We designed foraging areas consisting of forest conditions that would provide a high overall diversity and abundance of prey. Because not all 14 selected prey species occur in each of the forest types in the Southwest, three separate designs -- for ponderosa pine, mixed-species, and spruce-fir -- were required (Table 6). Sufficient prey habitats are provided so there is food to support goshawks in all seasons, especially during winter when fewer prey are available, and in years when prey populations are low due to factors such as drought or deep snow cover. Because no single prey species will be abundant enough to support goshawks, especially during winter, habitats for all 14 prey species are provided.

# Synthesis of Desired Forest Conditions

Forests can be described by either:

1) community associations or
2) forest cover types (Daubenmire and Daubenmire 1968, Larson and Moir 1986, Larson et al. 1987, Bassett et al. 1987).

An integrative approach, combining vegetation and forest growth, has been developed for the Southwest (after Thomas et al. 1979) and is a generalized description of forest age and tree size from seedling to old forests. To describe the southwestern forests we defined 6 vegetation structural stages (VSS) that were based primarily on tree diameters (Fig. 1). These stages are:

- VSS 1, areas dominated by grasses, forbs, and shrubs;
- VSS 2, forests dominated by seedlings and saplings;
- VSS 3, young forests;
- VSS 4, mid-aged forests;
- VSS 5, mature forests; and
- VSS 6, old forests.

## Nest Area

Nest areas are a key component of goshawk home ranges. In each of the three southwestern forest types, goshawks nest in older-aged stands that have a high density of large trees, high tree canopy cover, and high basal areas (Table 5, Fig. 7, and Fig. 8). Nest areas are usually on cool, shady slopes or canyon sides, and are often near streams.

## Post-fledging Family Area (PFA)

Post-fledging family areas (PFAs) contain patches of dense, large trees that provide protection for fledglings and small trees for hiding cover near the ground. Because newly fledged young have poorly developed flight, their spatial movements tend to be centered around the nest. With time, fledglings become proficient foragers and are fed less and less by their parents. To provide learning opportunities, prey should be abundant throughout the PFA; thus prey habitat should be intermixed with dense hiding

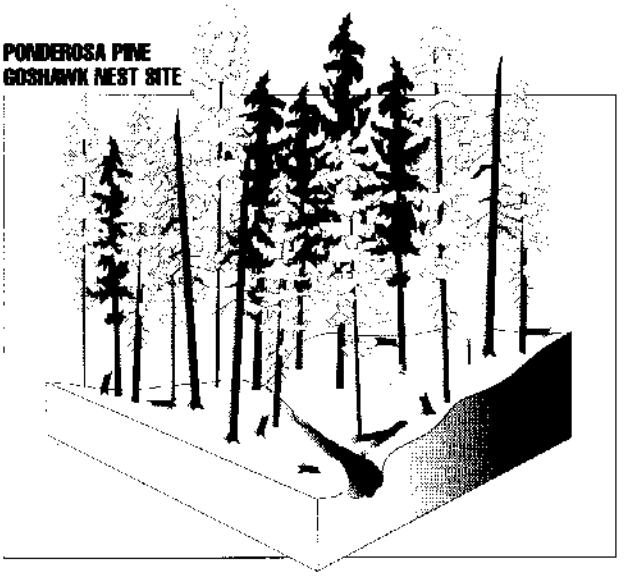



**Figure 7. Northern goshawk nesting habitat within a ponderosa pine forest, depicting tree density, canopy cover, and landform in the vicinity of the nest tree.**

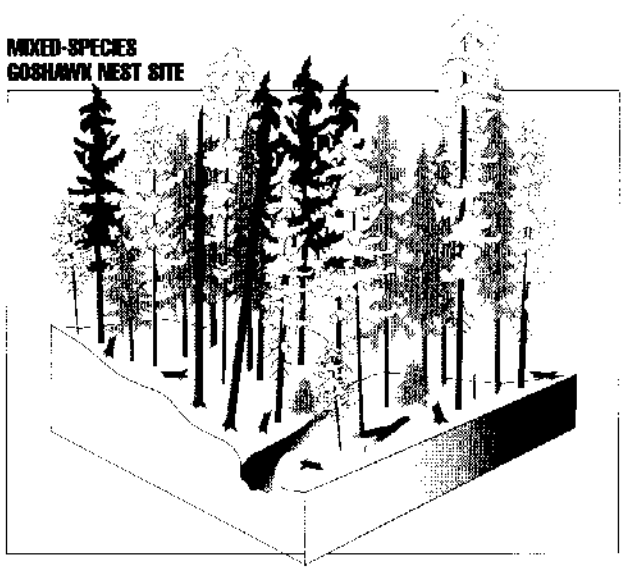



**Figure 8. Northern goshawk nesting habitat within a mixed-species forest, depicting tree density, canopy cover, and landform in the vicinity of the nest tree.**

cover. Features of prey habitat in the PFA include:

1) large (>18 inches DBH) feeding and/or nesting trees for tree squirrels,
2) large (>18 inches DBH and >30 feet tall) snags and/or trees with exposed heartwood for nest cavity excavation by woodpeckers,
3) patches of mid-aged forests with high canopy cover (up to 70%) that provide mesic conditions for fungi (important foods for all the mammalian prey),
4) small (<2 acres) openings in the tree canopy to produce herbaceous and shrubby foods for the herbivorous prey, and
5) large (>12 inches in diameter and >8 feet long) downed logs and other woody debris that provide hiding, feeding, denning, and nesting sites used by goshawk prey.

The PFA is an intermixture of forest conditions intermediate between the high foliage volume and canopy cover of the nest stands and the more open foraging habitats.

## Foraging Area

The foraging area comprises the largest portion of the goshawk nesting home range and therefore typically includes a greater diversity of landforms, forest cover types, and vegetation structural stages. Table 6 summarizes the importance of snags, downed logs, woody debris, openings, large trees, herbaceous and shrubby understories, and interspersion of VSS to the selected prey species of the goshawk. This information was based on a literature review of the life history, habitats, and foods of each prey species (Appendix 3, page 53).

Snags provide critical resources for many species of birds, mammals, invertebrates, and plants. Among the selected species of goshawk prey, all of the woodpeckers use snags for feeding, nesting, or both. Four mammalian prey use snags for nesting (when cavities are available) and cone caching. Several birds use snags for perches. The level of importance of snags as a habitat attribute is "medium" to "high" for 6 species, "low" for 6 species, and "not important" for 2 species (Table 6).

Downed logs (>12 inches in diameter and 8 feet long) provide cover, feeding and nest sites for a great variety of species. Among goshawk prey, downed logs are important feeding sites for several woodpeckers and as den sites for chipmunks, mantled ground squirrels, and cottontail rabbits. Downed logs are an important element in red squirrel cache sites and in blue grouse courtship sites. The level of importance of downed logs is "medium" to "high" for 9 species, "low" for 2 species, and of no importance to 3 species.

Woody debris is any downed woody material larger than 3 inches in diameter. Woody debris provides cover and feeding sites for a variety of vertebrates. The character, amount, and distribution of woody debris may affect the kinds and abundance of animals in an area (Dimock 1974). The level of importance of woody debris is "medium" to "high" for 7 goshawk prey species, "low" for 6 species, and of no importance to 1 species.

**Table 6. Importance of special habitat attributes for maintaining sustainable populations of selected northern goshawk prey[1].**

| Species | Forest Types[3] | Habitat Attributes[2] Snags | Downed Logs | Woody Debris | Opening | Large Trees | Herb, Shrub Understory | Interspersion of VSS |
|---|---|---|---|---|---|---|---|---|
| American robin | PP,MS,SF | none | none | low | medium[a,b,c] | low | high | high |
| Band-tailed pigeon | PP,MS | low | none | none | high[a,b,c] | medium | medium | medium |
| Blue grouse | MS,SF | none | medium | medium | high[a,b] | high | high | high |
| Chipmunks | PP,MS,SF,PJ | medium | high | high | medium[a,b] | medium | high | medium |
| Cottontails | PP,MS,PJ | low | medium | high | medium[a,b,c] | none | high | high |
| Hairy woodpecker | PP,MS,SF | high | medium | medium | none | high[4] | none | medium |
| Mantled ground squirrel | PP,MS,SF | low | high | high | medium[a,b] | medium | high | medium |
| Mourning dove | PP,MS,PJ | low | none | low | high[a,b] | medium | high | high |
| Northern flicker | PP,MS,SF,PJ | high | high | low | low[a,b,c,] | high[4] | medium | high |
| Red-naped sapsucker | PP,MS | high | low | low | none | medium[4] | medium | medium |
| Red squirrel | MS,SF | high | high | medium | none | high | medium | low |
| Steller's jay | PP,MS,SF | low | low | low | none | high | low | low |
| Tassel-eared squirrel | PP,MS | low | medium | low | none | high | low | medium |
| Williamson's sapsucker | PP,MS | high | medium | medium | none | high | medium | low |
| Total none | | 2 | 3 | 1 | 6 | 1 | 1 | 0 |
| Total low | | 6 | 2 | 6 | 1 | 1 | 2 | 3 |
| Total medium | | 1 | 5 | 4 | 4 | 5 | 5 | 6 |
| Total high | | 5 | 4 | 3 | 3 | 7 | 6 | 5 |

[1] *Importance values (none, low, medium, high) were based on interpretation of data available in literature. See Appendix 3 for additional information.*

[2] *snags = dead trees ≥ 18 inches DBH and ≥30 feet high;*

*downed logs = ≥12 inches diameter and 8 feet long;*

*woody debris = ≥3 inches diameter of woody material on the forest floor;*

*opening = a break in the forest canopy, a = small opening (<2 acres); b = medium (2-4 acres); and c = large (>4 acres);*

*large trees = live ≥18 inches DBH, large tree component is required for nest trees, feeding trees, and roost trees;*

*herb, shrub understory = presence or absence of herbaceous and shrubby species;*

*interspersion of vegetation structure stage (VSS) = the degree of intermixing of VSS measured on the scale of each prey species (low = relatively large contiguous patches of the same or similar VSS's; high = an intermixture of relatively small patches of dissimilar VSS's; medium = moderate degree of intermixture of dissimilar VSS's).*

[3] *Forest type: PP= ponderosa pine; MS=mixed-species;SF=spruce-fir; PJ=pinon-juniper.*

[4] *Large trees are a source of snags used for nesting.*

Openings, and associated herbaceous and shrubby vegetation, provide important food and cover for a number of goshawk prey species. Only three species (band-tailed pigeon, mourning dove, and blue grouse) have a high importance value for openings; blue grouse for nesting and brood-rearing, and the pigeon and dove for feeding. The level of importance of openings is "medium" to "high" for 7 prey species, "low" for 1 of the species, of no importance to 6 species. Because pigeons and doves typically travel long distances to feed in agricultural or other large non-forested areas, large openings in the forest are not required for them. Therefore, a forest containing small to medium (<4 acres) openings would benefit the blue grouse, chipmunks, and mantled ground squirrels while minimizing the effects on other interior forest prey species.

Large trees (>18 inches in diameter) provide important nesting, denning, feeding, and roosting sites for goshawk prey such as tree squirrels, large woodpeckers, and blue grouse. Large trees also are good cone producers, providing a source of seed for many species of goshawk prey (Appendix 1, Table 2; page 49). Because large trees are the source for large snags and downed logs, they are as important to woodpeckers as are large snags. Large trees also provide hunting perches and nest trees for goshawks. The level of importance of large trees is "medium" to "high" for 12 goshawk prey species, "low" for 1 species, and of no importance to 1 species.

Herbaceous and shrubby understories provide important foods (seeds and berries), and cover for many of the selected prey. Well developed understories occur in forests with canopy sufficiently open to allow the necessary light to reach the forest floor; closed canopied forests are often limited in the quantity of these plant foods. The level of importance of herbaceous and shrubby understories is "medium" to "high" for 11 goshawk prey species, "low" for 2 species, and of no importance to 1 species.

Interspersion measures the degree of intermixing of vegetation structural stages. Only the red squirrel responds negatively to interspersion of structural stages; its populations reach a maximum in unbroken old forests. Other goshawk prey populations either:

1) respond positively to high interspersion (e.g., blue grouse), or
2) are little affected by high levels of interspersion (e.g., chipmunks).

The level of importance of interspersion is "medium" to "high" for 11 goshawk prey species, "low" for 3 species, and of no importance to no species.

Table 7, identifies the VSSs and canopy cover classes in which selected species of goshawk prey occur at high, medium, and low populations (on the condition that the "special habitat attributes" identified in Table 6, are provided in amounts that do not limit prey populations). Although some species of goshawk prey occur at medium to low population levels in each of the structural stages, it is evident that the older age classes have the most species at an abundant population level (12 of 14 species).

Several species (such as American robin and mourning dove) are generalists and occur at medium populations in most structural stages, while others, including the red squirrel are specialists and occur in a limited number of structural stages. One species (blue grouse) requires both openings and older forests, interspersed with one another, to attain high populations during all seasons. A total of 12 species attain high or medium populations in older forests (VSS 4-6); of these 12 species, 5 occur only at low densities in the young forests (VSS 2-3) (Table 7).

Canopy cover influences population levels of goshawk prey in different ways. For example, 6 species of goshawk prey occur at greater densities in open forests (<40% cover). Seven species occur at high populations in closed forests ( >60% cover), but only 1, the red squirrel, requires closed older forests to attain high populations. The other 6 attain high populations in cover class B (40-60% cover) as well (Table 7). Of the 14 selected prey, only 4 species use closed canopy areas in the younger VSS.

All small mammals, and the majority of birds, of selected prey species are either granivores or herbivores -- feeding on seeds, berries, and foliage of plants that occur in openings in forests and in forest understories (Appendix 3, page 53). Many of these prey also depend heavily on seeds of conifers; for example, tree squirrels climb trees for cones and chipmunks and ground squirrels scavenge cones or seeds from the ground or steal cones from caches of others.

All mammalian prey species except cottontails depend heavily on fungi during summer and fall, and the physiological condition in which tree squirrels and chipmunks begin the winter may be dependent on the amount of fungi eaten (C. Smith 1968, Maser et al. 1978). Fungi are best produced in conifer stands with canopy cover greater than 60%. In ponderosa pine forests the best fungi-producing stands are mid-aged with high canopy cover (States 1985, States et al. 1988, Uphoff 1990).

Other additional elements in goshawk foraging areas in the Southwest include:

1) dwarf mistletoe infected trees that provide good nesting and feeding sites for many vertebrates (Hawksworth 1961, 1973, Bennetts 1991),
2) large quaking aspen that provide feeding and cavity nests that help maintain high densities of large woodpeckers (Scott et al. 1977), and
3) oaks, especially Gambel oak, that provide nest sites and food (Scott et al. 1977, Bock and Larson 1986, Uphoff 1990).

With the exception of red squirrel habitat, multi-storied stands do not appear to be an important structural element in the habitat of the selected goshawk prey.

In summary, goshawk foraging habitat in the three forest types consists of forests with relatively open understories and large trees. Large trees are required for hunting perches, and openness provides opportunity for detection and capture of prey by goshawks. These forests have small to medium openings (<4 acres) and patches of dense mid-aged forests. Openings are scattered to:

1) enhance the availability of food and habitat resources of prey that use them, and
2) limit the effect of large openings on the distribution and abundance of prey species that use interior forests.

For the most part, forests in the older age classes are relatively open (40-60% canopy cover) with increased sunlight and moisture reaching the forest floor. These forests have well-developed herbaceous and shrubby understories. Large tree components (live trees, snags, and downed logs) are scattered

**Table 7. Desired forest conditions within northern goshawk home ranges that contribute to various population levels of selected prey.**

| Prey Species | Forest Types[2] | Vegetation Structural Stage[1] and Canopy Cover | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1[3] | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
| | | | A[4] | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| American robin | PP,MS,SF | X[5] | X | X | | X | X | | X | XX | | X | XX | | X | XX* | |
| Band-tailed pigeon | PP,MS | X | X | | | | | | | X | | | X | | | X | |
| Blue grouse | MS,SF | XX | XX | X | | X | XX | | X | XX | XX | X | XX | XX | X | XX | XX |
| Chipmunks | PP,MS,SF, PJ | X | X | X | | X | X | | XX | XX | | XX | XX | X | XX | X | X |
| Cottontailst | PP,MS,PJ | XX | X | X | | X | X | | XX | X | | XX | X | | XX | X | |
| Hairy woodpecker | PP,MS.SF | | | | | | X | X | X | X | X | XX | XX | XX | XX | XX | XX |
| Mantled ground squirrel | PP,MS,SF | X | X | X | | X | X | | XX | XX | | XX | XX | | XX | X | |
| Mourning dove | PP,MS,PJ | X | X | | | X | | | X | X | | X | X | | X | X | |
| Northern flicker | PP,MS,SF, PJ | X | X | X | X | X | X | X | XX | XX | XX | XX | XX | X | XX | XX | X |
| Red-naped sapsucker | PP,MS | | | | | | | | | X | X | | XX | XX | | XX | XX |
| Red squirrel | MS,SF | | | | | | | | | X | XX | | X | XX | | XX | XX |
| Steller's jay | PP,MS,SF, PJ | X | X | X | | X | X | | X | X | | X | XX | X | X | XX | X |
| Tassel-eared squirrel | PP,MS | | | | | | X | XX | | XX | XX | | XX | XX | | XX | XX |
| Williamson's sapsucker | PP,MS | | | | | | | | | X | X | | XX | XX | | XX | XX |
| Total X | | 7 | 8 | 7 | 1 | 8 | 8 | 2 | 5 | 8 | 3 | 4 | 4 | 3 | 4 | 5 | 3 |
| Total XX | | 2 | 1 | | | | 1 | 1 | 4 | 6 | 4 | 5 | 10 | 6 | 5 | 9 | 6 |

[1] *Vegetation structural stage: 1 = grass/forbs/shrubs; 2 = seedling/sapling; 3 = young forest; 4 = mid-aged forest; 5 = mature forest; 6 = old forest. See glossary for additional information.*

[2] *Forest type; PP = ponderosa pine, MS = mixed-species, SF = spruce-fir, PJ = piñon-juniper.*

[3] *Diameter breast height limits. 1 = 0-1"; 2 = >1-5"; 3 = >5-12"; 4 = >12-18"; 5 = 18-24"; 6 = higher density of older and larger trees per unit area.*

[4] *Canopy cover: A = 0-40%; B = 40-60%; C = > 60%.*

[5] *Blank = low populations or no use; X = important for maintaining medium populations of species; XX = important for maintaining high populations of species.*

throughout the foraging area. The large tree component, often occurring in clumps with interlocking crowns, provides a myriad of unique hiding, feeding, denning, and nesting sites used during some part of the annual cycle of all selected goshawk prey species. Goshawk foraging habitat will have sustainable and abundant prey when the majority of forests are in older age classes.

# Present Forest Conditions

Forests in the southwestern United States occupied by goshawks are diverse in species composition and structure. Southwestern forests include ponderosa pine, mixed-species, and Engelmann spruce-subalpine fir. The extent to which goshawks use pinon-juniper woodlands is unknown. History of land-use in these conifer forests is highly variable. Timber harvesting, fire suppression, livestock grazing, recreation, and mining have altered the vegetation from pre-European settlement times.

Before the arrival of European settlers, ponderosa pine forests throughout western North America were burned every 2-15 years by low-intensity, lightning-caused, non-catastrophic surface fires (Cooper 1960, 1961, Avery et al. 1976, Gruell et al. 1982, Dieterich 1980, 1983, McCune 1983, White 1985, Swetnam 1988, Covington and Moore 1991). Similar fires in mixed-species forests occurred at frequencies between 5-22 years. Fire intervals varied from a more frequent burning in dry, low elevation sites to a lower frequency in moist, high elevation sites (Weaver 1951, Ahlstrand 1980, Wright 1988). However, wildfire suppression since the late 1800s has greatly reduced fire frequency; in many areas fire has been entirely eliminated (Weaver 1961, Dieterich 1983, McCune 1983, Stein 1988, Keane et al. 1990). Livestock grazing helped decrease the fire frequencies by reducing the amount of herbaceous fuels (Brawn and Balda 1988).

Surface fires typically maintained open forest conditions by continually destroying small trees. As a result of fire suppression, many ponderosa pine and mixed-species forests became dense due to increased seedling survival. Furthermore, the lack of fire has resulted in the conversion of many ponderosa pine stands to Douglas-fir and true firs (Barrett et al. 1980). The reduced fire-related mortality of young trees not only increased stocking levels, but increased competition for limited soil moisture and nutrients (Gruell et al. 1982, Moir and Dieterich 1988). Evidence suggests that, with increased stocking and competition:

1) tree vigor decreases, and
2) the frequency and intensity of epidemics of insects, root diseases, and dwarf mistletoe increases.

These factors result in higher tree mortality in the older age-classes (Weaver 1943, Fellin 1979, Williams and Marsden 1982, Ryker and Losensky 1983, Byler 1984, Anderson et al. 1987, Swetnam and Lynch 1989, Covington and Moore 1991).

Also, the increased number of small, young trees in present day forests result in a continuous "ladder" of fuels that carry fires from the ground to the tallest trees (Madany and West 1980). This, combined with a build-up of surface fuels, produces a high hazard for catastrophic, tree-killing fires. Under pre-settlement conditions, catastrophic crown fires were apparently rare (Brawn and Balda 1988, Covington and Moore 1991).

Spruce-fir forests, in contrast to ponderosa pine and mixed-species, have lower fire frequencies (63-400 years) (Arno 1980, Romme 1980). However, the effect of fire suppression on tree densities is unknown (Alexander 1974, 1987). Lightning, windfall, insects, and diseases have maintained a wide variety of conditions in these forests (Stromberg and Patten 1991).

Grazing of domestic livestock has been a major use in southwestern ponderosa pine and mixed-species forests since the mid 1800s (Rassmussen 1941, Cooper 1960). Dense grass cover lowers the establishment and survival of pine and fir seedlings (Brawn and Balda 1988). Heavy livestock grazing reduced ground cover, which allowed for the establishment of "dog-hair" thickets (Stein 1988). Furthermore, fire suppression, by allowing the encroachment of trees into openings and increasing shading, has reduced forage production. Although the effects of grazing in spruce-fir forests are poorly known, impacts are probably less than in the other forest types. Grazing in high-altitude meadows, however, has changed plant community composition and structure.

Tree harvest activities have caused additional structural and compositional changes in each southwestern forest type. Older forests, because of the economic value of the standing crop, have been the focus of traditional timber harvesting. Today, fewer older forests with large trees exist. Due to fire management practices and fuel-wood harvesting, snags are less abundant in present-day forests. The effects of removing old trees and snags are long-term; crop rotation periods of less than 150 years do not allow trees sufficient time to become large live trees, snags, and downed logs.

The land-use history of southwestern forests, particularly fire suppression and timber harvesting, and the lack of stand treatments directed at controlling damaging forest insects and diseases, has resulted in declining forest health (Parker 1991). Evidence indicates that dwarf mistletoes (*Arceuthobium* spp.) and root diseases (*Armillaria* spp., *Heterbasidion annosum*) are increasing in forests of the Southwest (Parker 1991, Maffei and Hawksworth in review). Similarly, because of high stand densities, the potential for epidemic outbreaks

of bark beetles (*Dendroctonus* spp.) is present in many ponderosa pine and mixed-species forests (Hedden et al. 1981, USDA Forest Service 1988, Rogers and Conklin 1991). The threat of western spruce budworm (*Choristoneura occidentalis*) outbreaks is also increasing in the multi-storied stands being perpetuated in the mixed-species forests (USDA Forest Service 1985, Swetnam and Lynch 1989) (Appendix 5, page 79).

The individual and cumulative effects of these forest modifications on the habitat of goshawks and their prey are poorly understood. However, we believe these modifications affect habitat use by the goshawk and the availability (abundance and vulnerability) of goshawk prey. Specifically:

1) in areas of thick tree regeneration, access to prey may be limited (Reynolds 1989),
2) increased tree canopy cover results in a loss of herbaceous and/or shrubby foods (Cooper 1960, Stein 1988) and therefore, reductions in populations of the many herbivorous prey of the goshawk,
3) reductions in the amount of older forests reduces the abundance of those prey that require large trees (Szaro and Balda 1979b, Patton et al. 1985, Sullivan and Moses 1986, Brawn and Balda 1988),
4) reductions of large snags decreases the abundance of those prey dependent on them (Balda 1975, Brawn and Balda 1988), and
5) creating large openings in forests results in the reduction of the abundance of fruiting fungi, and lower populations of prey that feed on fungi (States 1985, Pederson et al. 1987).

# Management Recommendations for the Home Range

The present forest conditions above reflect the extent of human influence on natural processes. Several types of active management such as thinning and prescribed fire should speed the process of producing and maintaining the desired conditions for sustaining goshawks and their prey. For example, if wild stands of ponderosa pine are not thinned naturally (by fire) or artificially (by tree cutting) they typically stagnate and will not develop into large, mature trees (Appendix 4, Table 5; page 84). When thinned regularly, trees can reach 10 inches in diameter within 80 years, depending on forest site. In some forests (such as spruce-fir), natural processes are still functioning, and little or no active management will be necessary to reach the desired conditions (Stromberg and Patten 1991).

There are three key components in the goshawk's home range: nest areas, post-fledging family area, and foraging area. Management objectives, desired conditions, and management recommendations based on goshawk nest habitat and foraging behavior, and the food and habitat of selected goshawk prey for each home range component has been specified.

Across the Southwestern Region there is considerable variation in site-specific growth potential. This variation is associated with elevation, slope, aspect, soil, available moisture and nutrients, and disturbance history. Therefore, sites have widely varying capabilities to produce the desired forest conditions; on certain sites desired conditions cannot be attained, while on others the conditions can be exceeded. Although high growth-potential sites have the greatest capabilities to produce nest areas, low potential sites may still provide foraging habitat with enough time.

Because trees and forests require many years to grow, and because much research is needed to improve our understanding of goshawk habitat use, it is prudent to minimize the possibility of immediate loss of goshawk habitat. Therefore, the following management recommendations are conservative; that is, they are designed to produce forest conditions that will sustain goshawk populations by minimizing long-term loss of their habitat due to unfavorable environmental conditions such as long periods of drought. Therefore, the largest areas (acres) reported in the literature (Table 3, page 9), rather than the average or the smallest, were used when developing the management recommendations for the nest area, PFA, and foraging area.

The opportunities to produce, maintain, and enhance goshawk habitat may not be equally applied on all forested lands because of "reserved forest land" designations, such as wilderness, research natural areas, National Parks, and "area limitations" related to slope and soil type. Desired conditions might be achieved in some of these areas through the application of allowable management tools (fire, hand-thinning).

## Nest Area

**Management Objectives, All Forest Types**

√ Provide long-term nesting habitat for goshawks in

a landscape.

**Desired Conditions**

√ ***Size***: Approximately 30 acres (3 suitable and 3 replacement totaling 180 acres per home range).

√ ***Location***: Along drainages, base of slopes, and on northerly aspects.

√ ***Stand structure***: See Table 5, page 14.

**Management Recommendations**

√ Maintain at least 3 suitable nest areas per home range. Selection priority:

1) the active nest area; and
2) the most recently used historical nest areas.

When possible, all historical nest areas should be maintained.

√ Provide at least 3 replacement nest areas (in addition to the 3 suitable nest areas) per home range.

√ All nest areas are best located approximately 0.5 miles from each other (Fig. 9).

√ No adverse management activities in nest areas at any time.

√ Minimal human presence in active nest areas during the nesting season, March 1 - September 30.

√ Preferred treatments for maintaining stand structure in nest areas:

- ***In suitable nest areas:*** thin unwanted understory trees, with non-uniform spacing, in using prescribed fire (except for spruce-fir), and/or hand operated tools.
- ***In replacement nest areas***:

1) thin from below (remove trees from the understory), with non-uniform spacing in the three youngest VSS to maintain low densities to promote faster tree growth and crown development, and
2) allow for stand density increases in the three older VSS to develop interlocking crowns (Fig. 10).

√ Replacement nest areas should be first selected from stands in the PFA that resemble vegetation and landform of suitable nest areas.

- ***To decrease fuel hazards***, in order of priority:

1) Use periodic prescribed fires (except in spruce-fir).
2) Lopping and scattering of thinning debris is preferred if prescribed fire cannot be used.
3) Piling of debris should be limited. When necessary, hand piling should be used to minimize compaction within piles and to minimize displacement and destruction of the forest floor and the herbaceous layer.
4) Grapple or dozer piling is not recommended.

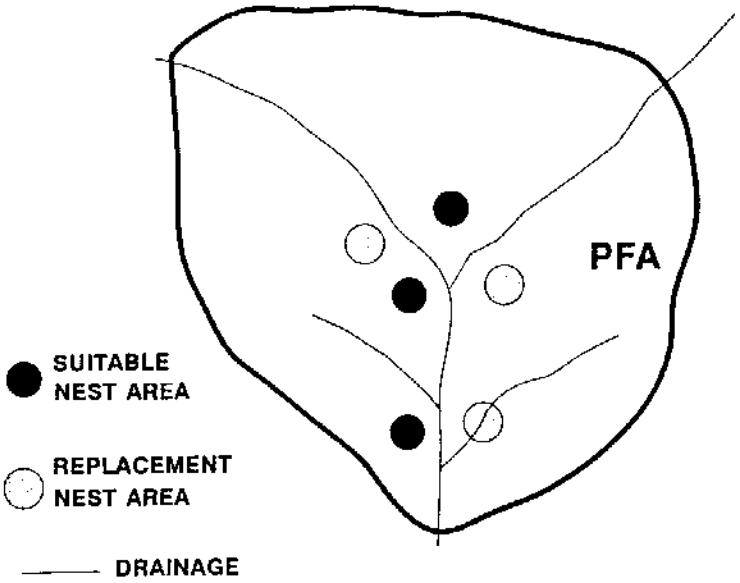



**Figure 9. Schematic diagram of suitable and replacement nest areas within a post-fledging family area. The foraging area surrounds the PFA.**

√ Manage road densities at the lowest level possible to minimize disturbance in the nest area. Where timber harvesting has been prescribed to achieve desired forest condition, use small, permanent skid trails in lieu of roads.

√ Wildlife and livestock utilization of grasses and forbs should average 20% by weight and not exceed 40% in any area, and shrub utilization should average 40% by weight and not exceed 60% in any area. These levels of utilization should maintain native food and cover for many of the prey species (Schmutz 1978, Wasser 1982).

## Post-fledging Family Area (PFA)

**Management Objectives**

√ Provide hiding cover (from predators, siblings, and weather) for goshawk fledglings.

√ Provide habitat for prey and foraging opportunities for the adults and fledgling goshawks during the fledgling-dependency period.

**Desired Conditions, All Forest Types**

√ ***Size***: Approximately 420 acres (not including the acres in suitable and replacement nest areas). Although portions of natural and permanently created openings close to forest edges may be

**INTERMEDIATE TREATMENT:**
*Thinning from Below*

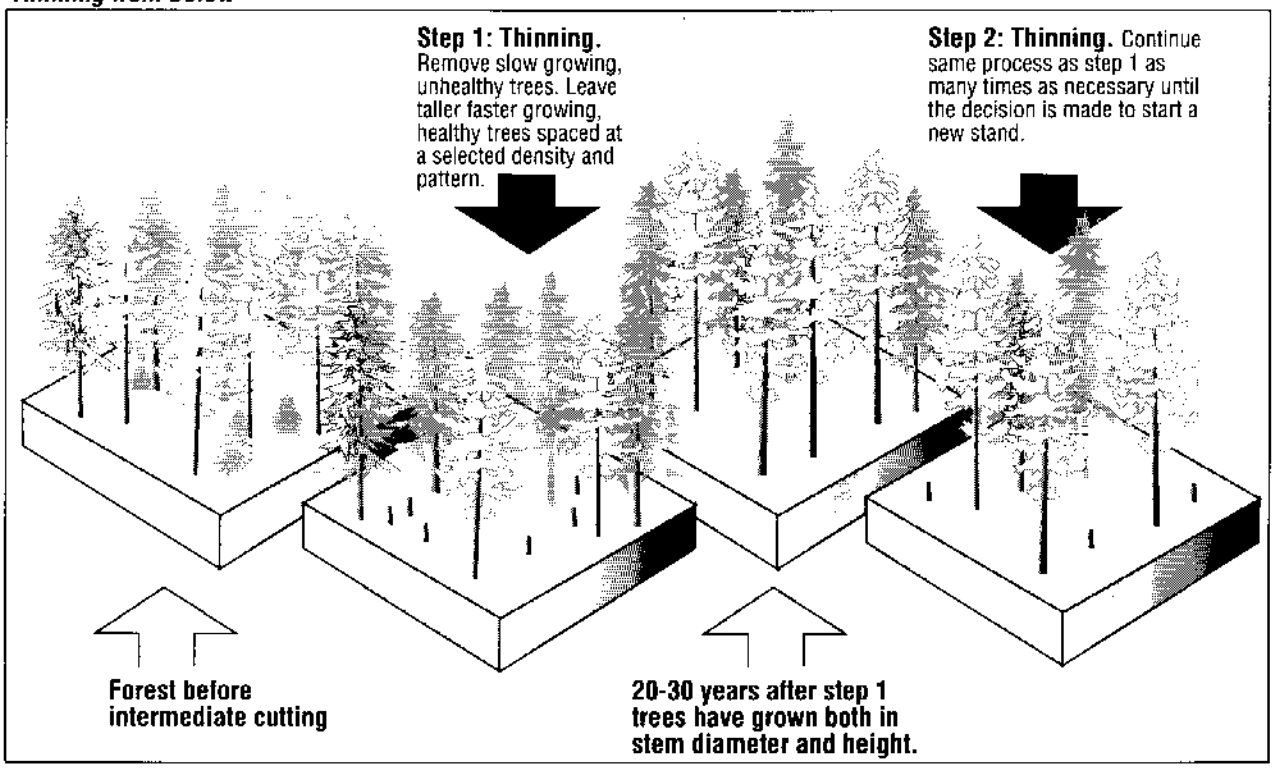



**Figure 10. Thinning from below (removing trees from the understory) to achieve desired forest conditions.**

utilized for foraging by goshawks, these areas are not counted as part of the PFA. Also, do not count created openings (such as forest health, fire) greater then two acres in size as part of the PFA.

√ ***Location***: Approximately centered around suitable and replacement nest areas (Fig. 9).

√ ***Stand structure:*** A mosaic of vegetation structural stages (VSSs) interspersed throughout the PFA in small patches.

- The majority (60%) of the PFA should be in the three older VSSs (4, 5, 6), approximately 20% in each. Of the remaining 40%, 20% should be in young forest (VSS 3), and 10% in the seedling/sapling (VSS 2), and 10% in grass/forb/shrub stages (VSS 1). The approximate proportions that can be maintained in the different VSS classes depend on:
  1) the years required for tree establishment and development,
  2) diameter growth rates, and
  3) tree longevity (Appendix 5, page 82).

The number of years spent in each VSS will depend on the intensity of management (Appendix 5, page 82).

- The large-tree component throughout the PFA should include: snags, downed logs, and mature and old, live trees in clumps or stringers with interlocking crowns.
- A developed herbaceous and/or shrub understory throughout the PFA should emphasize native species, especially grasses.

√ ***Woody debris:*** Present throughout the PFA.

√ ***Soil conditions:*** Developed, intact forest soils with emphasis on organic surface layers (humus, litter and soil wood) within the natural turnover rates. These conditions should provide for the sustainability of mycorrhizae.

**Additional Desired Conditions, Ponderosa Pine Forest Type**

√ ***Stand structure:*** The portions of the PFA in the mature and old VSSs have a minimum canopy cover of 50%. One-third of the area in the mid-aged portion has a minimum canopy cover of 60%, and the remaining two-thirds has a minimum canopy cover of 50%. This distribution provides hiding cover for fledgling goshawks and moist forest soils for development of fungi.

- ***Snags***: At least 2 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the PFA. These dimensions meet the minimum requirements for the majority of prey species.
- ***Downed Logs***: At least 3 large (≥12 inch

diameter mid-point, ≥8 feet long) downed logs per acre throughout the PFA. Downed logs of this number and size are important for many prey species.

- *Live trees:* A minimum of 3-5 mature and old, live trees per acre in groups or stringers with interlocking crowns. Interlocking crowns allow squirrels to move from tree crown to tree crown (Appendix 3, page 53).

**Additional Desired Conditions, Mixed-species and Spruce-fir Forest Types**

√ *Stand structure:* Those portions of the PFA in the mature and old VSS have a minimum canopy cover of 60% in mixed-species and 70% in spruce-fir. In the mid-aged portion of the PFA, the minimum canopy cover is 60% for both forest types. This distribution provides hiding cover for fledgling goshawks and moist forest soils for development of fungi.

- *Snags*: At least 3 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the PFA.
- *Downed logs:* At least 5 large (≥12 inch diameter mid-point, ≥8 feet long) downed logs per acre throughout the PFA .
- *Live trees:* Because the mixed-species (upper elevations) and spruce-fir forest types contain red squirrel habitat, a higher density of mature and old trees with interlocking crowns in clumps is required. A minimum of 1 group of 6 mature and old trees per acre in mixed-species, and at least 1 intact group (with at least 6 mature or old trees per group) per half-acre (2 groups per acre) in spruce-fir is required (Appendix 3, page 53).

**Management Recommendations, All Forest Types**

√ In cases where the PFA of one goshawk pair overlaps the foraging area of another pair, the management recommendations for the PFA take precedence.

√ No adverse management activities in PFAs during the nesting season, March 1 - September 30. Minimize human presence during nesting.

√ Preferred treatment for maintaining stand structure in the PFA: Thin from below (Fig. 10). In the three youngest VSSs, these treatments should result in lower stand densities (basal areas) to promote fast tree growth, crown development, herb and/or shrub development. Treatments should also allow for irregular spacing of trees in the three older VSS's, allow stand densities (basal areas) to increase (Appendix 5, Table 5; page 84). Provide for or preserve existing clumps of trees with interlocking crowns in the three older VSSs by avoiding uniform spacing of trees. Other treatments (such as sanitation, liberation, improvement) could be used when and where appropriate to create desired conditions.

√ Manage road densities at the lowest level possible to minimize disturbance in the PFA. Where timber harvesting has been prescribed to achieve desired forest conditions, use small, permanent skid trails in lieu of roads.

√ Wildlife and livestock utilization of grasses and forbs should average 20% by weight and not exceed 40% in any area, and shrub utilization should average 40% by weight and not exceed 60% in any area. This level of utilization should maintain native foods and cover for many of the prey species (Schmutz 1978, Wasser 1982).

**Additional Management Recommendations, Ponderosa Pine Forest Type**

√ Create small openings (2 acres or less) with regeneration cuts. Small openings are preferred to large openings because the PFA is a transition in vegetative structure from the nest area (no openings) to the foraging area with medium-sized openings (see Foraging Area). Openings should be irregular in shape and no greater than 200 feet in width to assure goshawk foraging opportunities in openings within them. If openings are greater than 1 acre, identify and retain 3 to 5 mature and old trees per acre (reserve trees) with interlocking crowns. In openings less than 1 acre, the large-tree component can be met in adjacent forested areas. Interlocking crowns provide squirrel habitat and food, minimize blowdown, and increase drought resistance. Scatter openings throughout the PFA wherever possible to develop the desired interspersion of structural stages (Fig. 11 and Fig. 12).

√ Encourage aspen and oak regeneration. These trees are desirable for woodpeckers and other prey species (Appendix 3, page 53). Animal exclosures may be necessary to develop and maintain tree regeneration.

√ Planting of ponderosa pine, in addition to relying on natural regeneration, is recommended.

√ Leave 5 - 7 tons per acre of woody debris (greater than 3 inches in diameter) and downed logs distributed across areas, after timber harvesting, for small animal habitat and to maintain long-term productivity (Harvey et al. 1987, Graham et al. in press). Treatments, in order of priority:

1) Use periodic prescribed fires to regenerate where needed and to develop desired stand conditions, recycle

**REGENERATION METHOD:**
***Shelterwood with Reserve Trees***

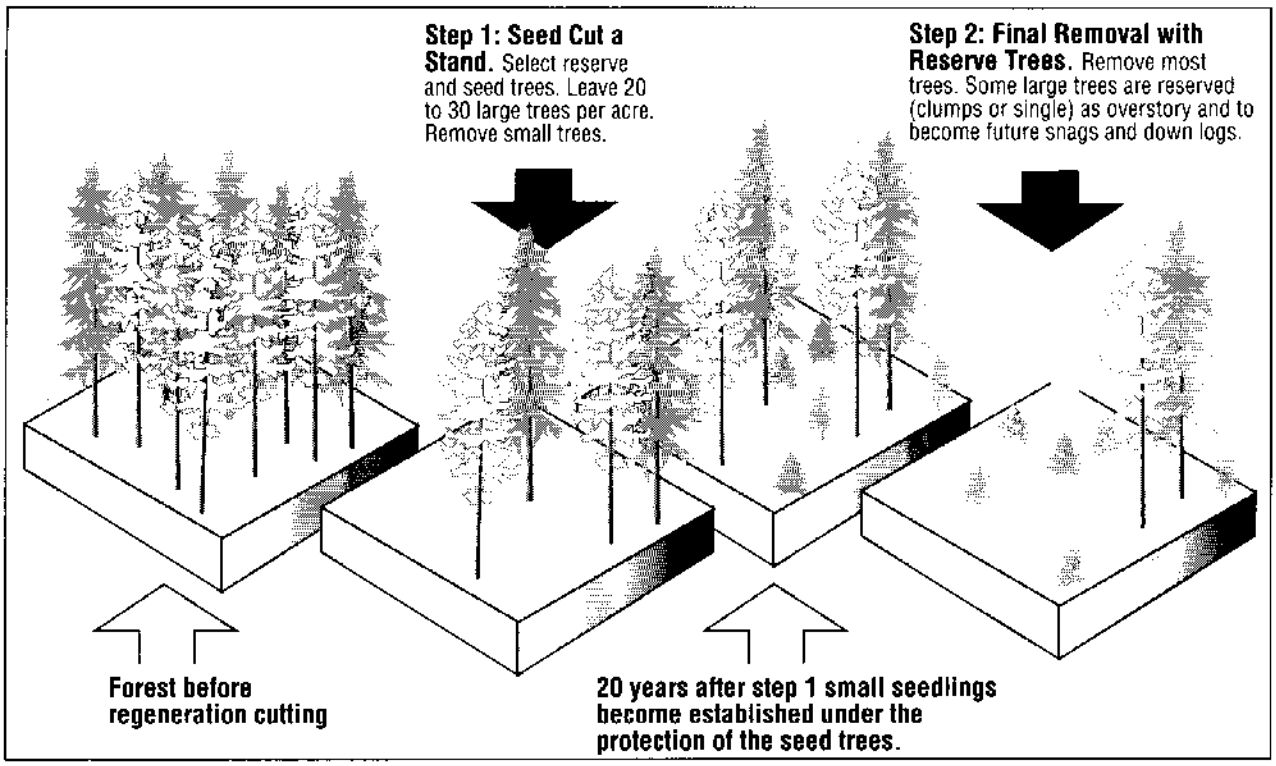



**Figure 11. The shelterwood regeneration method with reserve trees is appropriate in both post-fledging family areas and foraging areas.**

**REGENERATION METHOD:**
***Group-selection***

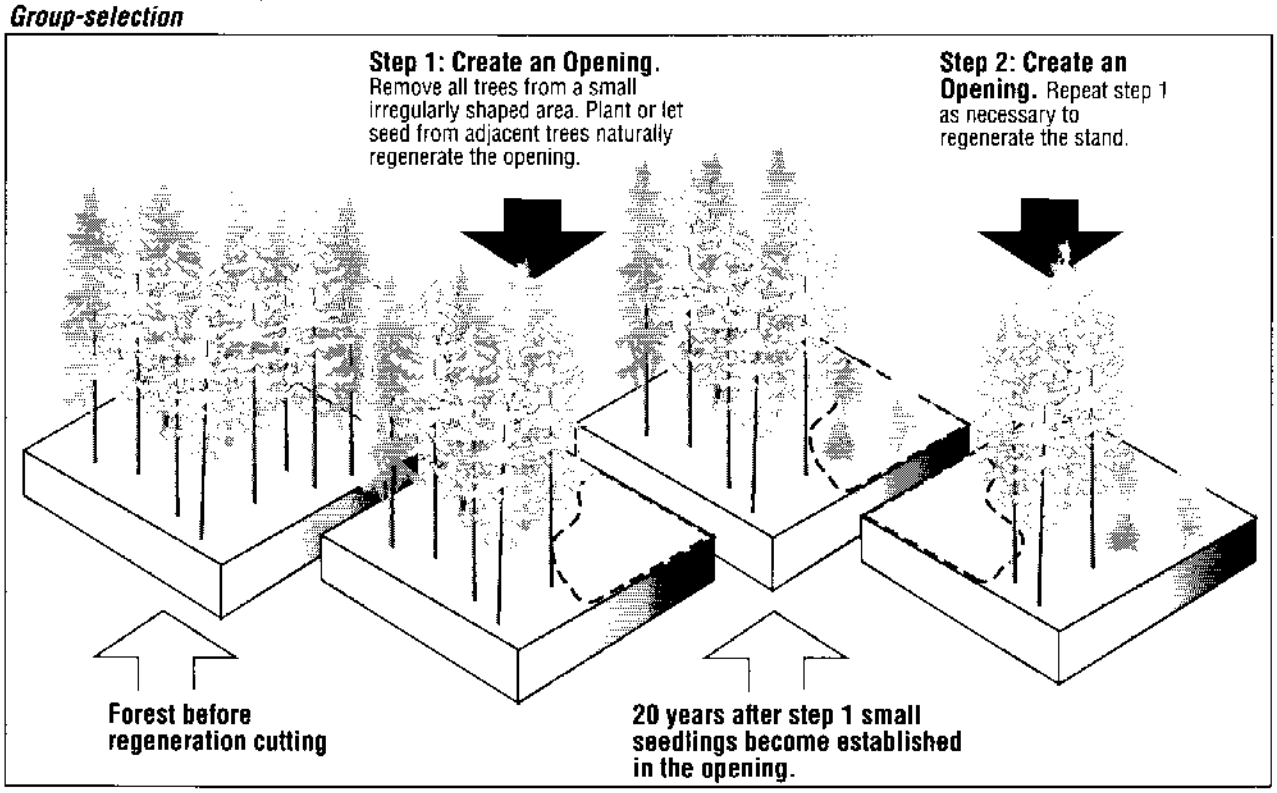



**Figure 12. The group-selection regeneration method is appropriate in both post-fledging family areas and foraging areas.**

organic matter, and decrease hazard fuels.

2) Lopping and scattering of logging debris is preferred if prescribed fire cannot be used. Some scarification may be necessary for regeneration.
3) Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
4) Dozer use is not recommended for piling or scattering of logging debris. Improper dozer use can displace and destroy the forest floor and herbaceous layer.

**Additional Management Recommendations, Mixed-species and Spruce-fir Forest Types**

√ In mixed-species forests, create small openings (2 acres or less) with regeneration cuts. Small openings are preferred to large openings in the PFA because it is a transition in the vegetative structure from the nest area (no openings) to the foraging area with medium sized openings (see Foraging Area). Openings should be irregular in shape and no greater than 150 feet in width to minimize the amount of squirrel habitat lost and provide desirable conditions for tree and understory development. If openings are greater than 1 acre, identify and retain at least 6 mature and old trees per acre (reserve trees) with interlocking crowns. In openings less than 1 acre, the large tree component can be met in adjacent forested areas. Interlocking crowns provide squirrel habitat and food, minimize potential of blowdown, and increase drought resistance. Scatter openings throughout the PFA wherever possible to develop the desired interspersion of structural stages (Fig. 11 and Fig. 12).

√ In spruce-fir forests, create small openings (1 acre or less) with regeneration cuts. Openings should be irregular in shape and should be no greater than 125 feet in width. Small openings, rather than large, minimize the detrimental effects of opening forests on red squirrel food and habitat. If openings are greater than 0.5 acres, identify and retain at least 1 intact group (with at least 6 mature and old reserve trees per group) per 0.5 acres with interlocking crowns. No trees should be cut within these groups. In openings less than 0.5 acres, the large-tree component can be met in adjacent forested areas. Interlocking crowns provide squirrel habitat and food, minimize potential of blowdown, and increase drought resistance. Scatter openings throughout the PFA wherever possible to develop the desired interspersion of structural stages (Fig. 11, Fig. 12, and Fig. 13).

√ In red squirrel habitat, center the intact tree groups around existing food caches (middens).

√ Leave 10 - 15 tons per acre of woody debris (greater than 3 inches in diameter) and downed logs distributed across areas, after timber harvesting, for animal habitat and long-term productivity (Harvey et al. 1987, Graham et al. 1991c). Treatments, in order of priority:

1) Use periodic prescribed fires only in mixed-species to regenerate where needed and to develop desired stand conditions, recycle organic matter, and decrease hazard fuels.
2) Lopping and scattering of logging debris is preferred if prescribed fire or grapple piling cannot be used. Some scarification may be necessary for regeneration.
3) Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
4) Dozer use is not recommended for piling or scattering of logging debris. Improper dozer use can displace and destroy the forest floor and herbaceous layer.

√ Planting of appropriate seral tree species, in addition to relying on natural regeneration, is recommended.

√ Encourage aspen and oak regeneration in mixed-species and aspen regeneration in spruce-fir. These trees are desirable for woodpeckers and other prey species (Appendix 3, page 53). Animal exclosures may be necessary to develop and maintain aspen regeneration.

## Foraging Area

**Management Objectives**

√ Provide quality habitat for goshawk prey.

√ Provide conditions that enhance foraging opportunities for the goshawk.

**Desired Conditions, All Forest Types**

√ *Size*: Approximately 5400 acres (not including nest areas and PFA acres). Although portions of natural and permanently created openings close to forest edges may be utilized for foraging by goshawks, these areas are not counted as part of

**REGENERATION METHOD:**
***Irregular Group Shelterwood***

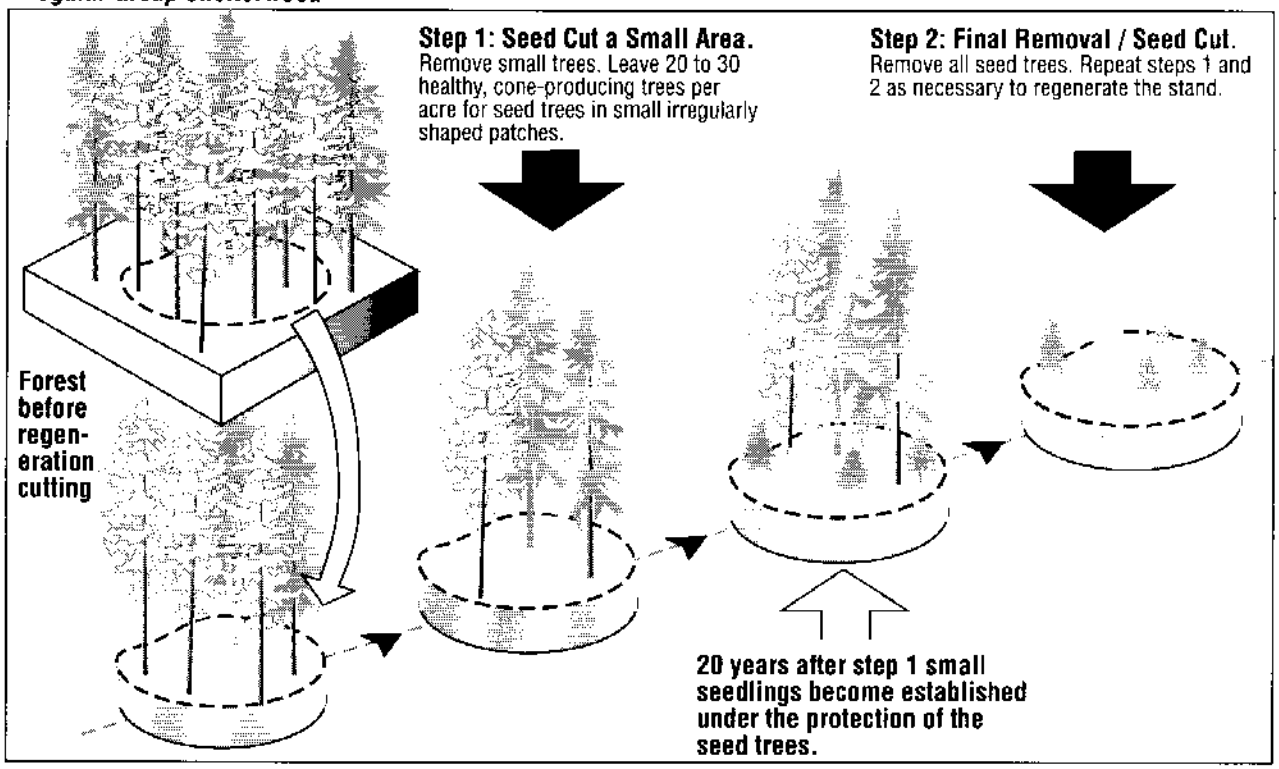



**Figure 13. The irregular group shelterwood regeneration method is appropriate in both post-fledging family areas and foraging areas.**

the foraging area. Also, do not count created openings (such as forest health, fire) greater then four acres in size as part of the foraging area.

√ ***Location***: Foraging areas surround nest areas and PFAs.

√ ***Stand structure:*** A mosaic of vegetation structural stages interspersed throughout the foraging area in small patches.

- The majority (60%) of the foraging area should ultimately be in the three older VSSs (4, 5, 6), approximately 20% in each. Of the remaining 40%, 20% should be in young forest (VSS 3) and 10% in the seedling/sapling (VSS 2) and 10% in grass/forb/shrub (VSS 1). The approximate proportions that can be maintained in the different VSS classes depend on:

1) the years required for tree establishment and development,
2) diameter growth rates, and
3) tree longevity (Appendix 5, page 82).

The number of years spent in each VSS will depend on the intensity of management (Appendix 5, page 82 ).

√ The large-tree component throughout the foraging area should include: snags, downed logs, and mature and old live trees in clumps or stringers with interlocking crowns.

√ A developed herbaceous and/or shrub understory should emphasize native species, especially grasses, throughout the foraging area.

√ ***Woody debris:*** present throughout the foraging area.

√ ***Soil conditions:*** developed, intact forest soils with emphasis on organic surface layers (humus, litter, and soil wood) within natural turnover rates. These conditions should provide for the sustainability of mycorrhizae.

**Additional Desired Conditions, Ponderosa Pine Forest Type**

√ ***Stand structure:*** The portions of the foraging area in the mature and old VSS should have a minimum canopy cover of 40%. This level helps provide moist forest soils for the development of fungi.

- ***Snags:*** At least 2 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the foraging area. These dimensions meet the minimum requirement for the majority of prey species.

- *Downed Logs:* At least 3 large (≥12 inch diameter mid-point, ≥8 feet long) downed logs per acre throughout the foraging area. Downed logs of this number and size are important for many prey species
- *Live trees:* A minimum of 3-5 mature and old live trees per acre in groups or stringers with interlocking crowns. Interlocking crowns allow squirrels to move from tree crown to tree crown. These groups of mature and old live trees will produce snags, supply perch and roost trees, and goshawk hunting perches (Appendix 3, page 53).

**Additional Desired Conditions, Mixed-species Forest Type**

√ *Stand structure:* In that portion of the foraging area that is VSS 6, there is a minimum canopy cover of 60%. In the portion of the foraging area that is in the mature stage (VSS 5), there is a minimum canopy cover of 50%. In the portion of the foraging area that is in the mid-aged stage (VSS 4), one-third of the area has a minimum canopy cover of 60%, and the remaining two-thirds has a minimum canopy cover of 40%. These levels provide moist forest soils for sustaining fungi.

- *Snags*: At least 3 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the foraging area.
- *Downed logs:* At least 5 large (≥12 inch diameter mid-point, ≥8 feet long) downed logs per acre throughout the foraging area.
- *Live trees:* Because the mixed-species forest type contains red squirrel habitat, a higher density of mature and old trees in groups with interlocking crowns is required. A minimum of 6 mature and old trees per acre in groups or stringers with interlocking crowns is required. Interlocking crowns allow squirrels to move from tree crown to tree crown (Appendix 3, page 53).

**Additional Desired Conditions, Spruce-fir Forest Type**

√ *Stand structure:* In the portions of the foraging area in the two oldest VSSs (5, 6), there is a minimum canopy cover of 60%. In the portion of the foraging area in the mid-aged stage (VSS 4), one-third of the area has a minimum canopy cover of 60%, and the remaining two-thirds has a minimum canopy cover of 40%. These levels provide moist forest soils for development of fungi.

- *Snags:* At least 3 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the foraging area.
- *Downed logs:* At least 5 large (≥12 inch diameter mid-point, ≥8 feet long) downed logs per acre throughout the foraging area.
- *Live trees:* Because the spruce-fir forest type contains red squirrel habitat, a higher density of mature and old trees per acre with interlocking crowns in groups is required. At least 1 intact group (with at least 6 mature or old trees per group) per 0.5 acre (2 groups per acre) is required.

**Management Recommendations For All Forest Types**

√ In cases where the PFA of one goshawk pair overlaps the foraging area of another pair, the management recommendations for the PFA take precedence.

√ Preferred treatment for maintaining stand structure in the foraging area is thinning from below (Fig. 10, page 23). In the three youngest VSSs (1, 2, 3), these treatments should result in lower stand densities (basal areas) to promote fast tree growth, crown development, and herb and/or shrub development. Treatments should also allow for irregular spacing of trees, in the three older VSSs, allow stand densities (basal areas) to increase (Appendix 5, Table 5; page 84). Provide for or preserve existing clumps of trees with interlocking crowns in the three older VSSs by avoiding uniform spacing of trees. Other treatments (such as sanitation, liberation, improvement) could be used when and where appropriate to create desired conditions.

√ Manage road densities at the lowest level possible to minimize disturbance in the foraging area. Where timber harvesting has been prescribed to achieve desired forest conditions, use small, permanent skid trails in lieu of roads.

√ Wildlife and livestock utilization of grasses and forbs should average 20% by weight and not exceed 40% in any area, and shrub utilization should average 40% by weight and not exceed 60% in any area. This level of utilization should maintain native foods and cover for many of the prey species (Schmutz 1978, Wasser 1982).

**Additional Management Recommendations, Ponderosa Pine Forest Type**

√ Create small to medium openings (up to 4 acres) with regeneration cuts. Openings of this size in the foraging area are preferred by the majority of the prey species. Openings should be irregular in shape and no greater than 200 feet in width to

assure goshawk foraging opportunities in openings. If openings are greater than 1 acre, identify and retain 3 to 5 mature and old trees per acre (reserve trees) with interlocking crowns. In openings less than 1 acre, the large-tree component can be met in adjacent forested areas. In addition, interlocking crowns provide squirrel habitat, minimize blowdown, and increase drought resistance. Scatter openings throughout the foraging area wherever possible to develop the desired interspersion of structural stages (Figs. 11, 12; page 25).

√ Encourage aspen and oak regeneration. These trees are desirable for woodpeckers and other prey species (Appendix 3, page 53). Animal exclosures may be necessary to develop and maintain tree regeneration.

√ Planting of ponderosa pine, in addition to relying on natural regeneration, is recommended.

√ Leave 5 - 7 tons per acre of woody debris (greater than 3 inches in diameter) and downed logs distributed across areas, after timber harvesting, for animal habitat and to maintain long-term productivity (Harvey et al. 1987, Graham et al. 1991c). Treatments, in order of priority:

1) Use periodic prescribed fires to regenerate where needed and to develop desired stand conditions, recycle organic matter, and decrease hazard fuels.
2) Lopping and scattering of logging debris is preferred if prescribed fire cannot be used. Some scarification may be necessary for regeneration.
3) Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
4) Dozer use is not recommended for piling or scattering of logging debris. Improper dozer use can displace and destroy the forest floor and herbaceous layer.

**Additional Management Recommendations, Mixed-species Forest Type**

√ Create small to medium openings (up to 4 acres) with regeneration cuts. Openings in the foraging areas are needed because several prey species require openings for feeding and breeding. Openings should be irregular in shape and no greater than 200 feet in width to assure goshawk foraging opportunities. If openings are greater than 1 acre, identify and retain at least 6 mature and old trees per acre (reserve trees) with interlocking crowns. In openings less than 1 acre, the large-tree component can be met in adjacent forested areas. Interlocking crowns provide squirrel habitat, minimize blowdown, and increase drought resistance. Scatter openings throughout the foraging area wherever possible to develop the desired interspersion of structural stages (Figs. 11, 12; page 25).

√ Encourage aspen and oak regeneration. These trees are desirable for woodpeckers and other prey species (Appendix 3, page 53). Animal exclosures may be necessary to develop and maintain tree regeneration.

√ Planting of appropriate seral tree species in addition to relying on natural regeneration is recommended.

√ Leave 10 - 15 tons per acre of woody debris (greater than 3 inches in diameter) and downed logs distributed across areas, after timber harvesting, for animal habitat and to maintain long-term productivity (Harvey et al. 1987, Graham et al. 1991c). Treatments, in order of priority:

1) Use periodic prescribed fires to regenerate where needed and to develop desired stand conditions, recycle organic matter, and decrease hazard fuels.
2) Lopping and scattering of logging debris is preferred if prescribed fire cannot be used. Some scarification may be necessary for regeneration.
3) Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
4) Dozer use is not recommended for piling or scattering of logging debris. Improper dozer use can displace and destroy the forest floor and herbaceous layer.

**Additional Management Recommendations, Spruce-fir Forest Type**

√ Create small openings (up to 1 acre) with regeneration cuts. Openings should be irregular in shape and no greater than 125 feet in width. Small openings minimize the detrimental effects of opening the forest on red squirrel food and habitat. If openings are greater than 0.5 acres, identify and retain at least 1 intact group (with at least 6 mature and old reserve trees per group) per half-acre with interlocking crowns. No tree cutting should occur

within groups. In openings less than 0.5 acres, the large-tree component can be met in adjacent forested areas. Interlocking crowns provide squirrel habitat, minimize potential of blowdown, and increase drought resistance. Scatter openings throughout the foraging area wherever possible to develop the desired interspersion of structural stages (Figs. 11, 12, 13; pages 25, 27).

√ Encourage aspen and seral tree species regeneration. Aspen is desirable for woodpeckers and other prey species (Appendix 3, page 53). Animal exclosures may be necessary to develop and maintain tree regeneration.

√ In red squirrel habitat, center the intact tree groups around existing food cache locations (middens).

√ Leave 10 - 15 tons per acre of woody debris (greater than 3 inches in diameter) and downed logs distributed across areas, after timber harvesting, for animal habitat and to maintain long-term productivity (Harvey et al. 1987, Graham et al. 1991c). Treatments, in order of priority:

1) Lopping and scattering of logging debris is preferred if prescribed fire cannot be used. Some scarification may be necessary for regeneration.
2) Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
3) Dozer use is not recommended for piling or scattering of logging debris. Improper dozer use can displace and destroy the forest floor and herbaceous layer.

# Related Benefits of Achieving Desired Forest Conditions

Achieving the desired forest conditions will benefit other aspects of forest health, forest productivity, forest protection, and the habitat of many native plants and animals.

## Landscape Ecology

Landscape ecology focuses on a mosaic of forest structural stages and the biological and physical processes that influence the development of a dynamic system (Risser et al. 1984). At the landscape scale, disturbance and the interactions among patches, such as the redistribution of nutrients, organisms, and structural diversity, occur at different spatial and temporal scales (Forman and Godron 1986, Risser et al. 1984).

Providing habitat for the many goshawk prey species results in a mosaic of interspersed vegetative structural stages in large landscape units. Through time, as the various structural stages age, a constant redistribution of the habitats of goshawks and their prey will occur. Extending the goshawk recommendations beyond these units will provide a long-term, sustainable mix of forest-age classes in the landscape, and will ensure that both established and dispersing goshawks will be able to find and settle into favorable habitats. Managing forests at the landscape scale shifts the focus from the more traditional single-species management, and stand level management, to management of ecosystems.

## Species Associated with Old-Growth

Forest plants and animals in the Southwest are adapted to the forest conditions that prevailed from the end of the Pliestocene (10,000 years ago) until European settlement.

The plant associations found in the ponderosa pine and mixed-species forests are habitat for a wide variety of species. At least 57 mammals and 128 bird species occur in them, and populations of about one quarter of these bird species are declining (Diem and Zeveloff 1980, Hoover and Wills 1984). More than a quarter of these vertebrates use the mature and old forests (Hoover and Wills 1984). Several species depend to a large extent on either mature ponderosa pine, such as Grace's warbler, flammulated owl, and spotted bat, or mature mixed-species forests, such as Townsend's warbler, wood thrush, and Mexican spotted owl (Reynolds and Linkhart 1987, Ganey 1989, Siegel 1989, Reynolds and Linkhart 1992). Retention of large trees and the maintenance of older stands provides forests that resemble the pre-settlement conditions -- forests to which these vertebrates are adapted.

## Susceptibility to Catastrophic Crown Fire

Prior to European settlement, naturally caused low-intensity surface fires burned under ponderosa

pine and mixed-species forests at frequencies from 2 to 22 years (Weaver 1951, Dieterich 1983, McCune 1983, Covington and Moore 1991). These episodic surface fires kept the forest floor relatively free of excessive fuels, and the understory relatively open by killing young trees. These pre-settlement forests were composed of older age-classes whose trees had clear trunks, and crowns that were above the reach of surface fires (Cooper 1960). These pre-settlement forests were "crown-fire resistant." Catastrophic fires, in which overstory trees were killed over large areas, appear to have been rare (Brawn and Balda 1988, Covington and Moore 1991).

In the past 100 years the frequency of low intensity surface fires has been reduced by fire suppression. Fire suppression and harvesting of large trees have resulted in high fuel abundance, dense understories, and stands of young, small trees with crowns close to the surface fuels (Greull et al. 1982, Stein 1988). Ponderosa pine and mixed-species forests are now more than ever threatened by catastrophic crown fires (Barrows 1978).

Attaining the desired forest conditions decreases the hazards of catastrophic crown fire in the ponderosa pine and the mixed-species forests by:

1) maintaining a more open canopy,
2) reducing tree-understory fuel ladders, and
3) increasing the growth rate of trees and reducing the length of time that stands are at risk to catastrophic fires.

## Large Snags and Downed Logs

Long-term maintenance of large trees assures a renewable source of future large snags and downed logs. Under previous timber management systems, trees often did not have sufficient time to grow to the dimensions of large snags and downed logs before they were removed.

Downed logs provide an important component to the habitat of many species; they serve as sites for perching, feeding, nesting, food storage, and cover. Habitat offered by snags and downed logs influences the abundance and distribution of many species of wildlife. For example, at least 41 species of birds are known to use tree cavities in the southwestern forest types (Scott and Patton 1975).

## Forest Productivity

Organic materials provide habitat for microorganisms and many plants and animals (Harvey et al. 1978, Maser et al. 1978, Harvey et al. 1987). It is critical that adequate organic material be cycled in ecosystems, especially after forest management activities (Graham et al. 1991b). In unmanaged forest ecosystems, organic materials were recycled by fire, disease, and decomposition. By providing a constant supply of organic material by proper management of logging debris, snags, and downed logs, site productivity can be maintained (Graham et al. 1991c). Organic materials in soil surface layers (humus, litter, soil wood) are also essential for maintaining ecosystem function and sustainability.

Because productive soils are essential to functioning ecosystems, including plant and animal populations, these recommendations offer a means to satisfy concerns that are fundamental to the health of the land and the soil-plant-herbivore-predator relationships.

## Maintenance of Mycorrhizal Communities

Mycorrhizae play an important role in the interactions between the soil, plants, and animals, especially small mammals. In forest ecosystems, ectomycorrhizae provide the main nutrient absorbing pathways (Harvey et al. 1976, Read 1991).

Within the organic surface soil layers, where ectomycorrhizae are concentrated, they are directly involved with the mobilization of nutrients (Harvey et al. 1976, Harley 1978, Harley and Smith 1983). Ectomycorrhizal roots not only capture and store phosphate ions (Harley and Smith 1983), they have the ability to mobilize nitrogen from protein (Abuzinadah and Read 1986, 1989). Nitrogen is generally considered the most important growth-limiting nutrient in many forest ecosystems (Baath and Soderstrom 1979).

Mycorrhizal fungi are also important food sources for small mammals (Tevis 1952, 1953, Stephenson 1974, Fogel and Trappe 1978, Maser et al. 1978, Uphoff 1990). Many of the major fungal taxa eaten by squirrels and chipmunks are hypogeous ectomycorrhizae (e.g., *Rhizopogon* spp., *Hysterangium* spp., *Gautieria* spp., *Geopora* spp., and Hydnangiales) (Maser et al. 1978, States et al. 1988).

Although some epigeous mycorrhizal disperse their spores via air currents, hypogeous fungi are dependent upon small mammals for spore dispersal. Small mammals ingest fungi, defecate, and thereby spread viable spores throughout forests and openings. The mycorrhizae then inoculate seeds and plant roots. This interrelationship between host plants, fungi, and small mammals helps maintain healthy forest ecosystems (Marks and Kozlowski 1973, Maser et al. 1978). Thus, mycorrhizal fungi function not only as important food for goshawk

prey, but they also form the foundation of a healthy forest ecosystem. These goshawk management recommendations ensure abundant mycorrhizal communities by providing for a continuing supply of woody debris, downed logs, and requisite soil conditions throughout the landscape.

### Forest Products

Managing southwestern forests to attain the desired conditions should provide a variety of forest products. The recommendations call for intensive management through understory treatments of forest stands to produce large trees quickly. These intermediate treatments provide small saw-logs and wood material for small product and fiber-based industries. In addition to providing goshawk habitat, large trees not permanently protected will make excellent saw-logs.

### Forage Production

In addition to supplying small mammal habitat, the open forest conditions generated by understory thinning will produce more forage for wildlife and livestock across the landscape.

# Research Needs

Current knowledge of certain aspects of goshawk biology and forest growth and development are limited. The overall effects of forest management practices on goshawks have not been measured. Therefore, several assumptions were necessary to develop these recommendations. These assumptions highlighted key research needs.

- √ A greater understanding of forest regeneration, growth, and development, both temporally and spatially, is needed to assure the sustainability of the desired forest conditions.
- √ The desired forest conditions require small forest openings, large reserve trees, and a high interspersion of forest age classes. What impact will these conditions have on the long-term growth, development, and sustainablity of these forests? What role will insects, diseases, wildfires, and other natural disturbances play in sustaining the desired conditions?
- √ Improved techniques for monitoring and inventorying forests at large geographic and temporal scales, and the application of this information, are needed to improve the forest-development models used in these recommendations.
- √ Goshawk demography is poorly known. Research is needed to determine population size and structure, rate and direction of population change, age-specific fecundity and survival, life span, mate and territory fidelity, and adult and juvenal dispersal.
- √ Characteristics of summer and winter home ranges and habitat use by foraging goshawks are poorly understood. Research is needed to determine the seasonal and annual variation in home range size, shape, location, and the composition of forests within goshawk ranges. Foraging behavior, activity budgets, and habitat-use patterns also need to be determined.
- √ Diets of goshawks by forest type, the numerical response of goshawk populations to prey abundance, and the habitat relationships of some of those prey are poorly known. Research is needed to determine the seasonal, annual, and inter-goshawk variation in dietary composition and the abundance of prey by topography, forest structure, and forest type.

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# Appendix 1. Description of ponderosa pine, mixed-species, and spruce-fir forest cover types

## Ponderosa Pine Forest Cover Type

Ponderosa pine (*Pinus ponderosa* var. *scopulorum*) is one of the most widely distributed forest cover types in the western United States (Table 1). Ponderosa pine is found in pure stands as a climax species or in mixed-species stands as a seral species. For the most part, seed production of ponderosa pine is predictable (Table 2). In a climax situation, natural regeneration of ponderosa pine establishes best on drier sites with some canopy cover. In a seral situation, seedlings establish readily in small openings on more moist sites. Ponderosa pine is a moderately shade- intolerant species, requiring nearly full sunlight for establishment and growth.

Seedling establishment can be expected to occur within 10 years after opening the canopy and forest floor disturbance. Seedlings develop best under partial shade.

**Table 1. Acres of reserved and nonreserved timberland on Southwestern National Forests and the proportion of nonreserved acres by forest cover types.[1]**

| Forest Cover Type | Percent nonreserved | National Forest Timberland, Acres | | |
|---|---|---|---|---|
| | | New Mexico | Arizona | Total |
| Ponderosa Pine | 73.6 | 1,639,548 | 2,212,420 | 3,851,968 |
| Mixed-species* | 22.9 | 946,516 | 253,322 | 1,199,838 |
| Spruce-fir | 3.5 | 105,444 | 76,671 | 182,115 |
| Total nonreserved acres | 100.0 | 2,691,508 | 2,542,413 | 5,233,921 |
| Total reserved acres | | 1,240,722 | 1,404,642 | 2,645,364 |
| Grand total | | 3,932,230 | 3,947,055 | 7,879,285 |

** Includes Douglas-fir, limber pine, white fir, spruce, other softwoods, and aspen forest types.*

[1] *Conner et al. 1990, Van Hooser et al. unpublished.*

**Table 2. Heavy cone crop interval years and optimum age of seed production for tree species in ponderosa pine, mixed-species, and spruce-fir forests.**

| Species | Interval of Heavy Crop (Years) | Age of Optimum Seed Production | Reference |
|---|---|---|---|
| Blue spruce | 2-3 | 50-150 | Fechner 1990 |
| Corkbark fir | 3-4 | 150-200 | Alexander et al. 1990 |
| Douglas-fir | 7 | 200-300 | Hermann and Lavender 1990 |
| Engelmann spruce | 2-5 | 150-250 | Alexander and Shepperd 1990 |
| Gambel oak | 4-5 | Sprouts vegetatively | Daniel 1980 |
| Limber pine | 2-4 | Unknown | Steele 1990 |
| Ponderosa pine | 3-4 | 60-160 | Minore 1979, Oliver & Ryker 1990 |
| Southwestern white pine | 3-7 | Unknown | Krugman & Jenkinson 1974 |
| Subalpine fir | 3-4 | 150-200 | Alexander et al. 1990 |
| White fir | 3-9 | Unknown | Laacke 1990 |
| Aspen | NA[1] | Suckers vegetatively | Perala 1990 |

[1] *NA: Not applicable.*

## Mixed-Species Forest Cover Type

Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) and white fir (*Abies concolor*) are the dominant species of the mixed-species forest cover type. Blue spruce (*Picea pungens*), aspen (*Populus tremuloides*) and limber pine (*Pinus flexilis*) are the major associates found in the cover type. Other species that may occur in minor amounts are subalpine fir (*Abies lasiocarpa* var. *lasiocarpa*), corkbark fir (*Abies lasiocarpa* var. *arizonica*), Engelmann spruce (*Picea engelmannii*), southwestern white pine (*Pinus strobiformis*), ponderosa pine, aspen, and Gambel oak (*Quercus gambelii*). Most often this type has a rich diversity of vegetation, including three or more tree species, and an abundant understory (Krauch 1956, Fyre 1980).

Tree species have different shade tolerance levels, regeneration requirements, and growth characteristics. Shade-tolerant species have the ability to establish and grow in the shade of other larger trees. Shade tolerance of the species, in decreasing order, is (Daniel 1980):

1. subalpine fir
2. Engelmann spruce
3. corkbark fir
4. white fir
5. Douglas-fir
6. blue spruce
7. southwestern white pine
8. limber pine
9. ponderosa pine
10. aspen
11. Gambel oak

Shade-tolerant tree species express their presence and dominance as mixed-species stands grow older and/or become more dense. There is a gradual change in species composition to the more shade-tolerant species.

Natural regeneration usually occurs easily and frequently in the mixed-species type. The more shade-tolerant species are favored when openings in the forest canopy are small. When larger openings (4 acres) are created the intermediate and shade-intolerant species are favored. Aspen and Gambel oak regenerate vegetatively and occur frequently in larger openings.

Relative seed production of trees (Krugman and Jenkinson 1974, Alexander et al. 1990, Alexander and Shepperd 1990, Hermann and Lavender 1990, Oliver and Ryker 1990), in the mixed-species type in decreasing order, is:

1. blue spruce
2. Douglas-fir
3. Engelmann spruce
4. corkbark fir
5. white fir
6. ponderosa pine
7. southwestern white pine

In general, natural seedling establishment in the mixed-species type occurs within a 10-year period except for blue spruce, Engelmann spruce, subalpine fir, and corkbark fir, which can require up to 20 years for establishment. Aspen and Gambel oak generally require one growing season to become established.

## Engelmann Spruce-Subalpine Fir (Spruce-fir) Forest Cover Type

Spruce-fir forests are especially prone to wind damage. The dominant tree species in the spruce-fir forest cover type are Engelmann spruce and subalpine fir. Minor tree species include Douglas-fir, blue spruce, white fir, aspen, corkbark fir, limber pine, and bristlecone pine (*Pinus aristata*).

In general, natural regeneration can require up to 20 years in the spruce-fir type after the forest canopy is opened and the forest floor disturbed. Because solar radiation is more intense and there are fewer frost-free days at higher elevations, regeneration is slow even with good seed production (Alexander and Sheppard 1990, Alexander et al. 1990). Shade in the form of down logs or large trees is critical for seedling establishment and early growth.

# Appendix 2. Vertebrates in the diets of nesting northern goshawks from various locations in North America

**Species are listed in approximate order of decreasing size and potential contribution to the biomass consumed by the goshawks.**

| Species[1] | Number of Prey (% in the diet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Schnell 1958[2] | | Meng 1959[3] | | Reynolds & Meslow 1984[4] | | Mannan & Boals 1990[5] | | Kennedy 1991[5] | |
| Great-horned owl | | | | | 1 | (0.5) | | | | |
| Mallard | 3 | (4) | | | 2 | (1) | | | | |
| Cat (*Felis* spp.) | | | | | | | | | 1 | (1) |
| Black-tailed jackrabbit | | | | | | | 2 | (1) | | |
| Snowshoe hare | 1 | (1) | | | 24 | (1) | | | | |
| **Blue grouse** | | | | | 5 | (2) | | | | |
| Unknown grouse | | | | | 1 | (0.5) | | | | |
| **Cottontails** | | | 7 | (4) | 3 | (1) | 16 | (12) | 25 | (20) |
| Gray squirrel | | | 4 | (2) | 5 | (2) | | | | |
| Common raven | | | | | | | | | 3 | (3) |
| Prairie falcon | | | | | | | | | 1 | (1) |
| Ruffed grouse | | | 5 | (3) | 2 | (1) | | | | |
| **Pigeon (Columba spp.)** | 1 | (1) | | | | | | | 2 | (2) |
| Common crow | | | 83 | (45) | | | | | | |
| **Tassel-eared squirrel** | | | | | | | 7 | (5) | 9 | (9) |
| Cooper's hawk | | | | | 1 | (0.5) | | | 2 | (2) |
| Bushy-tailed woodrat | | | | | 1 | (0.5) | | | | |
| Pileated woodpecker | | | | | 1 | (0.5) | | | | |
| Rock squirrel | | | | | | | 3 | (2) | | |
| **Tree squirrel spp.** | | | | | | | | | 7 | (7) |
| Belding's ground squirrel | 3 | (3) | | | 4 | (2) | | | | |
| Woodrat spp. | | | | | 1 | (0.5) | | | | |
| Mountain quail | 1 | (1) | | | 9 | (4) | | | | |
| Dusky footed woodrat | | | | | 1 | (0.5) | | | | |
| **Squirrel *(Tamiasciurus spp.)*** | 5 | (6) | 58 | (31) | 13 | (6) | 2 | (1) | 3 | (3) |
| Black-billed magpie | | | | | 1 | (0.5) | | | | |
| Screech owl | | | | | 1 | (0.5) | | | | |
| Northern flying squirrel | | | | | 15 | (7) | | | | |
| **Mantled ground squirrel** | 6 | (7) | | | 17 | (7) | 21 | (16) | 2 | (2) |
| **Northern flicker** | | | | | 15 | (7) | 5 | (4) | 15 | (14) |
| Townsend's ground squirrel | | | | | 2 | (1) | | | | |
| **Mourning dove** | | | | | 7 | (3) | | | 1 | (0.7) |
| American kestrel | | | 3 | (2) | | | | | 1 | (1) |

*Continued on next page.*

*Appendix 2 (continued) - Vertebrates in Diets of Nesting Northern Goshawks*

| Species[1] | Number of Prey (% in the diet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Schnell 1958[2] | | Meng 1959[3] | | Reynolds & Meslow 1984[4] | | Mannan & Boals 1990[5] | | Kennedy 1991[6] | |
| **Steller's jay** | 22 | (25) | | | 29 | (13) | 7 | (5) | 9 | (9) |
| Scrub jay | | | | | | | | | 1 | (1) |
| Clark's nutcracker | | | | | | | 3 | (3) | | |
| Belted kingfisher | | | | | | | 2 | (2) | | |
| Blue jay | | | 7 | (4) | | | | | | |
| Lewis' woodpecker | | | | | 1 | (0.5) | | | | |
| Unknown mammal | 5 | (6) | | | 6 | (3) | 5 | (5) | 28 | (21) |
| Townsend chipmunk | | | | | 3 | (1) | | | | |
| Meadowlark | | | | | 4 | (2) | | | | |
| Unknown jay | | | | | 1 | (0.5) | 2 | (2) | | |
| Northern saw-whet owl | | | | | 1 | (0.5) | | | | |
| Northern pygmy-owl | | | | | | | 1 | (1) | | |
| **American robin** | 27 | (31) | | | 20 | (9) | 7 | (7) | | |
| Varied thrush | | | | | 4 | (2) | | | | |
| Gray jay | | | | | 5 | (2) | | | | |
| **Hairy woodpecker** | | | | | 1 | (0.5) | | | 3 | (2) |
| Blackbird spp. | | | 15 | (8) | | | | | 14 | (10) |
| Unknown bird | 1 | (1) | | | | | | | | |
| California mole | 1 | (1) | | | | | | | | |
| **Chipmunks (*Tamias* spp.)** | 5 | (6) | 3 | (2) | 7 | (3) | 2 | (2) | | |
| **Williamson's sapsucker** | | | | | 2 | (2) | 2 | (1) | | |
| Weasel | 1 | (1) | | | | | | | | |
| Woodpecker spp. | | | | | 4 | (2) | | | | |
| **Red-naped sapsucker** | | | | | 1 | (0.5) | | | | |
| Black-headed grosbeak | | | | | 1 | (0.5) | | | | |
| Evening grosbeak | | | | | | | 1 | (1) | | |
| **Least chipmunk** | | | | | 1 | (0.5) | | | | |
| Western bluebird | | | | | | | 2 | (2) | 18 | (13) |
| Western tanager | 4 | (5) | | | 2 | (1) | | | | |
| Hermit thrush | | | | | | | 1 | (1) | | |
| Dark-eyed junco | | | | | 2 | (1) | | | 1 | (0.7) |
| Unknown sparrow | | | | | | | 1 | (1) | | |
| Yellow-rumped warbler | 1 | (1) | | | | | | | | |
| Unknown | | | | | | | | | 7 | (5) |
| Totals | 88 | | 185 | | 227 | | 105 | | 135 | |

[1] *Highlighted species = selected prey of the northern goshawk.*
[2] *California*
[3] *New York and Pennsylvania*
[4] *Oregon*
[5] *Arizona*
[6] *New Mexico*

# Appendix 3. Natural history, habitat, and management recommendations for selected goshawk prey species

The habitat and food needs of selected goshawk prey species were determined by a literature review. In the following, each species' distribution, habitat, food, special habitat needs, home range, populations, and recommendations for improving their habitat are described and summarized. This information was used to identify "special habitat attributes" (Table 6, page 17) and "vegetation structural stages" (Table 7, page 19) needed by the prey that formed the basis for developing the desired forest conditions for each species. Our assumption was that these desired conditions provide opportunities for sustaining abundant goshawk prey populations.

For some goshawk prey, natural history information from southwestern forests was limited; for these species, data from other forest types and/or geographic areas supplemented data from the Southwest. When possible, data from adjacent geographic areas and similar forest types were used preferentially over data from distant areas. We assumed that the foods and habitats used by these goshawk prey outside the Southwest approximated the food and habitat needs within southwestern forests.

## American Robin

*(Turdus migratorius)*

The American robin is a moderately sized passerine about 10 inches in length and weighing about 0.2 pounds (Kilgore 1971, Ramsden et al. 1979). The American robin comprised 6.6% of the diet of northern goshawks (227 prey remains and pellets from 59 nests) in eastern Oregon (Reynolds and Meslow 1984), and 5.6% of 36 prey deliveries to 7 nests of goshawks in north-central New Mexico (Kennedy 1991). No robins were noted in prey deliveries to 8 goshawk nests on the North Kaibab in northern Arizona (Mannan and Boal 1990).

### Distribution

The American robin is a common and widespread songbird throughout the United States (including Alaska), most of Canada and Mexico (Martin et al. 1951).

### Habitat

This wide-ranging passerine inhabits woodlands, hardwood and coniferous forests, riparian areas, shelterbelts, and wooded suburban areas and parks (Franzreb and Ohmart 1978, Stauffer and Best 1980, Savard and Falls 1981, Yahner 1983, Siegel 1989). In the West and Southwest, the robin is found throughout the ponderosa pine forest type, higher elevation mixed-conifer forests, and aspen and willow stands (Winternitz 1976, Franzreb and Ohmart 1978, Siegel 1989). Robins were not detected in censuses above 9,000 feet in the San Francisco Mountains of north-central Arizona (Coons 1984).

### Food

In the mixed-species and ponderosa pine forests in California, coleopterans (beetles) were the most common food item from stomach analyses of American robins (Otvos and Stark 1985). Additionally, caterpillars, earthworms, flies, sowbugs, snails, spiders, termites, millipedes, and centipedes are consumed (Martin et al. 1951). Animal food is primarily consumed during the spring, while during fall, plants are the primary food source. Mistletoe, wild grape, and a variety of other berries are consumed (Martin et al. 1951).

### Special Habitat Needs

The American robin requires no particular habitat attributes other than its use of trees for nest placement. Robins show a preference for nesting in coniferous trees early in the breeding season (April through June), and then nest more often in deciduous trees later in the summer (June through July) (Savard and Falls 1981, Yahner 1983). Winternitz (1976) observed robins most frequently in pure ponderosa pine stands (36%) and in aspen-willow stands (27%). Robins nested in ponderosa pine trees in proportion to their occurrence (33%), but utilized aspen-willow in greater proportion to their occurrence (13%).

In non-urban areas, mean heights of American robin nests ranged from 7.4 feet to 15.4 feet (Preston 1946, Preston and Norris 1947, Young 1955, Stauffer and Best 1980, Savard and Falls 1981). In riparian habitats in Iowa, the mean height of nest trees was 32.2 feet. In riparian habitat, canopy cover was "good" above robin nests and "fair" below the nests (Stauffer and Best 1986). Savard and Falls (1981) noted that vertical distribution of foliage was more important in determining nest height than was foliage volume. More nests were located in the foliage layer just below the layer with the greatest volume regardless of tree type (conifer or

deciduous). Cover was also considered an important variable in robin nest site selection by Preston (1946).

**Home Range**

No home range information on the American robin was found.

**Population**

Mixed-species forests across the West and Southwest supported similar densities of breeding birds. In control (unlogged or old-growth) plots, breeding densities ranged from 2.0 to 7.5 birds per 100 acres. Logged sites in mixed-species forests supported breeding densities of 2.0 to 12.8 birds per 100 acres. Timber management practices ranged from understory thinning to overstory removals in these studies (Franzreb 1977, Mannan and Meslow 1984, Medin 1985, Scott and Crouch 1988).

Nesting densities of robins ranged from 2.3 to 20.0 breeding birds per 100 acres in old-growth ponderosa pine stands. Halderman (1968) also noted that American robins were more abundant in an old-growth ponderosa pine forest (Pearson Natural Area, Arizona) than in logged ponderosa pine stands where densities ranged from 0.5 to 9.4 breeding birds per 100 acres. Selectively logged ponderosa pine stands that still had old-growth conditions (at least 14 trees ≥20 inches DBH, and basal area ≥90 square feet per acre) averaged 3.3 breeding birds per 100 acres over 2 years (Siegel 1989). Sites that were clearcut had the lowest densities of breeding birds, 0.5 birds per 100 acres (Halderman 1968, Szaro and Balda 1979).

American robin densities were also found to be positively correlated with the percentage of aspen overstory. Stands with aspen basal areas greater than 64% of the total basal area contained higher densities of birds per 100 acres (Scott and Crouch 1988).

**Management Effects**

Robins appear to be abundant in unlogged and logged forests with residual large trees. Robin densities were low in clearcut areas (Szaro and Balda 1979, Stauffer and Best 1980, Medin 1985). Partial overstory removals, selective tree harvesting, and understory thinning increased or maintained breeding densities similar to densities found in old-growth forests (Franzreb 1977, Stauffer and Best 1980, Mannan and Meslow 1984, Medin 1985, Scott and Crouch 1988, Siegel 1989).

**Habitat Management Recommendations**

√ **Habitat generalists**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Some evidence for higher densities in forests with large trees

√ **Nesting**
- VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Preferred nest placement is in forests with higher canopy cover
- Nests in trees over a wide range of tree sizes
- Nests are generally 7-16 feet high

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Forage primarily on the ground
- Little foraging in young forests with moderate to closed canopies
- Mistletoe berries important
- Insects important

√ **Other important habitat attributes**
- Moderately open overstory (VSS 3, VSS 4, VSS 5 and VSS 6) with herbaceous, shrub, and deciduous species in understory are the best habitat.
- Snags and downed logs are not important.
- Woody debris may be important in providing food (e.g., insects)
- Small openings probably improve habitat by providing diversity in shrub and herbaceous species.

## Band-tailed Pigeon

*(Columba fasciata)*

The band-tailed pigeon is a relatively large pigeon (0.9 pounds) (Drewien et al. 1966) that occurs throughout many forested mountain ranges of western North America southward into northwestern South America (Goodwin 1967).

Two subspecies are recognized north of Mexico: *C. f. monilis* occurs west of the crest of the Cascade and Sierra Nevada Ranges along the West Coast from California to British Columbia; *C. f. fasciata* is the interior subspecies, which is sparsely distributed in Arizona, New Mexico, Colorado, Utah, Texas, and into central Mexico.

The band-tailed pigeon is migratory, occurring in the northern parts of its range from March to December. Clutch size is usually one, and one brood is produced per year. In the Southwest, the pigeons arrive on the nesting areas in late June and nest from early July to early August. The southward migratory movements begin soon after completion of nesting--mid-August to mid-September. Available evidence suggests that pigeons tend to return to their previous nesting areas (Neff 1951). Goshawks are known to feed on band-tailed pigeons on the Colorado Plateau in the Southwest and in northern

Mexico (Marshall 1957, Kennedy 1991, Reynolds pers. obs.). The wide-ranging movements of the band-tailed during the spring and summer months may make it less available to the goshawk. Observations from Colorado indicate that the pigeon does not begin to appear in goshawk diets until late summer (Reynolds pers. obs.) when most goshawk diet studies typically end. Thus, the importance of this prey species in the Southwest has not been ascertained.

**Distribution**

Neff (1951) summarized the distribution of band-tailed pigeons in the southwestern United States as occurring in the foothill and mountain areas in the Transition and Upper Sonoran life zones.

**Habitat**

During spring and summer the band-tailed pigeon ranges widely, but nests mostly in forests at high elevations. In late summer the pigeon is more readily observed as it concentrates in favored feeding areas. Braun (1973) categorized 1,370 observations of flocks of band-tailed pigeons in Colorado by the vegetation the flocks were located in. Thirty-one percent of the observations were in areas dominated by small grains (wheat, barley, field peas, oats, and corn), 30% were in areas dominated by oak (*Quercus gambelii*), 18% were in areas dominated by ponderosa pine, and 12% were in areas dominated by spruce-fir-aspen and lodgepole pine forests. Only 4% of the observations were associated with piñon-juniper woodlands. Band-tailed pigeons were often observed perched in snags at feeding sites and mineral seeps.

**Food**

Band-tailed pigeons prefer berries and acorns but rely heavily on waste grain available in cultivated and livestock feeding areas (Braun 1973). Neff (1952) and U. S. Fish and Wildlife Service (1954) compiled monthly reports of the diet of pigeons in Arizona, Colorado, and New Mexico from observers in the three-State region:

| | |
|---|---|
| March: | Pine nuts |
| April: | Grain stubble |
| May: | Oats, manzanita berries, oak blossoms, cottonwood buds, mulberries |
| June: | Cherries, spruce buds, mulberries, oak blossoms, grains, pine seed, pine buds, oak leaf buds |
| July: | Cherries, choke cherries, mulberries, wheat, wild currents, juniper berries, acorns |
| Aug: | Acorns, cherries, wheat, stubble, barley, elderberries, wild raspberries, manzanita |
| Sept: | Acorns, fruit, grain stubble, piñon nuts |
| Oct: | Limber pine seed, piñon nuts, spruce seed, acorns |

**Special Habitat Needs**

Nesting habitat requirements of band-tailed pigeons are poorly known. However, pigeons are commonly found in areas dominated by ponderosa pine-Gambel oak, ponderosa pine, Engelmann spruce, Douglas-fir, lodgepole pine, and limber pine from May to September (Braun 1973). In Colorado band-tailed pigeon nests have been found in lodgepole pine (3 nests) (Curtis and Braun 1983) and in large Douglas-fir (2 nests) (Reynolds pers. obs.). The presence of water appears to be important to pigeons in Colorado, but lack of water is not limiting due to the great mobility of band-tails (Braun 1973).

**Home Range**

No information on home range was found on the band-tailed pigeon.

**Population**

Rasmussen (1941) reported that the abundance of band-tailed pigeons on the North Kaibab Plateau was not as high as earlier in the century when they were seen in "great flocks". Rasmussen (1941) suspected the decline was related to the decrease of berry producing shrubs during the 1920s when the range was severely depleted by the rapidly increasing Kaibab deer herd and domestic livestock. Numbers of band-tailed pigeons in Arizona, Colorado, New Mexico, and Utah during the 1950s were reported to be low (Neff 1951, 1952; U.S. Fish and Wildlife Service 1954, 1957; Arizona Game and Fish Dept. 1982). Populations have increased since the 1950s, and appear to be stable (Arizona Game and Fish Dept. 1982).

**Management Effects**

Little is known of the effects of vegetation management on the band-tailed pigeon or its habitat. However, any management practice (e.g., grazing, some activities associated with tree harvests) that reduces the abundance and composition of herbaceous and shrub food plants will likely affect the distribution and abundance of pigeons. Some forestry practices that may enhance band-tailed pigeon habitat include:

1) regeneration and protection of acorn producing Gambel oaks,
2) creation of openings up to 10 acres in mixed-species forests to increase berry

producing shrubs, and
3) maintenance of least 3 snags per acre to provide adequate roosting sites (Arizona Game and Fish Dept. 1982).

**Habitat Management Recommendations**

√ **Lower elevation conifer forest generalists**
- VSS 1, VSS 2, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- Large trees in ponderosa pine-oak (large diameter oak) and mixed-species forests
- VSS 4, VSS 5 and VSS 6

√ **Foraging**
- VSS 1, VSS 2, and in open canopy VSS 4, VSS 5 and VSS 6
- Acorn-producing oaks, berry-producing shrubs, and conifer seeds are important

√ **Other important habitat attributes**
- Snags are important for perching near feeding areas and mineral seeps
- Downed logs and woody debris are not important
- Forests with openings (or open overstory) to allow development of berry-producing shrubs and acorn-producing trees are important

## Blue Grouse

*(Dendragapus obscurus)*

(Dusky Grouse)

The blue grouse is a large (length 18.5-19.6 inches, weight 1.9-2.6 pounds) grouse that inhabits deciduous and coniferous forests in western North America. In the interior mountains of Oregon, blue grouse made up 2% of the prey items of nesting northern goshawks; however, because they were one of the largest prey taken, they contributed more than 10% of the diet by weight (Reynolds and Meslow 1984). The blue grouse has been recorded in the diets of goshawks nesting on the North Kaibab Plateau, Arizona and in Colorado (Reynolds pers. obs.).

**Distribution**

This grouse is widely distributed in the mountain regions of the Interior West (Rocky Mountains). In Arizona, blue grouse are restricted to high-elevation mixed-species forests in small, isolated populations (Severson 1986, Vahle pers. comm.). They are common in the White Mountains, less common in the Chuska Mountains and in the North Kaibab Plateau, and rare in the San Francisco Mountains (Phillips et al. 1964).

**Habitat**

Structural diversity is a major determinant of habitat suitability for blue grouse (Hoffman 1981, Stauffer and Peterson 1985, Schroeder 1984, Severson 1986). Structure of habitat is more important than species composition. In a habitat model, Schroeder (1984) specified optimal summer habitat as 20-50% tree cover, 10-30% shrub cover 1.6 feet high, and 40-75% herbaceous cover 7.9-11.8 inches high. Important forest cover types include spruce-fir, Douglas-fir, and ponderosa pine (Cade 1985, Cade and Hoffman 1990). Mixed-species forests (dominated by Douglas-fir) are probably the most important habitat type in high elevation sites (>9,000 feet) in Arizona (Severson 1986, Vahle pers. comm.).

Blue grouse nest in the lower portions of their range along forested edges of meadows and openings, and migrate to higher elevations in winter (Bendell and Elliott 1966). Adult male territories tend to occur on hillsides and ridge tops (Bendell and Elliott 1967). Blue grouse require open conditions for breeding and older forests are necessary during the winter. When these conditions are long distances apart, blue grouse will only be found in the nesting or overwintering sites depending on the season (Cade and Hoffman 1990). If wintering and breeding habitats are interspersed, then blue grouse may be abundant year round. Adjacency or interspersion of these two cover types is preferred when high blue grouse densities are desired. In coastal populations, openings created by fire or logging contained the highest densities of breeding blue grouse (Bendell and Elliott 1967). Winter habitat preferred by blue grouse was early seral stages and mature forests (Bendell and Elliott 1967). Dense, second-growth conifer stands generally were avoided (Hines 1986).

**Food**

Blue grouse forage in conifer trees, on the forest floor, along ridge tops, and in openings. Major food items are (Schroeder 1984):

| | |
|---|---|
| Spring: | Needles, buds, and new cones of conifers (85%); |
| Summer: | Fruits and seeds (45%), green leaves (25%), and insects (10%); |
| Fall: | Conifer needles (50%), green leaves (25%), and fruits and seeds (20%); and |
| Winter: | Deciduous buds (5%), and seeds (5%). |

The three major foods used in eastern Arizona (April-June) were Douglas-fir needles, Arizona peavine (*Lathyrus arizonicus*) and many other forbs.

**Special Habitat Needs**

Blue grouse prefer coniferous and aspen forest edges, forest openings, and meadows with well-developed herbaceous and shrub layers that provide the necessary food and cover. Coniferous forests are used throughout the year, where they feed primarily on conifer needles. Conifer needles are the most important winter food item (Mussehl 1963, Armleder 1980, Zwickel and Bendell 1985, Cade 1985, Crawford et al. 1986, Severson 1986, Niederleitner 1987).

Zwickel and Bendell (1985) believe that the level of canopy cover is the key element in the abundance of blue grouse. The amount and diversity of understory vegetation appears inversely proportional to overstory shading, especially at the highest level of canopy cover (Frandsen 1980).

In Colorado, wintering blue grouse preferred Douglas-fir trees for feed-trees, although some individuals used lodgepole pine or spruce-fir forests. Remington (1990) found blue grouse did little winter foraging in Engelmann spruce and subalpine fir. Grouse consistently used the largest Douglas-fir trees for feeding. Preferential use of large conifers during winter has also been reported by Stauffer and Peterson (1986), Pekins (1988), and Pekins et al. (1991). Preference for large conifers is likely related to thermoregulatory benefits (Pekins 1988) and food selection (Bryant and Kuropat 1980, Cade 1985).

In spring, the largest trees in blue grouse roosting sites in Arizona averaged 20.3 inches DBH (13-33 inches, n=21 sites); 71.4% of these roost trees were Douglas-fir. These roosting sites contained an average of 9.7 trees (1-35 trees) (Severson 1986).

Openings in the forest, meadows adjacent to forests, or openings in the shrub layer are three habitat components important in male territories. Within territories, small (0.1 - 1.0 acres) dense thickets adjacent to openings were also important for escape or hiding cover. These thickets were generally 20-40 years of age (5-8 inches DBH). Douglas-fir thickets provided better cover than ponderosa pine (Schroeder 1984). Males also used spaces under logs and stumps as resting, hiding, and courtship display sites (Schroeder 1984, Vahle pers. comm.). Breeding females used stumps and logs for concealment.

**Home Range**

Winter home ranges for 21 radio-marked blue grouse averaged 41.5 acres (7.4 to 105.0 acres). Home ranges of 18 juvenile females and one adult female overlapped extensively. Two juvenile males only had minor overlap with the other radio-tagged individuals (Hines 1986). Daily movements were greatest in late summer, averaging over 656 feet. During the fall (September through November), movements were between 328 and 410 feet per day. From winter until spring migration, daily movements ranged from 164 to 246 feet (Hines 1986). Cade (1985) observed fall migrations of 1.8 to 17.4 miles to wintering areas in high-elevation lodgepole pine and spruce-fir forests.

**Population**

Populations of blue grouse are probably cyclic, especially in the north of their range. Density of blue grouse in Colorado has been estimated at 52 birds per square mile, but on Vancouver Island, British Columbia, blue grouse may be as dense as 230 birds per square mile (Bendell 1955).

**Management Effects**

Excessive grazing can have localized, detrimental effects on breeding and brood-rearing habitat (Stauffer 1983, Zwickel and Bendell 1985). Availability of large winter feeding trees appears to be an important limiting factor. Partial harvesting is the most compatible prescription for maintaining suitable winter habitat. At least 16 large (>9 inches DBH) conifers should be left per acre in all cutting areas (Cade 1985). Severson (1986) called for maximizing interspersion of vegetation within blue grouse habitat. Maintaining uneven-aged stands dominated by Douglas-fir with an intermixture of aspen is also important. Roost sites should be managed as groups (5-10 trees with interlocking crowns) of large Douglas-fir or Douglas-fir/white fir. These groups should be irregularly spaced within the area (Severson 1986).

Age of the forest does not seem to be an important limiting factor to reproduction. The key element associated with breeding and brood rearing is the extent to which forest canopy remains open, open canopies allow sufficient light penetration for the development of herbaceous and shrub species (Zwickel and Bendell 1985).

**Habitat Management Recommendations**

√ **Higher elevation conifer forest generalists**

- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- 5-10 large trees in groups with interlocking crowns important for roost sites
- Interspersion of openings (VSS 1 and 2), and moderately dense VSS 3, and large trees of VSS 4, VSS 5, and VSS 6 are important for nesting, feeding, hiding cover, and winter roosting and feed-trees, respectively.

√ **Nesting**
- VSS 1, VSS 2, in forested meadow edges, openings with structural diversity, and adjacent thickets of VSS 3 are very important
- Well developed herbaceous and shrub layers in openings, and in VSS 4, VSS 5, and VSS 6 are very important
- Minimize grazing and browsing to maintain herbaceous and shrub layers

√ **Foraging**
- Breeding season - VSS 1; open canopy VSS 2, VSS 4, VSS 5, and VSS 6
- Winter - closed canopy VSS 4, VSS 5, and VSS 6
- Summer - forest edges and openings with well developed herbaceous and shrub layers adjacent to dense thickets for hiding cover
- Winter - primarily mature forests with large Douglas-fir

√ **Other important habitat attributes**
- Downed logs and woody debris are very important for resting and nesting sites, hiding cover, courtship display sites

## Chipmunks
*(Tamias spp.)*

Cliff Chipmunk (*T. corsalis*)
Colorado Chipmunk (*T. quadrivattus*)
Gray-collared Chipmunk (*T. cinereicollis*)
Gray-Footed Chipmunk (*T. canipes*)
Least Chipmunk (*T. minimus*)
Uinta Chipmunk (*T. umbrinus*)

Five species of chipmunks occur in southwestern conifer forests, or conifer forest-edge habitat. These species weigh 1.4 to 3.2 ounces and are more closely related to ground squirrels than to tree squirrels. In general, high populations of chipmunks are found in open sunny forests that have an abundance of herbaceous and shrubby plants and many logs, stumps, snags, rocks, and cliffs for lookout points and shelter. In general, the nests or dens of these species are underground, in old logs, among rocks, and in cavities in snags. Chipmunks are omnivorous--they feed on seeds, nuts, fruits, bulbs, roots, herbage, insects, and other animal matter (Gordon 1943, Brown 1971). Chipmunks regularly climb into bushes for seeds, fruits, leaves, and flower parts (Gordon 1943). Conifer seeds are obtained by cutting cones from trees, from cones that have fallen to the ground, or by robbing cones from red squirrel caches.

Two to 13% of goshawk diets in the western United States consisted of a variety of chipmunk species (Appendix 2, page 51). It is difficult to distinguish among chipmunk species in dietary remains and determine which species may be important prey of goshawks in the Southwest. Therefore, the following management recommendations are a composite of habitat needs of these species. These species are segregated along habitat-elevational gradients from piñon-juniper to spruce-fir. Key recommendations for ponderosa pine, mixed-species, and spruce-fir forests are based on the chipmunk species that predominate in these 3 forest types.

**Cliff chipmunk**

This species of chipmunk occurs in Arizona from the Arizona Strip, southeastward through the Mogollon Plateau to the White Mountains, and on isolated mountains such as Hualapai, Weaver, Bradshaws, Trumbull, Graham, Santa Catalina, Rincon, Chiracahua Mountains, and Defiance Plateau (Hoffmeister 1986). In New Mexico, the cliff chipmunk occurs in the western half of the state in the Sandia, Datil, Mogollon, Mimbres, Animas, Peloncillo, Guadalupe, Magdalena, San Mateo, and Black Mountains (Findley et al. 1975).

This is a medium to large chipmunk that occurs in extensive conifer forests. The cliff chipmunk is found in a variety of forest types (ponderosa pine, sparse juniper and chaparral, scrub oak and manzanita), and elevational ranges (from 9,400 feet in the Pinaleno Mountains to as low as 3,200 feet near the Colorado River), but only where large rocks or cliffs are present (Hoffmeister, 1986).

**Colorado chipmunk**

The Colorado chipmunk is a medium to large chipmunk that occurs in northeast Arizona (Hoffmeister 1986), and the northern half of New Mexico (Sandia, Manzano, Gallinas, San Antonio, Chuska, Zuni, Taos, and Sangre de Cristo Mountains) (Findley et al. 1975). This species is found in association with piñon-juniper woodlands, but also in rocky and bushy areas through the ponderosa pine zone and occasionally in the spruce-fir forests (Hoffmeister 1986). Summer home range for adult female and male Colorado chipmunks was 2.6 and 3.2 acres, respectively (Wadsworth 1972 as cited in Hoffmeister 1986).

**Gray-collared chipmunk**

This medium to large chipmunk is found in Arizona from the San Francisco Mountains, along the highest parts of the Mogollon Plateau, to the White Mountains (Hoffmeister 1986). In New Mexico, the gray-collared chipmunk occurs in the

southern portion of the State; in the Mogollon, Organ, Mimbres, Magdalena, San Mateo, and Elk Mountains (Findley et al. 1975).

The gray-collared chipmunk occurs in ponderosa pine and spruce-fir forests, and is commonly found up to timberline in the San Francisco Mountains. It seems to occur in more open forests (Hoffmeister 1986). The gray-collared is the least likely of any of the forest chipmunks to descend below the ponderosa pine forest zone (Findley et al. 1975). This chipmunk often nests in woodpecker holes.

In Arizona, Goodwin and Hungerford (1979) found the gray-collared in dense stands of mature ponderosa pine, whereas the cliff chipmunk was found only in the open (thinned) stands of ponderosa pine. In addition, Lowe (1975) found that the gray-collared chipmunk was abundant in mature ponderosa pine forest west of Flagstaff at elevations between 7,400 and 8,000 feet.

**Gray-footed chipmunk**

This chipmunk occupies the same spectrum of habitats as the Colorado chipmunk, but in some areas the gray-footed extends to the lower ponderosa pine zone. In New Mexico, this chipmunk occurs in the south-central portions of the State; in the Guadalupe, Capitan, Gallinas, Jicarilla, Sacramento, and White Mountains (Findley et al. 1975). In mixed-species forests of the Sacramento Mountains in southern New Mexico, Ward (unpublished data) estimated densities of 0.08 to 1.63 gray-footed chipmunks per acre on trapping grids, while in ponderosa pine forests, he estimated densities of 0.28 to 0.87 chipmunks per acre. In general, the gray-footed chipmunk was associated with mesic mixed-species forests. No gray-footed chipmunks were trapped in pifion-juniper woodlands (Ward unpublished data).

**Least chipmunk**

This is the smallest chipmunk in the Southwest. In Arizona this chipmunk occurs on the Kaibab Plateau, the Chuska-Lukachukai, and the White Mountains. In New Mexico, this chipmunk occurs in the San Juan, Jemez, Sangre de Cristo, and Sacramento Mountains (Findley et al. 1975).

The least chipmunk inhabits coniferous forests of the higher mountains of Arizona and New Mexico. It prefers spruce-fir forests, and is found in openings, often associated with rocky or mesic habitats (Hoffmeister 1986).

**Uinta chipmunk**

This is a medium-sized chipmunk that occurs only on the North Kaibab Plateau in Arizona (Hoffmeister 1986). This species occurs in ponderosa pine, white fir, subalpine fir, blue spruce, and quaking aspen stands.

In comparing two areas, Ruffner (in Hoffmeister 1986) found that chipmunk population density was highest in areas that had fewer trees per acre (243 versus 490), a greater cover due to conifer seedlings (34% versus 19%), and more downed logs and woody debris (11% versus 2%). There were no important differences in herbaceous cover or overstory cover between the two areas.

The Uinta chipmunk is more arboreal than any other chipmunk in the Southwest. Important foods are conifer seeds, fungi, raspberries, and insects. Nests are under roots of conifers and in cavities in trees and snags (Hoffmeister 1986).

**Habitat Management Recommendations**

The following is a composite recommendation for the five chipmunk species:

√ Conifer forest generalists
- VSS 1 open canopy VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- In VSS 1: need developed herbaceous layers and talus or rock fields
- In VSS 4, VSS 5, and VSS 6, forests may be open or moderately closed depending on the species

√ **Nesting**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- In VSS 1, VSS 2, and VSS 3 only when snags, downed logs, and woody debris are abundant or contains rocky habitat (talus slopes, rock fields, cliffs)
- Cavities are important nesting sites

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- In VSS 1, VSS 2, and VSS 3 only when snags, downed logs, woody debris, and well-developed herbaceous and shrubby layers are abundant or includes rocky habitats (talus slopes, rock fields, cliffs)
- Need cone-producing trees.

√ **Other important habitat attributes**
- Snags are important for nesting and escape cover.
- Downed logs and woody debris are important for nesting, lookout points, shelter, escape cover, and travel corridors.
- Berry-producing shrubs, seed-producing trees (oaks and conifers), caches, and fungi are important food sources.

## Cottontails
(*Sylvilagus* spp.)

Desert Cottontail (*S. audubonii*)
Eastern Cottontail (*S. floridanus*)
Mountain Cottontail (*S. nuttallii*)

Due to their medium size (14.8-15.6 inches in length and average weight of 3.3 pounds) and widespread distribution, several species of cottontails are common prey throughout the range of the goshawk (Reynolds and Meslow 1984, Reynolds 1989, Kennedy 1991). Mannan and Boal (1990) observed 16 cottontail prey deliveries (11.9%) to nests in northern Arizona. Twenty percent of prey remains collected at goshawk nests in north-central New Mexico were cottontails (Kennedy 1991). Because it is difficult to distinguish among cottontail species in dietary remains and because of differences in the habitats occupied, it is difficult to determine which species may be important prey of goshawks in the Southwest. Therefore the following management recommendations are a composite of the habitat needs of these species. These species are segregated along habitat-elevational gradients from grasslands to spruce-fir. During the nesting season, when goshawks are in coniferous forests, the eastern and mountain cottontails are more likely to occur in goshawk diets. During the winter, desert cottontails could also be consumed by goshawks in piñon-juniper woodlands and other low elevation habitats. Key recommendations for ponderosa pine, mixed-species, and spruce-fir forests are based on the cottontail species that predominate these plant communities.

### Distribution

All three species of cottontail occur in the Southwest. Desert cottontails are widespread and abundant in low- and mid-elevation habitats throughout the Southwest. Eastern cottontails are found in mountainous areas of southwestern New Mexico and southeastern Arizona (Findley et al. 1975, Cockrum 1982, Findley 1987). Mountain cottontails are found in mountainous regions north of the Mogollon Rim (Cayot 1978, Cockrum 1982). In New Mexico, mountain cottontails occur in the Jemez, San Juan, Sangre de Cristo, and Chuska Mountains (Findley 1987).

### Habitat

According to Findley (1987), desert cottontails are primarily located in grassland, shrubland, and woodland habitats in the upper Sonoran and Sonoran zones in New Mexico. In Arizona, desert cottontails are found at elevations below 6,000 feet in brushy areas as well as xeric forest habitats (e.g., ponderosa pine) (Cockrum 1982, Ffolliott 1990).

In New Mexico, the eastern and mountain cottontails chiefly inhabit montane forests, from lower elevation ponderosa pine forests to higher elevation mesic forests (mixed-species, spruce-fir) (Findley 1987). According to Cockrum (1982), eastern cottontails in Arizona are restricted to oak woodlands associated with riparian habitats.

In Colorado, mountain cottontails decreased in abundance as elevation increased from 6800 feet to 8900 feet (Cayot 1978). At higher elevations, mountain cottontail abundance tended to be greater on southeast aspects where ponderosa pine was more common and bitterbrush (*Purshia tridentata*) ground cover increased to 50% (Cayot 1978). Prevalence of bare ground, common juniper (*Juniperus communis*), and downed timber were negatively associated with mountain cottontail abundance.

In southern British Columbia, within the ponderosa-pine-bunchgrass plant association, which includes grassland, sagebrush, riparian, ponderosa pine parkland, open Douglas-fir forest, and lodgepole pine forest, mountain cottontails preferred habitats dominated by sagebrush (Sullivan et al. 1989).

### Food

Cottontail diets vary greatly among species, geographic region, and availability of palatable plants (Chapman et al. 1982). In a given geographic area, cottontails may eat more than 100 plant species but food preferences vary locally (DeCalesta 1971). A wide variety of vegetation is acceptable, provided basic nutritional requirements are met (Chapman et al. 1982). Herbaceous vegetation is typically selected during the growing season, and the bark, buds, and twigs of woody vegetation are consumed during the remainder of the year. Use of woody vegetation during the fall and winter is assumed to relate to reduced availability of herbaceous vegetation and not a preference for woody vegetation (Chapman et al. 1982). In southern portions of the Southwest where winter climates are mild, herbaceous vegetation may provide an adequate year-round source of food (Allen 1984).

### Special Habitat Needs

All three species of cottontail prefer habitat with well-developed shrub and herbaceous understory for food and escape cover (Cayot 1978, Pils et al. 1981, Allen et al. 1982). Most eastern cottontail nests are located in grass cover, dense brush, and downed logs (Allen 1984). No information on nest sites for the desert and mountain cottontail was available. However, mountain cottontails preferred crevices in

outcrops as daytime retreats in a sagebrush-juniper habitat in Oregon (McKay and Verts 1978). McKay and Verts (1978) concluded that mountain cottontail abundance in this habitat type was strongly influenced by the abundance of these daytime retreats. Conversely, in Colorado, Cayot (1978) found no relationship between the presence of rocks and mountain cottontail abundance.

**Home Range**

Home ranges of 25 radio-tagged eastern cottontails in a 14-acre woodlot in southwestern Wisconsin varied by season, sex and individual (Trent and Rongstad 1974). Adult male home ranges increased from an average of 6.8 acres in the spring to an average of 9.9 acres in early summer, and had decreased significantly to an average of 3.8 acres by late summer. Adult female home ranges were largest (average 4.3 acres) in spring, then decreased significantly to an average of 2.1 acres in early summer and remained about this size until mid-January. Additionally, fall home range sizes of four juveniles did not differ from 10 adults, and showed no difference according to sex (Trent and Rongstad 1974).

No information was found on home range sizes for desert and mountain cottontails.

**Population**

Cottontail populations are characterized by substantial seasonal and annual fluctuations. Scribner and Warren (1990) estimated winter densities of two populations of eastern cottontails in Texas to be 3.2 and 4.9 individuals per acre. After reproduction and juvenile dispersal, the densities in these two areas peaked at 10.9 and 11.3 individuals per acre, respectively.

Fall density of eastern cottontails in southwestern Wisconsin woodlots was estimated to be 3.6 individuals per acre (Trent and Rongstad 1974). In this population, annual survivorship was estimated to range between 0.15 and 0.2 depending on the estimation technique. Fall and winter eastern cottontail densities over a 5-year period in southern Wisconsin ranged from 7.4 to 23.7 individuals per acre and 3.7 to 12.9 individuals per acre on controlled and experimentally managed 50-acre woodlots, respectively (Pils et al. 1981).

Population densities of mountain cottontails in ponderosa pine-bunchgrass habitat in southern British Columbia varied annually, from 0.09 to 0.17 individuals per acre. McKay and Verts (1978) found that mountain cottontail population densities varied annually from 0.03 to 1.03 individuals per acre in shrub-juniper habitat in central Oregon.

**Management Effects**

Although habitat studies have not been conducted on eastern cottontails in the southwestern U.S., there is evidence that small areas of brush (in strips 100 feet wide) can provide cottontail habitat (Allen et al. 1982). Additionally, they suggest establishing brush areas at the edges of fields or meadows and forested areas by felling trees within 30 feet of the edge. However, their results also suggest that narrow brushy field borders may be useless for enhancing cottontail habitat if the adjacent wooded area provides only minimal or poor habitat (e.g. areas lacking in shrub and herbaceous understory for food and escape cover).

The effectiveness of experimental habitat management on eastern cottontail abundance was monitored in southern Wisconsin woodlots between 1976-1979 by Pils et al. (1981). Brush pile construction, planting of shrubs, and sowing of food patches were the primary management practices implemented in a 50.2-acre experimental woodlot to increase cottontail numbers. Half-acre portions of the woodlot were clearcut to encourage early successional growth and to construct loose brush piles. They also established food, nesting, and escape cover plots through plowing and disking, planting, mowing, and controlled burning. Cottontail populations were higher on the 50-acre control plot than on the experimental plot during the pre-habitat management and experimental periods. Abundance on both the control and experimental plots showed a downward trend during the 4-year period. Greater vulnerability of experimental populations to hunting because of improved hunter access and less dense total cover were presented as the major reasons habitat management efforts did not result in measurable population increases as compared to the control (Pils et al. 1981). The authors recommended that future habitat management practices should include denser concentrations of brush piles and food patches.

No information was found on specific management recommendations for southwestern populations of any of three cottontails.

**Habitat Management Recommendations**

The following are composite recommendations for the three cottontail species:

√ **Forest and woodland generalists**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 3, VSS 4, VSS 5, and VSS 6
- Large downed woody debris, base of snags and rocks important for eastern and desert cottontail. The importance of these

attributes for mountain cottontail is unknown.

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Well developed herbaceous and shrub layers are important
- Downed logs and woody debris are important for escape cover, particularly in areas with poorly developed shrub understory, for desert and eastern cottontail. The importance of these attributes for mountain cottontail is unknown.

√ **Other important habitat attributes**
- Small openings or sufficiently open overstories that allow development of herbaceous and shrub layers improves foraging habitat.

## Hairy Woodpecker
*(Picoides villosus)*

The hairy woodpecker averages 2.2 ounces (Li and Martin 1991) and is approximately 9 inches in length. It is widely distributed throughout forested habitats in the United States, and as a result of its abundance and distribution, regularly occurs in the diet of the goshawk (Reynolds and Meslow 1984, Mannan and Boal 1990, Kennedy 1991).

### Distribution
Hairy woodpeckers are year-round residents of nearly all forest types from central Canada to the southern United States (Scott et al. 1977).

### Habitat
This species is one of the most common woodpeckers in the Southwest, particularly in riparian habitats and in ponderosa pine, mixed-species, and spruce-fir forests (Hubbard 1978).

### Food
Hairy woodpeckers prefer to feed on insects on dead or diseased trees. Approximately 80% of the diet is animal matter -- larval and adult beetles, ants and caterpillars are most frequently eaten. Coleoptera (primarily Buprestidae and Scolytidae beetles) comprised an average of 63.8% of the diets of male and female hairy woodpeckers in California. Hymenoptera (mainly carpenter ants) were the second most common diet item in both sexes (Otvos and Stark 1985). This insectivorous diet was supplemented with fruit, grains, and nuts (Scott et al. 1977). Hairy woodpeckers (both sexes) also fed on seeds of ponderosa pine (Otvos and Stark 1985). The sexes of this species selected different foraging sites throughout the year (Morrison and With 1987). According to Scott et al. (1977), males foraged in trees away from the nest for large insects (usually borers). Females foraged close to the nest on the surface of trees, shrubs, or on the ground for small insects and plant material.

In the western Sierra Nevada during the breeding season, Morrison et al. (1987) and Morrison and With (1987) found that both sexes of the hairy woodpecker concentrated their foraging activities on trunks of trees at heights from 33 to 39 feet. During the winter, this species forages higher.

In a mixed-conifer area in the Sierra Nevada, Morrison et al. (1986) found that foraging hairy woodpeckers used lower and upper strata of the tree canopy and areas with smaller diameter trees (4-12 inches DBH).

### Special Habitat Needs
Live trees in open woodlands with deciduous understory are preferred nesting sites of hairy woodpeckers. This species excavates a nest entrance 1.6 to 1.8 inches in diameter. Because this is the nest cavity size preferred by other cavity nesters such as starlings (*Sturnus vulgaris*), competition for nest sites may occur (Scott et al. 1977).

Hairy woodpeckers will often excavate the nest entrance so it is hidden, such as on the underside of a limb. Nest heights vary from 15 to 45 feet, but are typically 35 feet high. This species will often use the same nest hole for several years (Scott et al. 1977).

Of 8 hairy woodpecker nests located in 3 study areas (ponderosa pine, subalpine fir, and aspen) by Scott et al. (1980), 2 were in aspen snags and 6 were in live aspen trees. Nest heights averaged 33 feet (range 22-50 feet), nest tree heights averaged 59 feet (range 35-70 feet) and nest tree DBH averaged 15 inches (range 10-23 inches) (Scott et al. 1980). Hairy woodpeckers showed a nest site preference for ponderosa pine snags with DBH of ≥20 inches in an area of the Santa Catalina Mountains in southeastern Arizona (Horton and Mannan 1988).

In the western Sierra Nevada, hairy woodpeckers showed high use of white fir and ponderosa pine for feeding trees throughout the year (Morrison et al. 1987, Morrison and With 1987). In this area, the hairy woodpecker foraged on live trees and snags with similar frequency, but about 70% of their foraging time was on dead substrate within the tree. The average DBH of the feeding trees was 17.4 inches (Morrison et al. 1987). The feeding trees of males and females did not differ in size during the breeding season, nor did trees used in winter differ from those used in the breeding season (Morrison and With 1987).

**Home Range**

No home range information on the hairy woodpecker was found.

**Population**

Scott and Crouch (1988) found that hairy woodpecker densities were negatively correlated with aspen basal area in west-central Colorado. Densities were almost twice as high in stands with 1% of total basal area in aspens (10 birds per 100 acres) compared to stands with more than 1% aspen basal area (3 to 5 birds per 100 acres).

Studies of woodpecker density responses to snag availability have been mainly correlative and not experimental. Dickson et al. (1987) demonstrated experimentally that snag density (2.2-3.8 snags >7.8 inches DBH per acre) in clearcuts of pine-hardwood forests in east Texas influenced the breeding densities of some woodpeckers, including the hairy woodpecker. Hairy woodpeckers were found exclusively on clear-cut plots with hardwood snags (averaging 0.8 birds per 100 acres) and were absent from snagless plots.

McPeek et al. (1987) experimentally doubled the density of snags greater than 3.9 inches DBH and greater than 16.3 feet tall in a hardwood forest in Kentucky, from 6.0 snags per acre in 1981 to 13.3 snags per acre in 1983. Snag densities on the control areas averaged 7.3 snags per acre. Winter densities of hairy woodpeckers were not significantly different between experimental (3.6-7.6 birds per 100 acres) and control (1.6-6.0 birds per 100 acre) areas. McPeek et al. (1987) concluded that no numerical response in winter was observed because:

1) the birds did not heavily depend on snags as a feeding substrate,
2) food was not limiting to these woodpeckers, or
3) they fed more heavily on fruits and seeds.

Breeding densities of hairy woodpeckers also did not differ significantly between control (1.2-1.6 birds per 100 acre) and experimental (0.8-3.6 birds per 100 acre) areas. Territoriality and/or high site fidelity of hairy woodpeckers during the breeding season may have contributed to the lack of a numerical response following treatment.

**Management Effects**

Snags are an important habitat component for many woodpeckers and other cavity-nesting species. Low snag availability resulting from timber harvest, fuelwood removal, or intense surface fires may adversely affect populations of these snag-dependent goshawk prey (Balda 1975, Thomas et al. 1979). Additionally, even-age management, short stand rotation, and removal of cull trees reduces snag densities, especially large diameter snags (McPeek et al. 1987). Snag availability in managed stands can be increased by:

1) leaving snags during timber harvest, and
2) creating snags using herbicides, topping, or girdling (Bull and Partridge 1986).

Szaro and Balda (1982) studied the effects of timber harvest on breeding bird densities in ponderosa pine forests on the Coconino National Forest, Arizona. During all years of the study, hairy woodpeckers were found in all types of harvested stands except clear-cuts, including:

1) untreated areas where trees had not been removed for 60 years;
2) light harvests in which large trees and dense thickets were selectively removed;
3) moderate harvests in strips alternating with strips of cleared areas and unharvested areas; and
4) heavy cuts where areas were severely thinned, and slash was piled in regularly spaced windrows.

Hairy woodpecker densities averaged about 3 pairs per 100 acres, and did not differ among treatments (Szaro and Balda 1982, 1986).

**Habitat Management Recommendations**

√ **Forest generalists - coniferous and deciduous**
- VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 4, VSS 5, and VSS 6 (may nest in younger VSS if many large snags are present)
- Cavities in snags or live deciduous trees averaging 15 inches DBH and 60 feet high

√ **Foraging**
- VSS 3, VSS 4, VSS 5, and VSS 6
- May forage on the ground during the nesting season
- Forages primarily on tree trunks averaging 17 inches DBH and > 30 feet high

√ **Other important habitat attributes**
- Mixed-species forests have higher hairy woodpecker populations
- Woodpecker populations are typically higher during insect (mainly tree beetle) epidemics
- Snags are important for nesting and foraging
- Downed logs and woody debris are important as a source of insects

## Mantled Ground Squirrel
*(Citellus lateralis)*

(Golden-mantled ground squirrel)

The mantled ground squirrel is a common mammal of the mountainous areas of western United States, southern British Columbia, and Alberta. This ground squirrel was important in all goshawk diet studies in the western United States (Schnell 1958, Reynolds and Meslow 1984, Mannan and Boal 1989, Kennedy 1991) (Appendix 2, page 51). This importance is related to its abundance and size (0.29 to 0.62 pounds). Weights, however, fluctuate considerably from a maximum just prior to hibernation to a minimum at emergence from hibernation.

### Distribution
In the Southwest the mantled ground squirrel occurs in woodlands to above timberline in northern New Mexico (Sangre de Cristo, Jemez, Chuska Mountains) (Findley et al. 1975) and from northern to east-central Arizona (Kaibab Plateau to Mogollon Rim to White Mountains) (J. Hall 1981).

### Habitat
The mantled ground squirrel is found in sunny habitats in forested or sparsely shrubby areas from the edge of the piñon belt to above timberline. It may be found on rocky slopes adjoining grasslands and on forest floors, in areas of scattered chaparral, and along forested margins of mountain meadows. It also occurs in recently burned pine forests where an abundance of stumps and fallen trees provide shelter, and the open habitat produces an abundance of berry producing shrubs and flowering plants (Bartels and Thompson, in press). The mantled ground squirrel is most abundant in open, pure or mixed stands of ponderosa pine, limber pine, lodgepole pine, Engelmann spruce, Douglas-fir, and quaking aspen. It is either absent or occurs sparsely in dense spruce-fir forests (Hatt 1927, McKeever 1964).

### Food
The principal foods are fungi and leaves of herbs (up to 90% of the diet) (McKeever 1964, Maser et al. 1978). During spring, the main food is young, succulent leaves, but as the season progresses and the leaves dry, hypogeous fungi become the main food. Flowers of many herbaceous plants are also consumed. In fall, conifer seeds become an important component of the diet. In California, arthropods and fruits were not an important part of the diet, but this may reflect the lack of local availability (McKeever 1964). In other areas the ground squirrel feeds on the seeds of ponderosa pine, white pine, Douglas-fir, spruce, and acorns of various oaks (Grinnell and Dixon 1918, Gordon 1943, Hoffmeister 1986). Conifer seed can contribute up to 33% of the diet in the fall (McKeever 1964). Shrubs whose fruits are eaten include *Rosa*, *Amelanchier*, *Rubus*, *Ribes*, *Grossularia*, *Purshia*, *Prunus*, and *Ceanothus* (Gordon 1943, Mullally 1953). Herbs consumed include *Lupinus*, *Capsella*, *Penstemon*, *Verbascum*, *Fritillaria*, *Galium*, *Swertia*, *Cirsium*, *Ceanothus*, *Bromus*, *Aconitum*, *Menzelia*, and *Trifolium* (Grinnell and Dixon 1918, Hatt 1927, Gordon 1943, Tevis 1952, Carleton 1966, Hoffmeister 1986). Animal foods include a variety of insects, eggs and the young of birds, voles and chipmunks, lizards, and almost any carcass (Warren 1942, Tevis 1953, Cameron 1967, Bartels and Thompson in press).

### Special Habitat Needs
Mantled ground squirrels dig their burrows beneath rocks or logs, or against the base of live trees or snags (Burt 1934, Gordon 1943, Mullally 1953). These habitat attributes are critical for breeding and hibernating. The mantled ground squirrel hibernates below ground from late November until March or April (McKeever 1964).

### Home Range
No home range information was found on the mantled ground squirrel.

### Population
In California, squirrels were much more abundant in ponderosa pine than in lodgepole pine or in red or white fir forests. This association was correlated with the abundance of herbaceous vegetation--herbaceous ground cover was most abundant in ponderosa pine, moderate in lodgepole, and lowest in fir forests (McKeever 1964). Logging in the dense fir forests was accompanied by an invasion of ground squirrels (Tevis 1956).

### Management Effects
Open areas should be maintained in pine and mixed-species forests for development of herbaceous and shrub species. Areas with more closed canopy for the production of fungi (see the management section for tassel-eared squirrel), and large downed logs are also important. The best seed trees should be maintained in the overstory.

### Habitat Management Recommendations
√ **Conifer forest generalists**
- VSS 1; open canopy VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Rocks, stumps, large downed logs and snags (hollows at the base) are important

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Herbaceous and shrub layers and deciduous species in the understory are very important
- Cones, fungi, berry-producing shrubs, and herbs are critical foods

√ **Other important habitat attributes**
- Best habitat is open sunny forest with large-diameter downed material with developed herbaceous and shrub layers. Cone-producing trees are important and dense forests are avoided.
- Snags, downed logs, and woody debris provide hollows for nesting and escape cover.

## Mourning Dove
*(Zenaida macroura)*

The mourning dove is moderately-sized, averaging 12 inches in length and weighing 0.5 pounds. Reynolds and Meslow (1984) found that mourning doves made up 3% of the diet of goshawks in eastern Oregon; the ninth most common prey item there.

### Distribution
The range of the mourning dove extends from southern Canada throughout the United States, Mexico, and into Central America. This species nests in every state in the conterminous U.S. It may also breed as far north as southeastern Alaska (Martin et al. 1951, Am. Ornithol. Union 1983).

### Habitat
Within its extensive range, this dove inhabits farm and ranchlands, deserts, grasslands and prairies, woodlands, and forests (Soutiere and Bolen 1972). In the Southwest, the mourning dove frequents grasslands, piñon-juniper woodlands, oak woodlands, ponderosa pine forests, and less frequently in mixed-species habitats above 7,000 feet, (Davis and Sintz 1973, Franzreb 1977, Sedgwick 1987). Within the ponderosa pine belt, elevations below 7,000 feet are preferred. Piñon-juniper woodlands are used extensively for nesting, as are riparian areas (R. Tomlinson pers. comm.).

### Food
Mourning doves are ground feeders, whose diet consists almost 100% of plant material. Only traces of insect or other animal foods have been found in diet studies. Seeds and grains are the primary components of their diets (Martin et al. 1951, Griffing and Davis 1974, Tyler and Jenkins 1979, Best and Smartt 1986).

### Special Habitat Needs
Mourning doves prefer forest edges. In contiguous forests, stream borders or boundaries between forest types is preferred. Broad or abrupt borders between fields and forests were not as favorable as narrow, finger-like forest edges (Hopkins and Odum 1953). In forested or woodland habitats, mourning doves often nest in association with small openings, 1 to 5 acres in size (R. Tomlinson pers. comm.).

Although mourning doves are considered habitat generalists, they do have specific nesting requirements (Stauffer and Best 1980, Sedgwick 1987). Coon et al. (1981) found that the structural stability of the nest, which was influenced by nest placement, determined the probability of nest success. Preferred nest sites are horizontal limbs. Nests placed on limbs away from the trunk provide an unobstructed flight path (Harris et al. 1963, Davis and Sintz 1973, Coon et al. 1981, Yahner 1983, Knight et al. 1984, Putera et al. 1985). In southwestern New Mexico, the average DBH of 41 nest trees was 18.6 inches, while the average DBH of all woody plants in the vegetation plots was only 13.8 inches (Davis and Sintz 1973). Haldeman (1968) observed that mourning doves nested in "large yellow-barked ponderosa pines" and in "large" mixed-conifer trees. Two studies in Iowa had average nest tree DBHs of 17.4 and 20.3 inches (McClure 1946; Jumber et al. 1956 in Davis and Sintz 1973). In California, 13 inches was the average DBH for nest trees, and in Nebraska, nest trees averaged 10.2 inches DBH (McClure 1946). Nest trees tend to be taller than surrounding trees (Davis and Sintz 1973). Davis and Sintz (1973) generally characterized nest trees in southwestern New Mexico as tall (average = 26 feet) sturdy trees, with most nests placed 8-12 feet above ground. Nest trees (N=40) were common where tree cover was patchy to moderately dense (78%); and less common in areas with dense or open canopy cover (22%). In piñon-juniper woodlands of Colorado, Sedgwick (1987) found that mourning doves were associated with areas containing:

1) large trees (33-40 inch DBH), and
2) dead and dying trees.

Soutiere and Bolen in Texas (1972) found that nesting doves used the largest mesquite trees available for nesting.

An important center of activity associated with fledgling mourning doves are "reference areas" (RAs) (Hitchcock and Mirarchi 1986). In eastern juniper (Juniperus *virginiana*) and loblolly pines (*Pinus taeda*), trees in RAs tended to have large, dense crowns (width average 26.3 feet; 76% average crown density). RAs are small sites (3.3 square feet) which are used by fledgling mourning doves for loafing and for feeding interactions with parents, primarily the male (Hitchcock and Mirarchi 1986). The RAs are within 150 feet of the nest tree and are used up to 27 days after hatching. An average of 3 RAs are used during the fledgling-dependency period (≤30 days). Fledglings 27 days of age and older move to and from feeding sites in juvenile flocks. At 27 to 30 days old, fledglings begin to abandon their RAs and may fly up to 0.9 mi from the nest site (Hitchcock and Mirarchi 1986).

RAs were located on the ground or on limbs of trees. These sites were characterized by "dense overhead canopies interspersed with openings" (Hitchcock and Mirarchi 1986). Ground sites were used more often than expected by fledglings older than 13 days. The average DBH of RA trees was 13.3 inches, while roost trees had an average DBH of 13.7 inches. Trees used as RAs and as roost sites had open-grown forms. Ground RAs were open (≥50% of the ground was unvegetated). Basal area of the overstory was low (average 48 square feet per acre) and stem densities averaged 267 stems per acre (Grand and Mirarchi 1988).

### Home Range

In Missouri, adult mourning doves moved up to 4.8 miles from nest sites to feeding sites (Sayre et al. 1980 in Howe and Flake 1988). In the desert situation of southeastern Idaho, Howe and Flake (1988) observed that adult mourning doves moved an average 2.3 miles from nest sites to feeding or loafing areas and 1.1 miles to watering areas. In Idaho, maximum daily movements ranged from 0.7 to 2.4 miles per day for 5 radio-tagged adult mourning doves (Howe and Flake 1988).

### Population

In a wooded floodplain in southwestern New Mexico, nesting densities reached 3.3 nests per acre, whereas 18.2 nests per acre were located in a small isolated shelterbelt in central North Dakota (Randall 1955, Davis and Sintz 1973). In fruit orchards in north-central Washington, Knight et al. (1984) noted the number of nesting pairs of mourning doves ranged from 0 to 6.6 pairs per 100 trees checked. The highest densities were in semi-cultivated orchards that had minimal human disturbance.

The average density of breeding birds was similar in dense old-growth ponderosa pine stands (1.2 breeding pairs per 100 acres) to logged stands with residual trees meeting old-growth ponderosa pine standards (14 trees ≥20 inches DBH, and basal area >90 square feet per acre) (1.1 breeding pairs per 100 acres), whereas open old-growth ponderosa pine stands averaged 1.4 breeding pairs per 100 acres (Siegel 1989). The Pearson Natural Area (old-growth ponderosa pine) near Flagstaff, Arizona, contained 7 pairs per 100 acres, whereas in an old mixed-species forest on the San Francisco Mountains near Flagstaff, only 3 pairs per 100 acres were observed (Haldeman 1968). In old-growth mixed-species forests in northeastern Oregon, no breeding birds were detected in 2 of 3 years. In the year breeding birds were detected, densities were less than 0.1 per 100 acres. In thinned mixed-species forests, densities averaged 0.5 breeding birds per 100 acres (Mannan and Meslow 1984). No breeding birds were counted in mixed-species forests in east-central Arizona; only presence was detected (Franzreb 1977).

### Management Effects

For nest areas, irregularly shaped forest openings or forested areas that range from patchily distributed to moderately dense trees appear to be most appropriate (Hopkins and Odum 1953, Davis and Sintz 1973). Trees with an open-grown form provide better limb structure for nesting (Knight et al. 1984). Based on studies in non-cultivated areas, nest trees should be at least 17 inches DBH (Davis and Sintz 1973).

To manage for ground and tree RAs, Grand and Mirarchi (1988) recommended "...conifer stands with low basal areas and stem densities, large amounts (>50%) of unvegetated ground, and dense clumps of vegetation in strata less than 10 feet in height. Prescribed fires in open pine stands would also help to maintain these conditions." The presence of hardwoods also provides additional roost sites. Grand and Mirarchi (1988) felt that the maintenance of open conifer stands might be important to fledgling survival.

Because mourning doves occur in extremely low densities in mixed-species forests, this habitat type should not be managed for mourning doves.

### Habitat Management Recommendations

√ **Lower elevation conifer forest generalists; little use of mixed-species and spruce-fir**

- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 4, VSS 5, and VSS 6
- Large trees >17 inches DBH
- Open to moderately dense canopy cover around nest trees and reference areas

√ **Foraging**
- VSS 1; open VSS 2, VSS 3, VSS 4, and VSS 5
- Primarily ground feeders on seeds
- Irregularly shaped open areas with clumps of trees

√ **Other important habitat attributes**
- Snags are used as perch sites
- Downed logs and woody debris are of little to no importance
- Openings that can be used as nest, roost or foraging sites should be small to moderate in size, and irregular in shape with scattered trees in the openings

## Northern Flicker

*(Colaptes auratus)*

The northern flicker is a relatively large woodpecker (length = 12.5-14 inches), weighing about 4.8 ounces (Kennedy 1991, Li and Martin 1991). Because of its widespread distribution in forested habitats throughout the US, conspicuous markings, and behavioral displays, it is a common prey of the goshawk. In north-central New Mexico this species comprised 14.3% of 106 prey remains collected at goshawk nests from 1984 to 1988 (Kennedy 1991). On the North Kaibab Plateau in Arizona, this species comprised 3.7% of 135 prey deliveries to 7 nests (Mannan and Boal 1990).

### Distribution

The northern flicker is a common resident in mountainous areas and lowland valleys throughout the Southwest (Hubbard 1978).

### Habitat

During the nesting season, northern flickers are common throughout North America in open woodlands, fields, and meadows. Scott et al. (1977) reported that flickers typically nest in forest edge habitats. In extensive forests they nest only in and around openings. Northern flickers had dense populations (7 birds per 100 acres) in mixed-species stands in which 98% of overstory trees were aspen; stands with less aspen had fewer flickers (1 to 4 birds per 100 acres) (Scott and Crouch 1988).

### Food

According to Scott et al. (1977), 60% of the northern flicker's diet is animal matter; of this, 75% is ants (Scott et al. 1977). Remaining animal matter includes beetles, wasps, caterpillars, crickets, and larval forms of many species. In a California ponderosa pine forest, 87% of the total food volume consumed by northern flickers was Hymenoptera species (*Liometopum* sp., *Prenolepis imparis*, *Formica* sp., *Lasius* sp.). Homoptera comprised an additional 9% (Scott et al. 1977, Otvos and Stark 1985). Plant material commonly found in flicker diets includes seeds of annuals, cultivated grains, and the fruits of shrubs and trees (Scott et al. 1977).

### Special Habitat Needs

Flickers excavate nest holes, 2.75 inch diameter entrances, in dead limbs or trees of many species (*Populus*, *Pinus*, *Quercus*, and *Juniperus*). Nests are sometimes as high as 100 feet, but are usually between 10 and 30 feet above the ground (Scott et al. 1977). In the Santa Catalina Mountains, Arizona, the northern flicker preferred ponderosa pine snags greater than 20 inches DBH in stands that had never been logged (Horton and Mannan 1988). In a mixed-species forest along the Mogollon Rim in Arizona, 36 nests were located in aspen trees (57% snags, 14% dead portions of live trees, and 29% live trees). Average nest height and DBH were 53.5 feet and 17.7 inches, respectively. Areas around nests contained an average of 2.7 snags per 0.1 acre (1.8 aspen snags and 0.9 conifer snags) (Li and Martin 1991).

Scott et al. (1980) characterized 29 nests located in 3 forest types (ponderosa pine, subalpine spruce-fir, and aspen) in the Rocky Mountains. Eight were in ponderosa pine snags, 6 were in aspen snags, 14 were in live aspen, and 1 was in another unidentified conifer snag. The nest height averaged 36 feet (10-67 feet), the nest tree height averaged 64 feet (24-91 feet), and the nest tree DBH averaged 16 inches (10-30 inches) (Scott et al. 1980).

### Home Range

No home range information was found on the northern flicker.

### Population

Northern flickers exhibited little numerical response to a variety of harvesting methods in mixed-species and ponderosa pine forests in the western United States. Only in areas that were clearcut did the flicker show a negative population response (Kilgore 1971, Franzreb and Ohmart 1978, Szaro and Balda 1979b, Mannan and Meslow 1984, Medin 1985). On the North Kaibab Plateau, flicker breeding densities were highest in dense old-growth (6.7 pairs per acre), intermediate in light harvested "old-growth" (6.4 pairs per acre), and lowest in open

old-growth ponderosa pine (3.4 pairs per acre) (Siegel 1989).

**Management Effects**

Szaro and Balda (1982) studied the effects of timber harvest on breeding bird densities in ponderosa pine forests on the Coconino National Forest, Arizona. During all years of the study, northern flickers were found in all types of harvested stands, except clear-cuts, including:

1) untreated areas where trees had not been removed for 60 years;
2) light harvests in which large trees and dense thickets were selectively removed;
3) strips of moderate harvest alternating with strips of cleared areas and unharvested areas; and
4) heavy cuts where areas were severely thinned and slash was piled at regularly spaced windrows.

Northern flicker densities averaged about 3 pairs per 100 acres and in ponderosa pine did not differ among treatments. No density values were available for clear-cuts (Szaro and Balda 1982, 1986).

**Habitat Management Recommendations**

√ **Habitat generalists**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 4, VSS 5, and VSS 6 (may nest in younger VSS if high density of snags present)
- Typically nests along forest edges of openings
- Large diameter aspen are especially important for nesting
- Snags ≥16 inches

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Other important habitat attributes**
- Snags are important for nesting and feeding
- Downed logs are an important source of insect prey

## Red-Naped Sapsucker

*(Sphyrapicus nuchalis)*

The red-naped sapsucker is a medium-sized woodpecker, 8.5 inches in length and weighing approximately 1.6 to 1.8 ounces (Dunning 1984, Li and Martin 1991). This species is 1 of 4 *Sphyrapicus* spp. found in forested habitats in the United States. Because of their abundance in forested habitats, members of this genus occur commonly in the diet of the goshawks (Reynolds and Meslow 1984, Kennedy 1991).

**Distribution**

The red-naped sapsucker is found throughout the intermountain west, but does not occur in the Pacific Northwest. In the Southwest, this species commonly breeds in mountainous terrain north of the Mogollon Rim. South of the Mogollon Rim it is an uncommon summer resident. It is a casual summer visitor in the lowlands of southern New Mexico and Arizona. During winter, it is rare north of the Mogollon Rim, but is locally common in the southern parts of the Southwest (Hubbard 1978).

**Habitat**

The red-naped sapsucker usually is abundant in riparian areas of mixed-species forests with a hardwood component. It is also found in ponderosa pine, aspen, mixed-species, lodgepole pine, and in mixed stands of fir-larch-pine (Scott et al. 1977). During the breeding season in northern Arizona, however, this species was not reported in pure stands of ponderosa pine (Szaro and Balda 1979a, 1986).

In the Huachuca Mountains in southeastern Arizona, red-naped sapsuckers wintered in the following habitats:

1) riparian woodlands associated with grasslands,
2) oak savannah and oak woodland,
3) oak-juniper woodland, and
4) pine-oak woodland (Bock and Larson 1986).

The average elevation of the birds wintering in this area was 5,476 feet (Bock and Larson 1986).

**Food**

Red-naped sapsuckers feed on sap throughout the year, but the amount taken and tree species used varies seasonally (Scott et al. 1977, Bock and Larson 1986). Ants comprise 80% of the animal matter in their diet (Scott et al. 1977). Other insects include beetles and wasps, but no wood-boring larvae have been recorded in their diet. Although plant material makes up a small portion of their overall diet, the fruits of some deciduous shrubs and trees can be important diet components when insect populations are low (Scott et al. 1977, Bock and Larson 1986).

**Special Habitat Needs**

Red-naped sapsuckers nest in cavities in snags or live trees with rotten heartwood (Scott et al. 1977). Nests have been found in a variety of deciduous and coniferous tree species, but in many areas aspen is the preferred nest tree (Scott et al. 1977). The nest

height varies from 5 to 7 feet above ground and the same nest is often used repeatedly, although a new cavity is excavated each year. Li and Martin (1991) located 20 nests in the Mogollon Rim country of central Arizona. All were found in aspen trees (20% snags, 25% dead portions of live trees, and 55% in live trees). The average nest tree height was 43.6 feet and the average nest tree DBH was 14.6 inches. Snag densities averaged 2.3 per nest plot (0.1 acre), 1.7 aspen snags and 0.6 conifer snags.

Scott et al. (1980) characterized 6 nests located in 3 forest types (ponderosa pine, subalpine spruce-fir, and aspen) in the Rocky Mountains. Five were in live aspen and 1 in an unidentified conifer snag. The average nest height was 39 feet (25-60 feet), average tree height was 62 feet (45-80 feet), and the average DBH of the nest trees was 16 inches (14-19 inches).

This species regularly uses 1 to 2 trees in its territory for foraging. These feeding trees generally show signs of damage (porcupines, logging) (Scott et al. 1977). Red-naped sapsuckers drilled sap holes in all tree species available in their winter habitat in the Huachuca Mountains, Arizona including: oak (45.7% of sap trees), juniper (4.9% of sap trees), pine (11.1% of sap trees) and a variety of deciduous species (19.8% of sap trees) (Bock and Larson 1986).

**Home Range**

No home range information was found on the red-naped sapsucker.

**Population**

McPeek et al. (1987) experimentally doubled the density of snags greater than 3.9 inches DBH and greater than 16.3 feet tall in a hardwood forest in Kentucky, from 6.0 snags per acre in 1981 to 18.3 snags per acre in 1983. Snag densities on the control areas averaged 7.3 per acre. Winter densities of sapsuckers were not significantly different between experimental (0.4-1.2 birds per 100 acre) and control (0.4-0.8 birds per 100 acre) forests. McPeek et al. (1987) concluded that no numerical response was observed in winter because:

1) the birds did not depend on snags as feeding substrate,
2) food was not limiting to these woodpeckers, or
3) they fed more heavily on fruits, seeds, and sap.

**Management Effects**

Due to this sapsucker's preference for aspen nest trees, maintenance or regeneration of aspen is important. Development of oak and other deciduous trees in the understory for feeding and nesting will also benefit the red-naped sapsucker. High snag densities appear to improve red-naped sapsucker habitat.

**Habitat Management Recommendations**

√ **Forest generalists (lower elevations), commonly mixed with aspen**
- VSS 4, VSS 5, and VSS 6
- Riparian and forests with oak understory very important, particularly in the winter

√ **Nesting**
- VSS 4, VSS 5, and VSS 6
- Snags or live decadent trees (wounded, decayed heartwood), especially aspen, very important
- Nest tree diameter 15-16 inches DBH and 39-44 feet in height

√ **Foraging**
- VSS 4, VSS 5, and VSS 6
- Decadent trees (wounded, decayed heartwood) very important

√ **Other important habitat attributes**
- Snags, especially aspen, are important
- Downed logs and woody debris are sources of insect food
- Deciduous understory (aspen, oak) is important for nesting and foraging

## Red Squirrel

*(Tamiasciurus hudsonicus)*

(Mount Graham Red Squirrel)

The red squirrel is a small tree squirrel, total length 12-14 inches, weight 0.4-0.5 pounds (Burt and Grossenheider 1964, Hoffmeister 1986). Within certain habitats, the red squirrel is commonly used as prey by the goshawk. Rusch and Meslow in Canada (pers. comm. in Rusch and Reeder 1978) estimated that a total of 306 red squirrels were taken by a pair of goshawks during three breeding seasons, and that goshawks may take a greater number during winter when the variety of prey species is reduced. In the Jemez Mountains of northern New Mexico, the red squirrel comprised 5.6% of 36 prey deliveries to 7 goshawk nests and 17.5% of 63 pellets analyzed from 8 goshawk nests (Kennedy 1991). In eastern Oregon, the Douglas squirrel (*Tamiasciurus douglasi*) comprised 5.7% of the diet of goshawks (Reynolds and Meslow 1984). In northern Arizona, 1.5% of 135 prey deliveries to 7 goshawk nests were red squirrels (Mannan and Boal 1990).

**Distribution**

This sciurid is a forest-dependent mammal that ranges from Alaska through most of Canada into the hardwood and coniferous forests of the upper midwestern, northeastern, and Appalachian states.

The red squirrel also is found throughout the coniferous forest of the Rocky Mountains and south into the mountains and higher elevation plateau areas of Arizona and New Mexico (Martin et al. 1951, Hoffmeister 1986, Sullivan 1990).

**Habitat**

In the western United States, the red squirrel is found almost exclusively in conifer forests, including spruce-fir, Douglas-fir, and lodgepole pine. Mature stands of conifers are preferred. In the Southwest, Engelmann spruce or a mixture of spruce and Douglas-fir are the most important and commonly inhabited forest types (Vahle 1978). The red squirrel is less common in mixed forests of ponderosa pine and Douglas-fir, and rarely in pure ponderosa pine stands (Rasmussen 1941, Gurnell 1984, Hoffmeister 1986, Sullivan and Moses 1986). However, Uphoff (1990) found that lower elevation mixed-species/ deciduous habitat supported high densities of red squirrels. Her study area was located on the Mogollon Rim in central Arizona (elevation 7500 feet). The ridge and drainage system contained a mixture of ponderosa pine, southwestern white pine, Douglas-fir, white fir, and Gambel oak. Riparian understories were dominated by big-toothed maple, quaking aspen, and New Mexican locust.

**Food**

Conifer seeds are the year-round dietary staple. Some commonly eaten and preferred seeds in the Southwest include Douglas-fir, blue spruce, Engelmann spruce, and white fir (C. Smith 1968, Rusch and Reeder 1978, Gurnell 1984, Hoffmeister 1986, Patton and Vahle 1986, Sullivan and Moses 1986). Ponderosa pine seeds were occasionally noted as being used on the North Kaibab Plateau, Arizona (Rasmussen 1941). Although ponderosa pine seeds had the highest quantity of energy per seed out of 7 species of conifers, they were taken second most frequently in feeding trials (91 of 108 trials = 84%) (C. Smith 1968).

Because seed crops fluctuate widely from one year to the next, cones caches not only provide a stable food source during the following winter, but they may also serve as the primary winter food source through an additional 1 or 2 years of cone crop failure (M. Smith 1968).

Meristematic buds are an important winter and spring food supplement, especially in years when cone crops fail (M. Smith 1968, Rusch and Reeder 1978). Leaf buds were eaten in early July in mixed-species forests in Arizona (Uphoff 1990). Conifer pollen is eaten from late spring to mid-summer depending on tree species. However, pollen is available for only 2 or 3 weeks during this period.

Fungi are available from spring through fall. Fungi are harvested and placed in forks of tree branches and logs for drying and storage. These stored mushrooms are eaten sparingly throughout the winter (Hatt 1929, C. Smith 1968, M. Smith 1968, Rusch and Reeder 1978). In southern British Columbia, C. Smith (1968) identified 42 species of fungi eaten by red squirrels. Preferred species included those in the genera *Suillus*, *Rhizopogon*, and *Chroogumphus*. In an analysis of 5 red squirrel stomachs from Oregon, Maser et al. (1978) noted that basidiomycetes fungi were taken most frequently and that fungi made up 77% of diet volume. In the Mogollon Rim country of central Arizona, the most common hypergeous fungi gathered by squirrels were *Fistulina hepatica*, *Cortinarius rufolivuccus* and *Pleurotus porrigens* (Uphoff 1990). These fungi were stored in secondary food caches, while hypogeous fungi, such as, *Geopora cooperi* and puffballs, would be eaten immediately upon discovery. Fungi were the most commonly eaten summer food by females in central Arizona. This food source was utilized from the beginning of the rainy season in mid-June through September (Uphoff 1990, Reiser pers. obs.).

Red squirrels also eat fruits, seeds, sap, acorns and nuts of angiosperm trees and shrubs (cottonwood, maple, wild rose, blueberry, raspberry, wild strawberry, bracken fern). They also chew on animal bones, and eat insects, soil, and feces (Hatt 1929, Layne 1954, Brink and Dean 1966, C. Smith 1968, M. Smith 1968, Rusch and Reeder 1978, Uphoff 1990). Red squirrels also regularly eat passerine bird eggs (Martin 1988, Uphoff 1990).

**Special Habitat Needs**

Food caches (middens) are of paramount importance to red squirrels. Without these middens, winter starvation is inevitable (M. Smith 1968, Kemp and Keith 1970). A large centrally located (primary) midden is the most prominent feature of red squirrel territories. These primary middens, along with several secondary middens, provide the energy requirements of a single squirrel for half of the year (Rusch and Reeder 1978, Gurnell 1984, Patton and Vahle 1986). Cache sites are in moist, shaded areas. At cache sites, groups of mature trees and shading from additional understory and overstory vegetation maintains the humidity necessary to prevent the cones from opening.

These mesic areas also support other foods sensitive to desiccation, such as fungi, conifer buds, grasses, berries, and insects. These foods are important to juvenile red squirrels learning to forage on their own (Uphoff 1990).

Vahle and Patton (1983) found that 90% of 141 cache sites had canopy cover greater than 60%, and received additional shading from surrounding uneven-aged groups of trees. Canopy cover in a 33-foot-radius plot centered on primary middens averaged 89% (n=144) for Mount Graham red squirrels (Mannan and Smith 1991). One or more large (≥20 inches DBH) snags, fallen logs, and/or live trees act as support structures for the primary midden (Vahle and Patton 1983). Basal areas at middens in old-growth mixed-species forests were higher (197 square feet per acre) than on randomly chosen sites (142 square feet per acre). Midden sites had more larger trees (≥20 inches DBH) than non-midden sites. Midden plots (0.1 acre) in the White Mountains contained an average of 3 large, dominant trees (≥20 inches DBH) (Vahle and Patton 1983, Patton and Vahle 1986). Mannan and Smith (1991) averaged almost 4 trees (≥16 inches DBH) per midden site.

Territory size has been linked with food requirements. The number of cones required to sustain a single red squirrel for a year ranges from 42,000 to 131,000, thus 9 to 25 large, mature, cone-producing trees per territory are necessary (C. Smith 1968, Rusch and Reeder 1978, Gurnell 1984, Patton and Vahle 1986).

In Douglas-fir, 200- to 300-year-old trees are the best seed producers. These old trees may produce 20 to 30 times more seed than trees that are 50 to 100 years old (Hermann and Lavender 1990). White fir begin producing cones around 40 years of age and continue beyond 300 years of age. Dominant trees in the 12 to 35 inch DBH range are the best and most reliable cone producers (Laacke 1990). Engelmann spruce begin to produce abundant cone crops once they have reached a DBH greater than 15 inches, and are 150 to 200 years old. This spruce is a long-lived species that does not fully mature until 300 years of age, and may live upwards of 600 years (Alexander and Shepperd 1990). Blue spruce is also a slow growing, but long-lived species (>600 years). However, its best seed producing years range between 50 and 150 years (Fechner 1990).

Nest trees have crowns that interlock with 2 or more adjacent trees (Vahle and Patton 1983). In a mixed-species forest in Arizona, nest trees averaged 14 inches DBH (3-35 inches). Average distance between nest trees and the primary middens was 15 feet (0-80 feet; 186 nests) (Vahle and Patton 1983). In a mixed hardwood forest in New York, Layne (1954) found leaf nests in trees whose DBH ranged from 4 to 16 inches, and DBH of trees with cavity nests ranged from 12 to 36 inches.

**Home Range**

Home range estimates for adult red squirrels range from 0.7 to 2.0 acres in a lodgepole pine forest (n=9), from 0.5 to 11 acres in a mixed hardwood-conifer forest (n=13) (Layne 1954, Gurnell 1984). Most researchers report estimates of territory size, and Gurnell (1984) found that territories were about 60% to 100% of the squirrels' home range. In two spruce-fir and hemlock-cedar sites in British Columbia, adult territories were contiguous and non-overlapping and averaged 2.2 acres (10 low elevation sites) to 1.3 acres (5 high elevation sites) (C. Smith 1968). Squirrel home ranges decreased in size as the number of trees greater than 10 inches DBH increased. These territories had the highest densities of cones available to the squirrels (C. Smith 1968). Territories, estimated from observations of 23 marked individuals, in mixed white spruce, black spruce, jack pine, and aspen and poplar forests ranged from 1 to 2 acres (Kemp and Keith 1970). Rusch and Reeder (1978) estimated territories of 0.6 to 1.6 acres in similar habitat. In a low elevation mixed-species/deciduous forest, Uphoff (1990) estimated minimum defended territories of 0.07 acres.

**Population**

Spring density of adult red squirrels over a 50 year period tended to be similar within a variety of conifer forests: densities averaged 1.1 squirrels per acre in spruce forests, 0.7 in mixed-species forests, and 0.4 in pine forests (Rusch and Reeder 1978, their Table 13). Since these studies spanned 50 years, a wide variety of overwintering conditions and cone production was encountered.

Vahle and Patton (1983) estimated population densities from 0.4 to 1.0 squirrel per acre in old growth mixed-species forests, while Ward (unpublished data) estimated red squirrel densities of 0.03 to 0.32 per acre in mixed-species forests of the Sacramento Mountains, New Mexico. In mixed-species/deciduous drainages, squirrel densities averaged 1.7 per acre in a 45 foot corridor down the center of the drainages (primarily occupied by females). Densities declined to 0.61 squirrel per acre in a corridor located on the upper slopes of drainages, where there were equal numbers of male and female territories. Ridgetops in mixed-species forests were more frequently occupied by males (Uphoff 1990).

Densities in a lodgepole pine forest were estimated at 0.3 adult red squirrels per acre (Gurnell 1984). Squirrels were more abundant in both unthinned and managed young (20 years of age)

stands of lodgepole pine, than in thinned (20 year) stands (0.5 versus 0.2 squirrel per acre, respectively). Unthinned young stands had similar densities to mature (110-year-old) stands of lodgepole pine.

In mature stands, 100% of adult females attained breeding condition, while only 56% did so in young stands. Survival was significantly higher in mature stands. Similar densities in young unthinned stands were thus maintained by higher recruitment rates into the young stands (Sullivan and Moses 1986). The suboptimal habitat of the unthinned young stands seemed to serve as a dispersal sink for yearling and young squirrels from the surrounding mature forests (Sullivan and Moses 1986). Red squirrel tracks were generally more abundant in uncut forests than in 1- to 33-year-old clear-cuts (Thompson et al. 1989).

Old-growth forest stands (250-730 yr) of Douglas-fir and western hemlock in the Cascade Range of Washington supported densities of Douglas squirrels that were 3 times higher than in young forest stands (42-165 yr). Young forests were dominated by Douglas-fir. Old-growth forests supported 0.25 squirrels per acre, while the young forest stands supported 0.07 squirrels per acre. Cone crops for both Douglas-fir and western hemlock were rated "very poor" and "extremely poor" for the first 2 years of this 3 year study (Buchannan et al. 1990). Like red squirrels, Douglas squirrel populations are similarly limited by food supply (C. Smith 1968, 1970).

**Management Effects**

Vahle and Patton (1983) and Patton and Vahle (1986) recommended maintaining areas with closely spaced groups of trees of different ages and sizes. Stands of trees greater than 15 inches DBH are necessary to provide cone producing trees and nest trees. For Douglas-fir, 200- to 300-year-old trees are the best cone producers (Hermann and Lavender 1990). Additionally, one or more large tree components (>20 inches DBH), consisting of snags, fallen logs, and live trees, are necessary for primary middens. Closed canopies (basal areas ≥200 square feet per acre) are also important for maintaining mesic conditions for middens and suitable cover for nesting. To provide adequate conifer seed for food, 3 to 4 large (≥18 inches DBH) trees are needed per acre (Vahle 1978).

In mixed-species forests in canyons of the Southwest, other habitat components may exceed conifers in their importance for the red squirrel. Females in these areas typically produce 2 litters (versus 1 litter at higher elevations) per breeding season because of a greater abundance of summer foods (fungi, berries, bird eggs) and superior nest sites (Uphoff 1990). Because these productive canyon areas are limited in number in the Southwest, they are particularly important squirrel habitat.

**Habitat Management Recommendations**

√ **Mixed-species and spruce-fir specialist**
- Closed canopy VSS 4, VSS 5, and VSS 6

√ **Nesting**
- Closed canopy VSS 4, VSS 5, and VSS 6 with interlocking crowns around nest sites
- Nests are close to middens
- Nest sites have high canopy cover and the best sites are mesic

√ **Foraging**
- VSS 5 and VSS 6 (infrequent use of VSS 4)
- Middens have high canopy cover and are mesic, preserving cones
- High canopy cover provides mesic conditions for greater fungi production

√ **Other important habitat attributes**
- Snags (>18 inches DBH) and downed logs (16-20 inches diameter) very important; smaller woody debris less important
- High canopy cover provides escape cover for squirrels
- Large mature cone-bearing trees, abundant fungi, and multistoried stands with many plant species in all forest layers constitute superior squirrel habitat
- Medium to large forest openings degrade the mesic microclimate in adjacent forests, and thereby reduce the quality of red squirrel habitat

## Steller's Jay

*(Cyanocitta stelleri)*

Steller's jays are a relatively large songbirds averaging 11.5 inches total length, weighing 0.25 pounds (Kilgore 1971). Steller's jays are a common resident of ponderosa pine and mixed-species forest, and occur often in goshawk diets. In eastern Oregon, 7.5% of goshawk prey remains were Steller's jays (Reynolds and Meslow 1984). Over 11% of the prey deliveries to 7 goshawk nests in north-central New Mexico were Steller's jays (Kennedy 1991). In northern Arizona, this corvid comprised 5.2% of 135 prey deliveries to 7 goshawk nests (Mannan and Boal 1990). Steller's jays were the most common prey in remains collected at a goshawk nest in piñon-juniper (K. Keel, A. Alexander and H. Reiser pers. obs.).

**Distribution**

The Steller's jay is found in coniferous forests throughout the west from southeast Alaska to the mountains of central Mexico, and from the Pacific Coast to the Rocky Mountains (Martin et al. 1951).

**Habitat**

In the Pacific Northwest, the Steller's jay is commonly associated with open old forest conditions (Egeline 1986). Steller's jays are present year-round in the San Francisco Mountains, Arizona. In the San Francisco Mountains, however, jays are more abundant in old-growth ponderosa pine during the winter (8400-8500 feet elevation), but are more abundant in mixed-pine forests (8800-9500 feet) during the rest of the year (Coons 1984). In the San Francisco Mountains, Steller's jays also occur in mixed forests of Douglas-fir and limber pine interspersed with stands of quaking aspen (Haldeman 1968). This corvid is also common in ponderosa pine, Douglas-fir, and spruce-fir forests between 7500-8500 feet in the mountains of east-central Arizona (Franzreb and Ohmart 1978). In the mountains of southeastern Arizona, Steller's jays tend to occupy forests above 6000 feet, which is the lower elevational limit of ponderosa pine forests (Brown and Brown 1985).

In the Southwest, Steller's jays occur in ponderosa pine stringers that extend into piñon-juniper woodlands; the ponderosa pine as well as the adjacent woodlands are used (Reiser pers. obs.). Piñon-juniper woodlands are heavily used during fall when this corvid harvests piñon pine seeds (Vander Wall and Balda 1983).

**Food**

Although the Steller's jay is a food generalists, during spring over 75% of its diet consists of insects. In a mixed-species forest dominated by ponderosa pine in California, 93% of food items were Coleoptera, of which 80% were Dyslobus spp. (Otvos and Stark 1985). Other insect foods included grasshoppers, wasps and other arthropods (Martin et al. 1951, Brown 1974). Summer diets were 50% animal and 50% plant foods, while fall and winter diets ranged from 70 to 90% plant material (nuts, acorns, fruits, berries, but primarily seeds of piñon, southwestern white pine, whitebark pine, and limber pine) (Martin et al. 1951, Hagar 1960, Brown 1974, Vander Wall and Balda 1983). The Steller's jay caches pine seeds during the fall to augment its winter diet. Unlike other members of the corvid family (Clark's nutcracker, piñon jay), the Steller's jay usually does not undergo eruptive movements when local pine crops fail (Vander Wall and Balda 1983).

**Special Habitat Needs**

Steller's jays forage in a variety of habitats. However, because of the jay's reliance on pine seeds during fall and winter, forests containing trees that produce large and predictable cone crops are required. Piñon pine trees do not begin producing large quantities of seed until 75 to 100 years of age, after which they will continue to produce abundant seeds for several centuries (Ronco 1990). Western white pine produces regular cone crops after 70 years of age (Graham 1990).

On an open, lightly harvested ponderosa pine site (8,000 feet elevation) in north-central Arizona, the number of Steller's jays ranged from 14 to 23 individuals per 100 acres during summer (Coons 1984). However, the number of breeding jays in an open, old-growth ponderosa pine forest in northern Arizona had only 1.0 to 2.8 pairs per 100 acres (Siegel 1989). With the exception of clearcuts, Szaro and Balda (1982) noted that Steller's jays were found throughout ponderosa pine forests.

**Home Range**

Among North American corvids, the Steller's jay is intermediate on a continuum between species that defend classic territories (regular spacing of nests) and species that nest colonially. Steller's jays maintained "areas of dominance" around their nests of 0.2 to 0.9 acre, and these areas were non-overlapping. Nevertheless, adjacent home ranges (2.1 to 3.4 acres) overlapped extensively (Brown 1963, Brown 1974).

Additionally, Steller's jays flew up to 2 miles to forage on seasonally abundant foods (pine seeds, acorns, berries). Steller's jays, like many other corvids, spend fall collecting and caching pine seeds and acorns. Piñon pine seeds were often carried from the piñon-juniper woodlands to the jay's breeding territories, which were in ponderosa pine and mixed-species forests (Vander Wall and Balda 1981, Vander Wall and Balda 1983).

**Population**

Studies show that the abundance of nesting Steller's jays is not associated with forest type or levels of tree harvesting. For example, in unlogged mixed-species forests in north-central and east-central Arizona, densities of breeding jays ranged from 10 to 25.6 pairs per 100 acres. Densities at higher elevations in unlogged mixed-species forests were lower (5 to 13 pairs per 100 acres) (Haldeman 1968, Franzreb 1977, Coons 1984). Similar breeding densities were found in unlogged ponderosa pine and mixed-pine forests (ponderosa, limber and southwestern white pine) (1.1 to 23 breeding pairs per 100 acres) (Haldeman

1968, Szaro and Balda 1979b, Coons 1984, Siegel 1989).

Individual tree removal in mixed-species forests appeared to have no effect on breeding populations of Steller's jay in east-central Arizona (average 20.7 pairs per 100 acres) (Franzreb 1977). In ponderosa pine stands in northern Arizona, densities of jays ranged from 0 (in clearcut areas) to 7.5 pairs per 100 acres (in unharvested areas) (Szaro and Balda 1979b, Siegel 1989). Densities of jays on the North Kaibab Plateau were lower in dense old-growth ponderosa pine (1.4 pairs per 100 acres) than in areas that were thinned but whose residual stands contained large trees (1.9 pairs per 100 acres) (Siegel 1989).

**Management Effects**

Some harvesting practices, such as thinning and partial overstory removal, when compared to control plots had little or no effects on the abundance of Steller's jays. Clearcuts and shelterwood cuts (few residual large trees), however, resulted in large declines of jay populations (Kilgore 1971, Franzreb and Ohmart 1978, Szaro and Balda 1979a, Mannan and Meslow 1984).

Abundant and well distributed seed-producing trees of oak, and limber, southwestern white, and piñon pines, are important to the Steller's jay.

**Habitat Management Recommendations**

√ **Coniferous forest generalists**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 4, VSS 5, and VSS 6 have highest breeding densities

√ **Foraging**
- VSS 1, VSS 2, VSS 3, VSS 4, VSS 5, and VSS 6
- Abundant cone- and mast-producing trees are important for summer and winter foods
- During fall, large piñon trees are an important source of food

√ **Other important habitat attributes**
- Downed logs and woody debris are important as habitats for insect food

## Tassel-Eared Squirrel

*(Sciurus aberti)*

(Abert's Squirrel, Kaibab Squirrel)

The tassel-eared squirrel is a relatively large tree squirrel (total length=19-21 inches, weight=1.5-2 pounds). Its body size and wide distribution in ponderosa pine forests in the Interior West make it an important prey of the goshawk. This squirrel made up 5.2% of diets of nesting goshawks on the North Kaibab Plateau (Mannan and Boal 1990), and 8.6% of 105 prey remains that were collected at 8 goshawk nests in the Jemez Mountains of New Mexico (Kennedy 1991). Because of their large size, the contribution of this squirrel to the above diets exceeded 10% of the total biomass consumed.

**Distribution**

The tassel-eared squirrel is a forest-dwelling mammal that ranges from southern Wyoming into Utah, Colorado, Arizona, and New Mexico (McKee 1941, Davis and Brown 1989).

**Habitat**

Tassel-eared squirrels are primarily restricted to ponderosa pine-dominated forests, although they are occasionally observed in piñon pine woodlands, Douglas-fir, and spruce-fir forests (Rassmussen 1941, Keith 1965, Patten and Green 1970, Patten 1975, Pederson et al. 1976, J. Hall 1981, Brown 1984, Pederson and Welch 1985, Hoffmeister 1986, Davis and Brown 1989).

**Food**

Food of the tassel-eared squirrel consists almost exclusively of items produced by ponderosa pine or fungi symbiotic with it (J. Hall 1981). Fungi are a major food item during summer and fall (Stephenson 1974, J. Hall 1981, States et al. 1988); in Arizona up to 98% of the diet is hypogeous fungi (Maser et al. 1978). The occurrence of fungi in the habitat of this squirrel is correlated with canopy cover and summer rains (States 1985, Pederson et al. 1987).

Apical buds and staminate cones of ponderosa pine are major food items during the winter and early summer, respectively (Keith 1965, Stephenson 1974, J. Hall 1981). Seeds of ovulate cones are a nutritious food source, but cone availability varies from year to year (J. Hall 1981). In contrast, phloem (cortical tissue of subterminal twigs), a dietary staple of tassel-eared squirrels, is always available (J. Hall 1981, Farentinos et al. 1981). Due to its low nutritional value, diets dominated by inner bark reduce squirrel survival during adverse weather (Patton 1974). In fact, several authors (Kenward 1983, States et al. 1988) have demonstrated a loss of body mass after squirrels switch from fungi to inner bark during winter.

In ponderosa pine stands with high densities of Gambel oak, acorns can comprise up to 40% of the squirrel's diet during fall (Stephenson 1974). In areas where oaks produce abundant acorn crops, squirrel densities may be higher than in areas without oak (Reiser pers. obs.). Also, cavities in large

diameter oaks are sometimes used for nesting (Vahle pers. comm.).

**Special Habitat Needs**

Squirrels show strong preferences for large trees for feeding and nesting (Keith 1965, Pederson et al. 1976, J. Hall 1981, Farentinos et al. 1981). For example, Patton and Green (1970) found that 90% of 538 feeding trees were between 11 and 30 inches DBH (average=19 inches DBH). In Utah, diameter of feeding trees averaged 16.6 inches (Pederson et al. 1976). In Ffolliott and Patton's (1975) production rating criteria for feed-trees, 20-inch-DBH trees had the highest value. In a study of winter feeding, States et al. (1988) found that 82% of the mature "yellow pines," which constituted 10% of their study stand, were fed upon, while only 61% of all young "black-jacks" (>4 inches DBH) were fed upon. In another study, the squirrels preferred to forage in trees with a DBH range of 8-16 inches (Allred 1989). Trees 8 to 16 inches DBH comprised 77% of all feed-trees, but represented only 31% of trees available in the study stand.

Squirrels did not utilize trees smaller than 4 inches, probably because the smaller branches did not support their weight. In contrast, larger trees (8-28 inches) had more foliage and offered the squirrels more terminal shoots and ovulate cones (Allred 1989). However, Keith (1965) suggested that forests of "over mature" ponderosa pine make poor squirrel habitat, and Patton's (1984, Figure 2) description of "poor" habitat for squirrels supported this supposition. Ratcliff et al. (1975) found basal area of ponderosa pine was the most consistent variable associated with an index of squirrel density (r=0.88).

Tassel-eared squirrel nests tend to be in groups of trees with interlocking crowns, and nest trees are often larger than the average stand DBH (Rasmussen 1941, Patton 1984). In Utah, nest tree diameters averaged 18.9 inches (Pederson et al. 1976). In Ffolliott and Patton's (1975) production rating criteria for nest trees, 15 inch DBH trees had the highest value.

The "best" squirrel habitat appears to have some mature ponderosa pine trees with areas having canopy cover greater than 60% (Keith 1965, Patton and Green 1970, Patton 1975, Pederson et al. 1976, J. Hall 1981, Patton 1984). Mature trees often produce the most cones (Larson and Schubert 1970), and abundant truffle foods are often associated with young pine stands with canopy cover greater than 65% (States 1985).

**Home Range**

Estimates of squirrel home range size vary by sex and age of squirrel, season (winter versus summer), and method of study (observations of marked individuals versus radio-telemetry). Keith (1965) studied squirrel movements near Flagstaff, Arizona. Although he did not give the number of squirrels studied, average home range (summer and fall) was 18 acres; home range size decreased in winter. Farentinos (1972a, 1979) reported average summer ranges for 3 males at 7.4 acres in 1972 and 6.4 acres for 8 males in 1979; average winter range sizes for males was 18.4 acres and for females was 14.4 acres. The average summer range of 3 males in 1970 was 10.9 acres (J. Hall 1981); an additional male and female over a 2 year period had home ranges of 18 and 34.8 acres, respectively. In Utah, Pederson et al. (1976) radio-tracked squirrels during summer on home ranges before and after timber harvests. Seven home ranges in this study averaged 6.2 acres before harvest, and three of these home ranges averaged 32.0 acres after harvest. Patton et al. (1985) also studied home range size before and after tree harvest. Within his study, average home range sizes were considerably larger than reported elsewhere: 66.7 acres before harvest and 123 acres after harvests (1 female, 4 males).

**Population**

Available evidence suggests that populations of tassel-eared squirrels fluctuate both in the short- and long-term (Pearson 1950, Keith 1965, Farentinos 1972b, J. Hall 1981). Factors causing these fluctuations are not clear. Predation, immigration, quantity and quality of food, timber harvest, tree density and age, sylvatic plague, and winter snow cover have all been suggested (Stephenson and Brown 1980). Patton (1984) developed a table that associated 5 habitat capabilities (poor, fair, good, very good, optimum) (see his Fig. 2) to support a given density of squirrels over the long-term. Of the 3 "best" habitat classes, "good" supported 0.14 squirrel per acre, "very good" supported 0.37, and "optimum" supported 0.99.

**Management Effects**

Pederson et al. (1976) investigated the effects of timber harvests on the tassel-eared squirrel in the Abajo Mountains of southeastern Utah. Their recommendations for minimizing effects of harvest included: 1) retaining "a large percentage" of trees with DBH of 12 to 19 inches and tree heights of 45 to 75 feet, 2) preserving undisturbed areas within a 150-foot radius of nests for nesting and feeding activities, and 3) avoid piling and burning of logging slash. The latter destroys the litter layer and the microclimate necessary for fungi (Pederson et al. 1987).

Both Patton (1984) and States et al. (1988) agree that prime squirrel habitat is comprised of stands containing a combination of tree age-classes whose size, density and grouping provide all the necessary seasonal foods, cover, and nesting sites. It is especially important to maintain groups of trees with interlocking crowns--an important feature of tassel-eared squirrel nesting habitat.

Large-diameter feed-trees also should be dispersed through the squirrel's home range (Patton and Green 1970). Ponderosa pine trees between the ages of 60 and 160 years produce more viable seeds than younger or older trees. In California, trees with DBHs greater than 25 inches were the best seed producers. Ponderosa pines continue to produce abundant seed up to 350 years of age (Oliver and Ryker 1990).

**Habitat Management Recommendations**

√ **Ponderosa pine specialist**
- VSS 3, VSS 4, VSS 5, and VSS 6

√ **Nesting**
- VSS 4, VSS 5, and VSS 6
- Groups of trees with interlocking crowns are very important

√ **Foraging (considered a food specialist)**
- VSS 3, VSS 4, VSS 5, and VSS 6
- Large-diameter trees important for cone production
- Areas of shaded overstory (>60%) necessary for fungi production

√ **Other important habitat attributes**
- Snags may sometimes be used for nest trees (Vahle pers. comm.)
- Downed logs and woody debris are important for food substrate and cover
- Large openings are detrimental because they force squirrels, moving from tree to tree, to travel longer distances on the ground. Retention of trees with interlocking crowns may serve as travel ways and escape corridors.

## Williamson's Sapsucker
*(Sphyrapicus thyroideus)*

Williamson's sapsucker is a medium-sized woodpecker, 9 inches in length and averaging 1.7 ounces in weight (Dunning 1984). The Williamson's sapsucker is widely distributed in conifer forests throughout the western United States.

**Distribution**

In the Southwest, the Williamson's sapsucker is a common year-round resident in the mountainous terrain north of the Mogollon Rim. South of the Mogollon Rim, it may be rare or locally common in wooded areas and forests at middle and lower elevations (Hubbard 1978).

**Habitat**

In the Rocky Mountains, the Williamson's sapsucker prefers forests of mixed-species and hardwoods (mainly ponderosa pine, Douglas-fir, spruce-fir, and aspen) (Scott et al. 1977). During the breeding season, this species was not found in pure stands of ponderosa pine in northern Arizona (Szaro and Balda 1979b, 1986).

In the Huachuca Mountains in southeastern Arizona, Bock and Larson (1986) found Williamson's sapsuckers wintering in oak-juniper and pine-oak woodlands. Females and males wintered at different elevations and habitats; females occurred at a significantly lower elevation (5,558 feet versus 6,120 feet for males) and more frequently in oak and oak-juniper woodlands. Wintering males frequented the pine-oak woodlands (Bock and Larson 1986).

In southwestern Colorado, densities of Williamson's sapsuckers were not associated with the amount of aspen in mixed-species stands (Scott and Crouch 1988).

**Food**

Their diet is approximately 85% animal matter (mainly ants) and 15% plant matter (mainly tree cambium) (Scott et al. 1977). Analysis of 5 sapsucker stomachs in California showed that 2 species of Formicidae (*Camponotus* spp. and *Liometopum* spp.) made up 70% of total volume of food items. Coleoptera comprised an additional 17.5% of the total volume (Otvos and Stark 1985). Like the red-naped sapsucker, the Williamson's sapsucker feeds on sap throughout the year (Scott et al. 1977, Bock and Larson 1986). Bock and Larson (1986) also noted that female Williamson's sapsuckers were attracted to fruit crops in southeastern Arizona during winter, especially berries of madrone trees.

**Special Habitat Needs**

The choice of tree species for nesting varies between regions. In the Southwest, the species exhibited a preference for aspen (Scott et al. 1977). In Arizona, 17 of 21 nests were in aspen snags, 3 were in live aspens with dead tops, and 1 nest was in a live aspen (Scott et al. 1977). Along the Mogollon Rim, in central Arizona, Li and Martin (1991) found 97% of 36 nest sites in aspen snags which averaged 15 inches DBH. Average nest tree height was 40.7 feet. Nest plots (0.1 acre) contained an average of

2.4 aspen snags and 0.5 conifer snags (Li and Martin 1991). Of 57 nests in Colorado, 49 were in aspen, and many of the nest trees were infected with *Phellinus* fungus. In areas without suitable aspen nest trees, pines were used for nesting (Scott et al. 1977).

In three forest types in Colorado and Arizona (ponderosa pine, spruce-fir, and aspen), 21 of 26 nest cavities were in dead aspen, 1 was in a live aspen, and 4 were in unidentified dead-topped conifers (Scott et al. 1980). The average nest height was 39 feet (range 25-60 feet), average nest tree height was 62 feet (range 45-80 feet), and the average nest tree DBH was 16 inches (range 14-19 inches).

During winter in the Huachucua Mountains, Arizona, male and female Williamson's sapsuckers used different feeding trees. Females drilled for sap only in oak and madrone trees, whereas males drilled for sap predominantly in Chihauhau pine (81.8% of the sap trees), juniper (12.1%), and madrone (6.1%) (Bock and Larson 1986).

**Home Range**

No home range information on the Williamson's sapsucker was found.

**Population**

In unlogged old-growth ponderosa pine stands, Williamson's sapsucker breeding densities during a 2-year study were much higher in dense stands (5.7 pairs per 100 acres) compared to open stands (1.0 pairs per 100 acres). Densities in open old-growth stands were similar to selectively harvested old-growth stands (1.7 pairs per 100 acres) (Siegel 1989).

**Management Effects**

Williamson's sapsucker populations remained stable or decreased in response to various logging practices (see Medin 1985, Table 3). Franzreb and Ohmart (1978) observed no differences in breeding densities in unlogged and logged areas with many large residual trees; densities averaged 3.9 pairs per 100 acres in this 2-year study.

Dense, mature forests are necessary for maintaining high densities of Williamson's sapsuckers (Siegel 1989). Due to the woodpecker's preference for quaking aspen nest trees, regenerating and maintaining aspen trees and stands is important. Development of oak and other deciduous trees in the understory for feed-trees may also benefit the Williamson's sapsucker.

**Habitat Management Recommendations**

√ **Conifer forest generalists**
- VSS 4, VSS 5, and VSS 6
- Prefers dense stands of large trees, commonly mixed with quaking aspen

√ **Nesting**
- VSS 4, VSS 5, and VSS 6
- Aspen very important, particularly snags
- Nest trees 15-16 inches DBH and 62 feet high; nests average 39-41 feet high

√ **Foraging**
- VSS 4, VSS 5, and VSS 6
- Deciduous trees are important as a sap source
- Snags are important for insect prey

√ **Other important habitat attributes**
- Woody debris and downed logs are important foraging sites

# Appendix 4. Forest Health

Forest health is a function of many of biotic and abiotic factors. Insects and diseases are essential components of ecosystems. They provide food (insects, fungi, mistletoe), structural diversity (snags, downed logs, witches brooms), and nest sites (tree cavities, witches brooms) for many wildlife species. Fire suppression and logging of large trees has increased the frequency and intensity of epidemics of insects, root diseases, and dwarf mistletoes. These epidemics may prevent forests from reaching the older age classes by reducing growth and increasing tree mortality. The distribution of pest-affected or pest-susceptible stands should be considered in ecosystem management. Pest prevention and suppression strategies, or in some cases no action, should be utilized where appropriate to develop or maintain the desired forest conditions for goshawks and their prey.

## Dwarf Mistletoe

Dwarf mistletoes are common on conifers in the Southwest, and were identified as early as 1909 as one of the primary causes of mortality in ponderosa pine (Krauch 1926, Hawksworth and Weins 1972, Hawksworth and Geils 1989).

Dwarf mistletoes can alter the structure of forests by reducing growth and increasing tree mortality. Some of these changes, as well as the mistletoe plant itself, benefit wildlife (Bennetts 1991). Over time, however, mistletoe related changes can be detrimental to some goshawk prey species. For example, ponderosa pine stands severely infected with southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) become stagnated and may not develop beyond the young forest stage (VSS 3) or may revert, because of high mortality, to the grass/forb/shrub stage (VSS 1).

Management recommendations for developing the desired forest conditions could include application of sanitation cuts and thinnings to reduce the detrimental effects of mistletoe in the post-fledging family areas and foraging areas. It makes good sense to select reserve trees that are free of or only lightly infected with dwarf mistletoe. Because mistletoe in large trees infects nearby understory trees, the understory might not reach the larger tree sizes. When necessary, infected trees can be killed and left standing by using intense basal fires, or by girdling (Conklin et al. 1991).

## Root Diseases

Fungal root diseases are common in many mixed-species and spruce-fir forests and in some pines in the Southwest (Wood 1983). Root diseases generally result in spreading centers of tree mortality, and all VSS are susceptible. Root diseases survive for decades in roots of stumps and snags, and can infect susceptible trees through root contact (Tkacz and Baker 1991). A recommended means for reducing root disease is to patch-cut disease centers and regenerate with resistant species (such as aspen) or ponderosa pine in mixed-species forests.

## Western Spruce Budworm

The western spruce budworm (*Choristoneura occidentalis*) is a widely distributed defoliator of mixed-species forests (Fellin and Dewey 1982). The spruce budworm can seriously affect the growth of young trees under a canopy. Affected trees display less vigorous growth, less foliage volume, and reduced cone production. Mature trees severely defoliated by budworm are predisposed to one or more species of tree-killing bark beetles.

The 2- to 4-acre openings and understory tree removal in mixed-species forests will make stands less susceptible to spruce budworm by allowing the regeneration of intolerant species such as ponderosa pine.

## Bark Beetles

Bark beetles, including engraver beetles (*Ips*), western pine beetle (*Dendroctonus brevicomis*), and mountain pine beetle (*D. ponderosae*) are periodically destructive to ponderosa pine in the Southwest. Spruce can be killed by spruce beetle (*D. rufipennis*) and Douglas-fir by Douglas-fir beetle (*D. pseudotsugae*). Bark beetles typically attack trees that are weakened by disease, overcrowding, defoliation, injury, or drought.

Thinning to reduce overcrowded conditions in young to old forests will reduce the susceptibility of trees to bark beetle epidemics.

# Appendix 5. Vegetation structural stage determination and management options

## Vegetation Structural Stage Determination

Vegetation structural stage (VSS) is a method of describing the growth stages of a stand of living trees. It is based on tree size (DBH) and total canopy cover. Overall, the VSS is dependent on the time it takes seedlings to become established and subsequent growth rates. Life expectancy of trees determines how long the oldest VSS can be maintained.

The time required for seedling establishment depends on:

1) cone crop frequencies ( Appendix 1, Table 2; page 49),
2) cone development,
3) seed production and distribution,
4) proper conditions for germination,
5) root system establishment, and
6) climatic conditions.

Seedling establishment varies from 10 years in ponderosa pine and mixed-species, to 20 years in spruce-fir after a canopy is opened and a forest floor is disturbed (Pearson 1950, Alexander 1974).

Tree diameter growth rates vary with:

1) initial diameter (starting point),
2) site productivity,
3) climatic conditions, and
4) level of management.

Ponderosa pine and mixed-species forest types have similar diameter growth rates, ranging from 0.2 to 2.5 inches per decade (Edminister et al. 1991) (Tables 1, 2). Spruce-fir forests usually have growth rates of 0.2 to 1.4 inches per decade (Table 3).

Pathological age of trees is the ages (years) when growth slows, significant decay develops, and mortality is high (Boyce 1961). Pathological age ranges from 10 years in Gambel oak to 250-450 years in Engelmann spruce (Table 4). However, individual trees can live much longer. In southwestern tree species, longevity ranges from 80 years in Gambel oak to >2000 years in limber pine (Table 4).

Site productivity and growth rates vary widely among forest types of the Southwest. The following site indices (SI) and basal areas per acre (BA/A) were chosen to typify each forest type (Tables 1, 2, 3):

1) Ponderosa pine: 70 SI, 60 BA/A
2) Mixed-species: 70 SI, 80 BA/A
3) Spruce-fir: 80 SI, 100 BA/A

## Management Options for Developing Vegetation Structural Stages

To develop the VSS proportions in goshawk home ranges many options are available. To achieve the desired forest conditions, some form of stand regeneration and tree density control (e.g., fire, insect and disease, understory thinning) is needed. Depending on management intensity (minimal, moderate, and intensive), the desired forest conditions can be obtained at varying rates (Tables 1, 2, 3, 5).

Intensity of forest treatments (thinning) influences the growth rates of trees . For example, because of competition, trees in unthinned ponderosa pine stands will not grow more than 11 inches in diameter over a 220 year period (Table 5). As a result, these unthinned stands will remain in a "young VSS" (DBH) even though they are 200 years old. Table 5, illustrates how trees and forests change (mean diameter, basal are, tree per acre, and VSS) through time under five different management intensities.

**Table 1. Estimated diameter growth rates, age in vegetation structural stage (VSS), accumulated age, and proportion of landscape in each VSS for the ponderosa pine forest cover type (site index = 70, basal area = 60 sq ft/ac).**

| Structural Stage (SS) and Diameter (Inches) | Grass/Forb/Shrub 0-1 | Seedling-Sapling 1-5 | Young Forest 5-12 | Mid-aged Forest 12-18 | Mature Forest 18-24 | Old Forest 24+ |
|---|---|---|---|---|---|---|
| **Minimal Managment** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.33 | 1.52 | 1.48 | 1.3 | 1 |
| Years (Acc-yrs)[1] | 20 (20) | 30 (50) | 46 (96) | 41 (137) | 46 (183) | 50 (233) |
| Percent in SS | 9 | 13 | 20 | 17 | 20 | 21 |
| **Moderate Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.91 | 1.76 | 1.64 | 1.4 | 1.10 |
| Years (Acc-yrs) | 20 (20) | 21 (41) | 40 (81) | 37 (117) | 43 (160) | 45 (204) |
| Percent in SS | 10 | 10 | 19 | 17 | 20 | 24 |
| **Intensive Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 2.5 | 2 | 1.8 | 1.5 | 1.2 |
| Years (Acc-yrs) | 20 (20) | 16 (36) | 35 (71) | 33 (104) | 40 (144) | 50 (194) |
| Percent in SS | 10 | 8 | 18 | 17 | 21 | 26 |

[1] *Years (Acc-yrs): Number of years in structural stage (SS) and accumulated years (Acc-yrs).*

**Table 2. Estimated diameter growth rates, age in vegetation structural stage (VSS), accumulated age, and proportion of landscape in each VSS for the mixed-species forest cover type (site index = 70, basal area = 80 sq ft/ac).**

| Structural Stage (SS) and Diameter (Inches) | Grass/Forb/Shrub 0-1 | Seedling-Sapling 1-5 | Young Forest 5-12 | Mid-aged Forest 12-18 | Mature Forest 18-24 | Old Forest 24+ |
|---|---|---|---|---|---|---|
| **Minimal Managment** | | | | | | |
| Diameter growth/decade (inches) | 0 | 0.82 | 1.02 | 1.20 | 1.1 | 1.03 |
| Years (Acc-yrs)[1] | 20 (20) | 49 (69) | 69 (137) | 50 (187) | 55 (242) | 44 (290) |
| Percent in SS | 7 | 17 | 24 | 17 | 19 | 17 |
| **Moderate Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.08 | 1.27 | 1.34 | 1.2 | 1.07 |
| Years (Acc-yrs) | 20 (20) | 37 (57) | 55 (112) | 45 (157) | 50 (207) | 47 (254) |
| Percent in SS | 8 | 15 | 22 | 18 | 20 | 18 |
| **Intensive Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.33 | 1.52 | 1.48 | 1.3 | 1 |
| Years (Acc-yrs) | 20 (20) | 30 (50) | 46 (96) | 41 (137) | 46 (183) | 50 (233) |
| Percent in SS | 9 | 13 | 20 | 17 | 20 | 21 |

[1] *Years (Acc-yrs): Number of years in structural stage (SS) and accumulated years (Acc-yrs).*

**Table 3. Estimated diameter growth rates, age in vegetation structural stage (VSS), accumulated age, and proportion of landscape in each VSS for the spruce-fir forest cover type (site index = 80, basal area = 100 sq ft/ac).**

| Structural Stage (SS) and Diameter (inches) | Grass/Forb/Shrub 0-1 | Seedling-Sapling 1-5 | Young Forest 5-12 | Mid-aged Forest 12-18 | Mature Forest 18-24 | Old Forest 24+ |
|---|---|---|---|---|---|---|
| **Minimal Managment** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.00 | 1.02 | 1.00 | 0.9 | 0.8 |
| Years (Acc-yrs)[1] | 20 (30) | 40 (70) | 69 (139) | 60 (199) | 67 (265) | 63 (328) |
| Percent in SS | 6 | 13 | 22 | 19 | 21 | 20 |
| **Moderate Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 1.75 | 1.51 | 1.40 | 1.2 | 0.9 |
| Years (Acc-yrs) | 30 (30) | 23 (53) | 49 (99) | 43 (142) | 50 (192) | 56 (248) |
| Percent in SS | 8 | 14 | 23 | 17 | 19 | 19 |
| **Intensive Management** | | | | | | |
| Diameter growth/decade (inches) | 0 | 2.5 | 2 | 1.8 | 1.5 | 1 |
| Years (Acc-yrs) | 20 (30) | 16 (46) | 35 (81) | 33 (114) | 40 (154) | 50 (204) |
| Percent in SS | 10 | 8 | 18 | 17 | 21 | 26 |

[1] *Years (Acc-yrs): Number of years in structural stage (SS) and accumulated years (Acc-yrs).*

**Table 4. The oldest and pathological ages (years) for several tree species in the Southwest.**

| Species | Oldest Age | Pathological Age (Age of Decline) | Reference |
|---|---|---|---|
| Ponderosa pine | 650 | 145-200 | Pearson 1950; White 1985; Covington and Mooore 1991 |
| Interior Douglas-fir | 400 | 150 | Hermann and Lavendar 1990 |
| Interior white fir | 300-360 | 150 | Markstrom and McElderry 1984; Hunter 1989 |
| Subalpine fir/Cork bark fir | 250 | 130 | Hunter 1989 |
| Engelmann spruce | 500-600 | 250-450 | Alexander and Shepperd 1990 |
| Blue spruce | > 600 | Unknown | Fechner 1990 |
| Eastern white pine | > 450 | 160-170 | Hunter 1989 |
| Southwestern white pine | Intermediate between eastern and western white pine | | |
| Western white pine | 500 | 300-400 | Graham 1990 |
| Limber pine | > 2000 | 200-300 | Preston 1961; Lynch 1990; Steele 1990 |
| Aspen | > 200 | 40-120 | Hunter 1989; Perala 1990 |
| Gambel oak | > 80 | 10 | Brotherson et al. 1983 |

**Table 5. Projected basal areas, trees per acre, and tree diameters from growth rates for unthinned and extensively thinned stands, Fort Valley Experimental Forest[1]**

| Treatment | | | Age[2] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thin from below, age | Leave basal area[3] | | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 |
| No Treatments | | BA[4] | 0 | 2.7 | 114.2 | 175.7 | 199.9 | 212.9 | 213.7 | 214.9 | 216.5 | 223.7 | 216.3 | 212.2 |
| | | TPA | 500 | 500 | 500 | 493.7 | 476.1 | 463.0 | 439.9 | 416.3 | 402.0 | 397.0 | 373.3 | 346.5 |
| | | DBH | 0 | 1.0 | 6.5 | 8.1 | 8.8 | 9.2 | 9.4 | 9.7 | 10.0 | 10.2 | 10.3 | 10.6 |
| 40 | 40 | BA | 0 | 2.7 | 40.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 60 | 100 | | | | | | | | | | | | | |
| 80 | 100 | | | | | | | | | | | | | |
| 100 | 100 | TPA | 500 | 500 | 171.4 | 162.6 | 112.2 | 81.2 | 60.7 | 47.5 | 38.2 | 31.2 | 25.9 | 21.9 |
| 120 | 100 | | | | | | | | | | | | | |
| 140 | 100 | | | | | | | | | | | | | |
| 160 | 100 | | | | | | | | | | | | | |
| 180 | 100 | DBH | 0 | 1.0 | 6.5 | 10.6 | 12.8 | 15.0 | 17.4 | 19.7 | 21.9 | 24.3 | 26.6 | 28.9 |
| 200 | 100 | | | | | | | | | | | | | |
| 220 | 100 | | | | | | | | | | | | | |
| 40 | 30 | BA | 0 | 2.7 | 30.0 | 88.9 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 60 | 100 | | | | | | | | | | | | | |
| 80 | 100 | | | | | | | | | | | | | |
| 100 | 100 | TPA | 500 | 500 | 128.0 | 128.0 | 96.8 | 71.6 | 54.5 | 43.1 | 35.0 | 28.8 | 24.1 | 20.5 |
| 120 | 100 | | | | | | | | | | | | | |
| 140 | 100 | | | | | | | | | | | | | |
| 160 | 100 | | | | | | | | | | | | | |
| 180 | 100 | DBH | 0 | 1.0 | 6.5 | 11.3 | 13.8 | 16.0 | 18.3 | 20.6 | 22.9 | 25.2 | 27.6 | 29.9 |
| 200 | 100 | | | | | | | | | | | | | |
| 220 | 100 | | | | | | | | | | | | | |
| 40 | 40 | BA | 0 | 2.7 | 40.0 | 50.0 | 60.0 | 79.9 | 79.0 | 89.8 | 100.0 | 110.0 | 120.0 | 130.0 |
| 60 | 50 | | | | | | | | | | | | | |
| 80 | 60 | | | | | | | | | | | | | |
| 100 | 70 | TPA | 500 | 500 | 171.4 | 79.0 | 50.6 | 38.1 | 31.3 | 27.4 | 24.9 | 23.3 | 22.2 | 21.6 |
| 120 | 80 | | | | | | | | | | | | | |
| 140 | 90 | | | | | | | | | | | | | |
| 160 | 100 | | | | | | | | | | | | | |
| 180 | 110 | DBH | 0 | 1.0 | 6.5 | 10.8 | 14.7 | 18.4 | 21.6 | 24.5 | 27.1 | 29.4 | 31.5 | 33.2 |
| 200 | 120 | | | | | | | | | | | | | |
| 220 | 130 | | | | | | | | | | | | | |
| 40 | 30 | BA | 0 | 2.7 | 30.0 | 80.0 | 80.0 | 80.0 | 79.7 | 80.0 | 80.0 | 80.0 | 80.0 | 80.0 |
| 60 | 80 | | | | | | | | | | | | | |
| 80 | 80 | | | | | | | | | | | | | |
| 100 | 80 | TPA | 500 | 500 | 128.0 | 114.1 | 72.9 | 50.4 | 36.7 | 28.0 | 22.0 | 17.7 | 14.5 | 21.1 |
| 120 | 80 | | | | | | | | | | | | | |
| 140 | 80 | | | | | | | | | | | | | |
| 160 | | | | | | | | | | | | | | |
| 180 | 80 | DBH | 0 | 1.0 | 6.6 | 11.3 | 14.2 | 17.1 | 20.0 | 22.9 | 25.8 | 28.8 | 31.8 | 34.8 |
| 200 | 80 | | | | | | | | | | | | | |
| 220 | 80 | | | | | | | | | | | | | |
| 40 | 30 | BA | 0 | 2.7 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 79.9 | 90.0 | 100.0 | 110.0 | 120.0 |
| 60 | 40 | | | | | | | | | | | | | |
| 80 | 50 | | | | | | | | | | | | | |
| 100 | 60 | TPA | 500 | 500 | 128.0 | 55.9 | 35.9 | 27.4 | 22.8 | 20.2 | 18.5 | 17.4 | 16.7 | 16.2 |
| 120 | 70 | | | | | | | | | | | | | |
| 140 | 80 | | | | | | | | | | | | | |
| 160 | 90 | | | | | | | | | | | | | |
| 180 | 100 | DBH | 0 | 1.0 | 6.6 | 11.4 | 16.0 | 20.0 | 23.7 | 27.0 | 29.9 | 32.5 | 34.8 | 36.8 |
| 200 | 110 | | | | | | | | | | | | | |
| 220 | 120 | | | | | | | | | | | | | |
| VSS[5] | | | 1 | 2 | 3 | | 4 | 5 | | | 6 | | | |

[1] *Ronco et al. 1985, Edminster et al. 1991.*
[2] *Conditions displayed in age class are a reflection for the end of each time period.*
[3] *Leave basal area: Basal area in square feet per acre after thinning.*
[4] *BA = Basal area/acre in square feet, TPA = trees/acre, DBH = Diameter Breast Height.*
[5] *VSS = Vegetation structural stage.*

# Appendix 6. The Scientific Committee

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# Appendix 7. Glossary of Terms

**Active nest**---A goshawk nest known to have contained an egg. A nest need not have successfully produced fledglings to be considered active.

**Active nest area**---A goshawk nest area containing an active nest.

**Adverse management activity**---Any activity that could adversely modify goshawk behavior, reproductive effort, or habitat.

**Alternate nest area**---Goshawk home ranges often contain two or more nest areas, only one of which will be active in a given year. All alternate nest areas are historical nest areas.

**Basal Area (BA)**---Basal area is the cross section at breast height (4.5 feet above ground level) or at the root crown of a tree or trees, usually expressed as square feet per acre. A measure of stand density.

**Breeding season**---The period from March 1 through September 30, which includes courtship, incubation, nestling, and fledgling-dependency periods.

**Blowdown**---Trees fallen over in a forest, usually exposing the root system.

**Brood**---Family of young in a nest. Brood size is the number of a young in nest.

**Canopy cover**---The percentage of a fixed area covered by the crowns of plants delimited by a vertical projection of the outermost perimeter of the spread of the foliage.

**Climax species**---Plant species occurring in a relatively stable community.

**Clumpiness**---The occurrence of trees in groups.

**Clutch**---Eggs in a nest. Clutch size is the number of eggs in a nest.

**Codominant tree**---Trees in the upper levels of a forest canopy, not quite as tall as the tallest trees. Together with the tallest trees (dominants) the codominants comprise the main canopy of the stand.

**Diameter at breast height (DBH)**---The outside bark diameter of a tree measured at breast height, 4.5 feet above the forest floor on the uphill side of the tree.

**Diameter root crown (DRC)**---The outside bark diameter of tree measured 2 inches above the break between root collar and the normal taper of the stem. Root collar is the region where root and stem merge. If the tree is multistemmed, the EDRC (equivalent diameter root crown) is calculated and the tree represents one tree.

**Dominant tree**---The tallest tree in a forest. Together with the codominants, the dominant trees comprise the main canopy of the stand.

**Downed log**---Fallen trees or portions of fallen trees.

**Epigeous**---Living or occurring near the soil surface.

**Estivation**---Lowering of the metabolic rate by animals in response to heat stress and/or drought.

**Failed nest**---An active nest in which the eggs or nestlings are lost (e.g., to predators, weather) or abandoned by the adult(s). No young fledged.

**Fire hazard fuels**---Leaves, needles, branches, and tree boles usually less than 3 inches in diameter that dry rapidly and burn easily.

**Fledgling**---A young bird that has left its nest but is unable to completely care for itself.

**Fledgling-dependency period**---The period beginning when the young leave the nest to when they are no longer dependent upon adults for food (about 30-60 days for goshawks).

**Foraging area**---Areas where prey are searched for, pursued by and captured by goshawks.

**Foraging habitat**---Forest lands and lands in openings within 100 feet of a forest edge. To be considered foraging habitat, a patch of forest must be 1 acre or larger. Roadside, streamside, and shelterbelt strips of trees must have a width at least 200 feet to be foraging habitat. Unimproved roads and trails, streams, and clearings in forest areas are classified as foraging habitat if they are less than 200 feet wide.

**Forest cover type**---Also referred to as forest type, cover type, or type. A descriptive classification of a forest based upon the tree species occupying an area (Eyre 1980). Forest cover types are named after predominant tree species. Predominance is determined by basal area, and the name is confined to one or two tree species (ponderosa pine, aspen, piñon-juniper, cottonwood-willow, Engelmann spruce-corkbark fir). The mixed-species conifer forest cover type is not a recognized forest cover type because it includes elements of several cover types (bristlecone pine, interior Douglas-fir, white fir, blue spruce, and limber pine).

**Forest lands**---Lands at least 10 percent stocked by trees of any size, including lands that formerly had such tree cover and that could be naturally or artificially regenerated.

**Fuel ladder**---Combustible materials that carry fires from the surface into the tree canopies. Important in the production of catastrophic fires.

**Grapple piling**---Piling of woody debris using a backhoe equipped with a grapple, or equipped with a bucket that is capable of opening and holding pieces of debris.

**Ground cover**---Cover produced by herbaceous (including grass and ferns) and shrubby plants.

**Group selection**---A regeneration method in the uneven-aged silvicultural system in which trees are removed in small groups. The purpose is to create a stand with 3 or more age classes.

**Historical nest**---A nest known to have been active in the past.

**Historical nest area**---A nest area containing one or more historical nests. An alternate nest area is an historical nest area. Historical nest areas are important because they may contain the habitat elements that attracted the birds originally.

**Home range**---The area that an animal habitually uses during nesting, resting, bathing, foraging, and roosting. Adjacent pairs of goshawks may have overlapping home ranges; the extent of overlap is unknown. A nesting home range contains nest areas (active and historical), the post-fledging family area, and the foraging area.

**Hypogeous**---Living or occurring below the soil surface.

**Improvement cut**---A cut done in either even- or uneven-aged stands where the residual trees are of pole size or larger.

**Interspersion of vegetative structural stage**---The degree of intermixing of vegetative structural stages. A low intermixing of the VSS would mean relatively large, contiguous areas of similar VSS; high intermixing would mean relatively small groups of all VSS.

**Intact group**---A group of trees delineated by mature and old trees, but containing all other trees (sizes and ages), shrubs, and ground cover.

**Intermediate tree**---A tree occupying a position below the crowns of dominant and codominant trees.

**Intermediate treatment**---The treatment (cutting) of trees from a stand between the time of regeneration and final harvest. Treatments include cleaning, thinning, liberation, improvement, salvage, and sanitation cuttings. Treatments other than removal (pruning, fertilization, prescribed fire) can also be called intermediate.

**Liberation treatment**---Removing the larger trees from a stand when the favored trees are saplings or smaller.

**Lopping and scattering**---A method to disperse logging debris, and to reduce it to a specific height (usually 2-3 feet) above the ground.

**Main canopy**---The dominants and codominants (overstory trees) in a stand.

**Mesic habitats**---Forests that are more moist and cool. Mesic habitats are usually located along drainages, at base of slopes, or on northerly exposures.

**Middens**---Food cache sites for red squirrels.

**Mixed-conifer**---Mixed-conifer forests are similar to mixed-species forest cover type. See **Forest cover type**.

**Multi-storied stand**---A forest stand having more than one horizontal layer of vegetation.

**Mycorrhizae**---Symbiotic fungi on plant roots that function in the absorption of water and nutrients from the soil.

**Natural opening**---An opening in the forest canopy not created by management activities.

**Nest**---A platform of sticks on which eggs are laid. Most goshawk nests are placed within the lower two-thirds of tree crowns, often against the trunk but occasionally on a limb up to 10 feet from the trunk.

**Nest area**---The nest tree and stand(s) surrounding the nest that contain prey handling areas, perches, and roosts. Nest areas are often on mesic sites (northerly facing slopes, along streams).

**Nest attempt**---An attempt to nest. Evidenced by courtship behavior in a nest area, new nest construction, reconstruction of an old nest, eggs, or nestlings.

**Nest stand**---The stand of trees that contains the nest tree.

**Nest tree**---The tree containing the nest.

**Nesting home range**---The home range of a pair of nesting goshawks. See **Home range**.

**Nesting season**---The period from the beginning of courtship behavior until the fledgling(s) are no longer dependent on adults for food.

**Nonreserved forest land**---Forest land not withdrawn from tree utilization through statute or administrative designation.

**Opening**---A break in the forest canopy that may be covered by grasses, forbs, shrubs, tree seedlings; or areas with sapling-sized trees and larger that are stocked less than 10 percent.

**Overstory**---The uppermost canopy layer of a forest.

**Permanent skid trail**---A pathway over which logs are removed. These trails are a permanent extension of the existing forest transportation system.

**Plucking post**---A perch used by a goshawk while removing feathers and fur from prey. Plucking posts can be in a tree, downed log, stump, or on the ground. Plucking posts are identified by feather and fur remains of prey.

**Post-fledging family area**---The area of concentrated use by the goshawk family after the young leave the nest.

**Protocol**---A formalized methodology to monitor resources.

**Regeneration method**---The silvicultural treatment of a stand that is employed to establish a new stand of trees.

**Replacement nest area**---Forest areas with physiographic characteristics and size similar to suitable goshawk nest areas. Replacement areas can have young to mature forests that can be developed into suitable nest areas.

**Reserved forest land**---Forest land withdrawn from tree utilization through statute or administrative designation.

**Reserved trees**---Old and mature trees retained in a management area forever. These trees are a recruitment source for snags and downed logs.

**Roost**---Tree or groups of trees used by birds or mammals for resting. A roost site consists of all other trees whose crowns overlap or interlock with the roost tree.

**Sanitation cut**---The removal of insect-attacked or diseased trees to maintain the health a stand.

**Scarification**---Soil layer disturbance(s) for the purpose of preparing seed beds and/or stimulating vegetative growth from root structures.

**Seral species**---Plant and animal species that will be replaced over time through forest succession.

**Sensitive species**---Plant and animal species identified by the Regional Forester for which population viability is a concern, as evidenced by: a) significant current or predicted downward trends in population numbers, b) significant current or predicted downward trends in habitats of these species (USDA Forest Service 1991, Manual 2600, Chapter 2670.50, pg. 12).

**Shelterwood**---A regeneration method in the even-aged silvicultural system that establishes new trees or seedlings under overstory trees. Overstory trees provide seed for regeneration, and shade and protection for seedlings. The overstory trees can be removed at one time (final removal) or gradually removed over a long period of time. Uniform shelterwood is applied over an entire stand. Irregular group shelterwood partitions the stand into groups.

**Silvicultural system**---A planned program of treatments during the life of a stand. There are two basic silvicultural systems, the even-aged and uneven-aged.

**Single-storied stand**---Stand of trees having a single canopy layer. See **Multi-storied stands**.

**Site index (SI)**---The capability of the soil or site to produce biomass (trees). Site index is expressed as the height a forest stand will achieve in a standard time-period. In southwestern forests, 100 years is the standard.

**Snag**---A standing dead tree.

**Stand**---An area of trees possessing sufficient uniformity (species composition, age, and physical features) to be distinguishable from trees on adjacent areas.

**Stringer**---A unique linear patch of forest, typically occurring along drainages.

**Successful nest**---A nest from which at least one young is fledged.

**Successional stage**---A recognizable stage that a plant community passes through during its development from seral to climax vegetation.

**Suitable habitat**---Habitat that is currently usable for nesting, roosting, and foraging. Forest habitat need not be occupied by goshawks to be considered suitable.

**Suitable nest area**---An area that includes all of the attributes of a nest area and is, therefore, usable for nesting by goshawks.

**Territory**---An exclusive area defended by a goshawks. An active nest is not an essential element of a territory.

**Thinning from below**---The removal of the slower growing trees in the lower portion of the canopy. This intermediate treatment leaves the taller, faster-growing trees at a selected density and spacing.

**Total basal area (BA)** ---The sum of the basal area of all trees in a stand or area expressed in square feet per acre.

**Total canopy cover**---The overall area covered by the crowns of plants delimited by a vertical projection of the outermost perimeter of the spread of the foliage in all vertical layers.

**Transitory range**---Areas capable of producing animal forage (shrubs, grasses, forbs) when trees are removed (fire, windthrow, timber harvesting)

from forested lands. Transitory range is temporary because of forest regrowth.

**Tree age**---Number of years a tree has lived. May be determined by counting annual growth rings.

**Understory**---Any layer of the forest canopy below the overstory; can consist of trees, shrubs and/or herbaceous layers.

**Unsuitable habitat**---Habitat that does not have the capability of attaining the characteristics of suitable habitat through standard, prescribed management treatments or natural processes.

**Vegetation Structural Stage (VSS)**---A generalized description of forest growth and aging stages based on the majority of the trees in the specific diameter distribution of the stand. For our purposes, 6 growth and aging stages were identified. If the majority of the stems of a stand (based on basal area) were in the 12-18 inch diameter class, the stand would be classified as a VSS 4.

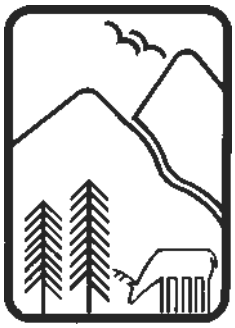
The tree diameter range and description for the vegetation structural stages are:

| Stage | DBH Range (inches) | Description |
|---|---|---|
| 1 | 0-1 | grass-forb-shrub (opening) |
| 2 | 1-5 | seedling/sapling |
| 3 | 5-12 | young forest |
| 4 | 12-18 | mid-age forest |
| 5 | 18-24 | mature forest |
| 6 | 24+ | old forest |

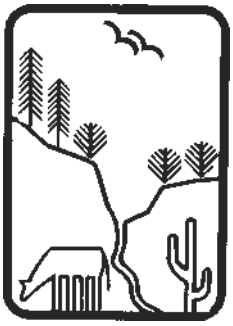
The codes, percentages, and descriptions for canopy cover are as follows:

| Code | Percentage (%) | Description |
|---|---|---|
| A | 0-39 | open |
| B | 40-59 | moderately closed |
| C | 60+ | closed |

**Woody debris**---Any dead and downed woody material composed of branches and tree boles.



Rocky
Mountains



Southwest



Great
Plains

U.S. Department of Agriculture
Forest Service

# Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota

*Station Headquarters: 240 W. Prospect Rd., Fort Collins,CO 80526

United States Department of Agriculture

Forest Service

Forest Products Laboratory

State and Private Forestry

Technology Marketing Unit

General Technical Report FPL–GTR–168

# Small-Diameter Success Stories II

**Jean Livingston**








## Abstract

Many of our national forests are in critical need of restoration. These forests are dense, with an abundance of small-diameter, tightly spaced trees and underbrush that can contribute to the rapid growth of fire. If economic and value-added uses for this small-diameter and unmerchantable material can be found, forest restoration costs could be offset and catastrophic wildfires would be reduced. This document tells the story of several U.S. wood product businesses that are successfully making use of this small-diameter and unmerchantable material. Some stories describe how the USDA Forest Service National Woody Biomass Grant Program is improving forest restoration by creating markets for this thinned material. One USDA Forest Service project in particular, the White Mountain Stewardship Contract, involves several wood product businesses that are receiving small-diameter and unmerchantable material and successfully producing value-added products.



Keywords: small-diameter timber, forest restoration, roundwood, small business, unmerchantable timber

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## Acknowledgment

I sincerely thank everyone who provided me with a personal interview and tour of their organization. The best part of my job is meeting all of you and possibly helping in some small way. Know that by sharing your story, you will help others.


## Contents


*Page*

Foreword ..... *iii*

Introduction ..... *v*

Dodge Logging, Inc. ..... 1

Central Oregon Intergovernmental Council ..... 3

North Slope Sustainable Wood, LLC ..... 5

Mount Wachusett Community College ..... 7

Northwest Wood Products Association ..... 9

P&M Signs, Inc. ..... 11

Pomegranate Center ..... 13

Santa Clara Woodworks ..... 15

Warm Springs Forest Products Industries ..... 18

White Mountain Stewardship Contract ..... 21

W.B. Contracting, Inc. ..... 22

Forest Energy Corporation ..... 24

Reidhead Brothers Lumber Mills Inc. ..... 26

American West Structures, LLC ..... 28

Cheyenne Log Homes, Inc. doing business as Arizona Log & Timberworks ..... 30



# Small-Diameter Success Stories II

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# Foreword

In President Bush's 2006 State of the Union address he acknowledged that "… America is addicted to oil ..." and set out a goal of replacing "… more than 75% of our oil imports from the Middle East by 2025." Wood chips are a part of this goal.

As a person who has spent more than 15 years on the issue of using small-diameter and low-valued trees that must be removed from our Federal lands to reduce the risk from catastrophic fire and insect and disease attacks, this endorsement is music to my ears. It took 15 years, a multitude of voices, and numerous catastrophic fires, but the issue has been raised.

However, with the President mentioning wood chips for biomass energy, we do not want to give the impression that the nation must start from ground zero. A considerable amount of progress has been made in those 15 years. But progress can be slow.

First, people had to recognize that we were talking about the "junk wood" in our forests. We were not talking about old growth or clear cuts but about removing the understory and opening up the canopy. Second, people had to discover that these treatments were very expensive; therefore, costs needed to be reduced. Third, people came to the realization that utilization might be a way to help reduce these costs. So people started discovering ways to use this "junk wood" to make products with economic value. Fourth, people had to understand that not all of this material was "junk." It may be small, but some of this material could be turned into flooring, paneling, and art work. If only 20% of the "junk wood" could be turned into higher valued products, it could help defray some of the forest treatment costs. We still need to find outlets such as biomass energy for the other 80%. Fifth, policies that emphasize these treatments on Federal lands needed to be established. The Healthy Forest Restoration Act of 2003 and the Energy Policy Act of 2005 were passed, helping to focus the goals and roles of the Federal agencies. In addition, new authorities for stewardship contracts, which facilitated the exchange of goods for services, provided new ways of doing business for both the Bureau of Land Management and the USDA Forest Service. Sixth, we needed to implement some economic opportunities that help defray economic risk to small forest product businesses. The USDA Forest Service initiated the National Woody Biomass Utilization Grant Program. Thus, the stage was set.

This publication highlights some examples of the businesses and entrepreneurs that are making the program happen. These businesses are taking "junk" or low-value wood and helping to make a product—studs, pulp, poles, posts, flooring, molding, millwork, wood pellets, or biomass energy. They are creating and expanding businesses that are helping to restore our Federal forestlands. Whether the material comes from overstocked stands of small-diameter ponderosa pine or hurricane blow down from Katrina, these people are creating successes in using small-diameter and low-valued trees. This publication contains their stories.

As with the first publication of *Small-Diameter Success Stories*, by Jean Livingston, this document continues the stories of the energetic and indomitable spirit of the entrepreneurs who are committed to healthy forests and healthy rural communities. They have determination. They have passion. But most of all, they have commitment and do not give up, even when the barriers seem insurmountable. To these people, and to all others who are engaged in using small-diameter and underutilized wood, this publication is dedicated.

**Susan LeVan-Green**
Program Manager
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Forest Products Laboratory

# Introduction

Many of our national forests have an abundance of small, tightly spaced trees and underbrush. This small-diameter and unmerchantable material has been left in the forest because either it is not economical to remove or local capacity to process such material does not exist. The dense material creates a ladder-type fuel that can lead to high-intensity fires that spread quickly. These types of fires can destroy entire stands of trees and cause major alterations to forested landscapes and watersheds.

Restoration of these overstocked stands, through mechanical thinning or prescribed burning, will remove most of the small-diameter material, thus helping the forest to recover its natural structure and ecological functions. Some of these forests are in a fire regime condition class 3, indicating that mechanical thinning is necessary prior to prescribed burning. However, mechanical forest thinning is extremely expensive. If new, economical, and value-added uses for thinned material can be found, forest restoration costs could be offset as the threat of catastrophic wildfires is reduced.



**Wildland–urban interface project: White Mountain Stewardship contract before restoration.**



**Wildland–urban interface project: White Mountain Stewardship contract after restoration.**

### National Woody Biomass Utilization Grant Program

The National Woody Biomass Utilization Grant Program (administered by the USDA Forest Service State & Private Forestry Technology Marketing Unit, located at the Forest Products Laboratory, Madison, Wisconsin) is intended to help improve forest restoration activities on national forestlands by using and creating markets for small-diameter material and low-valued trees removed in hazardous fuel reduction activities. These funds are targeted to help communities, entrepreneurs, and others turn residues from hazardous fuel reduction projects into marketable forest products or biomass energy products.

The following are the goals of this grant program:

- Help reduce Forest Service management costs by increasing value of biomass and other forest products generated by hazardous fuel treatments.
- Create incentives or reduce business risk for increased use of biomass on national forestlands.
- Institute projects that target and help remove economic and market barriers to using small-diameter trees and woody biomass.

To help accomplish forest restoration, various approaches are being taken to complete the necessary work and simultaneously contribute to the economic growth of communities. Forestry agencies and many local forestry-dependent communities are partnering—working side by side—to find new ways of collaborative forest management, adapting to the opportunities and constraints offered by the ecosystem, and implementing new forest product technologies.

Restoration of our forests will persist as long as we continue working together for the ecological health of our forests and the economic health of forestry-based rural communities. This document tells the story of several wood product businesses and communities that are successfully making use of this small-diameter and unmerchantable material. Some stories describe how the USDA Forest Service's National Woody Biomass Utilization Grant Program (see sidebar) is working to improve forest restoration activities by helping to create markets from this thinned material. One USDA Forest Service project in particular, the White Mountain Stewardship Contract (see p. 21), involves several wood product businesses that are receiving small-diameter and unmerchantable material from a 10-year contract.

# Dodge Logging, Inc.



Headquartered on the family ranch, Dodge Logging, Inc., is located outside of Maupin, Oregon, and it is truly a family affair with Dad, Mom, and their two sons and daughters-in-law all actively involved in the business. Richard Dodge, the Dad, has been active in the forest products industry for more than 30 years, and his wife, Janie, has been by his side all the way.

Starting in 1970 with just a chain saw and skidder, the Dodge family now owns and operates three mechanized logging operations; a stationary whole-log-ship and barge reload facility in Boardman, Oregon (Boardman Chip Company, Inc.); and a small-random-length dimension sawmill in Pendleton, Oregon (Blue Mountain Lumber Products, LLC).

The Dodge family is respected in the community and receives high praise from its project partners, in particular Morrow County. Richard prides himself in being a good steward of the land and has a long-time reputation for operating equipment that is "light on the land."

Maupin, in North Central Oregon, boasts that it is on the sunny side of Mt. Hood and one of Oregon's best kept secrets. This area is known for its white water rapids and wild trout and steelhead fishing on the Deschutes River.

Although home-based outside of Maupin, other Dodge family-owned companies are located in the Northeastern area of Oregon, where forest-thinning projects are challenged by rugged mountains, deep canyons, plateaus, and rolling hills. National Forests in this area include the Umatilla, Wallowa-Whitman, Mt. Hood, Ochoco, and Deschutes.

"Our company structure is lean," says Richard. Each company has an average of two people involved in day-to-day management, and most of these folks are working supervisors." All key personnel report to Richard, and final decisions are made through a committee consisting of the entire Dodge family in consultation with others if needed.

In 2005, Dodge Logging was awarded a grant for $250,000 from the USDA Forest Service National Woody Biomass Utilization Grant Program (see p. *v*) to upgrade and expand the small-diameter log processing capacity at their Boardman Chip Company.

The Boardman Chip Company is located near the Blue Mountains of northeast and central Oregon, where catastrophic wildfires are a common occurrence. The Dodge family understands the unhealthy forest situation in these regions and because of their unique enterprise—from logging to processing to marketing—are in an ideal position to contribute significantly to improving the health of several public and private forests in Oregon.

Richard notes that "Although we have already made substantial upgrades and equipment purchases to improve forest thinning operations and processing facilities to increase the value of the material removed from the forest, we still did not have the ability to economically process logs that were less than 7-1/2 in. in diameter and to recover every log segment that might produce studs or lumber."



**Owners Richard and Janie Dodge.**

Improving recovery is important to the operating margin of a business. It also decreases the time and money spent by the USDA Forest Service for additional thinning treatments such as piling and burning.

Richard says they are expanding the small-diameter log processing capacity at the Boardman chip plant using funds from the 2005 National Woody Biomass Utilization Grant Program (see p. *v*). They hope to accomplish this within a year's time. As an end result, they will have increased the speed and automation to sort, merchandize, and process logs through a single-pass saw; improved the capacity of the twin-band at the Blue Mountain plant to handle oversized logs from the Boardman plant; upgraded material handling capacity at the Blue Mountain mill; and converted their outdated inventory and accounting system to a software package that will track and schedule their material from the log through lumber, chips, and residuals.

"This upgrade will result in what could be the first facility in the Intermountain West specially designed to accept and process mixed loads, meaning pulp logs but with a few small sawlog segments," noted Richard. "We also hope to eventually add a roundwood operation, a pellet manufacturing facility, and possibly a baled wood-shavings operation to supplement current residual markets."

Richard and Janie said that their business vision is "to grow and maintain a healthy, diversified family of forest products businesses for the long term." They intend to retain the 100 current jobs in the Dodge

Dodge Logging, Inc.
78888 Walters Road
Maupin, OR 97037



**Dodge Logging, Inc., headquarters outside Maupin, Oregon.**

companies and hope to add at least 10 more jobs as a result of their latest expansion.

There is no doubt that the Dodge Logging, Inc., will continue to build on their past successes, and one day the Dodge family will pass on to their children not only the Dodge family of companies, but their land stewardship ethics and sustainable forestry values as well.

# Central Oregon Intergovernmental Council



The Central Oregon Intergovernmental Council (COIC) is an organization that helps businesses, residents, and communities in the central Oregon area. Since 1972, COIC has provided programs and services to the community such as employment and training, youth and adult education, business loans, and community and economic development.

One of COIC's projects, which was initially funded by the USDA Forest Service Economic Action Program in support of the National Fire Plan, is Central Oregon Partnerships for Wildfire Risk Reduction (COPWRR). This is a multi-stakeholder partnership with the ultimate goals of reducing forest wildfire risk, enhancing forest health, and providing community jobs in Central Oregon.

Scott Aycock, coordinator of the COPWRR project, explains the program:

"COPWRR was initiated to address the removal of dangerous build-up of woody biomass material in Central Oregon forests. Specific goals of COPWRR are to

- determine the long-term feasibility of using small-diameter logs and woody material to create wood products and produce energy,
- determine the best way to mechanically remove woody biomass from targeted forests, and
- develop a market-driven approach to hazardous fuel reduction that could maintain and create local jobs and bring differing stakeholders together in a common, sustainable resource direction."

In pursuing these goals, the COPWRR team learned through research that it is was critical to stabilize or "levelize" the supply of small-diameter material. They found that the wood supply on private and public forest lands has dramatically fluctuated for the past few years and that these fluctuations have contributed to a stall in technology investment and employment in the region.

Scott said that for planning purposes, forest products businesses need to be able to forecast a sufficient wood supply at least 5 to 10 years out. Small-diameter material is usually not managed as a resource, and it is very difficult to gather accurate data on its future supply.

These results lead the COPWRR team to work with numerous partners to implement a Coordinated Resource Offering Protocol (CROP) initiative. Developed by Catherine Mater of Mater Engineering, the CROP model coordinates small-diameter timber sales from multiple forests across large areas for 5, 10, and 15 years.

Catherine says this will "create a levelized supply of small trees, making logging them a more economically attractive proposition, especially for small companies that must rely on bank loans to finance their operations."




**Central Oregon Intergovernmental Council headquarters, Redmond, Oregon.**

In 2005, COIC was awarded a grant for $220,000 from the USDA Forest Service National Woody Biomass Utilization Grant Program (see p. *v*) to expand the CROP initiative.

By using CROP, these businesses are able to more accurately predict, achieve, and stabilize the wood supply, thus enabling them to invest in new technology and product development.

The CROP initiative is currently being applied across these public land agencies of Central Oregon: the Deschutes, Ochoco, and Mount Hood National Forests, the Prineville Bureau of Land Management, and the Confederated Tribes of Warm Springs.

Warm Springs Forest Products Industries, an enterprise on the reservation, is using CROP to help establish a 15-MW biomass power facility and a small-diameter timber processing line. Long-term supply is critical to the success of these biomass and processing facilities. Warm Springs can only supply 40,000 bone dry tons (bdt) from their mill waste. However, another 40,000 bdt has to come from off-reservation hazardous forest fuel reduction treatments, primarily from the Deschutes and Ochoco National Forests. Material used in the Warm Springs operations has to be sourced from 8,000 acres per year of forest fuel treatments. Currently, Warm Springs is able to pay only $10/bdt for very small-diameter biomass material. After installing their new facilities, estimates show that they can pay at least $20/bdt for the same material, equivalent to $100 to $200 per acre in reduced fuel treatment costs (assuming 10 to 20 bdt/acre). For 8,000 acres, this would result in a total treatment

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**Scott Aycock, Program Administrator.**

savings of $800,000 to $1.6 million (source: Calvin Mukumoto, Warm Springs Consulting Forester).

Scott explains that each year CROP partners are creating detailed small-diameter supply projections from public and private lands within community supply landscapes, tailoring projections to the needs of individual users. Using Geographic Information System (GIS) analysis and other tools, conservative estimates of supply are created based on harvest costs, proximity to communities, and environmental and social factors. Partners also develop new data on harvesting and transportation costs and other local economic factors crucial to business investment decisions.

This information is communicated to local businesses, community groups, entrepreneurs, and the general public through forums, one-on-one meetings, and the internet. CROP partners gather feedback and make ongoing improvements. At the same time, COIC will continue to expand small-diameter utilization in the region by researching and developing small-diameter market opportunities and providing technical assistance to new businesses.

According to Scott, “We anticipate that the levelization of small-diameter timber supply through the CROP project will have long-term (20+ years) positive impacts in terms of costs per acre, increases in acres treated, and community jobs. It is part of a long-term program to develop a new forest-based economy in rural Central Oregon, based in part on forest restoration activities, and is expected to hatch as a self-sustaining local initiative at the conclusion of the 2-year pilot project term.”

The CROP initiative is now being looked at as a project that could be implemented nationally. COIC definitely has the technical expertise, skills, and history of working with Central Oregon forest management stakeholders to implement this project. We look forward to watching the successful progress of this program.

# North Slope Sustainable Wood, LLC



In 2002, four unlikely partners came together to form North Slope Sustainable Wood, LLC, in Missoula, Montana. The company offers random-length tongue-and-groove flooring made from western larch logs harvested from forest restoration projects throughout the Northern Rocky Mountains.

Peter Stark, an outdoor and adventure writer, owned 80 forested acres of western larch and fir in Missoula's Rattlesnake Valley. Those 80 acres needed restoration. So when Peter's wife, Amy Ragsdale, also noted that she was in need of a professional dance floor to facilitate her dance instruction profession, Peter hired Matt Arno, a professional restoration forester, to thin their 80 heavily forested acres.

Maybe it was the cost of the professional dance floor that triggered Peter to wonder if there was a higher valued use for the small-diameter trees being removed than selling them for a very low cost to a local paper mill. We will never know for sure, but these questions lead Peter to research and subsequently discover that the harvested small-diameter larch could possibly be made into a high-valued wood flooring. Peter then hired a company to custom saw, dry, and mill the logs into high-valued flooring.

Next, Peter hired Shannon O'Keefe, a local professional flooring contractor, to install the beautiful, tight-grain larch floor in Amy's new dance studio. Stark, owner of the logs, Arno who actually thinned the forest, and Shannon, who laid the flooring, were extremely pleased with the quality of Amy's dance floor. In fact, they showcase Amy's dance floor in their business, highlighting the value and benefits of utilizing forest restoration material.

In their final move, these three men contacted Mike Wood, a forester and a lawyer with an extensive background in environmental issues and "green-certification" procedures. Mike saw the possibilities, joined the other three as the fourth partner, and North Slope Sustainable Wood, LLC, was born.

Mike notes, "Western larch, or tamarack, has a long tradition in Europe as a superior and beautiful flooring, with its dense, honey-colored grain and dark pinhole knots. Our western larch is unique to the Northern Rockies. In our region, it typically grows on mid-elevation north-facing slopes—sites with light to moderate annual precipitation."

Wood flooring has a prime market when cut from high-quality hardwood and softwood species. Although hardwood species are generally more popular as a flooring material, higher density softwood species are also used. Softwood species regularly manufactured into flooring include southern pine, Douglas-fir, western hemlock, and western larch.



**Owners of North Slope Sustainable Wood, LLC.**



**Amy's dance floor.**

Some literature erroneously suggests that wood cut from small-diameter trees is weaker than wood cut from large-diameter trees. USDA Forest Service research has established that the properties of wood from small-diameter trees may be just as good as those cut from large-diameter trees.

There is considerable interest in how the properties of such material compares with those traditionally assumed for western

North Slope Sustainable Wood, LLC
P.O. Box 8846
Missoula, MT 59807



**Larch flooring installed in Forest Service employee Angela Farr's home, Missoula, Montana.**

softwood species. The physical and mechanical properties of small-diameter trees thinned from overstocked stands are dependent upon species, the age of the tree, and the conditions under which the tree is growing.

As part of a USDA Forest Service evaluation of utilization options for wood harvested from forest thinning projects, the Forest Products Laboratory evaluated the hardness of two species currently being used in the West for finished flooring—Douglas-fir and western larch. Several Douglas-fir 2 by 4s were obtained from suppressed growth trees in northern California, and western larch flooring was provided by North Slope Sustainable Wood, LLC. The larch flooring was cut from suppressed, small-diameter trees growing in Montana.

Results indicate that the suppressed Douglas-fir had 22% to 44% greater-than-species-average hardness values commonly assumed for Douglas-fir. The western larch results were about 6% greater than values commonly assumed for larch.

"As word has spread about our company, sales have steadily increased over the past year. We're still operating on a fairly small scale, but it has actually been good for us and is allowing us to work out the small glitches in our processing and delivery," Mike says.

Sometimes when the most unlikely group of people come together, the best is accomplished. In the case of North Slope Sustainable Wood, this is definitely true.

# Mount Wachusett Community College



Mount Wachusett Community College has become a leader in promoting and demonstrating woody biomass as a sustainable and renewable energy source. Built in 1974, the college's main campus is located on 280 acres in Gardner, Massachusetts, and has about 450,000 square feet of buildings that need to be lighted, heated, and cooled.

The college campus was initially an all-electric system, and their utility bills over the years have skyrocketed, exceeding $750,000 per year. In 1996, a study was funded to find possible solutions to reduce their high energy costs.

Results of the college's study indicated a possible conversion to a biomass-fired hydronic system, utilizing woody biomass fuel. The plan indicated a possible annual savings of $276,000, with a simple payback on investment (excluding financing) in about 9 years. Wood residue material from local sawmills could meet the college's long-term supply needs.

The plan was adopted, and in April 2002 Mount Wachusett Community College began constructing a new wood biomass heating system that came on line for the 2002–2003 heating season, replacing the existing all-electric system. This new system is saving the college an estimated $300,000 per year.

Rob Rizzo, Director of Facilities Administration at the college, said, "Over the past several years, we have implemented a variety of energy conservation measures including variable air volume conversion, installation of variable frequency drives on air-handling units, chiller replacements, new energy-efficient lighting, heat pumps, cooling tower replacement, domestic hot water conversion, replacement of unit ventilators, and the installation of a new domestic hot water heat exchanger. These additional energy conservation measures have reduced our total electrical consumption to approximately 8 million kWH at a cost of approximately $670,000."

Building on its commitment to use woody biomass as a sustainable and renewable energy source, the college recently partnered with Community Power Corporation (CPC) to build and install a 50 kW downdraft gasifier (BioMax™), using wood chips as the feedstock. Located in Littleton, Colorado, CPC develops, commercializes, and markets modular biopower systems to meet the needs of distributed energy consumers in both nondeveloped and developed countries. The BioMax™ 50 will provide heat, air conditioning, and electricity for the college's newly constructed daycare center. This will be CPC's first installation of a BioMax™ 50.

The college hopes to have the BioMax™ 50 in operation at their daycare center by April 2006. Plans are to have Rob Rizzo oversee this project and provide the technology transfer to help bring it from the demonstration stage to commercialization.



**Mount Wachusett Community College's biomass power plant.**

"So far, Mount Wachusett Community College is the only state agency to switch to a biomass heating plant, a technology that's been in use in other states for about three decades," said Rob.

Rob also noted that the biomass plant has not only saved the college money. By cutting utility bills, the college has been able to keep student fees steady for the past 3 years. College President Daniel Asquino estimates that the decreased costs of operating a biomass heating plant has saved the average student about $400 a year in fees.

The college has indeed reversed the old proverb "practice what you preach" and turned it into "preach what you practice." The college is in the process of developing an associate degree program in renewable energy and technology. Right now Rob has developed three courses on renewable technologies, and these classes were offered for the first time in the Spring 2006 semester.

Rob acknowledges that "Support from many sources has made all this possible. One of the strongest supporters has been Massachusetts Congressman John Olver, who was able to secure funding to help complete the energy conservation measures at the college. Executive Vice-President Ed Terceiro coordinated and implemented the entire program, and College President Dan Asquino had the vision and supplied the guidance and leeway to move forward with these projects."

In 2005, the college received the "Excellence in Energy Efficiency" award from the Commonwealth of Massachusetts. In the past 3 years, the college has reduced their greenhouse gas emissions by 18½%, which is a phenomenal number. Rob remarks, "Our President has gone on record to say that the college will have a minimum of a 25% reduction of greenhouse gas emissions by 2012."

Mount Wachusett
Community College
444 Green Street
Gardner, MA 01440-1000




**Woodchip boiler inside the biomass power plant.**

The college began by wanting to cut its energy costs and now has progressed to becoming an authority on sustainable and renewable energy. Their goals have evolved into reducing greenhouse gas emission levels, teaching students about renewable energy sources, and helping to advance woody biomass as a viable energy option. Mount Wachusett Community College is definitely living up to its motto, “Education for a Changing World.”

# Northwest Wood Products Association



Located in Bend, Oregon, Northwest Wood Products Association (NWPA) is a private, non-profit trade association for secondary wood products manufacturers. The association provides assistance to their members in market development, capital access, technology and training, and supply development. Their 80 members are primarily from the Pacific Northwest.

Dennis Brock, Executive Director for NWPA, provides some statistics on the secondary wood products industry. "In 1990, it maintained about 19% of the employment in the wood products industry. In 2003, the secondary wood products industry retained 37% to 46% of Oregon's overall employment in the wood products industry and sometimes as much as 63% in the rural communities." Dennis strongly believes, "The wood products industry is not dying—it's just changing."

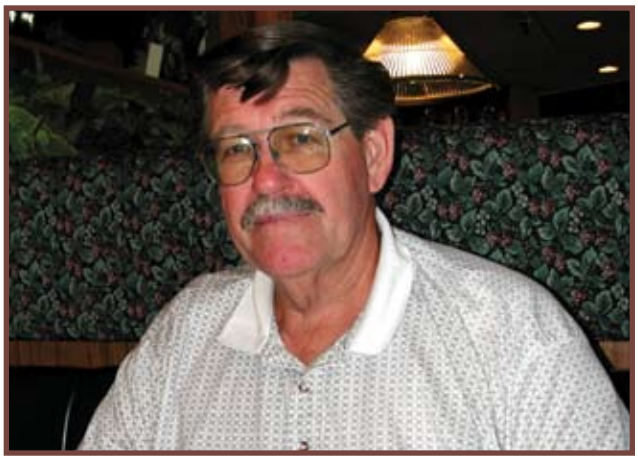
According to Dennis, "In 1990, 1 million board feet of raw exported log timber created one job. Today, in the secondary wood products industry, that same million board feet can create as many as 24 jobs." Dennis believes there are unlimited opportunities for the secondary wood products industry in Oregon.

As mentioned, supply development is a major function of NWPA. One recent project of NWPA's involved partners that included the USDA Forest Service, the Oregon Economic and Community Development Department, and the city of Fossil, Oregon. This project was designed to establish part of the new infrastructure needed to process small-diameter and underutilized species in Central Oregon. Installing a small-capacity dry kiln center became an integral part of this new infrastructure.

Data from this small-capacity drying system are helping establish proper drying schedules, cycle times, and other technical information needed to continue developing this new infrastructure. With this knowledge, the wood products industry is able to maximize nontraditional (e.g., juniper) and small-diameter species such as lodgepole pine, white fir, Douglas-fir, and ponderosa pine.

Large capacity kiln dryers are not suited for drying small-diameter timber, and most mills in Oregon that have large dryers have closed their doors. However, a large quantity of wood fiber is available from national forests and state and private forests. Estimates claim that over the next 20 years, about 880,000 acres of our national forests are scheduled to be thinned. The placement of a small-capacity dryer close to the timber resource reduces added transportation, processing, and drying costs for wood products manufacturers.

For example, wood harvested in a central Oregon community would have to be transported to another town to have it kiln-dried, the dried wood would then have to be transported back to central Oregon for manufacturing. This process alone could add $300 to $350 per thousand board feet to a company's processing costs.



**Dennis Brock, Executive Director, Northwest Wood Products Association.**

In June 1993, NWPA applied for and received a USDA Forest Service grant to install a small-capacity dryer in Fossil's new industrial park. In January 2004, the Oregon Economic and Community Development provided additional funding. The dry kiln is accessible to local manufacturers and individuals producing wood products. Several potential users signed up early for the service so that this drying facility could process trees removed from eight of Oregon's eastern counties.

The city of Fossil agreed to provide space in their newly developed industrial park. The city was also instrumental in securing grant funding to erect a new building to house the dry kiln. Local business owner Tim Coe and Brunt Ranch Juniper, located in Fossil, agreed to provide day-to-day management of the operation in return for reduced kiln drying charges. Although this project encountered numerous delays and challenges along the way, an open house for the dryer was held in July 2005.

The NWPA posts on their website all current information pertaining to the small-capacity dryer. Appropriate drying schedules for the dry kiln were determined with the support of Scott Leavengood, Oregon State University, and Paul Dailey, Dailey Wood Products in Reedsport, Oregon. Refinement of the process and modified drying schedules is continuing to be updated and shared on NWPA's website.

This small-capacity dryer project is just one of NWPA's many projects. Dennis notes, "NWPA is continuing to fulfill its original purpose of

Northwest Wood Products Association
18900 Riverwoods Drive
Bend, OR 97701



**Small-capacity wood dryer in Fossil, Oregon.**

helping wood products manufacturers grow and become more profitable by helping them make connections to new markets, locate financing opportunities, take advantage of employee training programs, and find alternate sources of supply."

The NWPA is a true believer in partnerships between private and public sectors and understands that this is a key element to successful job creation and community sustainability and profitability. Their mantra is, "Private industry can't do it alone. Education can't do it alone. Government can't do it alone. Together we are stronger."

# P&M Signs, Inc.



Phil Archuletta is an entrepreneur "extraordinaire." In addition to being an author, inventor, and community activist, he is the successful CEO of P&M Signs, Inc., and its sister companies P&M Plastics and P&M Small Timber Processing—all located in Mountainair, New Mexico. These for-profit companies are dedicated to "the recycling of forest residues in exchange for the creation of jobs in economically deprived communities."

Combined, the P&M companies employ 17 full-time employees, with a total experience of more than 75 years of creating high-quality signs. In 2004, P&M sales were about $1.8 million with a payroll of about $30,000 per month. Phil calculates that the family of P&M companies has a $3.6 million annual economic impact on the community.

Located adjacent to the Cibola National Forest, Mountainair is a rural community of about 1,300. Average household income is $25,651 per year, and the community has a 9.6% unemployment rate. The spread of western juniper and pinyon pine in this area has created millions of acres of small-diameter woodlands, resulting in problems such as lowering the water table, reducing rangeland, and creating severe erosion, which pollutes streams and lakes.

When Phil arrived in Mountainair in 1991, he had only $300 in his pocket, but he had a "can do" attitude and more than 30 years of experience in sign manufacturing. He had also spent 15 years working with the Missoula Technology Development Center on a durability study for signs while serving as Secretary-Treasurer for Ojo Caliente Craftsmen in northern New Mexico. As a result of his work experience, perseverance, and a little bit of luck, he opened P&M Signs, Inc., in 1991, and his business is now the largest employer in the area.

Phil knew that finding an economic use for western juniper and pinyon pine from these woodlands would alleviate some of the environmental problems associated with them. This area is also extremely vulnerable to forest wildfire as a result of the dense juniper and pine and a very dry climate. Reducing hazardous forest fuels is a priority in this area; however, the lack of local markets for small-diameter material is a limitation.

Historically, western juniper has been used for firewood and fence posts, but the high costs of harvesting and processing have limited attempts to develop and utilize it further. Even commercial firewood operations are only marginally successful because of the labor-intensive nature of harvesting, and the relative availability and low cost of steel posts and treated timber have diminished the practicality of using juniper for posts.

To reverse these trends, Phil developed a strategy to increase the value of the resource, primarily by developing products of higher value. One of those products is Altree™—a wood–plastic composite that has high value and has been a success for this company and the community.




**Phil T. Archuletta, CEO, P&M Signs, Inc.**



**Dense juniper and pine in a very dry climate.**

Phil led the effort to develop Altree™ in collaboration with the USDA Forest Service Forest Products Laboratory and other agencies and groups. Now listed on government contract, Altree™ is so named because all parts of the tree are utilized—the bark, branches, needles, and berries. Made from small-diameter western juniper and pinyon pine trees and recycled plastic containers, Altree™ is noncorrosive, insect and mold resistant, nontoxic, and stable in all weather conditions.

To increase the product's success, Altree™ has been designated as a USDA "biobased" product. Biobased products are those commercial and industrial non-food products that are made, in whole or a significant part, of biological or renewable domestic agricultural or forestry materials. The Federal Biobased Products Preferred Procurement

P&M Signs, Inc.
202 E. Broadway
P.O. Box 567
Mountainair, NM 87036-0567




**First Lady Laura Bush's Preserve America sign.**

Program (http://www.biobased.oce.usda.gov/public/index.cfm) requires all Federal agencies to develop an affirmative procurement program for purchasing USDA-designated biobased products. Analysts expect that the future biobased market could be worth several billions of dollars.

Altree™ can be used for signage, plaques, decking, fencing and railing, spindles and posts, picnic tables, sandboxes, trash can holders, park benches, window boxes, tool handles, shims, window boxes, landscape timbers, and grading stakes and in marine and waterproofing situations in place of treated plywood and pressboard.

Major customers of Altree™ include the USDA Forest Service, New Mexico Highway Department, New Mexico State Parks, New Mexico Game and Fish, and National Parks.

Two Altree™ customers from the USDA Forest Service are Phil Bono, Six Rivers National Forest in California, and Vicky Estrada, Mountainair Ranger District. Estrada says that "We have used the Altree™ signs for the past 4 years. P&M Signs has always been very responsive to our requests, completing and delivering on time, and has been an extraordinary positive partner in developing uses for our small-diameter western juniper and pine trees. Altree™ has proven to be resistant to weather, gun shots, and porcupines."

So next time you drive through a national forest, pay particular attention to the signs on the roads and trails. You may see the attractive and durable Altree™ signs produced by P&M Signs, Inc., made from recycled plastic and the invasive western juniper and pine.

Altree™ is not P&M Signs' only product. They can produce signage to any requested specifications. Phil said, "We even have a crew that will hang the outdoor signs, if asked." Right now, building a large-scale Altree™ processing plant (100 by 200 feet) is one of the company's goals, which they hope to achieve by summer 2006. Most of the equipment has been purchased; they just need to construct the building.

Another P&M goal is to open a sawmill operation, using an existing building to produce vigas, latillas, and other pole products in addition to sawn lumber. Between the new Altree™ processing plant and the sawmill, 65 more jobs could be available in the community.

In November 2005, Phil was notified that P&M Signs was awarded a 5-year, exclusive Smokey Bear licensing agreement. Phil said "I've been trying for 35 years to get this license. Printing an icon like Smokey Bear is an incredible opportunity for us."




**Smokey Bear sign made using Altree™ and coated with high-density reflective sheeting.**

Smokey Bear signs will be printed in full color using a high-density reflective sheeting material developed by Phil. This material has proven to last for years and not lose its reflective capabilities. According to Phil, "We are bringing Smokey back to New Mexico, his first home. We plan to launch a huge Smokey Bear campaign all across the country." (The first Smokey Bear was rescued from a fire near Capitan, New Mexico, in 1950.)

Phil also competed and won the contract to print the signage for First Lady Laura Bush's Preserve America initiative. This initiative is an effort to encourage and help fund community efforts for the preservation and enjoyment of America's priceless cultural and natural heritage. To date, more than 220 communities in 37 states have received this designation. Each community is required to order the official Preserve America logo signs from P&M Signs.

Phil has a vast network of contacts—from local to national—and he is very active in his community. The following is only a short list of his awards and accomplishments.

- USDA National Most Successful Minority Owned Business
- SBA New Mexico Advisory Board Chairman
- Small Business Association Regional Award
- Mountainair City Council Member
- Mountainair Chamber of Commerce, President
- Green Zia Quality Award

Phil Archuletta cares deeply about people and especially his community. This entrepreneur "extraordinaire" continues to have a successful future in the wood products business. The only problem is keeping pace with his ingenious ideas, his energetic company goals, and his dynamic aspirations for the community.

# Pomegranate Center





The Pomegranate Center is not a small-diameter wood business—it is a community-based nonprofit dedicated to social and environmental issues. The Center develops creative ways to achieve its goals; finds positive and sustainable solutions to problems; and works on projects in partnership with government and other public agencies. Located in Issaquah, Washington (near Seattle), the Pomegranate Center was incorporated in 1986 by Milenko Matanovic, Executive Director.

Milenko is a professional artist and community organizer. "I was concerned with the direction of modern communities, so I created the Pomegranate Center to explore how artists can have a role outside the narrow artistic world and be actively involved in building better communities."

The Pomegranate Center helps individuals use their talents to improve their communities. They do this by integrating social, artistic, and environmental viewpoints into "creating meaningful gathering spaces, initiating inclusive community-based planning, and providing educational outreach, research, and training."

Milenko explained further: "We plan and design gathering places, parks, neighborhood focal points, community trails, and public artworks that contribute to the community. Studies show that well-designed public spaces contribute to a stronger sense of community, good relations between neighbors, and feelings of safety and security. In our own experience, factors such as community distinction, cultural vitality, and social interaction are also greatly enhanced. These attributes are important not only to residents, but to policymakers, housing developers, lenders, and neighboring communities."

The Pomegranate Center facilitates public forums and town meetings, helping communities identify common concerns and objectives, discover creative methods of attaining goals, and find positive, sustainable solutions to problems. "Our programs reinforce civic connection and commitment, train local residents to solve problems, and create long-term leadership capacity within a community to meet future needs."

Their community-based planning projects are collaborative efforts between government agencies, non-profit organizations, architects, landscape architects, artists, developers, and community builders interested in public involvement processes. Their Gathering Places program focuses on affordable housing communities and neighborhoods in need of civic focal points. Affordable housing communities consisting of recent immigrants and refugees often provide the location for Pomegranate projects.

Milenko says their work proactively responds to the steady decline of community life. Rapid societal change and its byproducts (sprawl, traffic congestion, and environmental degradation) have lead to a loss of pride and sense of community and decreased participation in activities that support local vitality.

In 2000, the Pomegranate Center received a grant to study the social conditions of Springwood Apartments (Kent, Washington), one of the largest subsidized housing projects in the state of Washington. Based on their findings, the Center developed a plan to revitalize outdoor spaces that would provide a focal point for the entire community, where individuals from the community could provide hands-on construction and stimulate interaction among those living in the community.

Then in 2002, the USDA Forest Service awarded a grant to the Pomegranate Center to explore the use of small-diameter roundwood to revitalize Springwood's outdoor spaces. They constructed two mailbox shelters (10 by 36 feet and 10 by 24 feet) and a 10- by 8-feet kiosk where the Springwood community could post information and children could display their artwork. The suppressed-growth Douglas-fir 4- to 5-in.-diameter roundwood used had been harvested from a restoration project on a local smartwood tree farm in Shelton, Washington.

Since Springwood, the Pomegranate Center has also been exploring the use of roundwood as a viable construction material in creating outdoor facilities in two other low-income housing projects: Riverwalk Point in Spokane and Benson East in Kent. So far, they have renovated a playground and designed and built two mailbox shelters, kiosks, light posts, entry signs, a bus shelter, numerous tables and benches, a tea shelter, and fencing. Again, these projects were assisted through a grant from the USDA Forest Service, and the roundwood used in the projects was harvested from forest restoration projects.

Milenko commented, "We enjoy exploring the different uses for small-diameter roundwood because not only are we helping to add vibrancy to the outdoor spaces of numerous communities in need, we are contributing to the health of our forests."

The Pomegranate Center plans to continue playing a part in finding uses for small-diameter roundwood material harvested from forest restoration projects. Their goal is to partner with someone who will mass-produce the roundwood products Pomegranate has designed and used in their projects.

Pomegranate Center
P.O. Box 486
1400 NW Maple Street
Issaquah, WA 98027














**Pomegranate projects: entry signs, mailbox shelters, light posts, tables and benches, tea shelter, and a bus shelter.**

# Santa Clara Woodworks



Santa Clara, New Mexico, is fortunate to have an involved and vital member of the community like Gordon West. Gordon owns Santa Clara Woodworks, a "woodworking and fabrication business dedicated to the production of quality products from locally obtained materials in a manner that promotes good stewardship of the land and support of the community."

Gordon started his first business, Gordon West Joinery, in 1977 in Missoula, Montana. In 1982, he moved his company to northern Idaho, then in 1997 to Santa Clara, New Mexico, and renamed it Santa Clara Woodworks. Gordon came to New Mexico with 20 years of experience in carpentry, sawmilling, and logging; his plan was to focus on building log cabins made from small-diameter logs.

Santa Clara, formerly called Central City, is located 6 miles east of Silver City on U.S. Highway 180. Santa Clara covers 1 square mile and has a population of about 2,000, primarily Hispanic. It is the oldest village in the district and its history is closely tied to nearby Fort Bayard. This buffalo-soldier fort sprung up in 1866 and played an integral role in protecting settlers and those in the nearby mining districts.

Situated in Grant County, Santa Clara is nestled in the foothills of the Pinos Altos Mountains. It borders the Continental Divide and is very close to the Gila National Forest. As a result of low copper prices and the forces of the international economy on the border industries, approximately 1,200 jobs have been lost in the local mining industry and supporting sectors. In addition, two local sawmills have closed in the past 10 years, because of a lack of a reliable supply of saw logs. Statistics show unemployment levels have exceeded 12%.

Santa Clara proved to be no different than any other place Gordon has lived. Shortly after arriving, he soon found out that the supply that he wanted was not available when he tried to obtain logs to continue his log home business. However, the nearby 3.3 million acres of Gila National Forest faced, and continues to pose, a high risk of catastrophic wildfire because of an overabundance of dense, overstocked forest stands. So, to obtain a small-diameter wood supply, Gordon partnered with two organizations and helped them complete a 16-acre restoration project on the Gila National Forest.

Wherever Gordon has lived, he has been involved with local businesses and environmental groups to promote appropriate public and private forestry and to use the wood from these efforts to create wood product businesses. Over the years, Gordon has become known for his forward thinking, successful collaboration efforts, and strong forestry stewardship principles.

In 1999, he and Todd Schulke from the Center for Biological Diversity founded Gila WoodNet. Gordon says, "Their vision of forest restoration meshed with my logging equipment and forestry techniques, but the scale of Santa Clara Woodworks operations was too small to achieve landscape-scale results in the forest."



**Gordon West, owner of Santa Clara Woodworks.**



**Hand-peeled and notched small-diameter poles are used in log cabins, allowing natural logs to be used in traditional timber frame construction.**

Gila WoodNet, located in Santa Clara's Industrial Park, is a non-profit corporation associated with many wood businesses that perform forest restoration work. WoodNet operates a small log-sort yard and processing operation, which creates a biomass wood supply for small wood businesses and new jobs for the community. Gila WoodNet directly employs 6 people. Most of the start-up costs for Gila WoodNet were obtained through grant funds from the Ford Foundation and USDA Forest Service programs.

Gordon noted, "Twenty percent of the woody biomass from forest restoration projects is useful for high-value

Santa Clara Woodworks
4100 N. Gold Street
Silver City, NM 88061



**Chipcrete, a chip-based composite structural building block.**

products and 80% is not. This 20% produces 80% of the business complex's revenue." All profits from Gila WoodNet are put back into forest restoration work and product development. Products from the company currently include vigas, poles, juniper posts, firewood, mulch, and chips.

Although it's a different way to look at it, Gordon figures that "Gila WoodNet creates one full-time job directly related to wood for every 10 restored forest acres. Gila WoodNet has a target of treating 300 acres per year in mechanical forest restoration. About 10,000 forest acres are qualified for mechanical thinning within 50 miles of Santa Clara. That would give Gila WoodNet a 30-year plan of restoring 300 acres per year."

Gordon said, "Now that GilaWoodNet is up and operating and has a supply of ethically sourced logs, I am resuming my efforts through Santa Clara Woodworks to develop buildings and products utilizing small-diameter trees. I want to focus on maximizing added value while minimizing product costs and to promote small-diameter roundwood as a standard building material."

Santa Clara Woodworks is a one-employee business. Rather than hiring employees, Gordon prefers to have what he labels "collaborators." He does not always have continual work for employees, so he works with a collaboration of partners to get the job done, and he actively seeks other woodworkers and craftspeople to share future projects.

Some of the small-diameter wood products that Gordon has adapted or developed over the years include log cabins, trusses, timber frames, furniture, structural composite blocks, and erosion-control material.

His log cabins are built using hand-peeled and notched small-diameter poles. The styles reflect early USDA Forest Service guard stations and National Park Service structures. For his trusses, he uses a unique Center Line System Log Joint-Making Tool that he invented and fabricated. Because of this method, all parts are interchangeable between trusses, which makes it easier for later on-site log cabin assembly. In addition, the joint-making tool allows natural logs to be used in traditional timber frame construction.

One product still in development is Chipcrete, a chip-based composite structural building block, partially funded under a USDA grant. An erosion-control material called Zerosion is a spin-off of Chipcrete. Zerosion uses the lowest valued part of woody biomass and can be engineered for a wide variety of site-specific conditions.

To do small-diameter forest restoration projects, Gordon explains that you need multi-functional equipment. "For the scale that we and several other communities want to work at, there is no equipment or infrastructure appropriate to that scale. The equipment is either too small or too big, and we have to modify it to make it work." To fill in this equipment gap, Gordon built a light-on-the-land, 36-hp small-log forwarder that uses a small crane. He has subsequently attached a larger crane and is using the small crane as an attachment on the bobcat used in the yard.

Gordon also has developed a simple solar heat collector and has installed a solar dry kiln onsite. "Ponderosa pine is difficult to drawknife if it is wet, so we debark and sticker-stack our logs to air dry or use our solar-dry kiln if necessary."

Gordon has developed or modified other equipment, including bobcat log attachments, winch systems, and a Unilogger. Early on, his business was focused on construction so it was natural to modify equipment already in service to do the small-scale logging needed to get a supply of wood.

"Using a one-ton truck with log bunks, pulling a trailer with the Bobcat outfitted with a yarding winch attachment, two people can go to the forest in the morning and come home in the early afternoon with enough wood to keep busy for a week on a cabin or truss order," says West.

At the shop, a set of grapple forks for the Bobcat helps to move logs around efficiently. Recently, Gordon conducted a fabrication workshop with forest workers from northern New Mexico and Colorado, helping them to make their own winch attachments. The Unilogger is an improved version of the earlier small forwarder. It is a Mercedes-Benz Unilog truck heavily modified to be a cut-to-length feller, a three-winch mobile cable yarder, and a low-impact forwarder, all in one. It would also be possible to use the Unilogger to haul loads from the forest to the sortyard, although Gila WoodNet will use it as a dedicated forestry machine. West expects it to boost the pace of restoration



**Unilogger, an improved version of the earlier small forwarder.**

thinning; felling, limbing, bucking, and forwarding several hundred trees per day with a crew of two.

Gordon is involved with wood-related organizations and businesses throughout the region and feels that these contacts have great potential for developing new wood products and markets. In addition to Gila WoodNet, he works in collaboration with organizations that help with research and development of new wood products, innovative craft furniture makers, other decorative wood products, and a timber framer. He recently started a consulting business with several others in the region, Rural Business Implementation Group (RBIG), with a mission of actively assisting other communities to establish robust and diverse wood industries based on forest restoration.

Clearly this community has gained a valuable human resource by the name of Gordon West. He has a passionate land ethic and strong community-based values. Gordon has had a positive influence on the community, as seen by the increasing number of wood-based jobs and businesses created from forest-restoration thinning projects. We look forward to seeing more of Gordon's ideas on equipment development, his innovation in creating small-diameter wood products, and his forward thinking applied for the betterment of this community.

# Warm Springs Forest Products Industries

It's easy to find—Warm Springs Forest Products Industries (WSFPI) is just off to your right on Highway 26 as you pass north through the town of Warm Springs, which is in the north-central part of Oregon.

In 1967, the Confederated Tribes of the Warm Springs Reservation purchased Jefferson Plywood Corporation and established Warm Spring Forest Products Industries. With each having their distinctive heritage, the tribes of Warm Springs, Wasco, and Northern Paiute make up the Confederated Tribes of Warm Springs. The reservation consists of about 640,000 acres, half forested, between the Cascade Crest and the Deschutes River. The Deschutes, Mt. Hood, Ochoco, and Willamette National Forests either border or are adjacent to the reservation. There are more than 4,000 Tribal members and most live in or around the town of Warm Springs.

The Tribal economy here is based primarily on natural resources (hydropower, forest products, ranching), tourism, and recreation. With high unemployment rates (about 17% in summer and 35% in winter), the reservation struggles with economic development. The Tribes have always strived to develop sustainable businesses aligned with the environment and their culture.

Larry Potts, CEO of Warm Springs Forest Products Industries, said, "We harvest nearly 42 million board feet of timber per year. Species include incense cedar, ponderosa pine, white pine, lodgepole pine, Douglas-fir, western larch, noble fir, grand fir, and white fir." They maximize the return to the Tribe while using the raw material in an efficient and environmentally sound way. Most of their harvest is used in the manufacturing process; however, some logs are sold on the open market.

Warm Springs Forest Products Industries produces Douglas-fir, white fir, and ponderosa pine framing and industrial lumber and timbers, 4- by 4-in. through 12- by 12-in., in lengths of 8 and 20 feet. All framing and industrial lumber products are dried, planed, and graded under the industry standard rules and regulations of the Western Wood Products Association. WSFPI is also certified by Forest Stewardship Council (FSC), which is an international nonprofit organization devoted to encouraging responsible management of the world's forests.

Larry explains that the Tribal Council feels that "a strategy to provide jobs and revenue while in concert with reducing fuels from the forest is possible by producing biomass energy."

Warm Springs Forest Products Industries currently operates a biomass power plant. However, it is antiquated and inefficient.

Warm Springs Forest Products Industries
P.O. Box 810
3270 Highway 26
Warm Springs, OR 97761



**Larry Potts, CEO, Warm Springs Forest Products Industries.**

They have a three-phase plan to improve and enlarge their biomass energy plant and upgrade their capacity to process small-diameter logs.

Phase I, completed in September 2005, replaced the plant's 1927 boilers. Phase II replaces the current limited-use condensing turbine with an extraction turbine that is much more conducive to a sawmill operation. The WSFPI plans to use the steam produced to dry lumber and double their power production. The new boiler (Phase I) combined with the condensing turbine is capable of producing up to 3 MW of power. With the new larger extraction turbine, they could produce an additional 6 MW of power.

Phase III plans include installing a small-diameter (5- to 7-in. diameter) log processor and adding a second boiler and turbine. Their current mill can only efficiently process logs greater than 8-in. diameter. The new small-log facility could provide 20 new jobs. When the second boiler is added, WSFPI could potentially have 15 to 20 MW of power for sale or internal use.

Larry added, "The Tribe is actively reviewing a proposal to sell PacifiCorp, our utility provider, the renewable energy they produce. We want to be part of the solution of utilizing woody biomass material."

In 2005, a grant for $250,000 from the USDA Forest Service National Woody Biomass Utilization Grant Program (see p. *v*) to help with Phase II of their project was "extremely appreciated and helpful toward completion of our three-phase biomass energy strategy," noted Larry.

As a result of completing Phase II using the National Woody Biomass Utilization Grant, WSFPI hopes to increase the current price it pays for delivered woody biomass from off-reservation sources, such as the national forests that surround their land. The increase in price paid would help offset the cost of harvesting these fuels.






**Office of Warm Springs Forest Products Industries.**

Right now, WSFPI can supply only 40,000 bone dry tons (bdt) of biomass from their mill waste. They plan to purchase the remaining 40,000 bdt needed from off-reservation hazardous forest fuel reduction treatments, primarily from the Deschutes and Ochoco National Forests. The increase in power that WSFPI produces will allow them to pay more for a bone dry ton of woody biomass. For example, WSFPI is currently paying only $10/bdt for woody biomass material delivered. When the current condensing turbine is replaced with the new extraction turbine, WSFPI will be able to pay about $25/bdt of woody biomass delivered.

WSFPI has undergone many changes since its birth in 1967. Larry remarked, “Their management is constantly monitoring our progress to be certain that we remain a benchmark for the timber products manufacturing industry and a valuable asset to the Tribes. Sustainable forestry, sustainable communities—that’s what Warm Springs Forest Products Industries is all about.”

# White Mountain Stewardship Contract

In August 2004, the USDA Forest Service awarded Future Forest, LLC, the White Mountain Stewardship Contract on the Apache–Sitgreaves National Forest in Arizona.

The Apache–Sitgreaves National Forest, which comprises a significant portion of the largest contiguous ponderosa pine forest in North America, faces large-scale threats to communities from large wildland fires. The suppression of fire over the past hundred years contributed to the development of very dense forests. These forests that once were characterized by 20 to 60 trees per acre now average more than 400 trees per acre, which makes the forest vulnerable to intense wildfire and insect damage.

This project is the largest 10-year stewardship contract in the nation. The contract allows for the treatment of about 15,000 acres per year, up to 150,000 acres in 10 years. The stewardship contract also facilitates the development of a wood products industry better suited to market the excessive number of small-diameter trees on our national forests. Results include healthier forests, enhanced rural development, and utilization of previously unmarketable small-diameter trees and woody biomass.

Two individuals merit special recognition regarding the White Mountain Stewardship contract: Elaine Zieroth, USDA Forest Service Supervisor on the Apache–Sitgreaves National Forest, and Bill Greenwood, Eagar, Arizona, Town Manager.

Without Elaine's persistence, patience, and dedication to this process, the White Mountain Stewardship Contract would have never come to fruition. Bill Greenwood was born and raised in the White Mountain area and is very active in the community. He works closely with local agencies and businesses to improve forest health and create jobs, and he is dedicated to seeing the White Mountain Stewardship project succeed. Both Elaine and Bill continue to keep close tabs on the stewardship contract and are always there to offer their assistance.

The designated contractor, Future Forest, LLC, is providing services to perform woody biomass management, which may include tree removal, treatment of existing slash and dead trees, erosion control, resource protection, and haul-road maintenance. Future Forest, LLC, was formed by W.B. Contracting and Forest Energy Corporation to pursue this stewardship opportunity.

Because of the size, complexity, costs, and urgency of the task at hand, Future Forest, LLC, is engaging many other forestry and forest product entities in the White Mountains and elsewhere as they move forward to create healthy forests. The following wood products businesses in the community are currently receiving and successfully producing value-added products from material removed as a result of the White Mountain Stewardship Contract. Their stories are told in following pages of this document.

- W.B. Contracting
- Forest Energy Corporation
- Reidhead Brothers Lumber Mills Inc.
- Cheyenne Log Homes, Inc., doing business as Arizona Log & Timberworks
- American West Structures, LLC

### What is Stewardship Contracting?

**(Source: USDA Forest Service http://www.fs.fed.us/)**

Over the past two decades, the Federal timber sale program has declined while the need for restorative work or maintenance in ecosystems remains. Some of the project work includes watershed restoration and maintenance, road obliteration for sediment control, wildlife habitat improvements, fuel load reductions, timber stand improvements, and insect and disease protection.

To accomplish the USDA Forest Service's stewardship responsibilities, creative approaches are needed to complete the necessary work and simultaneously contribute to the economic growth of local and rural communities. "Stewardship End Result Contracting" is one solution to this problem.

Stewardship contracting includes natural resource management practices seeking to promote a closer working relationship with local communities in a broad range of activities that improve land conditions. These projects shift the focus of Federal forest and rangeland management towards a desired future resource condition. They are also a means for Federal agencies to contribute to the development of sustainable rural communities, restore and maintain healthy forest ecosystems, and provide a continuing source of local income and employment.

In February 2003, the U.S. Congress authorized the USDA Forest Service and the Bureau of Land Management (BLM) to implement stewardship contracting for a period of 10 years. Some features of the authorizing legislation include allowing USDA Forest Service and BLM to apply the value of timber or other forest products removed as an offset against the cost of services received, apply excess receipts from a project to other authorized stewardship projects, select contracts and agreements on a "best value" basis, and award a contract or agreement up to 10 years, which may stimulate long-term investment in the local community. The authorizing legislation is found in the 2003 Appropriations Act (16 U.S.C. 2104 Note).

# W.B. Contracting, Inc.

Implementing healthy forest restoration on Ted Turner's ranch in northern New Mexico is just one of the many jobs W.B. Contracting has on their reference list. Owned and operated by brothers Ricky, Dale, and Dwayne Walker, W.B. Contracting is a well-established wood contracting business that has been working in the Southwest for 18 years.

W. B. Contracting was formed in 1985 as a brush-thinning and slash-clearing operation, using small dozers and chainsaws to pile the brush. In the early 1990s, they realized that investing in mechanized small-diameter logging equipment was necessary to stay competitive and for their business to grow. So when they had an opportunity to buy some equipment (HydroAx cutter and clean wood chipper) from a local company that was going out of business, they did.

For the next several years, W.B. Contracting grew and prospered by moving their operation close to the market.

Dwayne said, "At first, this required us to move to New Mexico, but after 3-1/2 years we were able to come back to the White Mountains of Arizona, working exclusively on tribal lands, selling wood chips to the Stone Container paper mill and sawlogs to the Fort Apache Timber Company. However, in the spring of 1988 when the paper mill quit taking raw fiber, we purchased a feller–buncher and a stroke delimber in order to bid on a 3-year contract near Vermejo, New Mexico. In late 2001, that contract ended and we were able to move back one more time to the Arizona White Mountain area where work was again available."

All three brothers were born and raised in the White Mountain area. Ricky Walker is the President of W.B. Contracting, Dale is the Vice-President and Secretary, and Dwayne is Vice-President and Treasurer. Brothers Ricky and Dale are active full-time equipment operators or foremen on all forest restoration projects. The youngest of the brothers, Dwayne, participates in all decision making for W.B. Contracting but has also recently assumed a full-time position with Future Forest, LLC.

In 2004, W.B. Contracting partnered with Forest Energy Corporation, a local wood pellet fuel manufacturer, to form Future Forest, LLC, the prime contractor for the White Mountain Stewardship Contract (see p. 21).

"The right equipment is critical in our work," explains Dwayne. "We are continually looking to buy state-of-the-art equipment that operates on a variety of forest terrain." With the combined knowledge and experience of these three brothers, they are also quite capable of redesigning equipment if it is not commercially available.

W.B. Contracting, Inc.
P.O. Box 411
Eagar, AZ 85925



**Dwayne Walker, one of the three brothers who own W.B. Contracting, Inc.**



**500-acre wildland–urban restoration project, Woodland Lake Park, near Pinetop, Arizona.**

In 2005, W.B. Contracting received a grant from the USDA Forest Service National Woody Biomass Utilization Grant Program (see p. *v*) to purchase a versatile whole-tree log forwarder.

According to Dwayne, "A whole-tree log forwarder allows us to harvest acres that were previously inaccessible, thus reducing the number of new or reconstructed roads and landings. This piece of equipment has better weight distribution and less potential for ground disturbance and compaction than skidders. We hope to fit the forwarder with harvester heads that create a three-in-one felling, processing, and transport machine. This further reduces the number of passes that the equipment has to make over a site."

Dwayne's current job site is a 500-acre wildland–urban interface restoration project, Woodland Lake Park, near



**Grapple skidder operating on restoration project.**

Pinetop, Arizona. This forestland is on the Apache–Sitgraves National Forest and is part of the White Mountain Stewardship Contract. Wildland–urban interface areas comprise about 80% of this stewardship contract.

Several acres at this site have already been treated, and it was amazing to see the improvements they had made to this wildland-urban interface area. As I looked over the site and made favorable comments to the brothers, you could see in their faces the pride they have in their work and the gratification they get from doing it.

W.B. Contracting has a clear mission—to be the most successful, efficient biomass harvester in the Southwest. They are committed to making the White Mountain Stewardship contract a model for future stewardship projects in this country.

However, they also know that their company cannot do it alone, nor do they want to. W.B. Contracting is definitely a team player. They are active members of the Arizona Sustainable Partnership and Northern Arizona Wood Products Association that assist in marketing and small business development.

Dwayne spends a great deal of his time seeking out and helping to bring in new markets for the harvested forest restoration material. Since the White Mountain Stewardship Contract was awarded, new businesses in the area have emerged, such as a post and pole operation and a small-diameter sawmill. New companies that are on record as either in the process of beginning an operation or looking to locate in this area include a custom log home business, a power generation plant, and a chemical wood hardening company.

Among the three brothers, W.B. Contracting has 100+ years of experience in woodland operations and treatments, with a specialty in forest landscape restoration. The brothers have strong ties to the White Mountain community and have earned the respect of other local businesses in the wood industry. They have a reputation of delivering wood material for processing on time and within standard specifications. W.B. Contracting is a successful business not only because of its superior land stewardship ethics but because they know how to effectively collaborate on projects and build vital partnerships within the community. W. B. Contracting is well on its way to achieving its mission of being the most successful, efficient woody biomass harvester in the Southwest.

# Forest Energy Corporation

The owner of Forest Energy Corporation looks forward to accumulating most of the wood residues in the area. When he buys it, he dries, grinds, and compresses it into small-sized pellets for fuel. Only a small component of this wood resource comes from sawdust, shavings, and fines left over after processing trees for lumber and other wood products. The majority is obtained directly from restoring forest ecosystems or reducing fire hazard in surrounding forests.

Rob Davis is the owner and President of Forest Energy Corporation, which manufactures wood pellets for fuel, in addition to animal bedding, absorbents, and a 5-lb compressed wood log for use in fireplaces and wood stoves.

In the 1970s, when many countries were experiencing an energy crisis, the first wood pellet manufacturing plant opened in North America. People soon learned that wood pellets provide a safe, reliable, and clean heat. In the 1980s, the wood pellet residential market grew tremendously.

Rob started his business in Show Low, Arizona, in 1991, primarily because "The Southwest is home to my children and several generations before them, although there certainly were other reasons why I built in this area, such as taking advantage of the large volume of wood waste from the local forest products industry, the potential market in this area, and the increasing cost of fossil fuel."

Because of Rob's well-known expertise in the wood pellet industry and his interest in forest health issues, he is frequently an invited speaker at conferences throughout the United States. He is a Past President and Director of the Pellet Fuels Institute and a member of the Arizona Governor's Forest Health Oversight Council and Southwest Sustainable Forest Partnership Steering Committee, a member of the WGA (Western Governor's Association) Biomass Task Force and the Review Team of the Restoration of Fire-Adapted Ecosystems component of the WGA 10-Year Strategy Implementation Plan, Goal III. He is President of Forest Energy Systems, a company developing sustainable heating and cooling systems using renewable biomass fuels for commercial and industrial applications. Rob is also one of two partners in Future Forest, LLC, the prime contractor for the White Mountain Stewardship Contract (see p. 21).

General Manager Curtis Rogers gave me a tour of the plant when I visited Forest Energy Corporation. The company employs 30 people in their processing plant and consumes about 150,000+ tons of green wood per year.

Forest Energy Corporation
1001 North 40th Street
Show Low, AZ 85901

The wood pellet manufacturing process starts when loads of raw material arrive at the plant.




**Forest Energy Corporation, outside Show Low, Arizona.**



**Raw material (wood residue) just arriving at the plant.**

The material is stored and eventually transferred into an in-feed system where it is metered into a screen, which separates the chips from the sawdust. The chips are passed through a pre-grinder and mixed with the sawdust. The material then goes into the dryer, where it is dried to the proper moisture content. The sawdust is conveyed onto a screen, which separates the fine sawdust from the coarse material. The coarse material goes through a hammer mill to be reduced in size and recycled back into the system. The refined material is then metered into the die where the pellets are formed. The pellets are cooled and then conveyed into a storage silo. The wood pellets can then be packaged into 20- or 40-lb bags, or bulk delivered for central heating customers.

"We promote sustainable, efficient, state-of-the-art production of clean heat and power from our valuable biomass resources, industrial wood residues, and forest restoration projects. We call it home-grown energy," Curtis noted.




**Wood pellets packaged into bags.**

Wood pellet plants voluntarily follow standards to create a product that is consistent in content, density, size, and quality. Forest Energy Corporation takes great pride that they are known for producing a high-quality product. There are currently two grades of pellet fuel: standard and premium. The main difference between the two is that the standard grade contains more ash than the premium grade. Pellet manufacturers are encouraged to label their fuel and have it tested regularly.

Pellet fuel can usually be purchased at stores that sell building supplies, pet and farm supplies, and hearth appliances. The cost of pellet fuel depends on the geographic region where it is sold, whether it is in bulk or bag, and the current season. Usually, wood pellets cost about the same as a cord of well-cured wood and less than all fossil fuels. Pellet fuel is estimated to be only about a third the cost of electricity. A residential pellet appliance is capable of generating 10,000 to 150,000 BTUs of heat per house. An entire house can be heated by pellet fuel when the proper appliance is installed. Projects using commercial boilers up to 40 million BTU per hour are currently in the planning stages in several Southwest locations. All are automatically fed and controlled requiring only normal periodic maintenance.

Curtis explained, "To become more cost efficient, we would like to get to the point of bulk delivery of wood pellets. The consumer would never touch the fuel. You could compare it to how homeowners currently have their propane or fuel oil bulk delivered. The owner could have an enclosed bin for pellet storage and an automatic feeder would transport the pellets to the stove or boiler. We could deliver the wood pellets as we make them, reducing our storage costs. Eagar, Arizona's Town Hall is one example of where we are doing this right now."

The cost of heating continues to increase, and people are demanding alternative fuels. Wood pellets are becoming an extremely economical alternative. Rob expects that "the pellet stove will soon be joined in large numbers by pellet furnaces, central heating systems, boilers, and commercial systems."

Wood pellet fuel is a growing industry that has the potential to boost the local economy and create jobs, especially in rural communities. Forest Energy Corporation is a result of Rob Davis' commitment and dedication to his belief that all biomass residues, and especially those from sound forest ecosystem management, are a valuable natural resource, not a waste product. Their prudent use is necessary for a sound energy future of our nation. And, if by increasing the health of our forests, he can also help the local community by providing jobs and economic stability with a low cost, reliable heat, so much the better.

# Reidhead Brothers Lumber Mills Inc.

Reidhead Brothers Lumber Mills, Inc., in Nutrioso, Arizona, is a third-generation, family-owned operation with markets already established for various wood products.

Terry and his brother Darrel own Reidhead Brothers Lumber Mills, Inc., which includes a remanufacturing plant in Springerville, Arizona, and a large-diameter sawmill in Nutrioso. In addition, Terry owns a molding plant in Snowflake, Arizona. In April 2004, Terry purchased the former Precision Pine sawmill near Eagar, Arizona, and leased the land from the city of Eagar. This sawmill is becoming a major processor of small logs from the White Mountain Stewardship Contract (see p. 21).

Since purchasing the small-diameter mill, Terry has been busy retrofitting and installing new equipment. In October 2005, USDA Forest Service Sawmill Specialist Rusty Dramm was invited for a technical assistance visit to this small-diameter mill.

According to Dramm, "Terry Reidhead decided not to install a chipper canter in the existing mill in Eagar. This is because the logs are opened up with chipping heads and that reduces the ability to recover high- grade lumber from the quality zone of the log. The design of this mill is based on a 4-in.-wide bandsaw scragg mill, a modified bull edger, and a trim saw. The log factory has a bucking saw and debarker. When Terry purchased this mill, he left the old 7-foot bandmill in place because it is in good condition and could be used if larger grade logs become available."

This sawmill also has a planer mill with a breakdown hoist, planer matcher, and a certified truck scale. The planer mill has been running since August 2005, and the small-diameter mill is scheduled to be running some time in 2006.

Dramm said, "This mill design is suitable for processing the anticipated log mix of small-diameter material. The choice of a scragg primary breakdown and secondary cant breakdown are good choices for small logs. Terry has made good use of the existing mill equipment and materials-handling systems."

Terry's small-diameter sawmill presently receives all of its supply from the White Mountain Stewardship Contract. When in full operation, Terry expects to produce 12 million board feet of lumber per year and employ 15 people.

Terry recently installed a new wood chipper at his mill. Right now they chip wood slabs and sell these chips to Forest Energy Corporation in Show Low, a wood pellet manufacturing plant location about 60 miles from the mill. Terry proudly explains, "We make use of all the wood; we don't waste anything."

Reidhead Brothers
Lumber Mills Inc.
P.O. Box 84
Nutrioso, AZ 85932



**Mixed log supply from White Mountain Stewardship Contract.**



**Debarker and bucking station.**

American West Structures, a wood business located very close to Terry's small-diameter sawmill, could be Terry's largest customer of small-diameter lumber if they were able to kiln-dry their lumber to the required 8% moisture content.

This past year, Terry and American West Structures got together and figured out a way to help each other. In 2005, American West Structures received a National Woody Biomass Utilization Grant (see p. *v*) from the USDA Forest Service to secure increased capacity to dry lumber to 8% moisture content. Rather than build their own dry kiln, American West Structures is helping to fund a dry kiln at Reidhead Brothers small-diameter sawmill.

By helping to fund the dry kiln, American West Structures can increase their small-diameter lumber supply from 20% to 35% and increase their payment to Reidhead Brothers Sawmill by $20 per thousand board feet. In turn,



Terry is able to pay $3 more per ton for the raw material from Future Forests, LLC, the general contractor for the White Mountain Stewardship Contract. Terry hopes to have the dry kiln in full operation by spring 2006.

Terry wants to keep both the small log mill in Eagar and the large-diameter mill in Nutrioso running. However, he is not sure that the supply is there for the large-diameter mill. “It’s the old family mill, ya know.” Terry’s grandfather bought the large log mill in1939.

Dramm believes that “Terry’s approach to mill design is on track and should support efficient processing and handling of the log mix feeding the mill.”

This area is a community with a rich forest heritage, and Terry’s family has been part of that heritage since 1913. He is dedicated to the health of the forest and the prudent use of the wood materials being removed to promote that health. “It’s my hope that it all keeps going until at least 2013; by then it will 100 years of forestry for my family.” Terry would like his son, Charlie, to continue on with the family’s forestry businesses. “I hope that this is his future.”

# American West Structures, LLC

Steve Nicoll and his wife, Colleen, own and operate American West Structures, LLC. The company is located just outside of Eagar, Arizona, and right next to his brother Randy's log cabin and post-and-pole operation. American West Structures is another small-diameter business in the chain of White Mountain Stewardship Contract (see p. 21) partners that work to increase the supply for local wood businesses and improve the health of the forest.

Established in 1998, American West Structures is a successful and growing small-diameter business. It specializes in manufacturing and pre-assembly of glued-laminated wood trusses, pedestrian and vehicular bridges, and laminated log home packages. The company also provides pre-packaged headers (for doors, windows, and garage doors) and custom beams.

Steve has been manufacturing log, timber, and laminated architectural trusses for 25 years. One of the company's main attractions is its ability to make a laminated beam that spans more than 24 feet without support. American West Structures uses small-diameter wood as their main source of raw material and a unique horizontal finger jointing system, which provides added strength for larger structures.

Steve adds, "We also do tongue and groove re-manufacturing of 1 by 6s, 1 by 8s, 2 by 6s, and 2 by 8s for local lumber yards. Right now we bring in raw material from local lumber mills and from the Northwest and Southeast sections of the United States. Our goal is to use more local material."

The company also has a waste collection system and sells their wood waste to Forest Energy Corporation in Show Low, Arizona, a wood-pellet manufacturing plant located about 60 miles from American West Structures.

Just like any successful business, American West Structures wants to change with the times and improve their products as new sources become available. To do that, however, the company has two major barriers to overcome.

Their first barrier is the volume of lumber they need to dry locally. There is no local supplier available to kiln dry lumber to their required 8% moisture content. The second barrier is lost sales because American West Structures cannot provide laminated wood decking, which is one of the most popular choices for large open spans.

Steve said, "Customers prefer to buy the trusses and laminated decking from the same supplier. Currently, the closest manufacturer of laminated decking is in Montana."

American West Structures, LLC
2000 West Central Avenue
P.O. Box 2008
Eagar, AZ 89525



**Construction of small-diameter building to house deck laminating press equipment.**



**Vehicular bridge manufactured from pre-assembly glue-laminated wood trusses.**

In 2005, American West Structures received a National Woody Biomass Utilization grant (see p. *v*) from the USDA Forest Service to purchase deck laminating press equipment and to secure increased capacity to dry lumber to 8% moisture content. Rather than build their own dry kiln, American West Structures is helping to fund a dry kiln at Reidhead Brothers sawmill, another White Mountain Stewardship contract partner, where the kiln will benefit both businesses.

By helping to fund the dry kiln, Steve said, "We are able to increase our small-diameter lumber supply from 20% to 35% from the White Mountain Stewardship Contract. American West Structures currently uses about 450,000 board feet each year of local, small-diameter lumber for various wood products. As a result of the laminated



decking presses and the increased dry kiln capacity gained through the National Woody Biomass Utilization Grant Program, we can increase our usage to 2 million board feet each year and increase our payment to Reidhead Brothers Sawmill by $20 per thousand board feet."

As a result of the dry kiln and laminated decking equipment, Steve said that they expect to increase their sales by 20% each year for the next 4 years. They also predict that they will increase their employment from 13 employees in 2005 to 21 by December 2007.

American West Structures structural laminated decking will be available in lengths up to 24 feet. Steve explained, "We can produce random length and long-length laminated decking from local softwood species such as Douglas-Fir-South, ponderosa pine, and various face species. The face is a sound, tight-knotted grade that is machine sanded to accentuate the grain and the growth characteristics of the wood. It is required that the lumber be kiln dried to 8% moisture content rather than the standard 19% lumber. This lumber is then laminated with a fully waterproof exterior adhesive."

As of November 2005, American West Structures had a good start on construction of the 30- by 40-feet dry kiln to be located at the nearby small-diameter Reidhead Brothers sawmill. The building that houses the new laminating press equipment is being built entirely from small-diameter material. The building and installation of the press equipment are expected to be completed by early 2006. American West Structures plans to be ready to start receiving and shipping orders for laminated decking by July 2006.

Few companies manufacture laminating decking, and trends show that this market will continue to grow substantially. There is no doubt that American West Structures will continue to succeed. They are a dedicated partner of the White Mountain Stewardship Contract, and they will not let their partners or their community down.

# Cheyenne Log Homes, Inc.

## doing business as Arizona Log & Timberworks

Located just outside of Eagar, Arizona, Randy Nicoll and his brother Keith own and operate Arizona Log & Timberworks, a division of their Cheyenne Log Homes business. Although not the principal contractor for the White Mountain Stewardship Contract (see p. 21), 99% of their wood supply is a result of this contract.

Randy and his four brothers were born and have lived most of their lives in this area. For many years, the entire family owned and operated a glued-laminated (glu-lam) manufacturing business, Nicoll Laminates. In 1990 Randy and his brothers branched out to start Cheyenne Log Homes, Inc., which specializes in custom log home construction. At that time, most of their supply for the log homes was purchased from the Fort Apache Timber Company in Whiteriver, Arizona.

Cheyenne Log Homes had about $2 million in sales in 2004. "We have shipped log home kits all over the United States, and even to Japan and Taiwan," said Randy. After the family glu-lam business was sold in 1995, Randy and Keith became the sole owners of Cheyenne Log Homes.

In 2002, Cheyenne Log Homes purchased post and pole manufacturing equipment and formed Arizona Log & Timberworks as a division of their log construction entity. Their intention was to create a sustainable and highly effective business utilizing small-diameter trees and roundwood to produce a family of competitive wood products.

Since it began, Arizona Log & Timberworks sales have increased each year. "Our biggest problem has been getting the small-diameter material that we need to produce our products," commented Randy. "However, since signing the White Mountain Stewardship Contract, supply has not been a problem for us." In 2004, Arizona Log & Timberworks did about $400,000 in sales. In 2005, Randy says it was closer to $650,000.

Arizona Log & Timberworks has eight employees working in the yard for them. Current small-diameter products include vigas, posts, log railings, gazebos, utility poles, and log rail fencing. To increase their product line and remain competitive, Randy recently partnered with a successful wood pressure treatment company, Simmons Wood Products in Maricopa, Arizona, and made plans to install a pressure treatment plant at Arizona Log & Timberworks.

In 2005, Arizona Log & Timberworks received a National Woody Biomass Utilization grant (see p. *v*) from the USDA Forest Service for assistance with their treatment facility. Randy explained that this project is adding value to his small-diameter product material, which in turn means he can pay more for the raw material, and that ultimately helps reduce the cost per acre of forest restoration.

Cheyenne Log Homes, Inc.,
dba Arizona Log & Timberworks
1990 W. Central Ave.
Eagar, AZ 85925



**Gazebo built by Arizona Log & Timberworks, Eagar, Arizona.**



**Log rail fencing.**

Dwayne Walker, manager of Future Forests, LLC, and principal contractor for the White Mountain Stewardship contract, says, "Arizona Log & Timberworks is now able to accept mixed loads instead of sorted larger diameter material. By reducing the amount of time spent on sorting the product to be delivered, we are able to reduce our cost significantly in the removal of the biomass material from the forest and increase our profit by using more of the smaller diameter material that is currently being chipped. This in turn allows more woody biomass acres to be treated."

Arizona Log & Timberworks is in the midst of purchasing a few acres right next to their current yard for the treatment facility. They hope to have their treatment facility up and running by summer 2006. Randy said that the facility will be unique to the western United States in that it will



**Hand-peeled vigas.**

treat wood products from small-diameter trees using a borate-based chemical called EnviroSafe Plus™.

"This treatment results in wood products that are insect-free; rot-, fungus-, mold-, and fire-resistant; and durable. The treatment works especially well on ponderosa pine, which is the dominant species coming from the White Mountain Stewardship Contract. It is a clear treatment that doesn't stain the wood. The wood looks natural but can easily be stained by the user." Randy is counting on this treatment facility to increase his current market for wood decking, replacing cedar, redwood, or synthetic materials. He says it also allows more uses for pine siding, log railing, log rail fencing, and even whole logs for cabins.

Randy explained that this treatment facility can be used to treat material produced by other local partners of the stewardship contract, such as the Reidhead Brothers small-diameter sawmill (3 miles away), which currently has to send many of its finished products 200 miles away to a treatment plant, and American West Structures, for their treated log siding and laminated decking. With this treating plant, Arizona Log & Timberworks increases their the capability of producing almost 39 million board feet of treated material a year, operating at a 75% capacity level.

To be moderately successful, Randy said, "We need to treat about a semi-load of material per week or about 25,000 board feet. We hope to be treating about 3 million board feet a year after the first year. There is a huge

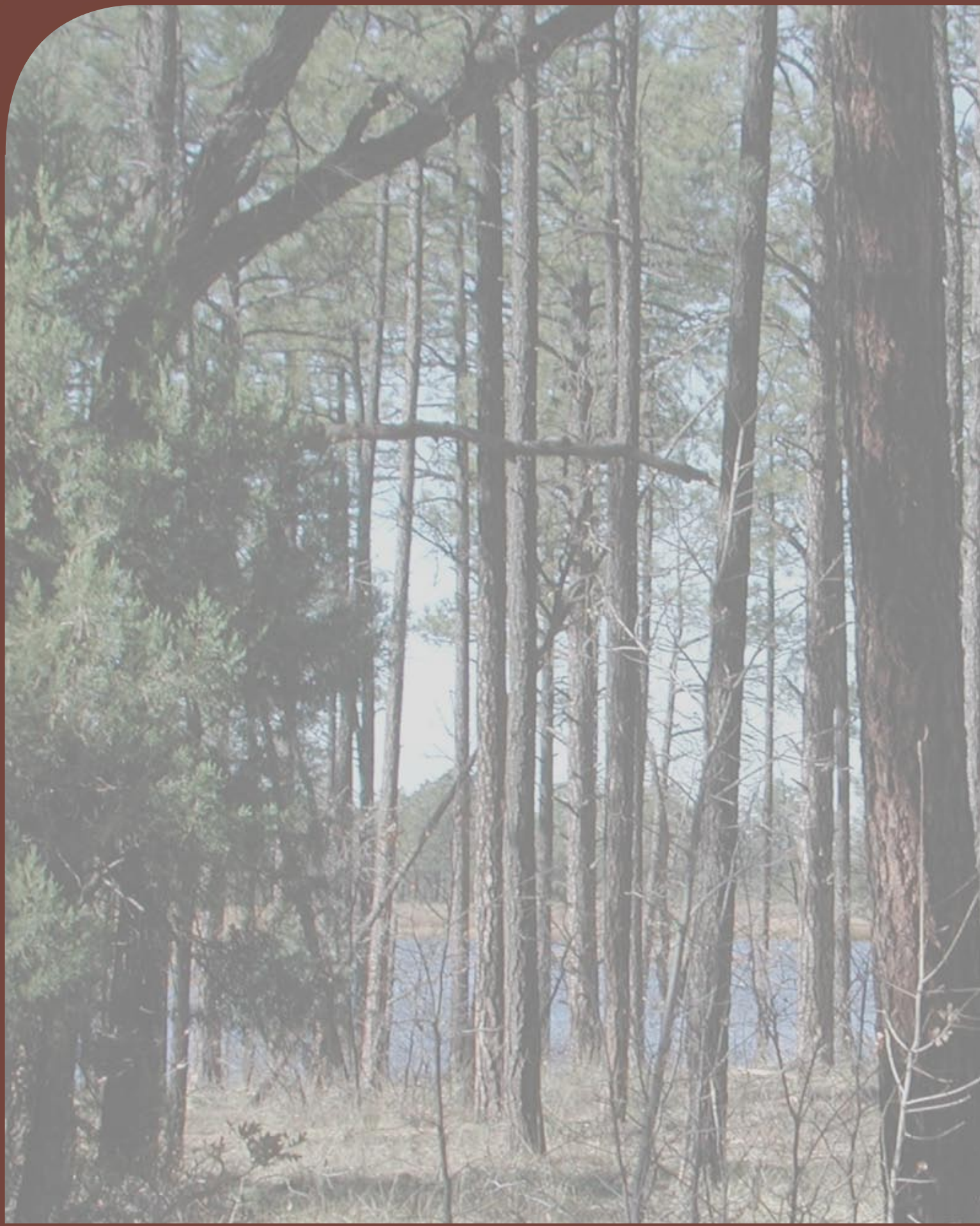


**Small-diameter log supply.**

market potential for this, and we have a major marketing campaign planned." Their marketing area covers about a 300-mile radius around Eagar. "People still want real wood if they can get it," added Randy.

Randy wrapped up our interview by telling me something that I had already come to understand—the camaraderie and noncompetitiveness among all those involved in the White Mountain Stewardship Contract. He said, "People in this area all work together. By ourselves we can't make it work; it takes everybody. I think you will see that we work together here better than anyone else does across this country."

Arizona Log & Timberworks has indeed created a sustainable and highly effective business using small-diameter material from the forest to produce a family of wood products. They are proud to be part of the White Mountain Stewardship Contract, and they have made a pledge to be a business that cooperates, collaborates, and partners with others in order to contribute to forest health and the economic prosperity of their communities.



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State and
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Marketing Unit

General
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Report
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# Small-Diameter Success Stories III

**Jean Livingston**












## Abstract

More than 73 million acres of our national forests and millions more in public and private forestlands are in need of some form of restoration. Our forests are declining in health because of major changes over the years in forest structure and composition. However, restoration of these overstocked stands is extremely expensive. If new, economical, and value-added uses for thinned material can be found, forest restoration costs could be offset as the threat of catastrophic wildfires is reduced. This is the third document that tells the story of several wood product businesses and communities across the country that are successfully using thinning material from forest restoration projects and converting it into wood products and biomass energy. Telling these small-diameter success stories is intended to accomplish several goals but three in particular: (1) clarify and enumerate the value and importance of funding programs to help small businesses and forestry-dependent communities; (2) provide marketing tools for these businesses; and (3) create a forest restoration networking system across the United States.



Keywords: small-diameter timber, forest restoration, roundwood, small business, unmerchantable timber, Woody Biomass Utilization grant, Bureau of Land Management, stewardship contracting



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**Conversion Table**

| To convert from inch–pound unit | To metric unit | Multiply by |
|---|---|---|
| inch (in.) | millimeter (mm) | 25.4 |
| foot (ft) | meter (m) | 0.3048 |
| mile | kilometer (km) | 1.609 |
| pound (lb) | kilogram (kg) | 0.4536 |
| ton | tonne (t) | 0.9071 |
| acre | hectare (ha) | 0.4047 |
| square foot ($ft^2$) | square meter ($m^2$) | $9.290 \times 10^{-2}$ |
| board foot | cubic meter ($m^3$) | $2.360 \times 10^{-3}$ |
| cubic yard ($yd^3$) | cubic meter ($m^3$) | 0.7646 |
| pound per square inch ($lb/in^2$) | pascal (Pa) | $6.895 \times 10^3$ |
| pound per square foot ($lb/ft^2$) | pascal (Pa) | 47.88 |

## Contents


*Page*

Foreword ..... *iii*
Introduction ..... *v*
Bearlodge Forest Products, Inc. ..... 1
Big Sky Forest Products ..... 3
Chadron State College ..... 5
England Sawmills ..... 7
Forest Guild ..... 9
Institute for Agriculture and Trade Policy ..... 11
Montana Community Development Corp. ..... 14
North Carolina State University ..... 16
Northern Nevada Correctional Center ..... 18
REACH, Incorporated ..... 20
Rough & Ready Lumber Co. ..... 22
Bureau of Land Management and Stewardship Contracting ..... 25



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# Small-Diameter Success Stories III

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Forest Products Laboratory
Madison, Wisconsin

# Foreword

This is the third edition of *Small-Diameter Success Stories*, by Jean Livingston. Each edition has focused on stories of the energetic and indomitable spirit of the many entrepreneurs who are using the woody biomass material that is being removed from our forestlands to reduce (1) the threat of wildfires, (2) the impact of insects and disease, and (3) the impact of catastrophic weather events such as hurricanes and wind storms. These include people like Jim and Lynn Jungwirth from Hayfork, California (first edition), who turn small-diameter Douglas fir into flooring; Phil Archuletta from Mountainaire, New Mexico (second edition), who uses juniper in his wood–plastic composite signs; and Link and Jennifer Phillippi from Cave Junction, Oregon (this third edition), who burn forest slash piles in their 1.5 MW wood boiler. These enterprises have taken woody biomass material that traditionally had little value and highlighted how "junk" or low-value wood can be made into studs, poles, pallets, pellets, flooring, molding and millwork, or biomass energy. Each edition has demonstrated projects throughout the nation. We hope that the examples highlighted in this three-volume series have helped create or expand new opportunities for both forest managers and rural communities. More importantly, we hope that you have a better understanding of the people behind these projects and are inspired by their commitment and dedication.

However, this is the last of the series. Our national interest for using woody biomass has increased due to $100/barrel oil. The U.S. Department of Energy, the U.S. Department of Interior, and the U.S. Department of Agriculture have initiatives aimed at stimulating the use of all biomass for both biofuels and biopower. The Energy Independence and Security Act of 2007 includes the use of woody biomass in the portfolio of feedstocks for renewable energy. The momentum for renewable energy from biomass is building and changes will be happening very fast and reported in comprehensive compendiums. Now the focus for the Forest Service will be to ensure that woody biomass removals are conducted in a sustainable manner, which improves the Nation's forest health and provides local economic opportunity.

However, another critical reason for discontinuing this series is that our writer–editor Jean Livingston has retired from the Forest Service after 37 years of dedicated service. Therefore, this issue is dedicated to Jean and her untiring efforts to capture in print the spirit of the businesses, organizations, and communities dedicated to helping improve our forestlands. We wish Jean the best in her retirement—but retirement is probably not the best description for her new endeavors. Jean will continue to work for many rural communities, helping them explain their stories, problems, and successes.

During Jean's many travels to capture these stories, she has encountered many obstacles, such as bad weather, plane delays, detours, dangerous fugitives, road blocks, and the most worrisome of delays—having to drive in unknown regions during snowstorms and blizzards. Her stories on her return to our unit always captured our imagination as we envisioned her hanging off a cliff in an eternity of blinding snow. If you see her, please ask her about her travels preparing these stories—you will be thrilled and entertained.

Personally, I want to thank Jean for always tackling these assignments with renewed dedication and enthusiasm for meeting and capturing the essence of the folks contained in these pages. Through her stories, one gains a greater appreciation for the folks out on the ground. Jean never said no, although she may later have wished that she did. However, I suspect her fear of a *Small-Diameter Success Stories IV* may have been the reason for her retirement. Jean, best wishes in your next endeavor.

**Susan LeVan-Green**
Program Manager
U.S. Forest Service
State & Private Forestry, Technology Marketing Unit
Forest Products Laboratory
Madison, Wisconsin

# Introduction

More than 73 million acres of our national forests and millions more in public and private forestlands are in need of some form of restoration. Forests are declining in health because of major changes over the years in forest structure and composition. This trend has a negative impact on the growth of native trees and plants, wildlife habitat, and watersheds. Unhealthy forests present a high risk for catastrophic fires and epidemic insect infestation and disease.

Restoration of these overstocked stands, through mechanical thinning or prescribed burning, will remove most of the small-diameter and woody biomass material, thus helping the forest to recover its natural structure and ecological functions. Mechanical thinning is usually completed prior to prescribed burning. However, mechanical forest thinning is extremely expensive. If new, economical, and value-added uses for thinned material can be found, forest restoration costs could be offset as the threat of catastrophic wildfires is reduced.

To help accomplish forest restoration, various approaches are being taken to complete the necessary work and simultaneously contribute to the economic growth of communities. Restoration of our forests will persist as long as we continue working together for the ecological health of our forests and the economic health of forestry-based rural communities.

This is the third document that tells the story of several wood product businesses and communities across the country that are successfully using thinning material from forest restoration projects and converting it into wood products and biomass energy. Telling these small-diameter stories is intended to accomplish several goals but three in particular: (1) clarify and enumerate the value and importance of funding programs to help small businesses and forestry-dependent communities; (2) provide marketing tools for these businesses; and (3) create a networking system for similar businesses across the United States.

*All Americans have an obligation to protect the Earth and a responsibility to be good stewards of our land, and my Administration has made forest health a high priority. Under the Healthy Forest Initiative, we are helping to protect the American people, their communities, and the environment from potentially devastating wildfires. Together we can conserve our woodlands and help leave a lasting legacy for future generations.*

*- President George W. Bush, National Forest Products Week, October 2007*

### National Woody Biomass Utilization Grant Program

The National Woody Biomass Utilization Grant Program (administered by the State & Private Forestry Technology Marketing Unit, located at the Forest Products Laboratory in Madison, Wisconsin) is intended to help improve forest restoration activities by using and creating markets for small-diameter material and low-valued trees removed from hazardous fuel reduction activities. These funds are targeted to help communities, entrepreneurs, and others (such as state, local, and Tribal governments; school districts; non-profit organizations; businesses; companies; corporations; public utility districts; fire districts; conservation districts; ports) turn residues from hazardous fuel reduction projects into marketable forest products and/or energy products.

This grant program has three principal goals:

- Help reduce management costs by increasing value of biomass and other forest products generated by hazardous fuel treatments
- Create incentives and/or reduce business risk for increased use of biomass from or near national forestlands (must include National Forest System lands, however, may also include other lands such as Bureau of Land Management, Tribal, state, local, and private)
- Institute projects that target and help remove economic and market barriers to using small-diameter trees and woody biomass

Some of the following stories describe how the Forest Service's National Woody Biomass Utilization Grant Program (see sidebar) is working to improve forest restoration by helping to create markets from this thinned material. Some stories explain how communities and small businesses are working together to solve our nation's forest crisis. The final section discusses the Bureau of Land Management (BLM) and how they work closely with the U.S. Forest Service. In addition, two completed BLM stewardship contracts are described. Observations from those stewardship contractors and comments from the contractor who helped establish the baseline for stewardship contracting in Ashland, Oregon, are given.

# Bearlodge Forest Products, Inc.



Wyoming

Incorporated in 1977, Bearlodge Forest Products, Inc., is a three-generation family business. Located in northeast Wyoming, near the town of Hulett, it is surrounded by the beautiful Black Hills National Forest.

The Black Hills National Forest is located in western South Dakota and northeastern Wyoming, covering 1.2 million acres; 160,000 of these are in Wyoming. From a distance, these pine-covered hills, rising several thousand feet above the surrounding prairie, appear black, thus the name Black Hills.

Family interest in the sawmill/logging business goes back to Great-Grandfather A.C. Neiman and his sons. Eventually, A.C. Neiman's son, Henry, and his three sons (Dan, Phil, and Walt) incorporated the business known today as Bearlodge Forest Products, Inc. In 2001, Henry Neiman's son, Dan, and his wife, Ann, purchased the business, and in 2002, Dan Neiman's daughter, Dena, and son-in-law, Doug Mills, joined the company.

Everyone in the family is part of the business and each has their specialty area. The business office is located alongside the mill and doubles as Dena and Doug's ranch-style home; they live in the lower level. At Bearlodge Forest Products, family comes first and practicing responsible land stewardship comes naturally.

Bearlodge Forest Products produces more than 6 million board feet of material each year from ponderosa pine. They specialize in products such as wood pallets, wood pellets, custom sawn lumber and timbers, and CHINK-A-LOG® siding.

CHINK-A-LOG® is unique to Bearlodge Forest Products—a product that necessitates explanation. It is an alternative to conventional log cabin siding and presents a natural, authentic log cabin look.

"We offer two profiles of CHINK-A-LOG® siding," says Dena. "Both are 7-1/4 inches wide and available in random lengths, but one is flat and is 3/4 inch thick, and the other has a radius and is 1-1/2 inches thick."



**Dena and Doug Mills**




**Newly designed company sign**

CHINK-A-LOG® siding comes as a package. There are custom window bucks, as well as turned log corners. Bearlodge Forest Products offers the Perma-Chink System® products (to stain, finish, and chink your project) and all the tools needed (the same tools needed to install any other type of wood siding). Bearlodge also offers a how-to-install video.

According to U.S. Forest Service District Ranger Steven Kozel, "In recent years this area [Black Hills National Forest] has experienced severe drought, compounded with wildfires of historic proportions for size and intensity, and has made treatment of high-density, fire-adapted stands that are at high risk for significant stand-replacement fire a priority."

Kozel also says that they will continue to have fuel reduction projects on about 500 acres per year on the Black Hills National Forest in sizes that could be utilized for pallet production. "Without a market outlet for this material, taxpayers will pay higher costs per acre for masticating, chipping, mulching, or otherwise shredding the woody biomass and leaving it spread over the forest floor." Kozel says that a facility like Bearlodge Forest Products is a perfect outlet for this material.

Each year, Bearlodge Forest Products utilizes 1.5 million board feet of products other than logs (POLs) for pallet parts. This wood is then manufactured into pallet parts for approximately 100,000 pallets per year.

Family owner, Dena Mills, says that they sometimes have difficulty purchasing lumber that is of adequate quality to use for making pallets. To meet their market demand and to ensure quality, Bearlodge Forest Products was determined to install a pallet cant processing system to produce pallet boards and stringers (pallet parts).

To help finance the pallet cant processing system,

Bearlodge Forest Products, Inc.
1506 Hwy. 24, P.O. Box 248
Hulett, WY 82720



**Dan Neiman (Dena's father)**



**CHINK-A-LOG® siding**

in 2007 they applied for and received a Woody Biomass Utilization grant, a program sponsored by the U.S. Forest Service. Their Pendu cant processing system was installed at Bearlodge Forest Products in the winter of 2007–2008.

"With this system we can now utilize 133,000 board feet of POLs generated from the Forest Service's hazardous fuel treatments," says Dena. "Also, we now have the ability to produce about 200,000 pallets, doubling our annual production. In addition, the sawdust produced as a result of the cant-line is converted into wood pellets, another one of our value-added products."

The owners of Bearlodge Forest Products are well known for promoting responsible forestry and have been in the small-wood utilization business for 30 years. The wood resource needed to sustain this business will undoubtedly be there for generations to come. In addition, I feel confident that this company will continue to maintain their strong stewardship values, which will be passed on to future family generations of Bearlodge Forest Products.



**Pallets made by Bearlodge**

# Big Sky Forest Products



As result of the 2006 National Woody Biomass Grant program, Big Sky Forest Products was able to purchase a small-log chipper, which is the final piece of equipment needed for their plan to efficiently turn low-value logs into the highest value possible. Big Sky Forest Products, located near St. Regis, Montana, was purchased in 1996 and is a profitable and efficiently run small roundwood facility.

In 2000, St. Regis was listed as having a population of 315 people. The town is surrounded by mountains with thousands of miles of creeks and rivers and numerous lakes, forests, hiking trails, ski slopes, snowmobile runs, wildlife, fishing, and whitewater rafting. The town was once a shipping point for the lumber industry, which is now minimal. Currently, the community is primarily a tourist area.

Gary Suppiger operates three roundwood manufacturing plants: Big Sky in St. Regis and Panhandle Forest Products in Priest River, Idaho, and in Cranbrook, British Columbia, Canada. In 1966, Panhandle merged with Big Sky, which was originally owned and operated by brothers Harley and Steve Freeman. Steve manages production at the mill in St. Regis.

When I visited Big Sky, Suppiger explained how the newly purchased small-log chipper "was a culmination of a series of projects designed to efficiently process small-diameter, low-value, and previously not merchantable logs into marketable products."

Steve Freeman designed and fabricated all the roundwood manufacturing machinery at Big Sky. He said, "Through National Fire Plan funds, Big Sky was able to complete the first phase of our small-log merchandizing expansion in 2003 with a new log deck, including a chop saw, log transfer, and electronic sorting system. The second phase included the small-log debarker that was installed in 2005."

Suppiger said that they process unmerchantable logs into doweled and peeled roundwood products such as fencing, poles, horse jump rails, doweled furniture grade rounds, half-round fence rails, and lattias. Their highest valued product is their dowelled logs. Byproducts include wood chips for pulp, clean fines for particleboard, and bark for hog fuel or landscape mulch.

"No fiber is wasted. The entire log is utilized to manufacture a marketable product. We utilize virtually every log without respect for species, straightness, soundness, size, or dryness," stated Suppiger.

Big Sky employs six people for an 8-hour work shift. With the purchase of the small-log chipper, they plan to add two more employees to their payroll.

Eighty percent of Big Sky's supply is from public forestlands such as the Idaho Panhandle, Kootenai, and Flathead National Forests, the Flathead Indian Reservation, and Montana Department of Natural Resources.




**Big Sky Forest Products, Regis, Montana**



**Gary Suppiger**



**Operation at Big Sky**

All products are marketed through their parent company, Panhandle Forest Products, which has a sales force of one full-time and one part-time person. Their sales strategy is to sell user direct and offer customer delivery.

Big Sky Forest Products
P.O. Box 489
St. Regis, MT 59866



**Debarking roundwood**

Kevin Chamberlain, Director of the County Office of Economic Development, and B.J. McComb, County Commissioner, strongly support Big Sky Forest Products. Chamberlain says that “Big Sky has been a partner with the county for many years. The fact that their business is thriving is testimony to their hard wood and dedication. Any business tied to roundwood or small-diameter timber is difficult, but through their attention to efficiencies and sound marketing, they are making it work.”

# Chadron State College



The community of Chadron, Nebraska, was moving toward using their abundance of woody biomass as the source of energy for a forest biomass steam plant at Chadron State College long before many of us even thought about this possibility.

The town of Chadron is a community of about 6,000 and is located in northwest Nebraska near the scenic Pine Ridge. In addition to some of the best cattle ranching land, this area boasts of its recreational opportunities such as fishing, hunting, and cross-country skiing.

Located within the town of Chadron, Chadron State College is the only 4-year graduate-degree granting college in western Nebraska. The 281-acre campus has almost 3,000 students, 24 buildings, and 1.1 million square feet of floor space. As one of the larger employers in the region, the college employs 300 people.

The community and Chadron State College also boast about the forest biomass steam plant that was installed at the college about 18 years ago. H. Doak Nickerson, Northwest District Forester for the Nebraska Forest Service, tells the story of how it all began.

"We initially got the idea from Northwest Missouri State University in Maryville, Missouri. We were aware of their wood-burning system and knew they were saving money. A delegation of community leaders from Chadron State College, Nebraska Forest Service, and the Nebraska National Forest came together and decided to take a road trip to Missouri to see their facility in operation."

Their trip to Missouri left a lasting impression on the Nebraska delegation. After returning home, the Nebraska Forest Service worked with Chadron State College staff to first develop a resource analysis and then an engineering feasibility study for possible installation.

"We knew we had the volume of wood resource that was necessary and the analysis from the college gave us positive feedback. However, at that time, the college did not have the capital investment fund available to follow through with the plan," said Nickerson.

So the forest biomass plan sat on the shelf for at least 5 years. In 1989, this community experienced one of the worst forest fires in the state's history, where 25,000 acres of the Fort Robinson Wilderness Area were destroyed in less than a week.

Nickerson said, "Just 1 month after the U.S. Forest Service had designated part of this land as the Soldier Creek Wilderness Area—catastrophic wildfires burned it to the ground!"

In a local meeting following these devastating fires, land owners, agencies, and others in the community came together to see how they could turn this devastating fire into some positive action. The fact was that a tremendous volume of wood would go to waste if they didn't do something. Eventually the resource analysis and engineering study for a forest biomass plant that had been sitting on the shelf for years came into play. In the end, State Senator Sandy Scofield came to the community's rescue by putting together an innovative, renewable energy package for the College.



**H. Doak Nickerson, Northwest District Forester, Nebraska Forest Service**



**Forest biomass steam plant**

Nickerson said "It's too bad it took a disaster to get the project moving, nevertheless, we received state appropriated funds to purchase and install the wood-burning system within a year."

According to Nickerson, two wood energy boiler units (6,000 and 12,000 lb/h) went into operation in 1991 at a cost of $1 million. Wood fuel storage capacity is 100 tons, with maximum daily consumption at 50 tons. Annual demand

Chadron State College
Chadron, NE 69337-2433



**Trucks delivering woody supply to biomass steam plant**

is between 7,000 and 8,000 tons, with wood ash generation an efficient 2% to 3%. Energy savings are averaging more than $130,000 per year compared with natural gas, resulting in a capital investment payback in 7 years! Because of these results, the college added a $1,350,000 air-conditioning chiller in 2004.

The majority of the college's wood fuel comes from logging slash piles and fuel treatment thinning in the wildland–urban interface on privately owned lands. Only a small percentage of supply is from state lands, and an even smaller percentage is from federal lands. In northwest Nebraska, two-thirds of forests are privately owned.

The supplier for Chadron State College is an in-woods chipping contractor who is part of a struggling forest products industry that infuses between $5 to $10 million per year into the local economy.

"I think if the College had it to do over again, they would have done a couple things differently," Nickerson said. "Instead of stockpiling the chips outdoors on the bare ground, they may have invested additional funds in an enclosed chip storage area. If the chips had been stored in a concrete lined bunker under roof, they may have avoided losing our entire chip inventory to the 2006 fires that nearly burned the college and town to the ground."

Nickerson noted that the college's success in pursuing fossil fuel independence is catching on in Chadron. The community is now in the early stages of constructing a new, state-of-the art hospital. As part of the engineering design for this facility, it is being built to allow for a ready "plug-in" of an adjoining wood energy plant sometime in the future. This conversion would make wood the primary energy source, with natural gas taking a back-up role and diesel fuel serving in emergencies only.

This community is fortunate that their leaders had the vision and foresight 20 years ago to convert Chadron State College to a forest biomass steam facility. I am sure that active stewardship and management of the Pine Ridge forestlands of northwest Nebraska will continue to sustain a continuous flow of forest biomass for both Chadron State College and the community's new hospital.

# England Sawmills



In the fall of 2006, England Sawmills, located near Salmon, Idaho, improved its capacity, decreased its shipping costs, increased its price per board foot, and gained the option of offering two new high-valued products. These achievements were a direct result of a newly installed dry kiln, partially funded from U.S. Forest Service National Woody Biomass Utilization grant dollars.

Salmon is located on the Salmon River in central Idaho, near the Montana border, and close to the Salmon–Challis National Forest. The legendary Lewis and Clark Expedition passed through Salmon in 1805, and it is the birthplace of Sacajawea's people, the AgaiDika Shoshone. The area is well known for its superior white-water rafting, hunting, and fishing. This small community of about 3,000 has been hit hard the past 10 years because of job losses in the mining and timber industries. The Federal government and the agricultural industry are the only major employers in the area.

Since 1999, Gary England has owned and operated England Sawmills, and it is the only small-diameter sawmill located within 150 miles of the Salmon–Challis National Forest, from which the sawmill gets almost all its supply. Gary is a very proud American who recently installed a large American flag on top of his wood chipper. The flag took priority over putting up a sign that identified the name of his sawmill.

The Salmon–Challis National Forest covers more than 4.3 million acres of east-central Idaho. Included within its boundaries are 1.3 million acres of the largest wilderness area in the continental United States.

"We have a dangerous fuel buildup condition on the Salmon–Challis National Forest that is contributing to poor forest health, potential for catastrophic wildfires, and a threat to communities from wildfires," said Bill Wood, Forest Supervisor for the U.S. Forest Service. "We are working to plan and implement fuel reduction treatments on thousands of acres in the next few years. The wood removed from these treatments will be mostly 4 to 12 inches in diameter."

Forest Supervisor Wood estimates that future projects on the Salmon–Challis National Forest will make available between 1,500 and 2,000 acres of timber annually, or 4 to 5 million board feet of timber over the next 2 years. The only local market for this timber is England Sawmills.

According to England, his mill has about $580,000 in equipment and is designed to process timber between 2 and 14 inches in diameter. It produces lumber in a variety of sizes 1 and 2 inches thick by 2 to 8 inches wide, posts and poles, and firewood. However, now that he has installed a dry kiln, England has added rough-sawn Douglas-fir flooring and house logs to his product line, which will increase his profit margin.



**Overview of England's dry kiln**



**Gary England**

Before installing the dry kiln, lumber was either air-dried, which slowed production about 3 weeks, or the lumber was shipped rough cut and green, which reduced the market value. This also increased shipping costs because he could ship only about 15,000 board feet of green material per load compared with 28,000 board feet of dried lumber.

The newly installed dry kiln increases England Sawmill's capacity from 750 thousand to about 9 million board feet per year. It has also increased his sale price per board foot because now he can sell finished lumber (instead of the rough cut lumber he sold previously). In

England Sawmills
P.O. Box 84
North Fork, ID 83466



**Small-diameter supply at England Sawmills**

addition, his new high-valued wood flooring and house log products will add considerably to his profit margin. In September 2006, wood flooring was selling for about $1,000 per thousand board feet.

Currently, England Sawmills has 9 employees. With the new dry kiln, England hopes to increase that to 25 employees. The dry kiln reduces drying time to 1 week and increases their production capacity to 35,000 board feet per 8-hour shift.

"Our increase in capacity and production has increased the number of employees I can hire at a living wage," said England. "The dry kiln makes it possible for me to continue production through the winter and year round, which I wasn't able to do before."

Forest Supervisor Wood says that "the addition of a dry kiln at England Sawmills should result in annual revenues for the Salmon–Challis National Forest of between $900,000 and $1,200,000 from the sale of timber and save the forest $850,000 to $1,100,000 in annual expenditures, if we were forced to hire crews to complete these thinning treatments."

England notes that his mill runs very efficiently. All waste wood is chipped to be either used in the boiler to power his dry kiln or sold and picked up by a pulp and paper mill from Montana.

England is well known and respected by land managers in the community and the Intermountain West. Timber manufactured by England is sold to two primary buyers: Tripp Lumber and Teton West, both in Missoula, Montana.

England says "My biggest concern is supply." Now with capacity increased to about 9 million board feet per year, the raw material may not be available. According to England, not all Forest Service timber sales have been going as planned. For example, a Forest Service timber sale that was suppose to be available for bid in June 2005 did not happen until the spring of 2006. England needs a steady flow of about 2 to 4 million board feet per year to take advantage of his new production capacity. He is quick to make special note of how much he appreciates all the help and assistance he receives from both Forest Service employees and those in local government who have made it possible for him to expand his business.

Gary enjoys this line of work and has no plans to do anything else, even though at times he is frustrated with the market fluctuations and the inconsistency of supply. Gary England is a very kind, soft-spoken, patient man with a good head for business. He says his interest in the lumber business began 36 years ago working alongside his "Granddad." "This is all I ever wanted to do—I just love sitting on my porch [which overlooks his sawmill] and smelling that lumber. This wood business gets in your blood and you just can't get it out."

# Forest Guild



Until a non-profit organization called Forest Guild took action, New Mexico had the highest workers' compensation insurance rates of any western state.

The Forest Guild "provides training, policy analysis, and research to foster excellence in stewardship, to support practicing foresters and allied professionals, and to engage a broader community in the challenges of forest conservation and management."

Mike DeBonis, SW Region Director for the Forest Guild, says, "One of the biggest barriers to contractors winning forest fuels reduction contracts is the excessively high workers' compensation rates in New Mexico. These rates are the highest in any of the western states. For example, in 2005 a New Mexico employer paid $79 in premiums for every $100 in payroll; other states paid an average of $25 per $100."

Workers' compensation insurance for forest thinning projects in New Mexico can be 20% to 50% of the treatment costs per acre. Many contractors employ three or fewer employees just to avoid the high cost of insurance premiums. However, a contractor with only three employees is unable to bid on large forest fuel reduction projects. In some cases, contractors do not cover their employees with workers' compensation insurance, which is not only risky for the worker, but a big risk to their business.

To help contractors with this insurance problem, in 2005 the Forest Guild sought and was awarded a $250,000 grant from the U.S. Forest Service National Woody Biomass Utilization Grant Program. The Forest Guild use of this grant included sponsoring a logger safety program with certification, which in turn would improve worker safety, reduce workers' compensation insurance losses, and help reduce the cost of removing hazardous woody biomass from national forests.

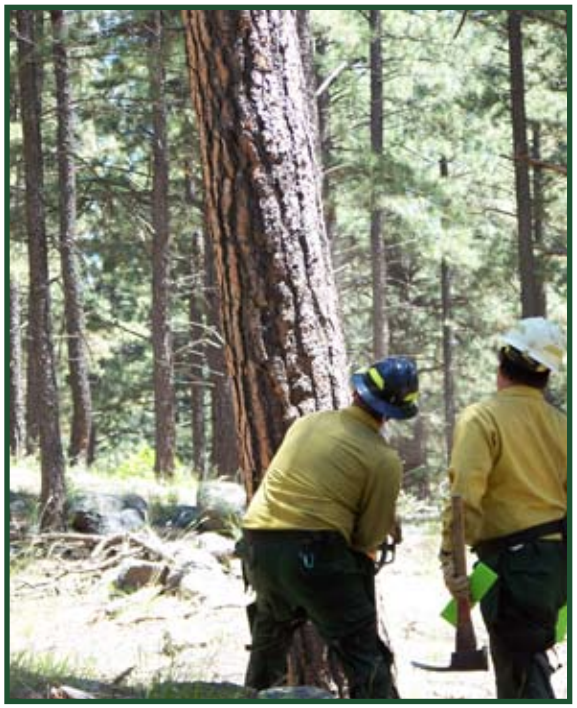
Employers in New Mexico who are "Safety Certified" qualify for an immediate reduction in insurance rates, from $79 to $30 per $100 in payroll. The Forest Guild began offering certification training around the state free of charge and sometimes even covered travel costs for attendees.

As of January 2008, the Forest Guild has offered 29 forest worker safety certification courses in locations across New Mexico; 432 workers have become safety certified. This training led the Public Regulation Commission of New Mexico to have the National Council on Compensation Insurance create a special classification for certified loggers, which means that now certified workers are eligible to receive the new rate of $30 for every $100 of payroll—a significant reduction from past rates.

"The Forest Guild's mission is to promote forestry that sustains ecosystem integrity and the well-being of human communities," said DeBonis. "The health of New



**Mountainair training, May 2007 (Source: Forest Guild)**



**Pine Hill (Ramah Chapter of the Navajo Nation) training, June 2007 (Source: Forest Guild)**

Mexico's forests is directly linked to the viability of forest-based communities and workers. By reducing the barrier of high workers' compensation insurance, the Forest Worker Safety Certification program has improved the ability of forest workers to make a living from the forests."

DeBonis notes the question from many regarding the program's sustainability: When the grant funds run

Forest Guild
P.O. Box 519
Santa Fe, NM 87504



**Taos Pueblo Recertification course, June 2007 (Source: Forest Guild)**



**Mescalero forest crew training (Mescalero Apache Tribe), May 2007 (Source: Forest Guild)**

out, will contractors and workers be willing to pay for the certification courses?

In answer to that, DeBonis says that since September 2007, three courses have been scheduled based on contractor requests. In addition to requesting the training, contractors have agreed to pay all costs associated with the course. "The fact that contractors are willing to pay the up-front cost for the training highlights the financial benefits gained through reduced workers' compensation insurance premiums," says DeBonis.

Results show that their logger safety program with certification has been a huge success. As for the future of this program—Forest Guild is working with the New Mexico Forest Industry Association (NMFIA) to serve as the program's permanent home when their National Woody Biomass Utilization grant has been exhausted. NMFIA is a newly formed association serving the forest industry, including forest workers.

# Institute for Agriculture and Trade Policy



In 2005, Don Arnosti from the Institute for Agriculture and Trade Policy (IATP), along with three partners, were awarded a grant through the U.S. Forest Service National Woody Biomass Utilization Grant Program. The grant will help the Superior National Forest, its community, forestry businesses, landowners, and others ensure sustainable management of these forest lands.

IATP "promotes resilient family farms, rural communities, and ecosystems around the world through research and education, science and technology, and advocacy." The Institute has several programs; forestry is the one of which Arnosti is the Director.

Arnosti briefly explains their Forestry Program. "We collaborate with landowners, forestry cooperatives, and conservation organizations to ensure sustainable land management. Our challenge is to make responsible forestry work for private landowners and their communities."

In 1909, President Teddy Roosevelt established the Superior National Forest. This 3-million-acre forest is located in northeastern Minnesota, is the eighth most visited national forest in our country, and is known worldwide for its Boundary Waters Canoe Area Wilderness.

The Superior National Forest is a natural fire-prone forest. As a result of decades of fire suppression and fuel accumulation, large areas of the forest are at risk of "stand replacing" crown fires. During the past 2 years, the forest has experienced the two largest such fires in its recent history in an area of blown-down timber.

All of this forest has been classified by the Forest Service as either Condition Class 2 or 3, which means that these areas have departed from their historical fire regimes and can present persistent wildland fire problems. Currently, three Community Wildfire Protection Plans are being prepared that identify large areas (660,000 acres) as high fire hazard and risk due to fuel loads and poor access. Much of the area is in the rapidly growing wildland–urban interface and is considered as a top priority for forest fuel treatments.

The specific purpose of the National Woody Biomass Utilization grant to Arnosti and his partners was to conduct test biomass harvests on fire-prone lands of the Superior National Forest. A study was designed to understand the economic and operational barriers as well as the impact on forest resources of such harvests.

Arnosti explained that two key barriers currently hinder removal of woody biomass from the Superior National Forest. "The first barrier is that many in the logging business had not previously cut woody biomass material and are unfamiliar with the operating conditions. They were concerned about compatibility of their equipment, and possibly the unknown cost of cutting non-commercial timber."



**Woody biomass bundles (Source: IATP)**

The second key barrier is "the inefficiency of completing environmental assessments on prescribed woody biomass removals from national forest sites due to present shortcomings of local best management practices (BMPs), which were developed without considering woody biomass removals from the forest."

According to Arnosti, the BMPs need to be updated to specifically consider not only the removal of tree trunks, tops, and limbs, but also efforts that specifically target small-diameter trees and brush in the understory.

The three partners with IATP on this woody biomass grant project are the Superior National Forest, the Laurentian Energy Authority (LEA), and Forest Management Systems, a cooperative logging business.

The plan for this project was thoroughly laid out. Nine test biomass harvests were conducted

Institute for Agriculture
and Trade Policy
2105 First Avenue South
Minneapolis, MN 55404



**Bundler (Source: IATP)**



**Loose woody biomass material (Source: IATP)**

on more than 100 acres of sites on the Superior National Forest identified in Community Wildfire Protection Plans. Little of the woody biomass material from these sites had any commercial timber value. Sites were selected in areas of insect-killed balsam and where understory trees provided dense "ladder fuel" from the ground to the forest crown. Various harvesting equipment and techniques were tested. The project partners collected and analyzed environmental, cost, and productivity data for each test site and made this information available to the public.

IATP served as the Project Coordinator and was responsible for, among other things, accurate reporting, making sure all parts of the project functioned together and on time, coordinating data to design ecological and monitoring components, and ensuring the results of the study would be published and made public.

Forest Service personnel from the Superior National Forest identified the high-priority sites for test harvests, coordinated National Environmental Policy Act (NEPA) and related analysis and procedures, and ensured that the woody biomass removal was performed properly.

Forest Management Systems and other area loggers did the actual harvesting. They identified and researched a variety of equipment and harvest techniques, trained operators, and are now helping to educate the logging community about the results of the project.

Laurentian Energy Authority loaned the grinder, purchased the woody biomass harvested from the test sites, and is also helping to publicize the results of this project. (LEA is a partnership of the Public Utilities of Virginia and Hibbing, Minnesota, which operate wood-fueled district heating and electrical generation facilities in these communities.)

This study was originally designed to provide information to address two sets of barriers. However, Arnosti said, "In the course of our study, we determined that administrative issues and constraints formed a third barrier to the development of biomass markets. Although no definitive right way to harvest biomass for energy use can be identified as a result of these trials, important information was uncovered that is of value to land managers as they consider the use of biomass harvest as a tool to achieve their desired land management goals."

The following, provided by Arnosti, presents only a few of the recommendations as a result of this study regarding key barriers that can hinder removal of woody biomass. For a complete project report, please contact Arnosti through IATP.

**Administrative Issues**

- Biomass management activities must be considered and incorporated at early phases of the planning process.
- Site prescriptions tailored to the practical and operational needs of biomass harvest are critical. When possible, these should be flexible prescriptions that allow operator-determined options to lay out skid trails, reserve areas, and permit a minimal removal of residual trees to facilitate harvest and forwarding.
- Combining roundwood and biomass harvest is one strategy to improve on-site maneuverability and harvest efficiency.
- Clear site demarcation can speed up operations.
- Minimize forwarding distance to biomass yarding areas.
- Plan landings of sufficient size to accommodate all harvested biomass.
- Focus biomass removals on larger materials and high-density areas.



- Emphasize communication and coordination between the forest managers and operators early in the planning.
- Communicating to operators why certain prescriptions require specific exclusions or restrictions promotes an informed understanding of the harvesting goals.

**Harvest, Forwarding, and Processing Equipment and Techniques**

- Efficient layout of harvest access trails reduces harvest and forwarding time.
- Equipment should be selected that is suitable to the terrain and forest conditions.
- Less expensive equipment (such as biomass processing heads in place of timber processing heads) can improve harvest economics.
- Learning the techniques necessary to search, harvest, and recover smaller biomass material will lead to improved efficiency and cost reductions.
- Forwarding of materials should take place right after material is cut to improve speed and total recovery of material.
- Forwarding and bundling hours can be reduced if material is sized and arranged in organized piles.
- Adaptations to standard forwarding equipment are not necessary for biomass; however, operators need to learn new techniques of loading and maneuvering to be successful.
- Bundling of biomass, although feasible, results in additional costs for the harvester, which must be rewarded with a superior price at the biomass market.
- Self-loading grinders should be used to eliminate the need for a separate loader.

**Environmental Considerations**

- Materials less than 1 inch in dbh (diameter at breast height) contained a small percentage of the total volume of biomass.
- On our test sites, materials from 1 to 5 inches dbh generally held far more volume than smaller materials and were a significant source of biomass.
- The highest harvest removal in these trials was 75% of the stems less than 1-inch dbh and 94% of stems greater than 1-inch dbh. Most sites fell well under this level of harvest.
- Snags were far less impacted by the harvesting activity than expected.



**Loading trucks (Source: IATP)**




**Harvester (Source: IATP)**

**Market Considerations**

- Distance to biomass markets should be no greater than 100 miles, preferably considerably less.
- Payment should be per ton and adjusted for moisture content to reward on-site drying and to transport dryer, more favorable materials.
- If bundles are desired for biomass storage reasons, payment must reflect this value.

# Montana Community Development Corp.

The need for hazardous forest fuel reduction has reached critical levels in Montana. According to State Forester Bob Harrington, "more than 80% of the 22.5 million acres of Montana forested land is at a high or moderate risk from damaging wildfires or insect and disease infestation."

However, forest fuel reduction treatment results in large quantities of woody biomass or slash left in the woods. Slash is the material (tops and limbs) left over when trees are thinned during forest restoration. Slash is either scattered or piled in the forest but this can also create a fire hazard. What do you do with 2 million tons of slash that is left each year at logging sites in Montana?

Slash material is considered very low in value, is not economical to transport, and can cause pollution problems if burned. However, slash can be ground into chips and transported to co-generation facilities and used as fuel to heat boilers.

Craig Rawlings, Small Wood Enterprise Agent of Montana Community Development Corporation (MCDC), agrees that burning slash in the forest is not the best answer. He believes that a good solution is the Woody Biomass Collection System, an economical alternative to burning and mechanical methods of handling slash. The Collection System involves a network of partners helping to solve the slash problem.

The MCDC, located in Missoula, Montana, is a nonprofit organization with 20 years of experience in business financing, project development, and business technical assistance, especially in the area of small-wood innovations.

According to Rawlings, in 2004 several agencies and MCDC brought Canadian containers and related machinery to Montana to conduct field trials and complete extensive cost analyses to determine the feasibility of collecting and transporting slash and to compare bin transport options with conventional hauling.

Private businesses invested in these trials by contributing money, equipment, and time. Several roll-on/roll-off containers were filled in the forested areas with slash and then hauled to a collection yard. At the yard, materials were combined and sold at the highest market value. Based on these field trials, the potential to expand this container technology was deemed very high.

"The trials also showed a direct savings to the federal government of $35–50 per acre when this collection system is substituted for burn treatment on federal land," said Rawlings.

Montana Community
Development Corporation
110 East Broadway #200
Missoula, MT 59802

Based on their findings and with the help of a U.S. Forest Service National Woody Biomass Utilization grant, the Collection System was then able to organize, equip, and address slash removal by developing an economical way to collect, transport, and sell it for profit. In due course, the Collection System plans to also handle removal of urban wood waste, wooden pallets, clean construction debris, and both merchantable and unmerchantable logs that are harvested in less than truckload quantities.



**Roll-on/roll-off container placed in fuel reduction site**

The MCDC is the project leader on this project and coordinates all work. Those that have committed to this project include All Woody Resources, Horizon Tree Service, Fire Solutions, the Bitterroot Resource




**Woody biomass being loaded onto container**





**Truck and trailer transporting small-diameter logs—Roll-on/roll-off refers to a straight frame tractor and pup trailer configuration in which modular containers are "rolled" onto and off of the straight frame tractor (commonly referred to as a "Hook Truck") and the pup trailer, by means of a tractor-mounted hydraulic grapple. (A pup trailer is a four-axle trailer towed by the hook truck.)**



**Truck loading roll-on/roll-off container.**



**Roll-on/roll-off rack for transporting logs**

Conservation & Development (RC&D) Council, and the University of Montana, School of Forestry. Currently, most of the forest fire reduction projects that the Collection System is working on are located on the Lolo and Bitterroot National Forests.

All Woody Resources operates and promotes the collection system. It developed the central collection yard, makes available the roll-on/roll-off containers, and provides partial staffing at the collection yard. All Woody Resources also provides a hook truck, trailer, and loader for container transport and service. This company contributes through their logging and hazardous fuel reduction services. Horizon Tree Service and Fire Solutions also provide logging and hazardous fuel reduction services and participates, especially in the wildland–urban interface areas. The Bitterroot RC&D Council cost-shares 700 to 800 acres of fuel reduction projects each year and plays a big role in the Collection System through their outreach and education efforts. The University of Montana, School of Forestry, collects data on this project for possible replication in other areas.

Rawlings explained how the Collection System operates. "We have a central yard with eight log bunks and nine slash bins (roll-on/roll-off containers); up to four containers always remain at the collection yard. The containers are transported to the job sites of various private logging and forestry companies. These companies use the containers to collect slash at the job site, then the full containers are transported to the central yard. There, slash from around the region is aggregated and sorted so that it can be sold for its highest value." He added, "We also hope to attract maximum use of the central yard by residential and municipal customers."

Roll-on/roll-off containers make slash totally accessible because the trucks that carry them can navigate the narrow and windy mountainous roads where many of the fuel reduction sites are located. In addition to the roll-on/roll-off containers, a hook truck and trailer for transport and a loader are needed.

Craig Thomas, Vice President of All Woody Resources, fabricated the roll-on/roll-off containers. Some hold 44 cubic yards of material, and some can hold 58 cubic yards. The containers are slightly wider on the bottom and slightly wider in the back. To provide for easy storage and transport, the containers fit inside each other, similar to the way paper cups stack up. Also, the loader can be handily stored on site inside these containers.

When asked about the future of this project, Rawlings said "I believe this project will change a part of the timber harvesting industry. The Collection System can be easily adapted to any area, especially where there is a lot of forest fuel reduction work going on. It will provide opportunities for value-added products, help create jobs, and contribute to healthy forest management."

# North Carolina State University

Some consider the pocosin ecosystem to include one of the most flammable vegetation types in the U.S. South. To help reduce these hazardous fuel conditions, Dr. Joseph Roise, professor of forest management operations at North Carolina State University, is working to develop an efficient machine that would swath-harvest woody biomass from pocosins.

Pocosins are evergreen shrub- and tree-dominated landscapes found on the Atlantic Coastal Plain from Virginia to northern Florida, although most are found in North Carolina. The word pocosin comes from the Native American word for "swamp on a hill." Usually, no standing water is present in pocosins, but a shallow water table leaves the soil saturated for much of the year. Pocosins range in size from less than an acre to several thousand acres.

On the Croatan National Forest and in many southern states, wildfire suppression activities over the past 60 years have allowed a large build-up of woody biomass on almost all forestlands, including pocosin ecosystems. The only safe way to reduce these fuel loads is by mechanical removal. However, current mechanical treatments can cost between $500 and $1,200 per acre. Mulching is also expensive, and prescribed fire is too dangerous to apply with such high fuel loading, especially in the wildland–urban interface areas.

According to Roise, "If this small-diameter (less than 6-inch diameter) woody biomass material could to be harvested by machine and sold to produce feedstock for energy production for less than the current rate of $500 per acre, it would spread the hazardous fuel reduction dollars over more acres."



**Close up of the head on experimental harvester**

Department of Forestry
and Environmental Resources
North Carolina State University
Raleigh, NC 27695



**A pocosin, showing type of woody biomass material that needs harvesting, in an urban–wildland interface area on the Croatan National Forest**



**Experimental harvester in operation**

FECON, Inc., had been working on a harvesting machine designed to collect woody biomass but had not manufactured or tested the design. After discussions with Dr. Roise at North Carolina State University, a project was laid out to manufacture, test, refine, demonstrate, utilize, and ultimately promote a redesign of the mulching head into a harvest and collection system that would efficiently harvest small-diameter woody biomass. It was decided that a good test for this prototype would be on Croatan National Forest acres that desperately needed fuel reduction in the wildland–urban interface.

In 2006, Dr. Roise applied for and received a National Woody Biomass Utilization Grant from the U.S. Forest Service to assist in his project to create a biomass harvesting machine by redesigning the mulching head into a harvesting head and collection system.

Many partners are involved in this experimental biomass harvester project. FECON, Inc., is providing the new head design, manufacturing, refinements, and operating expertise needed. The Croatan National Forest is providing access to acres needed to harvest woody biomass in addition to helping with equipment whenever needed. Craven



**Dumping the woody biomass material for pickup**



**Machine operator Tim Tabak, Resource Manager/Consultant, Association of Consulting Foresters, New Bern, North Carolina, standing next to harvester head**

Wood Energy, a 45-megawatt electric generating plant in New Bern, North Carolina, is supplying the market for the harvested woody biomass, helping to test the biomass fuel properties, and providing logistical support including transportation. The North Carolina Forestry Foundation is providing access to their machine shop, staff support, equipment, and living arrangements for project personnel.

The experimental harvester weighs 56,000 pounds and is pushed by a 440-horsepower engine tractor on treads. It produces a ground pressure of only 7.1 pounds per square foot, so it moves through the brush easily over the soft forest bed and pocosin. As it moves along, the harvester cuts a trail with carbide teeth and pulverizes the biomass in its 6-foot-wide path. A belt-driven vacuum sucks the cuttings back though a chute and into an agricultural wagon that is hooked to the tractor. When the wagon is full, it is dumped into a bin for later pickup. Each time the wagon is dumped, the contents are weighed to measure productivity.

According to Roise, the machine can now harvest between 2 and 4 tons of woody biomass material per hour. "The machine can harvest anything in its path but is most productive with 1- to 2-inch material." However, the machine needs to harvest about 10 tons per hour to break even. "Our ultimate goal is for a small business to operate one of these machines at a profit."

"In 4 or 5 years the biomass harvester will be commonly used in the renewable biomass energy/hazardous fuel reduction business. FECON is currently working on the next generation harvesting head, and refinements to the material collection and transportation system are underway. We will be doing 10 tons per hour by this time next year," said Roise.

Other uses for this equipment, when perfected, could be plantation thinning in tree farming, clearing between rows, and forest management.

Roise said their next move is to continue working on the machine's productivity rate. They are concentrating on



**Dr. Joseph Roise, professor of forest management operations at North Carolina State University**

density and material size right now. Stem density in the pocosins commonly ranges from 6,000 to 12,000 per acre. "We know what the improvements need to be—FECON is already working on making the improvements and we are excited about the next design."

"We are getting close to being able to cover all production and transportation costs with the sale of harvested biomass. This would surely be an incentive toward timely wildfire fuel reduction activities," concluded Roise.

# Northern Nevada Correctional Center

On September 4, 2007, I attended a ribbon-cutting ceremony for a woody biomass renewable energy, 1-megawatt combined heat and power plant at the Northern Nevada Correctional Center (NNCC), located just outside Carson City, Nevada. This Renewable Energy Center is believed to the first of its kind in the state and will save millions of dollars in energy costs over the next several years.

NNCC's Renewable Energy Center includes a 1-megawatt steam turbine generater. One megawatt is enough power for the electrical needs of 500 average-sized homes in northern Nevada. This heat and power plant efficiently burns woody biomass from forest restoration projects to produce the electricity, steam, and hot water for 1,500 inmates at the Carson City NNCC.

Founded in 1858, Carson City is named after the famous frontiersman and scout "Kit" Carson. Surrounding the area are U.S. Forest Service lands including the Eldorado and the Humboldt–Toiyabe National Forests and the Lake Tahoe Basin Management Unit. The Eldorado National Forest is located in the central Sierra Nevada Mountains. The Humboldt–Toiyabe National Forest encompasses all of Nevada and the far eastern edge of California. The Humboldt–Toiyabe is the largest forest in the lower 48 states, having 10 ranger districts to manage the acreage. The Lake Tahoe Basin Management Unit encompasses more than 150,000 acres of National Forest lands that overlook the city of South Lake Tahoe.

The NNCC has received several grants since the inception of this project. Directed by the Nevada Fire Safe Council, the Forest Service/Nevada State Economic Development group funded a $50,000 study of biomass potential in the Carson area. Carson City helped to develop a site for woody biomass processing next to the landfill with a $20,000 grant from the U.S. Forest Service Rural Community Assistance Program. In 2005, the NNCC received a $250,000 grant from the U.S. Forest Service for assistance in creating the Renewable Energy Center.

Projections are that this heat and power plant will save the facility and state more than $9 million in energy costs over the next 20 years. Excess energy will be sold to Sierra Pacific Power Co., which will also provide some revenue to NNCC. The Renewable Energy Center also includes 30 kilowatts of solar (photovoltaic) power located on the roof.

Lori Bagwell, Chief of Fiscal Services for NNCC, invested an enormous amount of time pulling this project together. She said "This project works on every level. Not only do we expect air and water quality in the area to be improved by the way we are now handling the disposal of woody biomass but we will see huge utility savings at NNCC."

Northern Nevada
Correctional Center
P.O. Box 7011
Carson City, NV 89702




**Sign outside correctional facility**



**Lori Bagwell, Chief of Fiscal Services, cutting ribbon at ceremony**

Bagwell says fuel requirements for the plant are estimated at about 17,000 tons per year and are being supplied by Carson City Renewable Resources. Although the majority of these fuels currently come from waste wood in the city's landfill, as more infrastructure is created in the area, more material will come from hazardous fuel reduction projects on the national forests.

Successfully completing this project required a host of partners from both the public and private arenas.

According to Ed Monnig, Forest Supervisor on the Humboldt–Toiyabe National Forest, "Grants along with the work of many dedicated local, state, and federal partners in both the private and public sector culminated in an $8.3 million investment on the part of the State of Nevada in this energy project. We are all committed to this facility and to doing what we can to ensure its success."

APS Energy Services, the general contractor, was responsible for the analysis, design, and construction of the NNCC facility. APS Energy Services is a full-service energy services provider based out of Arizona.

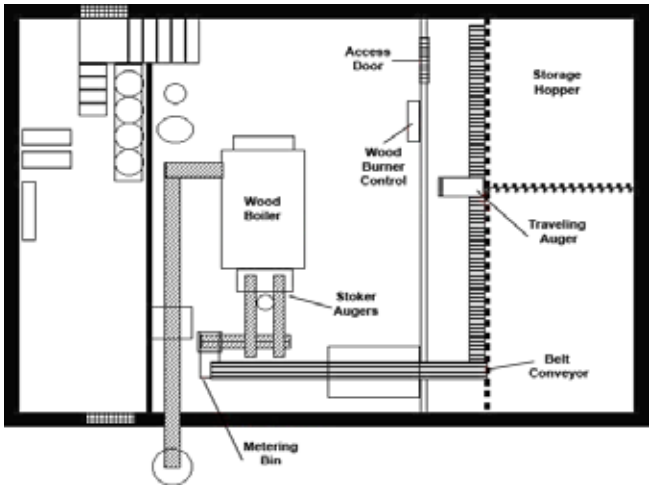


The Bureau of Land Management (BLM) made 43 acres available to Carson City next to the landfill for a biomass staging and processing site. Carson City Renewable Resources removes the biomass from forest thinning operations and delivers it to NNCC. The Nevada Division of Forestry and the U.S. Forest Service work in harmony to provide information on the availability of woody biomass.

Monnig summed up the success of this project when he spoke at the ceremony. “This is an amazing story of persistence and cooperation interspersed with occasional false starts, miscommunications, and organizational challenges. In the end, the cooperative spirit prevailed. We salute the efforts of several agencies and all partners in bringing this facility to reality.”



**Ed Monnig, Forest Supervisor on the Humboldt–Toiyabe National Forest**




**Layout of energy facility**

# REACH, Incorporated

REACH is a special company in a special community. Its motto is "Sustaining People, Communities and the Earth," which gives you some insight into this company. REACH offers employment that provides experience and training for people with disabilities.

Organized in the early 1980s, REACH, Incorporated, stands for Restoration, Education and Community Habilitation. The company is located in Klamath Falls, Oregon, which has a population of about 42,000 and is located in the south central region of Oregon, nestled in the eastern slopes of the Cascade Mountains.

In 1998, the Klamath Falls community of ranchers, farmers, environmentalists, governments, and others came together to try to solve their problem of the invasive western juniper. Part of their solution was to contact REACH to help develop and manufacture value-added products made from this species.

Over the past 150 years, western juniper (*Juniperus occidentalis*) has increased almost tenfold. Juniper outcompetes other vegetation for water and poses a threat to watersheds and ecosystem health. Until REACH's involvement, juniper had little value as a product except for fence posts and firewood. Juniper is also expensive to harvest because it is short and extremely tapered and has a very dense limb structure.

In contrast, positive traits of western juniper include its high durable and aromatic scent, similar to that of cedar. The wood is resistant to decay and insects; it is dense, hard, and machines, glues, and finishes well. When dried, juniper shrinks and swells less than other Pacific Northwest species. It is considered to be one of the hardest softwoods.

Upon accepting the challenge, REACH began receiving the salvage from western juniper forest restoration projects in the area. After 9 years of work and experience, REACH employees have developed and now manufacture a variety of value-added products from western juniper. REACH has 12 employees dedicated to the juniper project. In other local manufacturing companies, most of these employees would have significant challenges finding work.

"The more wood mill jobs we have the better job we can do of matching skills to employees. That's what this is all about—the people—that's why we are here," said Toby Loetscher, Production Manufacturing Director and Special Projects Manager.

REACH, Incorporated
2350 Maywood Drive
P.O. Box 1089
Klamath Falls, OR 97601

As a donated executive from a local land holding company, JWTR, LLC, Toby enthusiastically runs the juniper portion of the REACH mill.



**Toby Loetscher (center), of REACH, and Mike Bechdolt (left) and Terry Fairbanks (right), both from the Bureau of Land Management, beside pallets made by REACH**



**Decking material, paneling, and 2- by 4-inch kiln-dried cutstock blocks shaped into an aromatic shoe tree**

The REACH mill is staffed with about 90 employees, and roughly 80% of their sales volume is from non-juniper products, such as pallets and dimension lumber, which are made from pine or fir. The mill also has a state-of-the-art dehumidification dry kiln and does some custom drying of other species.

Initially, REACH's only juniper product was animal bedding. Their line of products now includes pre-finished engineered flooring, rough-cut flooring, tongue-and-groove paneling, decking material, 4- by 4- inch to 8- by 8-inch posts 8 to 10 feet in length, fence boards, peeled and doweled poles, and 2- by 4-inch kiln-dried cutstock blocks. These juniper blocks are made from the waste from other products. The blocks are shipped to China, shaped into an aromatic shoe tree, and sold in Japan and some European countries.

Toby says their biggest problem is supply. "We are lucky to get two or three truck loads of juniper from a large logging operation in one day. It's just flat out hard to work with, hard on the chain saw, and hard on the equipment."

REACH has both small- and large-diameter mills. Twelve-inch diameter material is the largest that their small-diameter mill can handle. For the non-juniper mill, they





**Truck load of juniper supply being delivered to yard**



**Juniper supply in yard**

run one 8-hour shift, five days per week. In their juniper mill, they have two 10-hour shifts, 4 days per week. On a good day, they can run six log trucks through the mill.

Toby figures that one log truck is the equivalent of about 2,000 board feet of solid lumber. “We process anywhere from 10,000 to 12,000 board feet per day.” Toby recounts the following breakdown from juniper logs: “For every 1,000 pounds of logs that come into REACH, 650 pounds become chips for a local fiber plant that is making a 1/8-inch-thick skin for a hollow-core interior door, and 150 pounds are fines for hog fuel. The remaining 20%, or 200 pounds, are processed in our mill into posts and kiln-dried products.”

About 90% of REACH’s non-juniper products are sold to three businesses, all within the Klamath Falls area: Columbia Plywood Corp., Collins Products LLC (particleboard), and JELD-WEN Windows & Doors. Toby notes that most of their pallet and packaging products are custom made for the client.

REACH has been instrumental in providing a solution for a diverse group of community concerns—from establishing a market for the invasive western juniper, to helping restore watersheds and ecosystems, to creating jobs in the community. It is a unique, non-profit rehabilitation business that I was fortunate to tour. I am proud to know this business not only exists but that is has prospered in so many ways.

# Rough & Ready Lumber Co.

Link and Jennifer Phillippi, owners of the Rough & Ready Lumber Co., have found a positive way to connect wood waste with their energy needs.

Rough & Ready is a third-generation sawmill and lumber manufacturing business located about 4 miles south of Cave Junction, Oregon. It has been in operation for 84 years.

Cave Junction is a small town of about 2,500 and is considered the "Gateway to the Oregon Caves National Monument." In a rural community made up of small farms, woodlots, craft people, and families, Cave Junction is nestled in the Siskiyous Mountains—about half-way to the Oregon Coast. Seventy percent of the forests in this area are managed by either the U.S. Forest Service or the Bureau of Land Management (BLM).

Rough & Ready is a traditional cutting sawmill. In other words, the majority of its fir and pine lumber products are cut to order and sold to remanufacturers for doors, windows, and other specified cuttings. These products are distributed throughout the United States, Japan, and Europe.

As a well-established company, most of the bottlenecks within Rough & Ready have been worked out. After 84 years of providing good service and quality products, its customer base is almost unshakable. It is also one of the largest, most dependable businesses in the area, with about 85 full-time employees.

Link noted that although they have two sawmills on site, one for large-diameter logs and one for small-diameter logs, their current supply dictates running only one sawmill at a time and one shift. He wishes they had enough supply for both sawmills and another shift.

Supply has been a problem for the past 10 years. Link says "We struggle to find logs. We used to get about 90% of our supply from federal lands. Now it is almost zero percent. We haven't been able to buy a federal timber contract since 1997. Right now two of our BLM contracts are tied up in litigation."

Due to the unknown quantity of supply and in order to continue operation, over the years Rough & Ready has purchased and manages 30,000 acres of timber.

Their most recent project is building a steam-generated power plant at their facility that is fueled by wood and capable of providing 1.5 megawatts of energy.

Link says "We wanted to build a woody biomass power facility to be in balance with our operation. In 4 years, we expect the project to pay back its cost in energy savings."

Rough & Ready Lumber Co.
30365 Redwood Highway
Cave Junction, OR 97523



**Jennifer and Link Phillippi**



**Lumber ready for transport**

The new boiler and turbine will produce enough combined power and heat to operate the two sawmills, eight existing dry kilns, and the four new dry kilns that the company is in the process of building.

"We feel drying is a value-added part of our business. Most of the market demands dry lumber," commented Link.

Both Energy Trust of Oregon, Inc., a nonprofit organization that promotes energy efficiency and clean, renewable energy, and the U.S. Forest Service, through their National Woody Biomass Utilization Grant Program, have helped with the new boiler/turbine system by providing dollars to ease the financial burden on Rough & Ready. The total cost of Rough & Ready's project is about $5.4 million.

The new boiler/turbine system requires 30,000 bone dry tons (BDT) of wood per year. Rough & Ready has plenty of wood residuals on hand for burning—at least 15,000 BDT per year. The remaining 15,000 BDT will be collected from fuels treatment and thinning projects from nearby Forest Service, BLM, and other lands. This woody biomass material will be burned in the mill's upgraded boiler system to produce process steam for their dry kilns and generate electrical power. At present, they have a signed interconnect agreement and will soon finalize



**Wood-fueled steam-generated power plant**

additional documents so that electrical power can be sold to their public utility.

Rough & Ready has had a few problems along the way with the installation of the new boiler/turbine system. Although their plan has been delayed by at least a month, Link said they are now operational and on-grid with their public utility.

Link modestly said, “We could not have afforded to build this without the financial and technology assistance from so many. We are proud that we are going to be producing clean renewable energy and at the same time contributing to the health of southwestern Oregon’s forests.”

This community is fortunate to have creative and forward-thinking members like Link and Jennifer Phillippi from Rough & Ready Lumber Co., who I am confident will continue to serve their community well.

# Bureau of Land Management and Stewardship Contracting




Contrary to what some people assume, the U.S. Forest Service does not manage all federally held forest lands.

In 1905, Congress established the Forest Service to provide quality water and timber for the Nation's benefit. Over time, Congress and the public have directed the Forest Service to manage national forests for additional multiple uses and benefits and for the sustainability of renewable resources such as water, forage, wildlife, wood, and recreation. Today, the Forest Service encompasses 193 million acres, with 155 national forests and 20 grasslands.

The Bureau of Land Management (BLM) was established in 1946 and is responsible for a variety of programs on approximately 958 million acres of both surface lands and subsurface mineral resources, located primarily in 12 western states. Included in these acres are about 57 million acres of forests and woodlands.

The BLM and U.S. Forest Service have common fire management missions and work cooperatively to administer numerous federal programs.

## BLM History

The history leading to the establishment of the BLM is an interesting chronicle. In the 1700s, only "Ordinances" existed to provide guidance for the survey and settlement of the lands that the original 13 colonies ceded to the Federal government after the War of Independence. As additional territories were acquired, Congress directed that these lands be explored, surveyed, and made available for settlement.

In 1812, Congress established the General Land Office to oversee the disposition of these Federal lands. However, in the late 19th century, priorities shifted and the first national parks, forests, and wildlife refuges were created. The U.S. Congress made the decision not only to promote private settlement on public lands but also to hold some of these lands in public ownership.

Over the years, several Federal Acts were passed to allow leasing and the production of coal, oil, and gas and to manage these public rangelands and timberlands. It wasn't until 1946 that the U.S. Congress established the BLM as an agency within the U.S. Department of Interior; it was a consolidation of the General Land Office and Grazing Service.

Until 1976 and the passage of the Federal Land Policy and Management Act (FLPMA), the BLM had no unified laws to manage these public lands. In FLPMA, Congress not only declared that these lands would continue to be owned by all Americans but they gave us the term "multiple use" management, defined as "management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people."

### BLM Stewardship Contracting

**(Source: Western Forester, Sept/Oct. 2006, vol. 51, no. 5, Society of American Foresters)**

Until September 30, 2013, the U.S. Forest Service and BLM have the authority to enter into stewardship projects with private persons or public or private entities by contract or agreement to perform services to achieve land management objectives for the national forests or public lands that meet local and rural community needs.

- Stewardship contracting is not a replacement for the established timber sale program. Forest management projects designed primarily to enhance volume are not suitable for stewardship contracts.
- Stewardship projects shall comply with applicable environmental laws and regulations, including the appropriate level of environmental review under the National Environmental Policy Act (NEPA) and are consistent with the applicable land use plans.
- Any vegetative material removal must be a byproduct of meeting the stewardship contracting project goals. Removal of these products must be consistent with the objectives developed through the collaborative process and the applicable land use plan objectives.
- Stewardship contracting projects involve treatments and techniques to make forests, woodlands, and rangelands more resilient to natural disturbances such as fire, insects, disease, wind, and flood.

For contracts exceeding 5 years in duration, field managers consider such factors as scope of the project, type of the material to be treated, availability of local capacity to process and use the material removed from the land, and potential development of new markets for small-diameter material, as well as operational factors such as local weather patterns, sensitive wildlife species, habitat use cycles, and seasonal restrictions for wildfire prevention.



## BLM Today

In 2007, the BLM managed 258 million acres of surface land and approximately 700 million acres of subsurface mineral resources. Most BLM-managed lands are located in the western United States and Alaska and are dominated by extensive grasslands, forests, high mountains, arctic tundra, and deserts. These public lands provide significant economic benefits to our Nation and to states and counties where these lands are located. Income generated from public lands makes BLM one of the top revenue-generating agencies in the Federal government.

BLM manages a wide variety of resources and uses, including energy and minerals; timber; forage; wild horse and burro populations; fish and wildlife habitat; wilderness areas; archaeological, paleontological, and historical sites; and other natural heritage values.

In the Pacific Northwest, Fire and Aviation Management is managed cooperatively between the BLM and the U.S. Forest Service. This interagency authority covers both Oregon and Washington and includes 10 BLM districts, 19 National Forests, and the Columbia Gorge National Scenic Area.

In western Oregon, the BLM manages 2 million acres of forest in a checkerboard ownership pattern. These forests provide important habitat for many threatened and endangered fish and wildlife species and are considered some of the most productive forests in the world.

The BLM and U.S. Forest Service have common fire management missions and objectives. They cooperatively administer fire, fuels, and aviation programs in a manner that eliminates duplication, increases program efficiency, and capitalizes on the expertise of each agency's personnel. In 2003, both BLM and the Forest Service received authority to enter into long-term stewardship contracts (see sidebar on BLM Stewardship Contracting).

Stewardship contracting is an important tool that is available to both the Forest Service and BLM to aid in the increased utilization of small-diameter and woody biomass material. BLM stewardship contracts are a little different in the particulars from Forest Service stewardship contracts. However, both BLM and the Forest Service stewardship contracts have the same objectives.

## BLM Stewardship Contracting

In 2003, the Consolidated Appropriations Resolution was signed, giving authority to BLM and the Forest Service to enter into long-term stewardship contracts.

According to Mike Bechdolt, Lead Forester and Timber Manager from the BLM Lakeview District, since receiving this authority, Washington and Oregon BLM offices have awarded 24 stewardship contracts. These contracts involve restoration treatments such as streamside habitat enhancement, fish habitat improvement, biomass utilization for energy production, precommercial thinning, fence construction wildlife habitat improvement, and hazardous fuel reduction.

Two of southwestern BLM's successful stewardship contracts include the "Gerber" in the Lakeview District and "Penny" in the Medford District.

**Gerber Stewardship Project:** The Gerber Stewardship contract was awarded in September 2004. The objective was to treat 10,000 acres over a period of 10 years. The Gerber project is located in southern Oregon near Klamath Falls.

Bechdolt said the purpose and design of the initial contract and treatments were to experiment with the restoration and utilization markets for western juniper. "As part of the National Fire Plan, from 1997 through 2005, the Klamath Falls Resource Area had treated more than 20,000 acres of rangelands and western juniper woodlands, primarily cutting and burning the western juniper as a rangeland restoration treatment. Up until 2003, when the Stewardship Authority was received, less than 500 acres of western juniper had been utilized by local wood products facilities. The expanding and increasing local demand for western juniper and increasing use in lieu of burning was the primary impetus for the design of the Gerber Stewardship contract in 2004. The design of the stewardship contract quickly expanded when additional funding became available to treat additional lands for forest health needs and hazard fuel reduction purposes."

Two aspects of the stewardship contracts, says Bechdolt, are that it (1) authorizes the value of vegetative material to be applied as an offset against the costs of services received and (2) allows multi-year contract authority up to 10 years. Neither of these authorities is available under standard BLM timber sales or service contracts.

The Gerber Stewardship contract was set up as an Indefinite Delivery/Indefinite Quantity (ID/IQ) contract. This type of contract specifies minimum and maximum quantities of services and products and allows the government to place task orders against the base contract. This means individual treatments such as cutting, yarding, and removal of juniper; manual cutting and piling of juniper around sensitive spring sites; road resurfacing; fencing; seeding; removal of residual landing slash for biomass; and slashbusting can be requested through task orders. The benefit to the government is that additional work can be accomplished as funding becomes available, and the benefit to the contractor is the opportunity to bid on a long-term contract.

In the Gerber Stewardship contract, the cost of the service work exceeded the value of the product removed.















**Bureau of Land Management stewardship contracts in progress.**



However, Bechdolt says that this is not always the case with stewardship contracts. It all depends on the amount of commercial sawlog material included in the contract and how much service work is involved.

Another aspect noted by Bechdolt is the challenge that it presents to contractors when bidding on stewardship contracts. The contractor takes a big risk when bidding on multiple types of treatments, not knowing the amount of income that will be realized from the material and the challenges, changes, or modifications that could occur over the life of a 10-year contract, including fluctuating forest product markets. Allowances need to be built into the contracts, which has posed a challenge for all.

Bechdolt says that the "Gerber Stewardship contract is considered successful because it is providing employment in rural communities, meeting restoration goals, building utilization markets, and reducing wildfire risks." He also feels that "these contracts encourage long-term commitments and stability between the government, the contractors, and the community. BLM and the contractors are learning to adapt as each treatment is implemented and new stewardship contracts are awarded."

**Penny Stewardship Project:** I interviewed Terry Fairbanks, BLM Oregon/Washington Stewardship & Biomass Coordinator for information on the Penny Stewardship contract.

The Penny Stewardship project was also awarded in 2004. The project is located in the Applegate Valley, near Williams, Oregon, and initially included 100 acres of commercial and precommercial thinning, brushing, and fuels hazard reduction work.

The project area was officially listed as a community at risk under the National Fire Plan, and there was strong community interest in developing strategies that would facilitate economic and recreational opportunities in the Williams community.

Located in the rural wildland–urban interface, the project objectives were to (1) improve stand vigor, including resistance to insect and disease in Douglas-fir and ponderosa pine stands, and (2) reduce hazardous fuels by thinning understory conifers, shrubs, and hardwood trees.

The BLM held a variety of meetings with local community groups and small businesses who were interested in participating in small project and utilization activities in the Williams Watershed.

For example, the local watershed council was involved in several meetings to discuss this project. Small businesses and local individuals evaluated the project, became familiar with stewardship projects, and were interested in bidding on this project. A couple of organizations were interested in job development opportunities and met with BLM to discuss this project. More than 20 people attended the pre-bid meeting.

The Penny Stewardship project was purposefully designed to test the ability to market small-diameter material, gain acceptance by the environmental community, and provide hazardous fuel reduction near rural homes while maintaining aesthetic values.

The contractor was required to demonstrate in their proposal an awareness of local uses and values, the ability to market material locally, the skills to meet fuel model and condition class ratings through the development of site-specific prescriptions, and the ability to conduct public meetings and field trips.

An unused BLM maintenance yard was made available for the contractor to use as a sort yard. Products resulting from the project included post and poles, teepee poles, saw logs, fire wood, and biomass.

This stewardship project, although small, was determined to be successful for the following reasons:

- Widespread acceptance was gained for the types of treatments that were included in the contract.
- Four new stewardship projects that are much larger and can extend up to 10 years were awarded in the adjacent valley.
- Initial skepticism by contractors has been overcome and new contractors are coming forward to bid on the projects.
- The local environmental community is involved in several collaborative efforts to promote small-wood development.

After interviewing Bechdolt and Fairbanks, I interviewed the two contractors who have been successful in using the stewardship contract authority and one contractor, who through a demonstration project, helped pave the way for successful stewardship contracting in this area.

**Contractor Lomakatsi** (Ashland, Oregon) is a "non-profit organization, which develops and implements pro-active community based ecological restoration projects throughout the Klamath–Siskiyou bioregion of southwestern Oregon and northwestern California. Since 1995, our projects have assisted in the regeneration, rehabilitation, and restoration of ecologically degraded ecosystems throughout the region, with a strong emphasis on the development of Community Based Forestry and Watershed Stewardship Programs that cross land ownership boundaries."

Lomakatsi was the primary contractor for the Penny Stewardship project. On this project, they combined restoration forestry practices with low-impact tree harvesting systems.




**Lomakatsi managers Justin Cullumbine (left) and Marko Bey (right)**

Marko Bey, Director of Lomakatsi Operations, said that this was their "first Federal land project, but certainly not our first Federal funding for fuels reduction projects in the region. Since 2001, we have been awarded 11 National Fire Plan grants through BLM to perform fuels reduction on private land adjacent to federal land, mill and market the byproducts harvested, and train the workforce in restoration forestry."

Justin Cullumbine, Lomakatsi Program Coordinator, said that they have a formal training program with a curriculum that includes on-the-ground experience. "Our biggest hurdles are finances, producing products that actually bring in a profit, and finding niche markets. Our greatest success is in keeping our workers busy and re-training other crews in our ecological approach."

Lomakatsi has created a "green collar workforce" of skilled ecosystem practitioners still guided by experts in many fields, including Traditional Ecological Knowledge. Lomakatsi has applied their "*Ecological Principles for Fuels Reduction and Restoration*" on thousands of acres of private, municipal and federal lands, across the region, and convened more than 60 trainings for 300 people.

"The Penny Stewardship project was a bridge builder within the community. It also helped pave the way for future stewardship projects," Justin added. "We continue to be called upon by that community as the model of practices that they prefer and the practitioners they trust."

Before performing the actual work on the Penny Stewardship project, Lomakatsi set up a team of economic consultants, community residents, and members of other local groups who were very interested in seeing this project handled with an ecological restoration focus. This group worked together to design the best forest restoration treatments for the Penny Stewardship project.

The Penny project included a mixture of ponderosa and sugar pines, white and black oaks, and Pacific madrone. Lomakatsi applied a variety of restoration methods, from thinning small trees, retaining the largest and healthiest trees to burning smaller fuels, and reseeding burn piles with native grasses.

Lomakatsi's goals were to reduce wildfire intensity, modify the configuration of plants and fuels, reduce fuel loads along roads and landscape areas, enhance wildlife habitat, control invasive species, and provide appropriate erosion control.

Also, Marko said that because Lomakatsi had worked primarily on private lands before this project, they were eager to demonstrate on public land their ecological restoration work as a sustainable model for fuels reduction and byproduct utilization.

Lomakatsi hosted a series of educational workshops, one of which included 150 area residents, environmental organization members, and BLM personnel. Many people remained engaged, regularly touring the project at each stage of the process.

"We worked closely with BLM during the Penny Stewardship project and have developed a great partnership with BLM. We are focused on contributing to the long-term economic sustainability by developing a workforce to work on these projects," Marko said.

Over time, Lomakatsi has become a dedicated mentor in providing technical assistance and training to small-scale forestry-related businesses, contractors, and communities.

Their forest restoration projects have provided merchantable logs and alternative wood products to the local forest economy, jobs to local residents, and a level of community involvement in forestry operations never before experienced in southwestern Oregon.

Chris Rusch, BLM Tiller Ranger District botanist and silviculturist, says about Lomakatsi, "They are professional, responsive, and knowledgeable in the area of stewardship contracting."

**Contractor Don Hamann** (Butte Falls, Oregon) is one of the most passionate and kind people you will ever meet. He is not driven by money or prestige. He truly cares and is motivated about doing what's right for the land. He is a forestry contractor who sometimes enlists the assistance of several subcontractors on his projects.

Hamann said he became tired of just production logging for the industry people and wanted to focus on forest improvement. "I got involved with stewardship contracting through networking with BLM people. When stewardship contracting came along, it opened the door for me. It is definitely a learning process for both BLM and the contractor, but BLM does a great job of helping me through the process. "



**Don Hamann (left), Butte Falls, Oregon**



**George McKinley (left) and Blair Moody (BLM, right)**

Regarding completing the necessary paperwork for stewardship contracting, he says "It is quite a procedure to put it all together. It took a couple of weeks of work and I had a lot of help. Stewardship contracting is not for everybody—lots of logistics, planning, and marketing. We need stable markets and supply to make contracting work."

Hamann feels that stewardship contracting ties in well with economic development and training people for the future, which is a must for improving the land for the next generation. He is extremely motivated and rewarded by looking back on what they have accomplished over the past 25 years.

"One of the things I like best about stewardship contracting is coordinating the people and developing a team. It's satisfying to see when the guys finally get a hold of it and then get it. They are excited about what they do. They start to develop the proper thinking about taking care of our natural resources," says Hamann.

Hamann usually has a crew of six. "When we get more work, we hire more." He uses mostly standard logging equipment.

Jack LeRoy, one of Hamann's subcontractors, recently purchased a purpose-built machine designed to remove small-diameter material economically. It has low ground pressure—4.5 pounds per square inch. Leroy says that "The technique you use for each application is very important. Every acre has a difference application, different slope, and different type of timber. It is very difficult to find one machine that fits all."

"It takes many within the community such as BLM, subcontractors, the working crew, and even our end market folks working together to accomplish the task. We support each other. We share workers, trucks, equipment, etc.," says Hamann.

Hamann notes that "The community is now starting to see the philosophy behind stewardship contracting and that it works. I feel like we are passing the torch on to the next generation."

**Contractor George McKinley** (Ashland, Oregon), owner of Mountain Millworks, worked closely with BLM long before there were stewardship contracts. It was McKinley who set the stage for stewardship contracting in this area.

McKinley moved to Oregon in 1992. He grew up in the Midwest, where his family had a Christmas tree business. As a young student, he left the Midwest to attend college in Oregon, where he has lived ever since.

McKinley says "As a result of owning land, I got engaged with forestry; I eventually bought some land and became very concerned about the management of forest lands. I began to see the importance of public lands and wanted to become more involved in better management of public land, probably from an environmental perspective. I felt that doing nothing was one of the worst things we could do as far as taking care of public lands."

To get more involved, McKinley headed up the Boaz Forest Health and Small-Diameter Utilization Project. This demonstration project was a collaboration between the Jefferson Sustainable Development Initiative and the Medford District Bureau of Land Management. The project was implemented during the field seasons of 2004–2006.

The goal of this project was to enhance forest health and provide regional employment through a collaborative project to remove and process small-diameter material.

Project objectives included assessing technical and economic feasibility, monitoring forest health and fire hazard reduction, determining market opportunities for small-diameter material, expanding the capacity of the rural work force, improving community/agency relations, and informing policy discussions at various levels.

During this project, McKinley took hundreds of people interested in this project out to tour the site, explaining the environmental aspect, stand characteristics, the type of



land prescription they were applying, the harvest methods, the cost of the operation, and the adjustments needed to improve revenue. Eventually he wrote a report discussing the entire project, which included his results and recommendations.

His primary finding was “restoration and management focused upon the utilization of smaller, underutilized material is more cost effective and achieves broader goals than fuel treatments focused on piling and burning alone.”

McKinley said that this project “Changed his thinking on the opportunities in the forest.”

According to Blair Moody, BLM District Lead: Biomass, Small Diameter, Stewardship Contracting, Medford District Office, “As a result of this project, George basically established the baseline for stewardship contracts in this area.”

McKinley expresses deep gratitude to BLM, especially to Blair Moody, for his leadership and guidance and the expertise of folks at the Watershed Research and Training Center, in Hayfork, California.

“Looking back,” McKinley says, “I realize the most important ingredients in the implementation of an on-the-ground collaborative endeavor are partners that practice trust, flexibility, and patience. Strong partners and skilled workers are essential.”



2011-03-14 -40

"Richard Spotts"
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03/13/2011 09:10 PM

To <4FRI_comments@fs.fed.us>
cc
bcc
Subject My comments on the 4FRI proposed action

March 13, 2011

Dear Forest Service officials:

general - I appreciated receiving the January 21st "Dear Interested Party" letter on the 4FRI proposed action.

48-1 I reviewed the information materials and checked the related web site, and I strongly support this proposed 4FRI. I believe that this proposal is comprehensive, well-balanced, and urgently needed. I also want to applaud and commend those responsible for developing this exciting consensus proposal. I am thrilled that many diverse interests and stakeholders were able to negotiate in good faith and reach such a broad and positive proposal.

general I urge the Forest Service to fully adopt and promptly begin implementing this proposal. I also hope that Congress and the Obama administration will actively support such implementation, and ensure that sufficient funding is provided to do so. It would be tragic if myopic budget constraints led to grasping defeat from the jaws of victory by preventing effective and timely implementation.

-1 If successfully implemented, I believe that this proposal will result in significant environmental, economic, social, and recreational benefits, and perhaps serve as a precedent for reaching consensus elsewhere on how to resolve complex and potentially contentious resource management challenges.

general Thank you very much for your courage and vision in advancing this proposal, and for considering my comments.

Sincerely,

Richard Spotts
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2011-03-14 - 41

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March 14, 2011

Earl Stewart, Coconino National Forest Supervisor
Michael Williams, Kaibab National Forest Supervisor
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001

RE: Four Forest Restoration Initiative – Coconino and Kaibab National Forest Proposed Action

Dear Supervisors Stewart and Williams,

general

The Arizona Game and Fish Department (Department) appreciates the opportunity to comment on the Four Forest Restoration Initiative (4FRI) – Coconino Kaibab National Forest Proposed Action (PA). The Department is an active member of the 4FRI Stakeholders Group and supports landscape-scale restoration of ponderosa pine ecosystems to protect communities, restore wildlife habitats, and enhance rural economies in northern Arizona.

general

The PA proposes to conduct restoration activities within a 750,000-acre ponderosa pine ecosystem over approximately 10 years. Restoration activities proposed include mechanical tree thinning, prescribed fire, riparian protection/rehabilitation, and decommission/obliteration of closed or user-created roads. Activities are proposed on the Williams and Tusayan districts of the Kaibab National Forest and the on the Flagstaff, Mogollon Rim, and Red Rock districts of the Coconino National Forest (hereafter, Forests). The US Forest Service 4FRI Team held 5 workshops during February 2011 to share the draft PA and collect comments from the public. We thank you for this high level of collaboration with the Department and the 4FRI Stakeholders Group. The Department attended all of these workshops and submitted many comments, questions, and recommendations in that forum. It is our understanding that a refined PA may be forthcoming, and we look forward to seeing how our input has been incorporated in this refinement.

The purpose of this letter is to highlight some key issues; however we ask that you consider not only comments contained herein, but also those in which we provided during the workshops.

*Comprehensive Ecological Restoration*

As stated in the PA, "this project is expected to put the analysis area on a trajectory towards comprehensive, landscape-scale restoration with benefits that include improved vegetation biodiversity, wildlife habitat, soil productivity, watershed function, and an opportunity for the safe use of managed fire." The Department strongly supports this purpose; 4FRI is intended to be comprehensive restoration. This PA moves us a lot closer to that ultimate goal, however it does not (and feasibly could not) tackle all of the causes of ecological decline in our ponderosa pine ecosystems. The Department would like to work collaboratively with all four national

forests in 4FRI (Coconino, Kaibab, Apache-Sitgreaves, Tonto) and the 4FRI Stakeholders Group on a comprehensive restoration assessment. This assessment could identify possible management actions that focus on a wider range of forest resources than just timber and fire; such as hydrology, range, recreation, and wildlife. We envision an outcome of this assessment being a menu, or list, of comprehensive restoration activities that could be tackled over time, not only by the Forests, but also by stakeholders and other partners. This assessment would set forth a collaborative program of work with benefits for wildlife and forest users. We would like to begin working with you on this assessment as soon as possible.

And since this project is intended to achieve ecological restoration, we would also like the Forests to elaborate on how conventional silvicultural treatments described in the PA will be applied and/or adapted to achieve ecologically-based restoration objectives.

*Landscape Scale to Site Specific Scale*

Planning a restoration project at the 750,000-acre scale is unprecedented in Arizona. And while we can all envision achieving restoration at the landscape scale, we must analyze the effects to wildlife and other resources at the site-specific scale. Transitioning from landscape-scale goals to site-specific plans is difficult at best, and the Department recognizes the challenges faced by the Forests in doing so. As such, desired conditions for this project are extremely important. The Department agrees with all of the desired conditions stated in the PA, and we also recommend consideration of the desired conditions from the *Landscape Restoration Strategy for the First Analysis Area - Report from the Four Forest Restoration Initiative Stakeholder Group to the USFS 4FRI Planning Team (October 2010).* We also encourage the Forest to consider the desired conditions as described in the *DRAFT Desired Ponderosa Pine Forest Conditions for Wildlife in Arizona* paper currently undergoing revision by the Department, the US Fish and Wildlife Service, and the Ecological Restoration Institute. Your 4FRI Team already has a copy of this document.

Desired conditions are a good starting point for understanding what forests will look like after proposed restoration treatments are implemented. However, we are seeking greater specificity in your approaches to mechanical treatment. During the workshops, we learned that the Forests are proposing 5 treatment types (grassland, savannah, uneven aged, stand improvement, and intermediate thin). We also learned that these treatments will vary in terms of the percent in an open (non-forested) condition (10-25%, 25-40%, 40-55%, 55%+, 70-90%, and 90%+). While the desired conditions do state that the forested portions should be comprised of uneven aged trees in a clumpy-groupy structure, the PA lacks detail at finer scales. We are not asking for site-specific prescriptions, rather, we are seeking greater detail in the descriptions of what the forests will look like after treatment. For example, we would like a better understanding of targeted ranges for tree group size, basal area, trees per acre, and stand density index. The proposed action would also benefit from an expanded discussion of how to achieve vertical and horizontal heterogeneity in forest structure; an important component of wildlife habitat as well as an important characteristic of developing old growth forest.

The Department strongly supports the inclusion of riparian and ephemeral channel restoration in the PA. However, the PA currently lacks specificity on where and how this will be achieved.

*Wildlife Recommendations*

It is our understanding that the maps displaying proposed silvicultural treatment approaches have yet to be filtered for wildlife factors such as Mexican spotted owl (MSO) protected activity centers (PACs), MSO restricted habitat and target/threshold habitat, northern goshawk nest cores and post-fledgling family areas, as well as the AGFD – Coconino County Wildlife Corridor Project information. We predict that the inclusion of these wildlife features will alter the layout and design of the proposed silvicultural treatments and we are hoping to have the opportunity to review these new maps in the refined PA.

Without having those refined wildlife-silviculture maps to review, our initial reaction to the proposed treatments is that overall they seem reasonable based on the methodology described by your silviculturalist during the workshops. However, the majority of the treatments appear to be in the uneven-aged, 40-55% open category and this particular treatment occurs in large, contiguous swaths across some of the Firescapes where heterogeneity in forest condition is particularly important for wildlife. We fully support uneven aged treatments, but would recommend the Forests consider additional heterogeneity in the percent open condition. Greater spatial variability in forest density will provide a broader range of habitat conditions for the diverse wildlife species that occur across the two Forests. For treatments that occur on mollic intergrade soils, consider using topography and aspect to increase heterogeneity, allowing for more treatments in the 10-25% and 25-40% open category. Inter-mingling these different treatment intensities across the landscape will better help to provide habitat heterogeneity for wildlife at the landscape scale.

As evidenced by the length of discussions during the workshops, interpretation of the northern goshawk guidelines (as per the 1996 Amendment to the Forest Plans) remains an issue. The Department recommends further exploration of how the shift from measuring forest canopy cover at the group level versus the stand level will impact wildlife. Perhaps more important than any percent canopy cover measurement is a clear description for how canopy interconnectedness, vertical heterogeneity, and group size variability will be achieved at various scales. The Department would like to continue to work with the Forests and stakeholders on this issue.

*Importance of Monitoring, Research, and Adaptive Management*

We cannot overemphasize the critical importance of monitoring and adaptive management in 4FRI. The 4FRI Stakeholders Group developed an initial monitoring framework that is a good starting point for discussion. We encourage the Forests to build upon this effort and work collaboratively with the Department and other stakeholders to develop a robust, science-based, realistic monitoring plan with clear thresholds that trigger changes in management. Scaling up our restoration effort means scaling up our impact on wildlife and other resources; as such, we need a complementary scaling up of our monitoring efforts.

The Department also recognizes the 4FRI effort as a key opportunity to increase our understanding of forest restoration's impacts to wildlife. We would like to begin working collaboratively with the Forest and 4FRI Stakeholders to capitalize on wildlife-based research opportunities.

Again, the Department thanks you for working closely with us and other stakeholders in the 4FRI planning efforts to date. This is an ambitious project with clear ecological and social benefits. We are committed to working with you through the planning, implementation, monitoring, and adaptive management phases of this project to ensure positive outcomes for wildlife and the public. Thank you for the opportunity to comment on the PA. If you have any questions or need further clarification, please do not hesitate to contact Sarah Reif, Habitat Program Manager in Region II, at 928-214-1253 or sreif@azgfd.gov.

Sincerely,

Ron Sieg
Regional Supervisor

# LANDSCAPE RESTORATION STRATEGY FOR THE FIRST ANALYSIS AREA

**REPORT**

**FROM THE FOUR FOREST RESTORATION INITIATIVE**

**STAKEHOLDER GROUP TO THE USFS 4FRI PLANNING TEAM**

## OCTOBER 1, 2010



**TECHNICAL EDITORS:** Steven E. Sesnie[1], Jill Rundall[1], Shaula Hedwall[2], and Valerie Horncastle[1]

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The October 1st, 2010, version of the Four Forest Restoration Initiative Landscape Strategy document is intended to be a first draft product to assist the Forest Service as it moves closer to developing a proposed action in late 2010. The 4FRI stakeholder group fully intends that this document will be meaningfully considered and integrated within the 4FRI NEPA process. Equally importantly, however, the 4FRI stakeholder group considers this document to be a starting set of recommendations to be substantially built upon throughout the NEPA process. The stakeholder group intends to build out the Landscape Strategy and provide more explicit guidance, including that outlined in Recommendation 4 of this document. The group intends that its work will be closely coordinated with the Forest Service, such that recommendations can be meaningfully integrated throughout the NEPA process.

# Contents

I. EXECUTIVE SUMMARY ..... 4
II. STUDY AREA DESCRIPTION ..... 6
III. EXISTING PONDEROSA PINE FOREST CONDITIONS ..... 7
IV. TREATMENT AREA IDENTIFICATION ..... 20
V. EXAMPLE TREATMENT AREA DESCRIPTION ..... 28
Site Characteristics ..... 30
Landscape Context ..... 33
VI. DESIRED CONDITIONS FOR PONDEROSA PINE FORESTS IN ARIZONA ..... 33
VII. RECOMMENDATIONS ..... 41
VIII. LITERATURE CITED ..... 43
APPENDIX A. The Economics of Forest Restoration. ..... 45
APPENDIX B. List of analyses identified as important for landscape level restoration planning by the LSWG. ..... 48

## I. EXECUTIVE SUMMARY

The 4FRI landscape restoration strategy is a planning effort designed to develop a comprehensive, ponderosa pine forest restoration strategy for a 2.4 million acre assessment area. To achieve desired outcomes, the 4FRI Stakeholder Group, in cooperation with the U.S. Forest Service (USFS), is preparing a 4FRI Landscape Restoration Strategy (FLRS) to contribute information, analysis outputs, and guidance for forest restoration implementation planning at the programmatic and project levels.

In order to fulfill a collective desire to conduct landscape level forest restoration, a group of stakeholders and the USFS created the Four Forest Restoration Initiative (4FRI) to address ponderosa pine forest restoration across 2.4 million acres on four National Forests in northern Arizona: the Apache-Sitgreaves, Coconino, Kaibab, and Tonto National Forests. The Landscape Strategy Working Group (LSWG), a sub-group of the 4FRI Stakeholder Group, was tasked to work with an integrated USFS team of specialists, the USFS 4FRI Team to develop a comprehensive restoration strategy for the entire 4FRI area. Specifically, by October 1, 2010, the USFS requested information regarding existing conditions, identification and prioritization of treatment areas, descriptions of desired post-treatment conditions, ranges of treatment types, best management practices/sideboards, and a monitoring framework. This information is needed in order to provide recommendations to the USFS as they develop a proposed action under the National Environmental Policy Act (NEPA) for the first restoration analysis area. Additional time is required for the collaborative group to complete the comprehensive landscape strategy.

To develop a landscape strategy for locating forest restoration treatment areas, the LSWG developed a "Firescape" approach. We identified firescapes as sub-landscapes within the analysis area where treatments were further defined and mechanical thinning and prescribed fire treatments could be applied to implement forest restoration. We used spatial data layers the LSWG developed which identified candidate treatment areas within the ponderosa pine forest type most likely available for mechanical thinning treatments. Areas defined as "excluded" have low-potential for receiving mechanical thinning treatments. These areas may still benefit from forest restoration activities, and may be identified for treatment during site-specific

restoration planning. These techniques were applied to the first analysis area to provide a set of recommendations that can aid the USFS 4FRI Team with development of proposed forest restoration actions. This document provides a proof-of-concept for using a systematic approach to stratify a large analysis area into strategic areas for treatment area identification and description of existing and desired conditions within the first analysis area on Coconino and Kaibab National Forest System Lands. From this process, six working group recommendations were developed which specified how forest restoration could be strategically applied within the 4FRI landscape.

1. Three scales at which landscape-level forest restoration planning should be conducted.
2. A process for identifying and delineating firescapes and treatment areas
3. A set of desired conditions for ponderosa pine restoration at three scales
4. A desired context within which to proceed with collaborative planning
5. A monitoring framework from which to implement adaptive management
6. A request that the USFS work with the 4FRI stakeholders to identify and use appropriate decision support and forest modeling tools

The Science and Monitoring Working Group (SMWG) developed the monitoring framework and will deliver this document to the USFS under separate cover. The 4FRI stakeholder group is continuing to develop ranges of treatment types, best management practices/sideboards, prioritized monitoring indicators, and address outstanding issues within the collaborative. This information will be included in the comprehensive landscape strategy to be delivered to the USFS.

Implementation of the 4FRI should be ecologically and economically sustainable. Although these two distinct goals can be at odds, the 4FRI stakeholders believe they can work together to accomplish landscape-scale forest restoration in northern Arizona. Through the utilization of restoration byproducts by appropriately scaled industry, 4FRI aspires to implement ecologically sustainable restoration treatments in an economically sustainable manner.

Wood utilization provides one approach to offset treatment costs. However, the current state of the economy and the volatility of wood products markets suggest that we should consider other means to offset treatment costs as well. In addition to relying on industry investment, other funding possibilities include the monetization of ecosystem services, development of cost-share agreements, and if necessary, direct financing of treatment activities.

The Economic and Utilization analysis of the landscape strategy identifies issues and solutions to the barriers that undermine wood utilization. It also examines policy changes that may be required for stewardship contracting. Finally, it explores the desired and emerging opportunities to capture the value of ecosystem services so that they can be used to support ecological restoration. A fuller discussion can be found in Appendix A.

## II. STUDY AREA DESCRIPTION

The first analysis area of the 4 Forest Restoration Initiative lies primarily within the "Western Mogollon Plateau" forested landscape outlined in the *Statewide Strategy for Restoring Arizona's Forests.* Located in north-central Arizona, between the Grand Canyon and Mogollon Rim, this area encompasses numerous communities including those of Flagstaff, Williams, Payson, and Strawberry. US Forest Service (USFS) lands dominate the area of ponderosa pine with private, state and military lands interspersed. All of the Coconino and two-thirds of the Kaibab national forests with Williams and Tusayan ranger districts are represented in this first EIS area. Elevation ranges from 935-3800 meters where areas above 1400 meters are dominated by overstory vegetation comprised of ponderosa pine and adjacent mixed conifer at higher elevations and pinyon-juniper woodlands at lower elevations, with diverse and abundant grass and forb community understory. Large areas of small, dense thickets of ponderosa pine are a common condition responding to

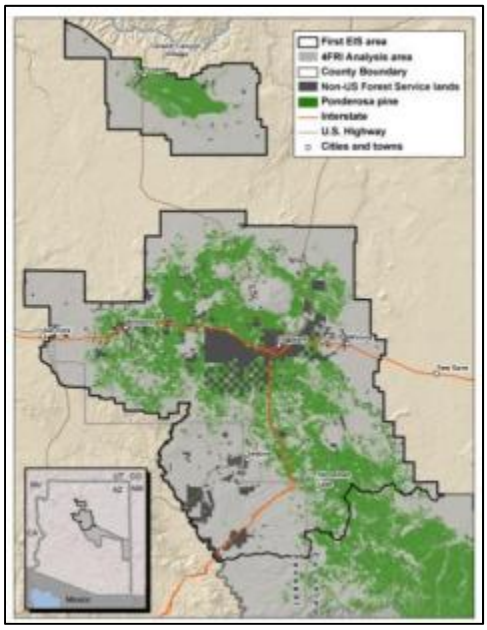



**Figure 1.** Study area and geographic location for the first 4FRI Analysis Area.

land management practices of fire suppression for many years in the southwest. From 2000-2010 56 wildfires greater than 100 acres have occurred with one of the largest in Coconino National Forest history in 2010 of over 15,000 acres.

## III. EXISTING PONDEROSA PINE FOREST CONDITIONS

Knowledge of existing ecological conditions within southwestern ponderosa pine (*Pinus ponderosa*) forest is needed as a basis for land management planning, decision-making and identifying steps toward desired conditions. Ponderosa pine forests in northern Arizona have shifted from naturally open conditions to high densities of small diameter trees in the last century (Covington and Moore 1994), dramatically increasing the size and severity of wildland fires (Swetnam and Betancourt 1998). These circumstances represent a loss of ecosystem services such as biodiversity and watershed health, climate change mitigation, and recreation and scenic values that are tied to Arizona's economy and quality of life.

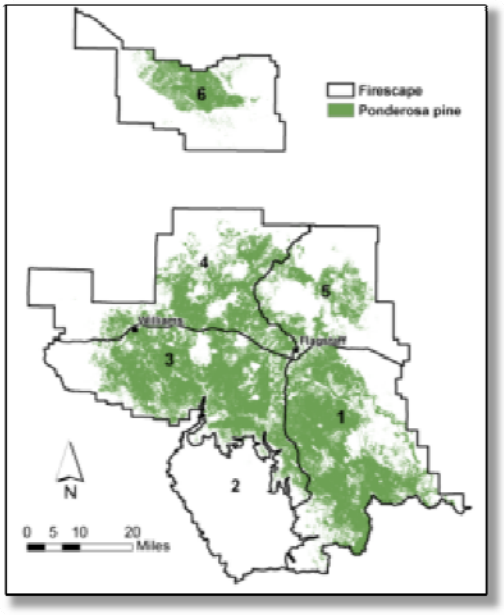



**Figure 2.** Six firescapes delineated within the first 4FRI EIS area.

For this assessment, we synthesized data and information at multiple spatial scales to identify restoration strategies that can reduce high fire hazard and maintain or enhance ecosystem values. Existing ponderosa pine landscape conditions were described according to forest structure, composition, potential fire behavior and focal wildlife species habitat such as the Mexican spotted owl (*Strix occidentalis lucida*). Available forest inventories and geospatial information were combined to estimate forest conditions and provide landscape planning and forest restoration recommendations to the USFS.

We assessed existing conditions for the first analysis area within the 4FRI area at three separate spatial scales (**Table 1**). The analysis area scale comprised the full spatial extent of the ponderosa pine type within the first analysis area (**Figure 1**). Outlined below is the approach

used to map and analyze "firescapes" as strategic locations for landscape planning and implementing ponderosa pine restoration treatment within the first analysis area. A firescape scale was used to subdivide the analysis area into geographic areas where forest treatments can be implemented in a step-wise fashion to restore fire adapted conditions. Analyses at the smallest spatial extent used 6th code watersheds that were aggregated according to similar ecological[1] values and risks posed by extreme wildland fire danger. To inform the development of a Proposed Action, an analytical process was used to map "treatment areas" within firescapes and describe current and desired conditions in section VII of this report. Treatment areas were defined as forest which contain 5,000 to 50,000 acres of ponderosa pine that can potentially be treated with mechanical thinning and prescribe burning.

**Table 1**. Three spatial scales at which existing ponderosa pine forest conditions were described.

| Analysis scale | Extent (acres) | Definition |
|---|---|---|
| Analysis Area | ~875,000 | First NEPA analysis area |
| Firescape | ≥200,000 | Firescapes w/in 1st analysis area |
| 6th-code watershed | ≤50,000 | Individual watershed or sub-basins within 1st analysis area |

**Mapping Firescapes**

To develop a landscape strategy for locating forest restoration treatment areas, a "Firescape" approach was developed. Firescapes are roughly synonymous to "firesheds" following Bahro et al. (2007). Firescapes were identified as sub-landscapes within the analysis area which encompass >200,000 acres and where mechanical thinning and prescribe burning treatments can be applied in a strategic and systematic manner for restoring fire adapted ponderosa pine conditions at a landscape scale. Therefore, a firescape was defined as a contiguous geographic area where endemic levels of fire and other disturbances can be safely restored over time-periods of approximately 5 to 20 years. A time period of up to 20 years was assumed necessary for completing forest restoration treatments and reintroducing the role of fire to an individual firescape.

[1] The term ecological is defined here as including ecosystem processes, biological attributes and human livelihoods as listed under 2007 forest conservation and sustainability Criterion 1 thru 6 of the 1993 Montréal Process**.**

Within the analysis area, six firescapes were mapped (**Figure 2, Table 2**) based on a combination of the following criteria:

1. The area is sufficiently large (≥200,000 acres) to encompass extensive and contiguous ponderosa pine forest and contain wildland fires of greater than average size and severity.
2. Area is generally oriented southwest to northeast to accommodate natural burn paths of large wildland fires.
3. Perimeters are delineated along or near level 3 or better roadways (e.g., state highways and other paved roads) to facilitate fire management access and operations.
4. Perimeters were also delineated along or near ecological and topographic boundaries such as ponderosa pine vegetation, watersheds, and other prominent terrain features.

**Table 2.** Criteria used to map each firescape within the first analysis area and the total number of ponderosa pine acres (PIPO) within each firescape. Firescape 2 contains less than 1000 acres of ponderosa pine and was not considered in further analyses.

| Firescape No. | Total acres | Total PIPO acres[1] | Description |
|---|---|---|---|
| 1 | 526,542 | 285,117 | Area east of I-17 and south of I-40 following PIPO and watershed boundary along eastern border. |
| 2 | 283,571 | 930 | Area below the Mogollon Rim, west of I-17 and along watershed boundaries. |
| 3 | 494,630 | 291,385 | Area above the Mogollon Rim, west of I-17 and south of I-40. |
| 4 | 462,026 | 159,737 | Area west of Hwy 180 and northI-40 following the watershed boundary and PIPO type north of the San Francisco peaks. |
| 5 | 307,422 | 73,154 | Area containing the San Francisco Peaks and PIPO type east of Hwy 180and north of I-40 |
| 6 | 331,403 | 65,302 | Kaibab NF, Tusayan Range District and PIPO type |
| Sum | 2,405,593 | 875,625 | |

[1]Ponderosa pine (PIPO) forest acres excluding areas with a high level of disturbance occurring between 1999 and 2010. Disturbance was calculated as Landsat TM ΔNDVI values < 1 standard deviation from the mean change value (ΔNDVI< -0.05).

**Analyzing firescapes**

Firescapes provide a unit of analysis with which to compare and contrast current forest structure, canopy fuel and modeled fire behavior conditions across the analysis area. These data provide baseline information for:

1. Developing proposed actions to restore fire adapted conditions in a strategic and systematic fashion.

2. Identifying and describing candidate treatment areas which contain 5,000 to 50,000 acres of ponderosa pine that could be treated with mechanical thinning and prescribe burning.
3. Monitoring progress towards achieving desired conditions at both analysis area and fireshed scales.
4. Identifying adaptive strategies for refining restoration treatments that are transferable to other firescapes and subsequent analysis and implementation areas.

In addition, Finney (2007) suggested that spatial fuel treatment patterns over a sub-set of areas across a landscape can be optimized to influence the movement of large fires and reduce the threat of severe crown fire behavior. The firescape concept lends itself to an iterative fire modeling and a Strategic Placement of Treatments (SPOTS) approach that can be modeled with Treatment Optimization Model (TOM) functions in the FlamMap fire modeling software package (Collins et al. 2010). LSWG participants anticipate that a SPOTS modeling approach could be used to model potential areas for mechanical thinning within a firescape and treatment area, which over time would facilitate the safe operational management of planned and unplanned fire ignitions.

**Existing Ponderosa Pine Composition and Structure**

Forest land within the analysis area form contiguous acres of tree cover that is dominated by ponderosa pine. Plant species diversity within the ponderosa pine forest type is typically comprised of annual and perennial grasses, forbs and other woody plants. As many as 20 plant associations exist within the ponderosa pine type (USDA Forest Service 1997), that are distinguished from one another on the basis of other low stature trees and understory plants. In light of these attributes, detailed and up-to-date landscape-scale data describing ponderosa pine forest composition is limited. Vegetation information collected with the USFS Terrestrial Ecosystem Survey (TES) can afford general information on percent cover of understory species within TES polygons circa 1980. However, these data were not analyzed due to time constraints and desire to focus on existing forest conditions. An exception was ponderosa pine and oak species (*Quercus spp.*) associations. Given the importance of pine-oak vegetation to multiple wildlife species (Abella 2008), particularly the threatened Mexican spotted owl (USDI FWS

1995), we used available and land cover data developed by the ForestERA project and LANDFIRE program to estimate the amount of pine-oak vegetation across the analysis area and within each firescape (**Figure 3**). Firescapes 1 and 3 have the greatest proportion of pine-oak vegetation.

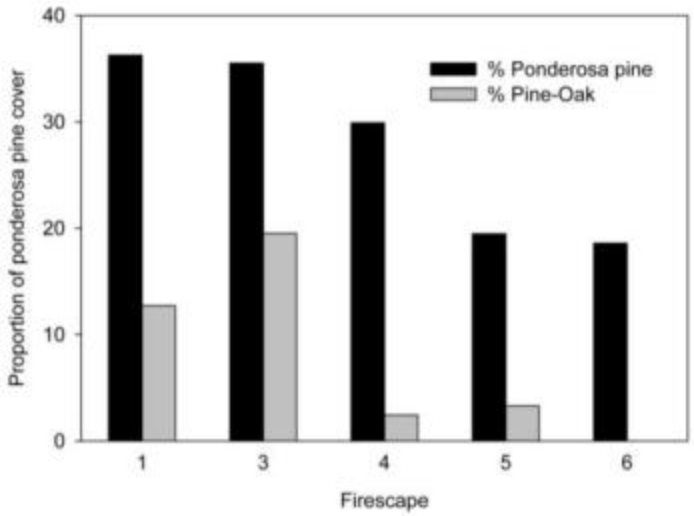



**Figure 3.** Proportion of ponderosa pine and pine-oak vegetation within each firescape.

We estimated ponderosa pine forest structural conditions using tree data collected between 1995 and 2005 from the USFS Forest Inventory and Analysis (FIA) plots. FIA tree data were summarized with the Forest Vegetation Simulator (FVS) for all ponderosa pine dominated plots[2]. We only used plots without a record of disturbance post-dating the inventory date ($n = 277$). Disturbance on a plot was estimated using Normalized Difference Vegetation Index (NDVI) values derived from Landsat Thematic Mapper (TM) imagery taken between the dates of 1999, 2004 and 2006. All plots with negative NDVI change values, indicating a potential disturbance, were eliminated from the analysis.

Modeled forest structure layers for 2009 were derived by combining FIA permanent plots and remotely sensed data. FIA forest plots and coordinates were used as ground reference data to generate a set of forest structural parameters at each plot location. Plots measured between 1995 and 2005 were imported to the Forest Vegetation Simulator (FVS) and Central Rockies variant and initially grown forward to 2007 to match TM imagery from the end of 2006 growing season[3]. Therefore, structural parameters for all trees ≥1" diameter-at-breast height (dbh) on FIA

[2] For this analysis, we used previously summarized FIA plots in the ponderosa pine type and the entire 2.4 million acre 4FRI area. This had little impact on forest structure values summarized at a large spatial scale.

[3] Forest structure models constructed from 2006 Landsat TM images and FIA plots were applied to 2009 Landsat TM images. The 2009 images were radiometrically calibrated to 2006 image dates using pseudo invariant targets and an empirical line image normalization technique.

plots were estimated using FVS sub-models (e.g., tree growth, wood volume, tree biomass and percent canopy cover) and projected to 2007. Change detection with previous Landsat image dates was used to eliminate FIA plots showing disturbance after tree measurements were taken. A total of 781 undisturbed FIA plots representing all major forest types were used to develop predictive models of forest structure using Random Forest regression trees (Brieman 2001). An additional 579 non-forest points were also included in the reference dataset generated from high resolution digital orthophotos (1-m pixels) as FIA plots did not represent non-forest spectral conditions across TM images. A best model selection process, bootstrapped error estimates and variance explained by each model were used to evaluate forest structure model outputs.

**Summarized Data**

Forest structural attributes summarized from FIA plots and digital data were used to estimate overall ponderosa pine conditions across the analysis area and firescapes. All ponderosa pine areas with a moderate to high level of disturbance using TM image-based change detection methods between1999 to 2010 (~89,000 ac) were removed from digital grids for characterizing existing conditions. Moderate to high level disturbance was considered <1 standard deviation from the mean ΔNDVI value, (ΔNDVI< -0.05; *see* also Beck and Gessler 2008). Disturbance areas post-dating 2006 and 2009 were not sufficiently represented in forest structure data layers (e.g., 2010 Schultz Fire). In addition, ponderosa pine forests with a high level of disturbance from 1999 to 2010 were not considered candidate areas for restoration treatments (**Figure 4**).

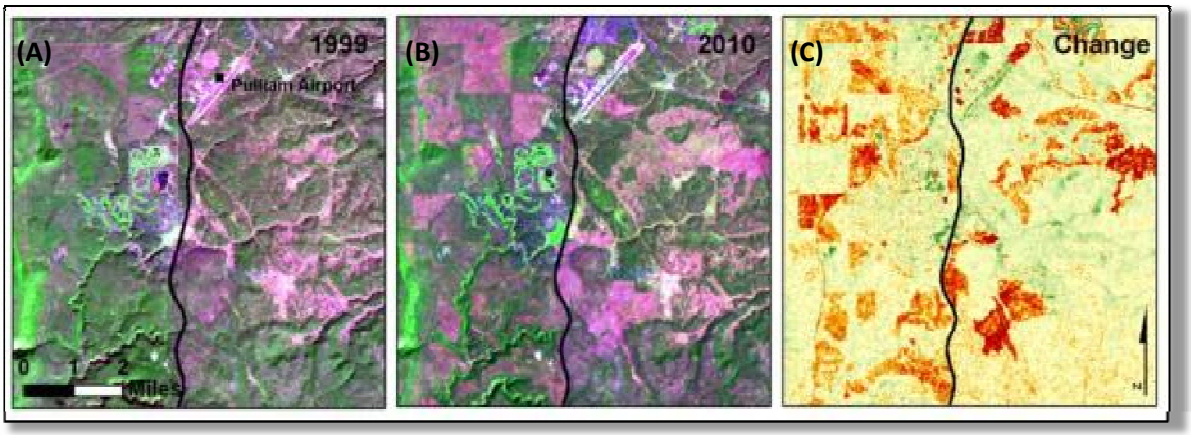



**Figure 4**. Change detection using ΔNDVI values from a (**A**) 1999 TM images and (**B**) 2010 TM images to identify (**C**) areas of moderate to high disturbance (orange to red) resulting from

activities in the analysis area such as forest thinning treatments, urban development, and wildland fires.

Digital forest structure data matched closely with FIA plot summaries (**Table 3A, B**). Most of the forest structure data layers were derived with 65% or more of the variance explained from validation statistics. Exceptions were variables such as tree density, canopy base height and quadratic mean diameter which were below 50%, which translates to higher levels of uncertainty for these forest structure data layers.

On average, ponderosa pine forest show high stem densities and stem biomass **(Table 3A, B)** relative to historical forest conditions (Covington and Moore 1994, Covington et al. 1997). At the turn of the century, an average of 47 trees per acre (TPA) and 58 $ft^2$/ac of basal area (BA) were measured in 15 permanent plots from Arizona and New Mexico (Moore et al. 2004). Conditions summarized from FIA plots and digital forest structure data layers indicate that lower $25^{th}$ percentile forest conditions are close to or exceed tree basal area and density estimated from these historical plots. Uncertainty exists about historical forest plots and reconstruction data and their representation of prior forest conditions (Bell et al. 2009), particularly with respect to the spatial heterogeneity and structural conditions across large landscapes. However, strong evidence suggests that widespread forest change has occurred during the last century such as increased tree densities as a result of reduced fire activity for most Southwest forest types, greatly increasing forest vulnerability to large scale disturbances and climate change (Fule et al. 2010).

**Table 3.** Ponderosa pine forest structure conditions summarized by (**A)** FIA permanent plots (*n* = 277) and (**B**) newly developed digital data layers from 2009 satellite data.

| **A. Forest structure variable**[1] | **Max** | **Median** | **Min** | **Mean** | **Std. Dev** | **25%** | **75%** |
|---|---|---|---|---|---|---|---|
| Trees per acre | 4124 | 327 | 6 | 562 | 675 | 161 | 619 |
| Canopy cover (%) | 83 | 42 | 7 | 41 | 14 | 32 | 51 |
| Basal area ($ft^2$/ac) | 237 | 114 | 13 | 117 | 48 | 81 | 153 |
| Stand density index | 523 | 241 | 29 | 247 | 107 | 162 | 322 |
| Quadratic mean diameter (in.) | 27.0 | 7.9 | 1.9 | 8.6 | 3.9 | 6.1 | 10.5 |
| Cubic foot volume ($ft^3$/ac) | 6834 | 2048 | 270 | 2275 | 1170 | 1449 | 3064 |
| Crown bulk density ($kg/m^3$) | 0.20 | 0.05 | 0 | 0.06 | 0.03 | 0.04 | 0.07 |
| Canopy base height (ft) | 94 | 14 | 2 | 16.5 | 11.3 | 9 | 21 |

[1]Values derived from summarized FIA plots which provide a rough estimate how forest structure conditions are distributed across the 4FRI landscape.

**Table 3 (cont.).** Ponderosa pine forest structure conditions summarized by (**A)** FIA permanent plots (*n* = 277) and (**B**) newly developed digital data layers from 2009 satellite data.

| **B. Forest structure variable**[1] | **Max** | **Median** | **Min** | **Mean** | **Std. Dev** | **25%** | **75%** |
|---|---|---|---|---|---|---|---|
| Trees per acre[2] | 2989 | 530 | 0 | 563 | 282 | 280 | 941 |
| Canopy cover (%) | 69 | 38 | 0 | 37 | 11 | 28 | 42 |
| Basal area ($ft^2$/ac) | 224 | 112 | 0 | 109 | 35 | 74 | 125 |
| Stand density index | 538 | 238 | 0 | 232 | 77 | 151 | 267 |
| Cubic foot volume ($ft^2$/ac) | 5995 | 1934 | 0 | 1875 | 845 | 916 | 2266 |
| Crown bulk density ($kg/m^3$) | 0.122 | na | 0 | 0.043 | 0.018 | 0.023 | 0.051 |
| Canopy base height (ft) | 40 | na | 0 | 13 | 4.7 | 8.1 | 15 |

[1]Values derived from digital data layers and 30m grid cells which provide a detailed estimate of forest structural conditions and distributions across the first 4FRI analysis area.
[2]Trees per acre were summarized from available 2006 digital data, also removing recent disturbance areas.

Digital maps of forest structure visually identified large-scale differences in ponderosa pine conditions such as areas of high or low canopy fuels and basal area among firescapes (**Figure 5A, B**). Areas of high canopy fuel conditions and basal area were observed in three large contiguous areas within firescapes 1, 3, and 4. A large portion of ponderosa pine forest was excluded from forest structure variables mapped in firescape 5 as a result of the high severity 2010 Schultz Fire and our change detection analysis.

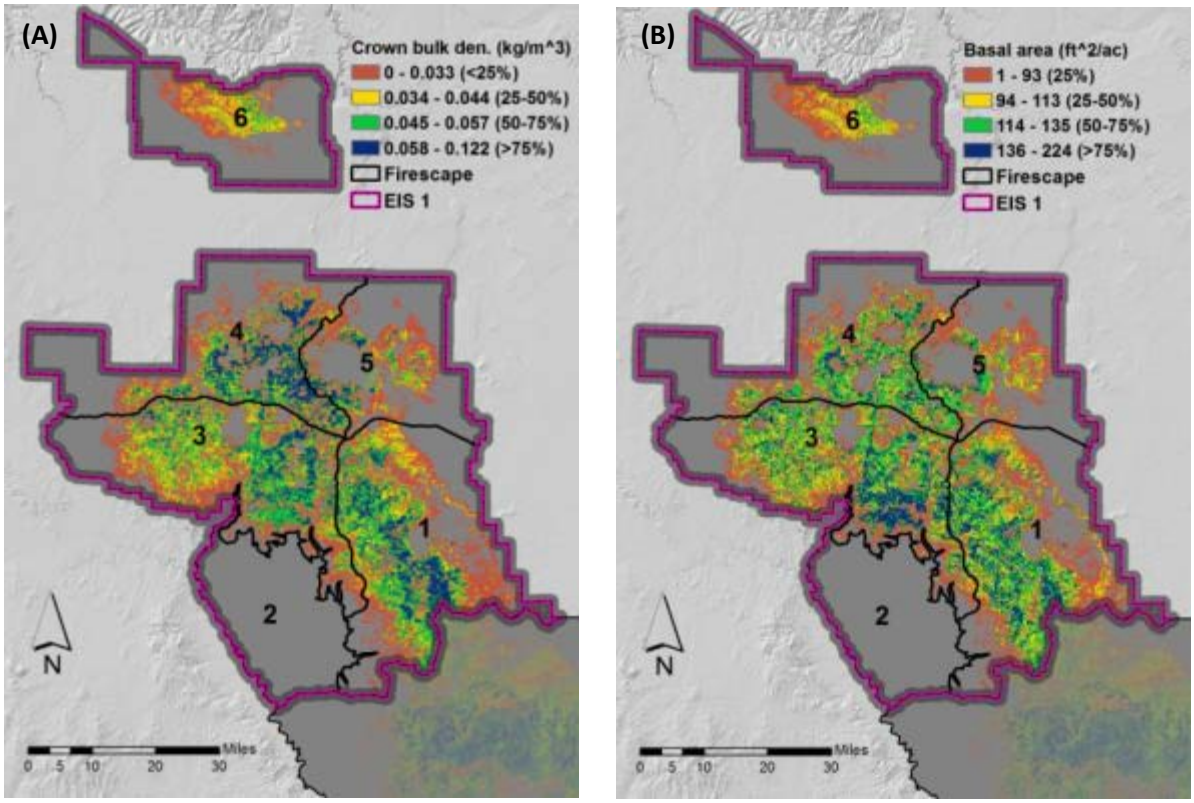



**Figure 5.** Updated 2009 ponderosa pine forest structure data layers for (**A**) crown bulk density and (**B**) basal area across the analysis area and firescapes.

Mapped forest structure conditions (2009) for ponderosa pine basal area, tree density and canopy fuels and cover were also summarized in each firescape to compare and contrast existing conditions between areas (**Figure 6A-D**). Firescapes 5 and 6 were lower in all forest structure categories in comparison with the other three firescapes. As noted above, firescapes 1, 3 and 4 have more contiguous areas of ponderosa pine and showed consistently greater canopy fuels, basal area, canopy cover and tree density than the other two firescapes. Nevertheless, synthesis methods were needed to more comprehensively evaluate existing forest conditions and estimate the potential for high-severity wildland fires. In the following section fire behavior models were used to assess the interaction between forest structure parameters, topography, fuel moisture, and fire weather conditions.

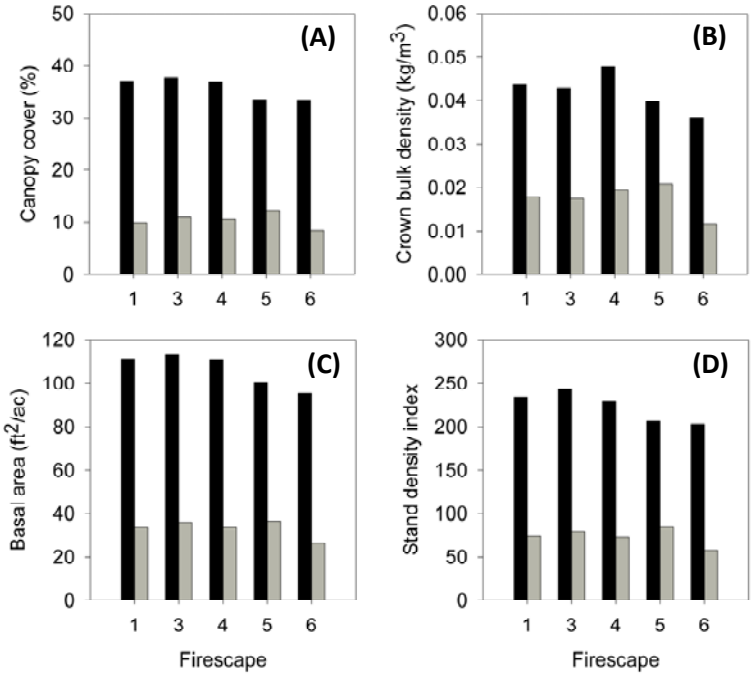



**Figure 6.** Ponderosa pine forest (**A**) canopy cover, (**B**) crown bulk density (canopy fuels), (**C**) basal area and (**D**) stand density index summarized by firescape using digital data layers. Black bars are average values are and grey bars standard deviation.

**Predicted Fire Behavior**

In southwestern ponderosa pine ecosystems, high-severity fires currently burn across areas many times larger than they did less than a century ago (Swetnam and Betancourt 1998, Westerling et al. 2006). Ponderosa pine ecosystems were historically shaped by a variety of natural processes, including a fire regime characterized by predominantly frequent, low-intensity surface fires (Covington and Moore 1994). Current fire behavior is a result of the shift in forest structure from low tree densities and open conditions toward more contiguous canopy fuels with high crown fire potential (**Figure 5A**). An increased number, size, and severity of stand-replacing fires continues to pose a threat to human communities and infrastructure, in addition to a potential loss of ecosystem services such as forest carbon storage and climate mitigation, and biodiversity and watershed protection. Uncharacteristic fire behavior can also alter successional patterns within burned areas, leading to novel post-fire plant communities further perpetuating unnatural fire regimes (Savage and Mast 2005, Kuenzi et al. 2008).

An important theme articulated by the LSWG was to develop strategic approaches to reducing the threat of large and severe wildland fires, while restoring fire as an ecosystem process which plays a vital role in developing desired forest conditions. Reestablishing ecosystem resilience to wildland fire events will require the safe reestablishment of natural fire regimes, which can allow for changing climate conditions (Fulé, 2008). When coupled with the re-establishment of landscape-scale fire processes over time, the strategic implementation of thinning and burning treatments in parts of the study area is anticipated to create forest conditions that are less prone to shifts in native plant community structure and composition (Allen et al. 2002, Falk et al. 2006).

Current fire conditions within the analysis area were estimated using the FlamMap fire behavior model and LANDFIRE refreshed digital data layers (http://www.landfire.gov/). Remote Automated Weather Station (RAWS) data from the analysis area were used to parameterize the model based on 85$^{th}$ and 97$^{th}$ percentile fire weather conditions. Eighty-fifth percentile conditions were characterized as average fire season conditions and 97$^{th}$ percentile conditions were identified as extreme fire weather conditions associated with intense fire behavior in northern Arizona. Low fuel moisture conditions and higher sustained wind speeds (18 miles per hour) at or close to the 97$^{th}$ percentile are consistent with fire weather conditions for several large fires that burned on the Kaibab National Forest since 1992 (Kleindienst 2009, unpublished report). Kleindienst (2009, unpublished report) also noted that 98% of all fires are contained with initial attach efforts and nearly all large fires have occurred under 90$^{th}$ percentile or greater fire weather conditions.

The LANDFIRE refresh process updates forest structure data layers in locations with wildland fire or other disturbances >1000 acres in size[4]. Therefore, smaller fires and thinned areas are not accounted for in these updates. LANDFIRE data layers have also been adjusted for Southwest forest condition and improve forest structure model estimates of crown bulk density and canopy cover important to fire mode runs. As a post processing step, areas moderate to high disturbance according to 2010 - 1999 ΔNDVI values were assumed to be reduced to surface fire only to

[4] LANDFIRE forest structure data layers are derived from 1999-2001 Landsat TM images which predate numerous large and small disturbance areas within the analysis area.

better incorporate recently thinned areas and other disturbances <1000 acres. In addition, fire model outputs and predicted fire behavior categories were rescaled to a 50 acre minimum mapping unit.

Fire model outputs indicated potential fire behavior categorized as surface fire, passive crown fire and active crown fire for the two fire weather scenarios across all vegetation types. Areas of no prediction were urban areas or other barren lands with no vegetation. Model outputs estimated for 85$^{th}$ percentile conditions showed notably less area predicted as active crown fire behavior than under 97$^{th}$ percentile conditions (**Figure 7A, B**). These predictions appear consistent with known fire behavior under moderate versus extreme fire weather conditions in the analysis area. All further analysis was performed on 97$^{th}$ percentile fire model runs to characterize current conditions within firescapes that that could potentially result in large scale, high-severity wildland fires.

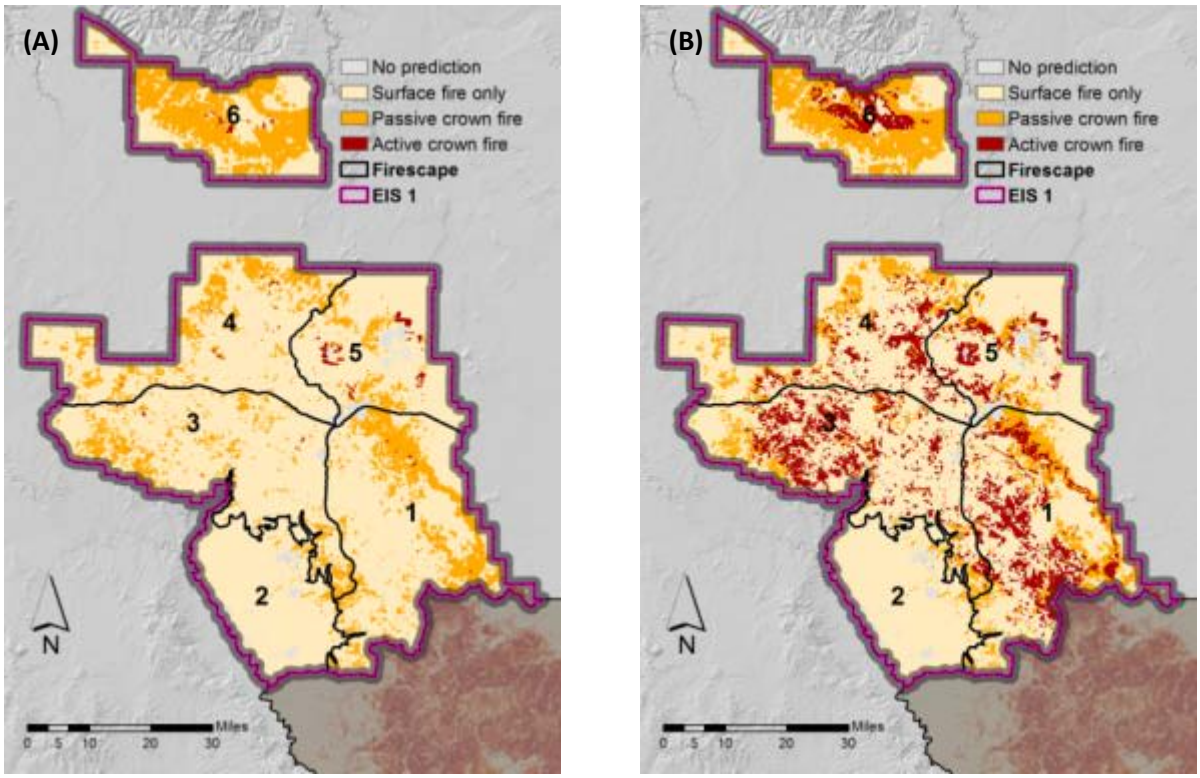



**Figure 7.** FlamMap fire behavior model outputs from model runs at the (**A**) 85th percentile fire weather conditions and (**B**) 97th percentile fire weather conditions. Model outputs have been rescaled to a 50 acre minimum mapping unit.

Comparisons of 97th percentile fire behavior for ponderosa pine forest among firescapes showed that firescapes 6, 1 and 3 had the greatest proportion of area predicted to achieve active crown fire (**Figure 8**). Result from all but firescape 6 appear consistent with forest structure data summarized for each firescape. Firescapes 6 which covers the Tusayan Ranger District on the Kaibab National Forest was lowest, on average, for all forest structure attributes compared (**Figure 6A-D**), but showed the greatest proportion of predicted and contiguous areas in passive and crown fire categories. Fire model outputs for the Tusayan Ranger District warrant further evaluation as several planned and unplanned natural ignition fires have been implemented for this area in recent years, likely to reduce crown bulk density and other forest structure parameters related to fire behavior (personal observation). These changes may not have been registered in LANDFIRE refreshed data, or less severe fire behavior during burning activities may also have produced lower levels of change levels than the ΔNDVI threhold used (1 standard deviation) to

post-process fire model outputs. Regardless, additional information is needed for this area to accurately portray current fire risk.

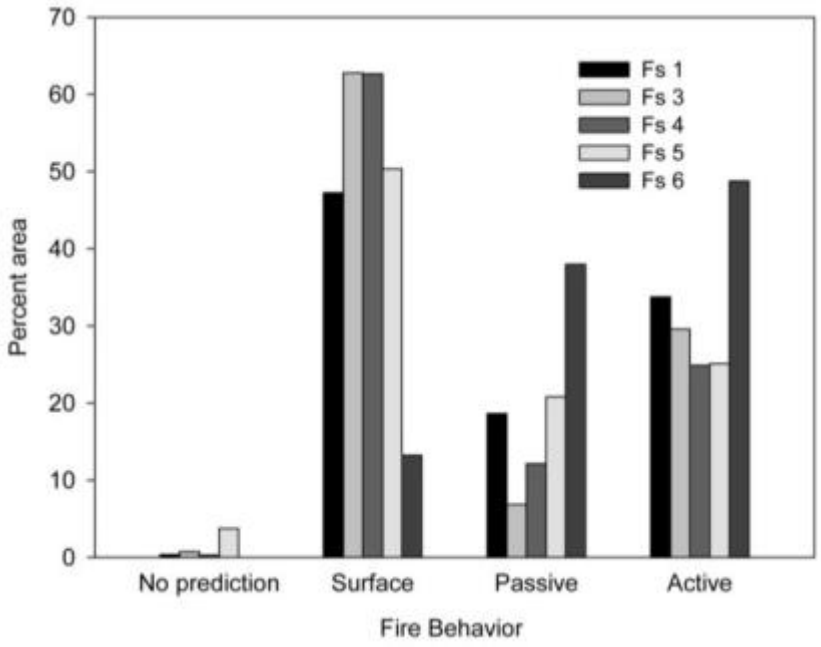



**Figure 8**. 97th percentile FlamMap fire behavior predictions for the ponderosa pine forest type and five principal firescapes covering the analysis area. Fire behavior categories include 1) areas with no prediction (e.g., urban areas), 2) surface fire conditions, 3) passive crown fire and 4) active crown fire.

## IV. TREATMENT AREA IDENTIFICATION

Mechanical thinning and burning treatments should occur in a configuration which meets objectives to restore ponderosa pine forest structure and fire adapted conditions within the analysis area. The LSWG recommends that a standardized and repeatable method be used for subdividing firescapes into treatment areas that encompass 5,000 to 50,000 acres of ponderosa pine forest where mechanical thinning and prescribed fire can potentially be applied. Proposed actions and treatment strategies for each of these areas can be developed and allow for multi-scaled and spatially explicit descriptions of existing conditions, desired post-treatment and future conditions, and treatment options. An example of the process developed by the LSWG is described in detail below.

**Treatment Area Identification and Mapping**

Analyses were conducted using 6th code watershed boundaries that are based on terrain features and hydrologic function. Treatment areas were necessarily identified within firescape boundaries to facilitate the spatial and temporal sequencing of treatments and enhance opportunities to restore fire adapted conditions in a stepwise fashion. To develop a standard process for identifying treatment areas within a firescape, three types of ponderosa pine conditions were defined:

1. **Candidate treatment areas** are ponderosa pine forest where mechanical thinning treatments could likely occur first.
2. **Excluded areas** are ponderosa pine forest where mechanical thinning was unlikely to occur.
3. **Matrix areas** are ponderosa pine forest not represented by the candidate or exclusion areas/categories (**Tables 4, 5**). We defined these areas as ponderosa pine forests that were not identified for initial treatments, but may be treated based upon additional analyses.

More specifically, candidate ponderosa pine forest were defined as areas most likely to receive mechanical thinning and burning treatments according to digital data layers representing social and ecological values and risks to values posed by potential fire behavior (**Table 4**). Exclusion areas were defined as locations within the ponderosa pine type where mechanical thinning was unlikely to be implemented as a restoration approach according to digital data layers (**Table 5**). However, mechanical, other non-mechanical, or low impact restoration approaches may potentially be applied to exclusion areas to enhance habitat conditions and reduce the threat of wildland fire or other severe disturbance events. These exceptions should be identified during the site-specific treatment identification process the USFS will conduct. In addition, matrix areas may also be given preference for mechanical thinning and prescribe burning over candidate ponderosa pine depending on the spatial context of these areas and restoration objectives.

To develop a systematic process for identifying important differences between treatment areas (e.g., areas where community protection may be the focus versus an area where other resource

values would guide treatment), we developed two different scenarios. Each scenario estimated a numerical value representing the level of intersection between candidate area data layers and individual 6$^{th}$-code watersheds ($n$ = 144) in the analysis area. For Scenario I, each candidate data layer was given a possible classification score of at least 1 if it occurred in a non-overlapping pixel with other layers. However, an increased classification score of 4 was given to the intersection of community protection areas and areas of active crown fire predicted using 97$^{th}$ percentile fire weather conditions. Community protection and active crown fire areas occurring independent of one another were given an increased clarification score of 3 and 2, respectively. This process allowed us to spatially identify community protection areas, locations with active crown fire, and other high-value resources within wildlands to aid the USFS in developing treatment scenarios for these important areas. The intersection of layers could have a maximum classification score of 10, as any other candidate layer was counted only once. Although these areas do receive more points than others, this process was not meant to rank communities above wildland areas for treatment, but to provide a means of classifying and identifying different forest management settings within firescapes. Below are all of the steps used to process data layers in Scenario I:

**Step I. Watershed classification score (for each pixel in watershed)**

1. Intersection of community protection & active crown fire = 4
2. Community protection = 3
3. Active crown fire = 2
4. Any other candidate area = 1
5. Maximum weight = 10
6. Calculate the average pixel classification score within a watershed

**Step II. Proportion of candidate areas**

1. Calculate the proportion of area occupied by each candidate treatment area in a watershed
2. Calculate the average proportion of all candidate treatment areas

**Step III. Watershed similarity value**

1. Multiply the average watershed classification score by the average proportion of candidate treatment areas in a watershed

**Step IV. Group similar watersheds as treatment areas**

1. Combine 6th code watersheds with similar watershed classification scores
2. Contain treatment areas within 5th code watersheds, when possible

Scenario II used a different set of watershed classification scores giving active crown fire a 3 and all other layers a score of one (**Table 4**). For this scenario, the additive value of all overlapping candidate area data layers was summed on each pixel in a watershed which also resulted in a maximum classification score of 10. For example, areas of 97th percentile passive and active crown fire do not overlap and can be counted only once in a given area. All other processing steps were equal between the two scenarios.

The above scenarios and set of analysis steps provided four principal outputs:

1. A method to group 6th code watersheds into treatment areas ranging in size from 5,000 to 50,000 acres.
2. The total number of acres of ponderosa pine forest within candidate treatment areas for each watershed, firescape and the analysis area.
3. The total number of acres of ponderosa pine forest excluded from mechanical treatment within a watershed, firescape and the analysis area (i.e., analysis area).
4. The total number of "matrix" acres that are not within either of the excluded or candidate treatment area categories.

The total number of non-overlapping candidate, excluded and matrix ponderosa pine forest acres for the analysis area were 557,713, 208,562, and 109,054 acres respectively (**Tables 4, 5**). An example of these calculations by firescape and treatment area is given below with results from the treatment identification scenarios.

**Table 4.** Digital data layers representing candidate areas for treatments areas within the ponderosa pine forest type.

| Layer | Candidate treatment areas | Description | # Acres | Scenario I[4] | Scenario II[5] |
|---|---|---|---|---|---|
| na | Active crown fire 97th and community protection | Intersection between active crown fire and community protection data layers | na | 4 | na |
| 1 | Active crown fire 97th | 97th percentile w/50 acre filter | 271,454 | 3 | 3 |
| 2 | Municipal + aquatic species watersheds[1] + Flagstaff CWPP watersheds | Community Wildfire Protection Plan watersheds/flood protection | 264,341 | 1 | 1 |
| 3 | Community protection areas[1] | | 188,348 | 2 | 1 |
| 4 | MSO restricted habitat[2] | Mexican Spotted Owl restricted habitat | 177,062 | 1 | 1 |
| 5 | Passive crown fire 97th | 97th percentile w/50 acre filter | 132,117 | 1 | 1 |
| 6 | NEPA completed acres | Areas USFS has completed NEPA analysis and compliance; Areas where specified treatment can happen more readily | 120,359 | 1 | 1 |
| 7 | Major roads buffer (USFS level 3-5) | 0.5 mile upwind | 92,243 | 1 | 1 |
| 8 | Mountain top buffer[3] | 1 mile from derived mountain top | 27,969 | 1 | 1 |
| 9 | NOGO PFAs minus nest cores | Northern Goshawk post-fledging areas | 26,107 | 1 | 1 |
| | | | | | 1 |
| 10 | MSO PAC buffer[3] | 0.5 mile upwind in restricted habitat | 19,992 | 1 | 1 |
| 11 | Active crown fire 85th | 85th percentile w/50 acre filter | 6,440 | 1 | 1 |
| 12 | Recreation areas w/ infrastructure + named campgrounds | Point locations buffered 1/8 mile | 597 | 1 | 1 |
| | OVERLAP | Subtract areas of overlap, no double counting of acres | 769,318 | | |
| | | **Total Acres** | **557,712** | **10** | **10** |

[1]Estimated from the Small Diameter Wood Supply Assessment (www.forestera.nau.edu)
[2]Model derived during Western Mogollon Plateau Adaptive Landscape Assessment (www.forestera.nau.edu)
[3]High value buffer areas are derived from buffering selected landscape features. These may depict priority areas for treatment
[4]Senario I had a maximum classification score of 10, as only 1 point is added for another candidate area apart from 97th percentile active crown fire and community protection areas.
[5]Senario II also had a maximum classification score of 10, as some layers do not overlap such as active and passive crown fire.

**Table 5.** Digital data layers representing exclusion areas within the ponderosa pine forest type

| Layer No. | Exclusion areas | Description | No. of Acres |
|---|---|---|---|
| 1 | Non-NFS lands | Private, state, and other lands not managed by the USFS | 81,955 |
| 2 | MSO protected activity centers | Occupied MSO sites, approximately 600 acres in size | 56,914 |
| 3 | Sensitive soils[1] | Soils with mechanical treatment limitations due to compaction, etc. | 34,646 |
| 4 | Specially designated areas | Inventoried roadless areas, research natural areas, wilderness, special management areas | 31,483 |
| 5 | Steep slopes[1] | Slopes greater than f[illegible] percent | 27,601 |
| 6 | NOGO nest core areas[1] | Consist of 3, 30-acre nest areas, for a total of 90-acres | 25,681 |
| 7 | Mountain tops | Elevation and vegetation thresholds, areas greater than 1000 acres | 2,797 |
| 8 | Stream buffers[1] | 100 foot buffers on either side of perennial streams | 450 |
| 9 | Areas of significant change | Landsat derived change detection 1999-2010 capturing all types of disturbance (e.g. treatments, fire, etc.) | |
| | OVERLAP | Subtract areas of overlap, no double counting of acres | -52,965 |
| | | **Total Acres** | **208,562** |

[1]Estimated from the Small Diameter Wood Supply Assessment (www.forestera.nau.edu)

**Treatment Area Results**

Outcomes between Scenarios I and II were not extremely different given that many of the conditions represented by candidate data layers are spatially autocorrelated (**Figures 10A; 11A**). Therefore, watersheds with similar values and fire behavior conditions tended to be grouped rather than widely dispersed. Firescape 3 was used as an example to compare and contrast the two scenarios for grouping watersheds and create treatment areas. In each case, the resulting fire treatment areas were similar in size, extent and location (**Figures 10B, C; 11 B, C**). To process the two outputs in a similar manner, treatment areas were generally defined by similar groups of watersheds along 5$^{th}$ code watershed boundaries. Fifth code watersheds provided a second level of organization with which to cluster similar 6$^{th}$ code watershed groups. Highly aggregated watersheds close to Flagstaff, AZ formed relatively straight forward treatment areas. Other watersheds such as those close to the town of Williams, AZ contrasted more highly with surrounding watersheds. These watersheds were grouped with several other watersheds up-wind of this location. The rational used was that ponderosa pine forest up-wind of Williams contained a large number of areas categorized as active crown fire from 97$^{th}$ percentile fire behavior model runs (**Figure 7B**). In addition, the two watersheds surrounding Williams are bisected by firescape 3 and contain a low number of candidate ponderosa pine when delineated as a separate treatment area (data not shown).

Candidate, excluded and matrix areas were summarized for Scenario I and II resulting in 162,500 total candidate acres and 27,642 total matrix acres within firescape 3 (**Table 6**). For scenario I candidate ponderosa pine acres within each treatment area ranged in size from 6,500 ac to 47,000 ac, in addition to matrix areas not accounted for in candidate and exclusion digital data layers. Scenario II resulted in a similar distribution of ponderosa pine forest categories within firescape 3 (**Table 7).** These data indicate that relatively large treatment areas are needed to encompass candidate areas for treatments between 5,000 ac and 50,000 ac.

Each of the two scenarios presents a process for grouping watershed areas into meaningful treatment areas. Additional steps are likely needed to prioritize and sequence firescapes and treatment areas to receive initial forest restoration projects. Nevertheless, results suggest that

~20 treatment areas will potentially be defined in the first analysis area using these methods.

The group selected Scenario 2 as the recommended process for selecting treatment areas.

**Scenario I**

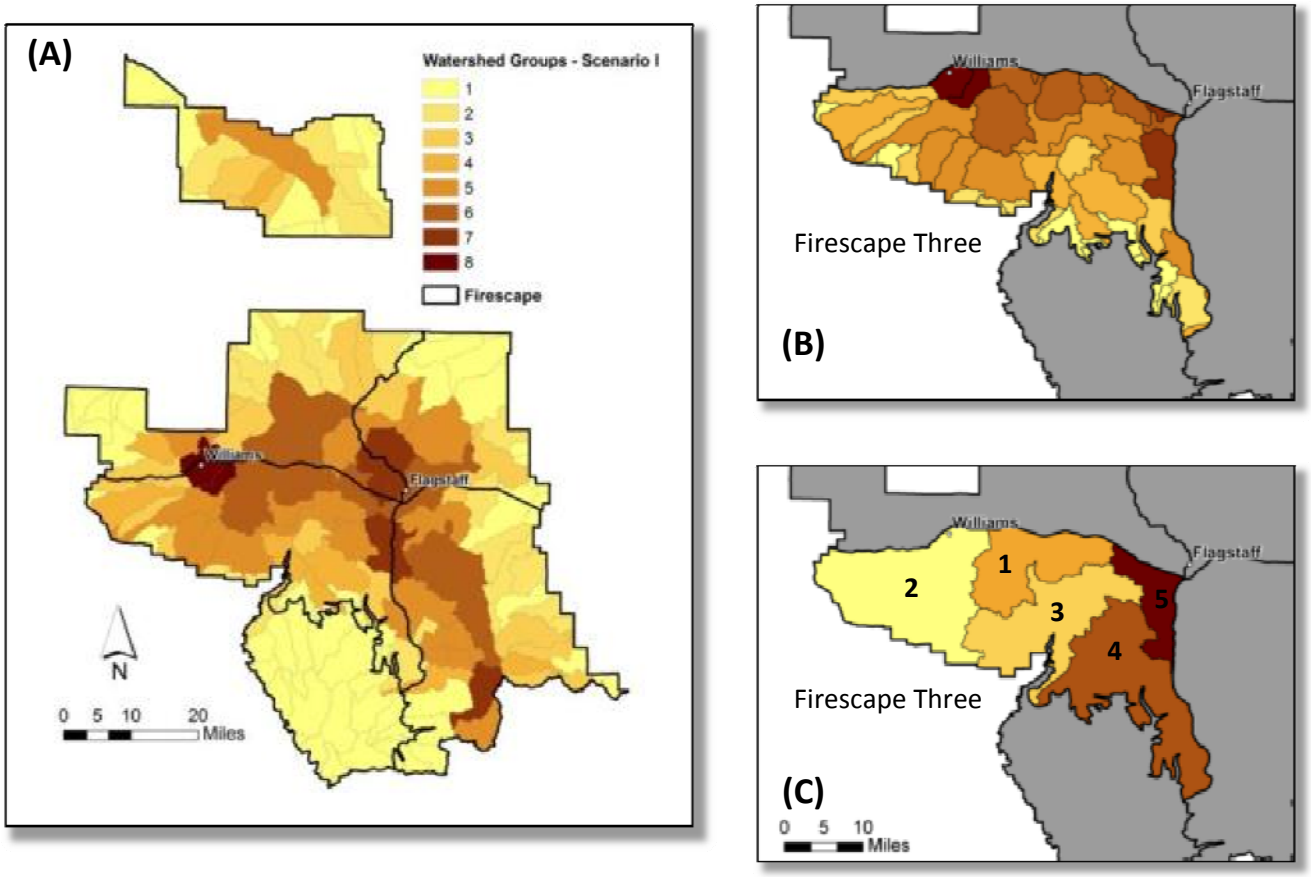



**Figure 10**. Scenario I treatment area identification that is defined according to (**A**) weighted candidate areas for treatment at the 6th code watershed scale, (**B**) firescape boundary, and (**C**) selected watershed groups.

**Table 6.** The number of ponderosa pine acres in the three categories (candidate, excluded and matrix) from Scenario I, firescape three.

| | Ponderosa pine acres | | | |
|---|---|---|---|---|
| **Treatment area** | **Candidate** | **Excluded** | **Matrix** | **Total** |
| 1 | 32,701 | 12,294 | 4,875 | 49,870 |
| 2 | 43,830 | 11,940 | 4,800 | 60,569 |
| 3 | 32,324 | 30,052 | 14,728 | 77,104 |
| 4 | 47,206 | 28,884 | 3,241 | 79,331 |
| 5 | 6,523 | 17,942 | 0 | 24,465 |
| **Total acres** | 162,583 | 101,112 | 27,643 | 291,339 |

**Scenario II**

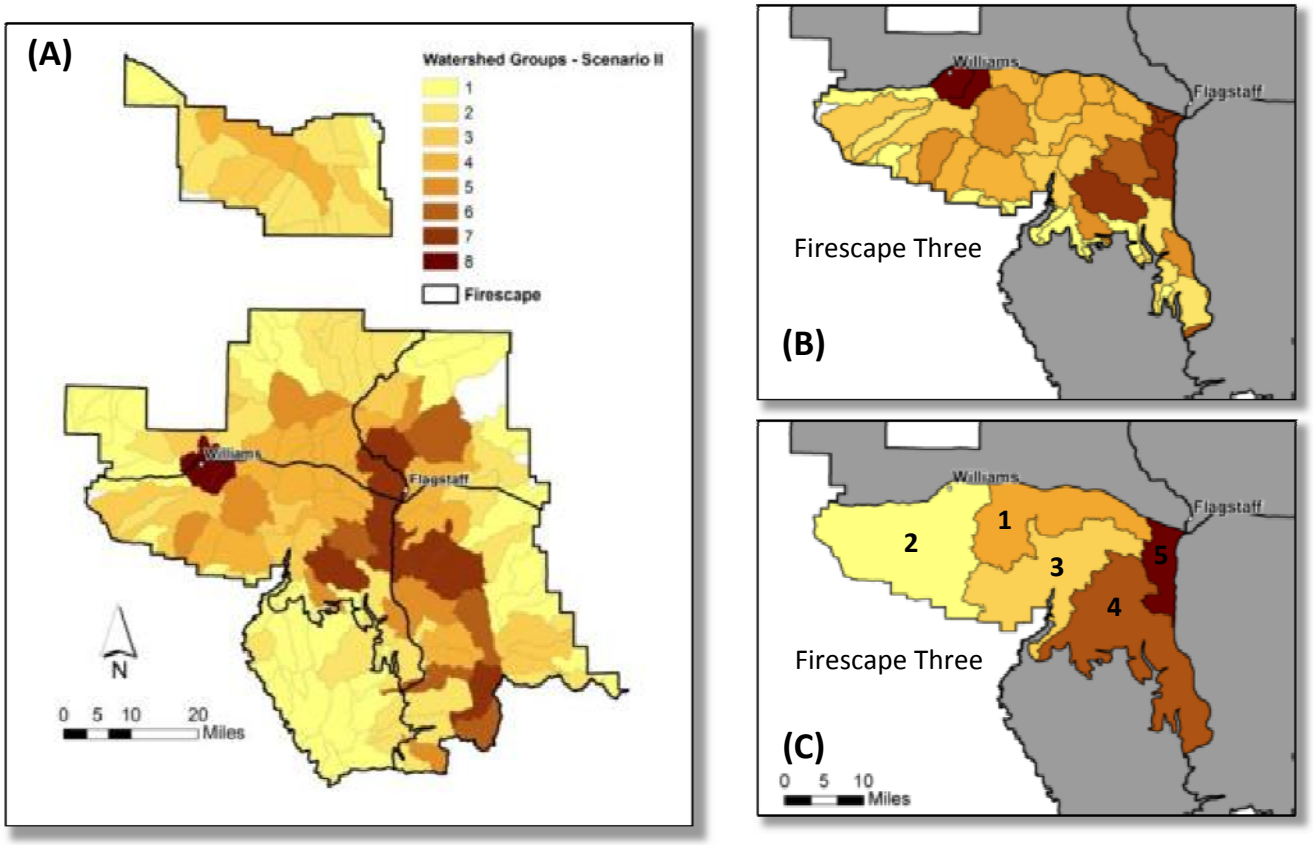



**Figure 11**. Scenario II treatment area identification that is defined according to (**A**) weighted candidate areas for treatment at the 6th code watershed scale, (**B**) firescape boundary, and (**C**) selected watershed groups.

**Table 7.** The number of ponderosa pine acres in the three categories (candidate, excluded and matrix) from Scenario II, firescape three.

| | Ponderosa pine acres | | | |
|---|---|---|---|---|
| **Treatment area** | **Candidate** | **Excluded** | **Matrix** | **Total** |
| 1 | 32,856 | 18,871 | 4,875 | 49,870 |
| 2 | 43,830 | 11,940 | 4,800 | 60,569 |
| 3 | 32,324 | 30,052 | 14,728 | 77,104 |
| 4 | 47,206 | 28,884 | 3,241 | 79,331 |
| 5 | 6,267 | 11,365 | 0 | 24,465 |
| **Total acres** | 162,482 | 101,112 | 27,644 | 291,339 |

## V. EXAMPLE TREATMENT AREA DESCRIPTION

The following process used to describe treatment areas can serve as a template for developing area specific current conditions, proposed actions and desired post-treatment and future conditions for each treatment area. For a few locations in the example below, text remains highlighted where data and information can be inserted when data layers and other ongoing work is finalized, such as revision and consolidation of TES units.

### Firescape 3 - Garland Prairie Treatment Area Example

As part of the treatment area identification process, an individual treatment area was selected and characterized using derived datasets (**Table 4, 5**), in addition to spatial data representing current forest conditions. The Garland Prairie Treatment Area (herein called the 'Garland Area') (**Figure 12**) was chosen as an example because of its moderate to high weighted value from the analyses above. It is an area with high potential for active crown fire under extreme fire weather conditions, but has low overlap with community protection areas.

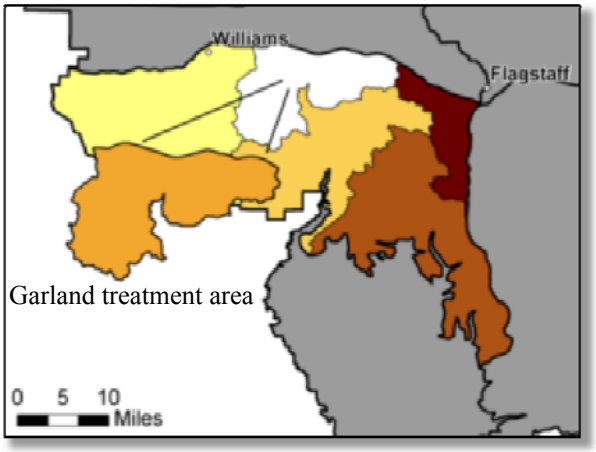



**Figure 12**. Garland prairie treatment area.

### Treatment Area Description

The Garland Area encompasses a total of 73,998 acres, 49,870 acres of which are dominated by the ponderosa pine forest type (**Figure 13A**). Candidate and matrix ponderosa pine areas comprised 32,701 and 12,294 acres of the treatment area and 4,875 acres were excluded (**Figure 13B**). The Garland Area contains portions of six, 6$^{th}$ code watersheds. It is located in Firescape 3 and includes the upper portion of Big Spring Canyon, a primary contributing watershed basin of the Sycamore Canyon watershed, approximately 10 miles west of Flagstaff, Arizona. The town of Bellemont, Arizona is at the eastern edge of the treatment area which includes national forest lands to the west of Camp Navajo and forest surrounding Garland Prairie. The Garland Area also provides an excellent opportunity to demonstrate 4FRI approaches to forest restoration and easy access to the project area from Interstate Highway 40. The Garland Area is considered

to have a moderate to high level of priority treatment area due to its contiguous areas predicted to be susceptible to active crown fire, but lower concentration of community protection areas.

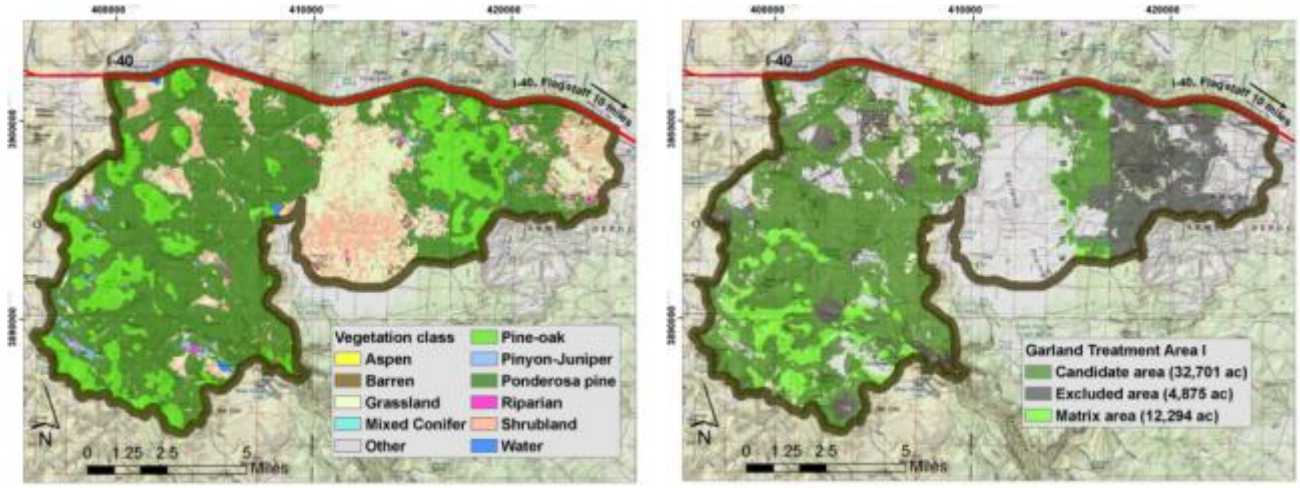



**Figure 13.** Garland Area west of Flagstaff, Arizona (A) forest composition and (B) spatial data representing candidate treatment, matrix and excluded ponderosa pine forest areas.

**Site Characteristics**

**Abiotic Characteristics** – From available Stand Exam forest inventory data, ponderosa pine forests within the Garland Treatment Area are located on moderate productivity sites with an average site index of 71 (SD ± 10) using a base age of 100 years (**Figure 14A**). The ponderosa pine forests within the Garland Area are located on Terrestrial Ecosystem Survey (TES) strata [## (## acres), ## (## acres), and ## (## acres]. Based on TES soil data, the area is predominately characterized by only slight erosion potential (**Figure 14B**).

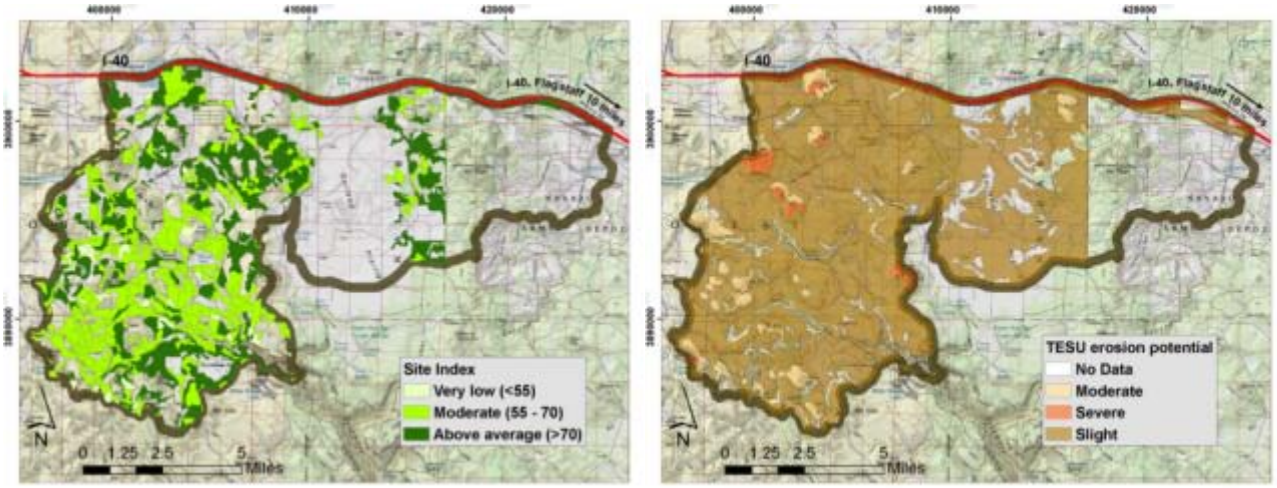



**Figure 14**. Garland treatment area (**A**) available stand exam site index values and (**B**) TES unit erosion potential data.

**Forest Composition and Structure** - The ponderosa pine forests within the Garland Area are characterized by dense forest conditions dominated by small diameter trees. According to existing USFS stand inventory data (n=319 stands) grown forward to 2007[5], ponderosa pine forest averages 156 (SD±20) trees per acre (tpa) for trees <5 inches dbh and 109 (SD±4) tpa for trees 5 to 16 inches dbh. Larger diameter trees >16 inches average 24 (SD±0.6) tpa. Average stand basal area (BA) and stand density index (SDI) are 120 $ft^2$/ac (SD±2.3) and 221(SD±5), respectively. These estimates are similar to ponderosa pine estimates from gridded data that showed an average BA of 114 $ft^2$/ac (SD±27) and SDI of 243 (SD±60) (Figure 15 A,B). Differences in standard deviation among the two estimates are due to sampling differences between forest inventory and gridded data. (PLACE SUMMARY DATA IN TABLE) Within the ponderosa pine forest type, 24% (12,614 acres) is characterized as pine-oak vegetation (i.e., ~20

[5] These data were previously processed during the 2008 Small Diameter Wood Supply Assessment and have not been evaluated for disturbance post-dating forest inventory dates.

$ft^2$/ac of Gambel oak) across all land ownerships in the Garland Area. Areas comprised of pine-oak within candidate and matrix ponderosa pine forest on USFS lands accounted for 23% (8,478 acres) of these areas (Figure 13A).

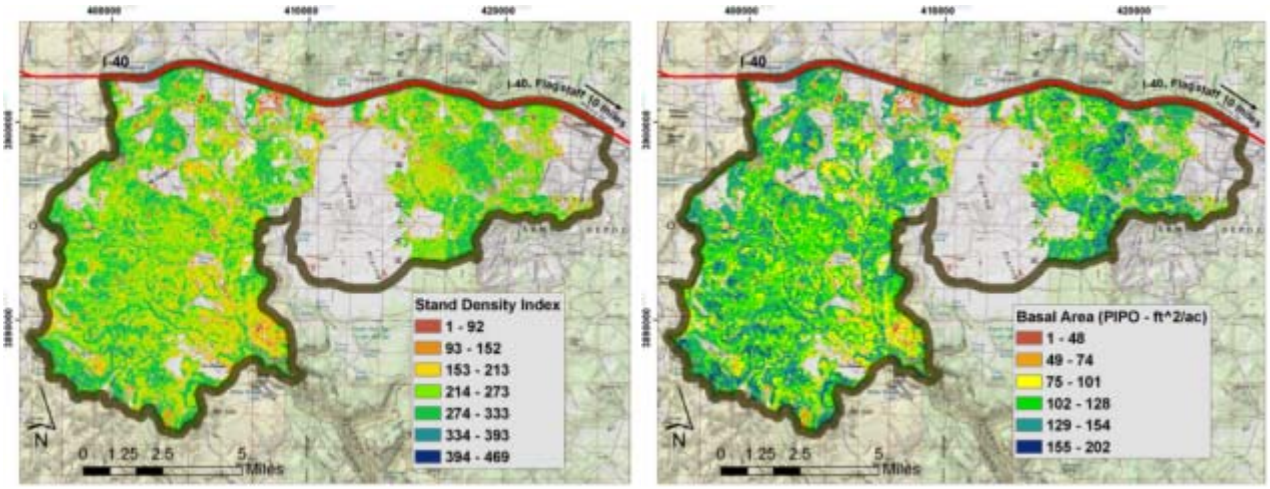



**Figure 15.** Digital forest structure layers for (**A**) SDI and (**B**) basal area.

**Fire Behavior/Risk**

Based on existing forest structure and fire behavior models, the Garland Area contains 180 acres of ponderosa pine forest that could potentially support active crown fires at 85$^{th}$ percentile conditions and 20,792 acres of ponderosa pine forest that could potentially support active crown fires at 97$^{th}$ percentile conditions (**Figure 14A, B**). Passive crown fire conditions in ponderosa pine forest accounted for 7,603 acres and 3,791 for 85$^{th}$ and 97$^{th}$ percentile fire weather categories, respectively.

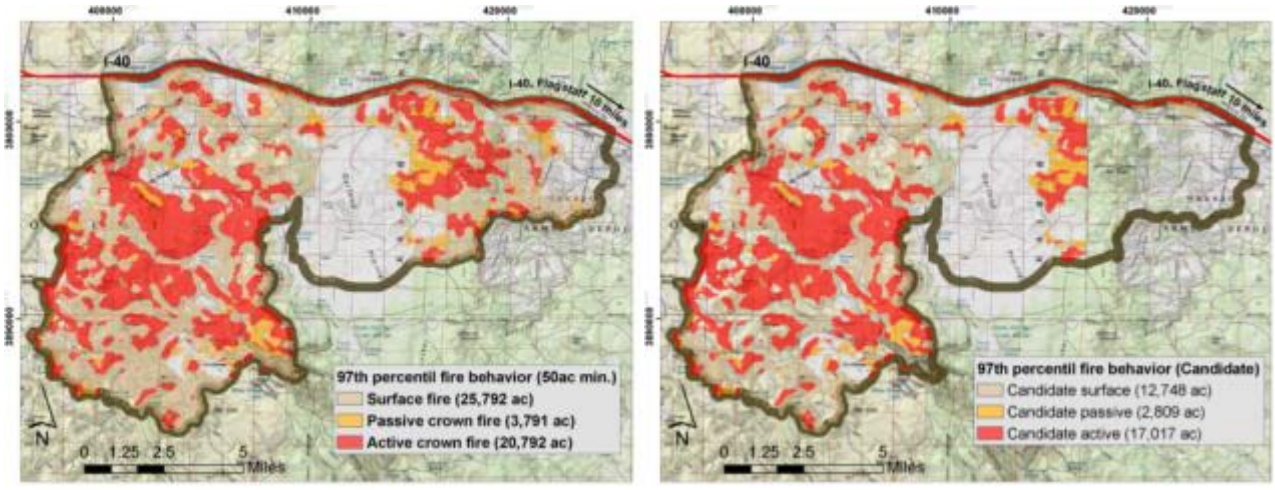



**Figure 14**. Predicted 97$^{th}$ percentile fire behavior for (**A**) ponderosa pine forest and (**B**) candidate ponderosa pine forest areas only.

**Specific Management Criteria**

The Garland Area contains areas that require specific management consideration in terms of treatment or fire protection:

17,018 acres of [TYPE OF TREATMENT] within areas of predicted active crown fire behavior within candidate areas

2,810 acres of [TYPE OF TREATMENT] within areas of predicted passive crown fire behavior that are typically adjacent to areas of active crown fire within candidate areas

4,875 acres of excluded areas [LIST TYPE OF ALL EXCLUDED ACRES]

8,382 acres of Pine-oak Mexican spotted owl restricted habitat

18,614 acres of grass and shrub dominated meadows to consider potential conifer encroachment.

**Landscape Context**

Treatment Area [##] is adjacent to Treatment Areas [#,#,#,# and #]. It is upwind from Treatment Areas [# and #], which contain relatively [DESCRIPTION OF AMOUNT OF "VALUABLE AREAS"], and downwind from Treatment Areas [# and #], which have [DESCRIPTION OF POTENTIAL FIRE BEHAVIOR IN DOWNWIND TREATMENT AREAS]. Additionally, Treatment Area [#] is bordered by [DESCRIPTION OF AREAS THAT REQUIRE SPECIFIC MANAGEMENT CONSIDERATION CONTAINED IN ADJACENT TREATMENT AREAS] that is contained in Treatment Areas [# and #].

## VI. DESIRED CONDITIONS FOR PONDEROSA PINE FORESTS IN ARIZONA

The ponderosa pine forest type occurs in the Lower Montane Coniferous Forest. Within the Four Forest Restoration Initiative (4FRI) area, the ponderosa pine ecosystem is dominated by *Pinus ponderosa* var. *scopulorum*, which occurs in pure stands and may also occur with oaks, junipers, pinyon pine, and aspen. In addition, there are transition or ecotone areas where ponderosa pine may be the dominant species, but is intermingled with juniper on drier sites, and white fir and Douglas-fir on more moist sites. Plant associations include numerous grass, forbs, and shrub species, which enhance native plant diversity within the ponderosa pine type.

The natural variability of ponderosa pine forests in northern Arizona includes predominantly frequent surface fire regimes, robust and diverse understory communities and more open, variable forest structures dominated by large, old trees often growing in groups. Fires naturally occur in late spring and summer and their frequency, extent and severity vary with climate, topography and elevation. The variability of forest productivity and structure supports diverse wildlife and facilitates natural trophic interactions. Our understanding of natural variability derives from converging lines of evidence. Those include surveys, photographs and written accounts of pre-settlement forest conditions; research reconstructing pre-settlement forest structure, function, and dynamics; and research studying contemporary relict forests not subject to industrial logging, fire suppression and livestock grazing. Reference conditions help to describe the evolutionary context of ecological systems and identify major determinants of self-regulating ecosystem structure and function.

**Desired Conditions**

Desired conditions (DCs) are defined for the 4FRI area as a set of ecological, social, and economic objectives established as both qualitative aspirations and measureable outcomes of forest restoration activities. The DCs are long-term goals and are different from post-treatment conditions and near-term plant community responses, which are regarded as milestones toward meeting landscape-scale forest restoration objectives. Restoration treatments should put forest ecosystems on a trend toward their natural structure, composition and patterns and facilitate the re-establishment of self-regulating processes consistent with reference conditions. An adaptive management approach would be implemented to promote flexible decision-making that can be adjusted in the face of uncertainty as outcomes from management actions and other events become better understood.

a. Spatial Scale

   DCs for ponderosa pine forests are identified within the 4FRI area at three spatial scales and extents:

   i. *Landscape*– 2.4 million acres in size, encompasses the entire 4FRI project area
   ii. *Analysis area*– ~750,000 acres in size, encompasses the entire analysis area contained in 4FRI's first Environmental Impact Statement (EIS)
   iii. *Firescapes* [6] -(≥200,000 acres) are a unit of analysis for comparing current base-line forest conditions and desired future conditions as a result of strategic forest restoration activities.

b. Thematic Areas

   Within each spatial scale, DCs are categorized by five thematic areas: 1) conservation of biological diversity, 2) ecosystem resilience, 3) conservation and maintenance of soil, water and air resources, 4) economics, and 5) social systems. The specificity and nature of DCs within these thematic areas differs depending on the particular spatial scale at which they are addressed.

[6] Firescapes are landscapes where fire is an important part of ecosystem processes. They are ≥200,000 ac in size and broadly delineated by terrain features, watershed boundaries, the spatial extent of ponderosa pine forest, contemporary wildland fire patterns, and infrastructure such as major roads. For purposes of the 4FRI they provide a framework to support managing fire across large landscapes in order to achieve sustainable, resilient ecosystems.

**Landscape Desired Conditions**

At the landscape scale, DCs are described as qualitative goals that should be achieved through the restoration of ponderosa pine forest types within the entire 4FRI area.

a. Conservation of biological diversity
    i. Ponderosa pine ecosystems provide the necessary composition, structure, abundance, distribution, and processes that contribute to the diversity of native plant and animal species across the 2.4 million acre 4FRI landscape
    ii. Viable, ecologically functional populations of native species that include common, listed rare and sensitive species persist in natural patterns of distribution and abundance.
    iii. Natural disturbance processes (e.g., fire, drought-mortality, endemic levels of forest pests and pathogens) are the primary agents shaping forest ecosystem structure, dynamics, habitats, and diversity over time.
    iv. Where fire use is not possible, mechanical treatments are designed to restore and/ or maintain forest structure over time.
b. Ecosystem resilience
    i. Ponderosa pine ecosystems in the 4FRI are capable of adapting to or persisting with climate change without rapid, large scale type shifts.
    ii. There is reduced potential for introduction, establishment, and spread of invasive species and the reduction of existing infestations.
    iii. Low intensity frequent fire operates as the primary natural process maintaining forest structure and function.
    iv. Mixed severity fire is sometimes used as a restoration tool in appropriate ecological and social settings (e.g., non-WUI areas) to restore and maintain natural forest types
    v. Forest insects and pathogens occur and operate at endemic levels.
    vi. Ponderosa pine ecosystems in the 4FRI are capable of regeneration and recovery following natural disturbance (e.g., fire, outbreaks of insects and pathogens).

c. Conservation and maintenance of soil, water and air resources
    i. Soil productivity, watershed function, and air quality are not at risk of being degraded by uncharacteristically severe disturbances (e.g., landscape level high-severity fire).
    ii. Sensitive soils are protected through use of appropriate timber harvesting equipment and techniques to reduce erosion and sedimentation that could otherwise damage aquatic life, increase flooding, reduce reservoir capacity, and increase costs of maintaining infrastructure in the vicinity of waterways.
    iii. Forest structure supports a variety of natural resource values and processes, including hydrologic function, which meets ecological and human needs.
    iv. Fire is used as a management tool to support hydrologic function while minimizing impacts to soils and other natural resource values.
    v. Rare and ecologically valuable springs and wet meadows are protected and enhanced through appropriate restoration treatments where needed.
d. Economics
    i. The byproducts of mechanical forest restoration offset the costs of treatment implementation.
    ii. The economic value of ecosystem services provided by restored forests (such as the value of recreation or water) are captured and re-invested to support forest restoration and ecosystem management.
    iii. Rural communities receive direct and indirect economic benefits and ecosystem services as a result of forest restoration and resilient forests.
e. Social systems
    i. There is broad public awareness, understanding/knowledge and support for collaboratively based forest restoration decisions, processes, and outcomes, including the use of fire as a management tool.
    ii. Social values and recreational opportunities are protected and/or enhanced through forest restoration activities.
    iii. Rural communities are protected from high-severity fire and their quality of life is enhanced through forest restoration.

iv. Rural communities play an active part in reducing fire risk by implementing FIREWISE actions and creating defensible space around their property.

v. There is broad public support for the 4FRI collaborative as forest restoration activities are implemented.

**Analysis Area Desired Conditions**

At the analysis-area scale, DCs are described as qualitative and functional goals that are tailored to address the specific ponderosa pine forest types and other ecological, social, and economic issues within the identified EIS analysis area.

a. Conservation of biological diversity

i. Ponderosa pine ecosystems provide the necessary composition, structure, abundance, distribution, and disturbance processes that contribute to the diversity of native plant and animal species across the analysis area.

ii. Viable, ecologically functional populations of native species that include common, listed rare and sensitive species persist in natural patterns of distribution and abundance. sustainable habitat, effects to species displayed. Sensitive and listed will be addressed, rare and declining are subjective and broad.

iii. Natural disturbance processes (e.g., fire, drought-mortality) are the primary agents shaping forest structure dynamics, habitats, and species diversity over time. Not consistent with 4FRI DC Primary natural agents, but not exclusive.

iv. Ponderosa pine ecosystems are composed of all age and size classes within the analysis area and are distributed in patterns more consistent with reference conditions.

v. Ponderosa pine ecosystems are heterogeneous in structure and distribution at the analysis area. Openings and densities vary within the an is area to maintain a mosaic appropriate to support resilience of individual trees and groups of trees.

vi. Ponderosa pine vegetation supporting listed, rare, and declining species and surrounding vegetation is strategically managed to be resilient to uncharacteristic disturbances. See ii, FS is specific to managing sensitive and listed

vii. All pre-settlement trees are Not targeted for retained. Exception for safety, some lost from fire. Neil's draft



i. Understory vegetation composition and abundance are consistent with the natural range of variability. PNV by soil type - moving toward Restoration Notes for Ft Valley, Review P&N

b. Ecosystem resilience

i. A majority of the ponderosa pine ecosystems supports frequent, low-intensity fire.

ii. Mixed severity fire is sometimes used as a restoration tool in appropriate ecological and social settings (e.g., non-WUI areas) to restore and maintain natural forest types Not a tool, result of fire because of fuel conditions

iii. Ponderosa pine ecosystems are Moving Toward restored to more natural tree densities in order to maintain availability of moisture and nutrients to support adaptation to climate change without rapid, large scale type shifts.

iv. There is reduced potential for introduction, establishment, and spread of invasive species and the reduction of existing infestations. Mitigation

v. Vegetation treatments in ponderosa pine ecosystems are designed and implemented to prevent the spread of invasive species. Ponderosa pine treatments are designed to protect soil and increase understory biodiversity and productivity to improve their resilience to invasive species. Mitigation/Monitoring

vi. Natural disturbance processes (e.g., fire, endemic pests, and pathogens) are within the natural range of variability. See P&N

c. Conservation and maintenance of soil, water and air resources

i. Ponderosa pine vegetation treatments are implemented so as to minimize negative impacts to water quality, soil productivity, and air quality. Short-term impacts are minimized through the implementation of best management practices and strategies. Consistent w/ Mitigations

ii. Restored ponderosa pine ecosystems accommodate natural and other fires without uncharacteristic impacts to soil productivity and or watershed resources. Consistent

iii. Ponderosa pine vegetation within the analysis area is managed strategically and at a level appropriate to prevent degradation of air quality beyond regulatory standards (through wildland fire or managed fire). Consistent

iv. Forest openings are designed to improve snow accumulation and subsequent soil moisture and surface water yield. Consistent, Eff Anal

v. Hydrologic processes are re-established to restore springs and wet meadow ecosystems. Consistent

d. Economics

i. The average net cost of treatment per acre for all treatments in the analysis area over a ten year period is reduced significantly. Econ Anal

ii. Sufficient harvest and manufacturing capacity exists to achieve restoration of at least 300,000 acres in the next ten years.Econ Anal, Objectives

iii. Rural communities in the analysis area experience economic benefits and improved ecosystem services associated with a restored forest and reduced high-severity fire risk. Consistent

e. Social systems

i. A majority of the general public is aware, knowledgeable and supportive of 4FRI related plans and implemented treatments within the analysis area. Implementation, Communication Strategy

ii. The general public is aware of 4FRI educational and outreach programs and has the opportunity to participate in the 4FRI effort. Implementation and Comm Strategy

iii. Treatments within the analysis area minimize short-term impacts and enhance vegetation characteristics valued by Forest users over the long-term. Effects Anal

**iv.** 4FRI restoration efforts maintain and/or enhance the quality of life of residents in the analysis area. **Diablo Trust quality of life info**

**Firescapes**

Firescapes are sub-landscapes within the analysis area which encompass >200,000 acres and where mechanical thinning and fire can be applied in a strategic and systematic manner for restoring fire adapted ponderosa pine conditions. The goal is to create a contiguous geographic area where natural fire and other disturbances can be safely restored over a time-period of approximately 5 to 20 years, depending upon existing conditions. FRCC anal

a. Conservation of biological diversity

i. There is low potential for unnaturally severe fire to spread across the firescape. Need for fuels mgt before fire.

i. Protect old-growth forest structure during planned and unplanned natural ignition fires. Implementation and Mitigation

i. Natural and prescribed fires maintain and enhance, but do not degrade habitat for listed, rare and sensitive species. Project design and eff anal

v. Habitat management is contributing to the recovery of listed species. Forest Plan/ESA

v. Wherever practicable, natural fire regimes regulate forest structure and composition. Moving toward. Inconsistent with economic DC
vi. Planned and unplanned fires support diverse native understory communities and their associated biodiversity. Unplanned outside scope, part of DC, Eff anal
vii. Populations of native species occur in natural patterns of distribution and abundance. Yes , Forest Plan
viii. Forest conditions facilitate species' movement to and from adjacent landscapes, ecosystems or habitats. Project Design

b. Ecosystem resilience

i. There is low potential for unnaturally severe fires to spread across the firescape. See above
ii. Strategically placed treatments allow fire managers to safely manage planned and unplanned natural ignitions fires in a way that benefits and enhances the resilience of forest ecosystems. Implementation
iii. Restoration results in forests that are trending toward natural variability, self-regulating, and positioned to adapt to climate change without large, rapid type shifts. Move toward resiliant forests. Not self regulating - MUSYA?
iv. Where possible, natural fire regimes regulate forest structure and composition and align forest changes with climate changes. MUSYA?
v. Natural disturbance processes (e.g., fire, endemic pests and pathogens) occur at endemic levels.
vi. Exotic species are rare or absent and do not create novel ecological communities following disturbance. FS manages habitats, Weed Mgt

c. Conservation and maintenance of soil, water and air resources

i. Strategically placed treatments allow fire managers to manage planned and unplanned fires in locations, seasons and conditions that maximize smoke dispersion and minimize smoke impacts. Design and Implementation
ii. Emissions factors, smoldering, and smoke residence time are reduced as fires burn more grass and less green or woody biomass over time. Okay
iii. Stable, restored ecosystems foster watersheds that yield enhanced water quantity and quality and are resilient to climatic variability. Okay

d. Economics

i. Fire management costs are reduced; aggressive fire suppression is unneeded or rare. Fire suppression costs reduced, Not fire mgt

ii. Mechanical treatment costs are reduced. See above

e. Social Systems

i. There is low potential for fires to enter communities. Reduced Potential

ii. Rural communities play an active part in reducing fire risk by implementing FIREWISE actions and creating defensible space around their property.

Outside of scope

iii. Strategically placed treatments allow fire managers to safely manage planned and unplanned natural ignition fires without loss of human life and property, or severe environmental impacts. Design Features

iv. Strategically placed treatments allow fire managers to manage planned and unplanned natural ignition fires in locations, seasons, and conditions that maximize smoke dispersion and minimize smoke impacts. Design Features/Implementation

v. Emissions factors are reduced as fires burn more grass and less green or woody biomass over time.

vi. The public understands, accepts, and supports fire's natural role in forest ecosystems. Okay

## VII. RECOMMENDATIONS

The above process provides a proof-of-concept for using a systematic approach to stratify a large analysis area into strategic areas for treatment area identification and description of existing and desired conditions within current and future analysis areas. From this process, the following six working group recommendations specify how forest restoration could be strategically applied within the 4FRI landscape:

1. We recommend that forest restoration proposed actions be described at three scales of analysis: the analysis area, the firescape, and the treatment area.
2. We recommend that the USFS use the process described for identifying and delineating firescapes and treatment areas as a consistent method to conduct landscape scale forest restoration and meet desired conditions. Firescapes provide a systematic process of

characterizing current forest conditions and allows managers to compare and contrast landscape differences.

3. We recommend that desired conditions for conservation of biodiversity, conservation of soil, air, and water resources, ecosystem resiliency, economics, and social systems are acknowledged at each of the three defined scales. These desired conditions should be carried forward into project-level planning and decision-making.
4. We recommend that the USFS continue to collaborate with the 4FRI stakeholder group throughout all phases of the planning process and as the LSWG and stakeholder group completes the comprehensive landscape strategy for the entire 4FRI area. This collaboration should continue to have a high-level of transparency and development of analysis milestones. The following recommended next steps would occur in collaboration with USFS and coincident with USFS planning:
    - Treatment Area Descriptions for treatment areas in the first EIS analysis area, which shall include a description of treatment area-specific site characteristics, desired future conditions, and management options for achieving comprehensive ecosystem restoration (e.g., thinning, fire management, wildlife habitat improvement, watershed management, riparian restoration).
    - A comprehensive landscape strategy report for the entire 2.4 million acres
    - Treatment Area Descriptions for the remaining 2.4 million acres that were not included in the first EIS analysis area
5. We continue to recommend that the USFS implement a monitoring program consistent with the framework and recommendations developed by the SMWG as a necessary step in the adaptive management process.
6. We recommend that the USFS work with the 4FRI stakeholder group to use available decision-support and forest modeling tools, where appropriate, to develop proposed actions, potential treatment alternatives, and to aid with post-treatment monitoring.

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**APPENDIX A. The Economics of Forest Restoration.**

The Economic and Utilization analysis of the landscape strategy identifies issues and solutions to the barriers that undermine wood utilization. It also examines policy changes that may be required for stewardship contracting. Finally, it explores the desired and emerging opportunities to capture the value of ecosystem services so that they can be used to support ecological restoration. A fuller discussion will be provided in the comprehensive landscape strategy report. A summary of the key elements of the strategy are included below.

Wood Utilization

⇒ ***Issue:*** **Administrative costs of treatment preparation are too high**. Administrative costs to the Forest Service for treatment preparation include: project preparation, task order/contract administration, planning required under NEPA and NFMA, and project management.

***Solution:*** **Strive for greater efficiency by qualifying more acres per treatment per dollar spent.**

- Where appropriate use task orders rather than contracts to save overhead cost. Although still untested, working at the landscape scale and qualifying more acres under one EIS will hopefully reduce the cost of NEPA.

⇒ ***Issue:*** **It is difficult to profitably utilize large volumes of small-diameter wood**. In order for the private sector to make a profit there must be a market place for small diameter wood products.

***Solution:*** **Where appropriate use federal and state policies to influence markets for wood products.**

- From an energy perspective maintain and/or increase renewable energy standards to increase demand for biomass generated electricity and thermal energy
- Define biomass-generated electricity and thermal energy as a "renewable energy"
- Provide a definition of biomass that is inclusive of products harvested from federal lands during forest restoration activities
- Encourage the state to purchase wood products that are manufactured from wood in Arizona
- Generally and specifically support the use of Arizona-grown, ponderosa pine-derived products (e.g., modify building codes to allow for the use of pine lumber)
- Develop financial incentive programs that support Arizona's existing and future wood products industry.

⇒ ***Issue*****: There is uneven harvest, milling and manufacturing capacity across the 4FRI region.** On the western side of the Mogollon rim infrastructure is limited; on the eastern side capacity has developed as a result of the stewardship contract.

***Solutions*****: Infrastructure should be supported where it exists and encouraged where none exists but is needed.**

- Existing infrastructure that is capable of utilizing sufficient quantities of restoration byproducts and supporting 4FRI's restoration efforts should be sustained and supported. It may be necessary in these places to subsidize treatments. The value of

restoration combined with the value of avoiding severe fire and associated damage justifies this investment.

- Where infrastructure capable of supporting forest restoration does not exist, or where exiting industry is struggling, actions should be taken that support a favorable investment climate. The Forest Service can encourage investment by configuring contracts and structuring task orders to ensure wood supply and economically viable harvest regimes over time periods that are long enough to recover costs and provide a return on investment.

⇒ ***Issue*: Wood supply can be unpredictable and therefore undermine private investment.** Predictability of wood supply from federal land is a key issue to investors. Decreasing wood supply from federal land during the late 1980s and 1990s contributed to the closing of wood-based industries in the Southwest. Several factors influence the flow of wood from federal land: (1) the capacity of the federal government to complete administrative tasks and (2) disruptions due to legal challenges.

***Solution:*** **To ensure a predictable wood supply**:

- The 4FRI will collaboratively plan management in order to build stakeholder support. The goal is to create a plan that is broadly supported, thereby lowering the risk of administrative and legal challenges.
- The NEPA documents will unfold at a large scale to achieve administrative efficiency, improve cumulative effects analysis, and improve the strategic timing and placement of treatments.
- The Forest Service and Congress will need to invest in the recruitment and training of sufficient personnel to accelerate administrative planning and deliver 50,000 acres of mechanical treatments per year.

⇒ ***Issue:*** **The contracting instrument chosen to implement treatments will influence private investment and business sustainability.**

***Solution:*** In order to sustain or attract business the contract instrument should be flexible and should:

- Support actions that are needed to perform ecological restoration
- Span a sufficient time period to provide an adequate return on private investment
- Provide a guarantee of annual acres of treatments
- Allow the exchange of goods for services

**Stewardship Contracting**

⇒ ***Issue:*** There are two significant challenges associated with using stewardship contracts to accomplish the 4FRI's goals: (1) stewardship contracts have a statutory 10-year limit on contract duration and (2) stewardship contracts generally require a cancellation ceiling. Additionally, the Forest Service's authority to execute Stewardship Contracts is scheduled to expire in 2013 and uncertainty remains regarding a legislative extension.

***Solutions:*** In order to overcome the challenges associated with using a stewardship contract the industry representatives in the 4FRI stakeholders collaborative have identified the following questions:

With regard to the contract duration:

- Can the Forest Service develop and implement a long-term strategy to sequence/phase contract issuance, within the confines of its stewardship contracting authority, to provide a contract commitment to industry that is greater than 10 years?

- Can the Forest Service immediately follow issuance of a 10-year stewardship contract with a second, prospective stewardship contract?
- Are there other options for extending the term of a stewardship contract?
- Is a statutory extension of the stewardship contract term limit feasible?

With regard to the contract cancellation ceiling policy:

- Can the Forest Service waive or negotiate the amount of the cancellation ceiling requirement for contracts that require significant investment in new infrastructure? Are funds available at the department or agency level to support the cancellation ceiling? Could such funds be guaranteed for the necessary length of time?

- Are there alternative mechanisms that would allow the Forest Service to comply with stewardship contracting cancellation ceiling requirements without creating undue financial burdens for the department, agency, or contracting entity?

With regards to the contracting authority:

- Will the Forest Service or Congress be renewing the Stewardship Contracting Authority?

**The Economic Benefits of Restored Forests: Wood Utilization and Ecosystem Services**

The strategy identifies numerous economic benefits provided during and after restoration in a restored forest. These include:

- Significant economic benefit for local and regional economies due to businesses and jobs created.
- Reduced wildfire costs both in terms of the cost of wildfire suppression and potential losses due to severe fire.
- Enhanced economic activity associated with recreation, wildlife viewing and hunting
- Protection and conservation of watersheds that support water quality and quantity
- Carbon Sequestration and uncharacteristic loss of carbon due to severe wildfire in overstocked forests.

**APPENDIX B.** List of analyses identified as important for landscape level restoration planning by the LSWG.

**Biodiversity**

1. Model wildlife habitat corridors for focal species.
2. Incorporate existing species richness models (for both wildlife and plants).
3. Incorporate the characteristics of fire refugia into decision criteria for prioritizing treatments (e.g., identify areas that would have a higher probability containing naturally dense canopy conditions).
4. Incorporate existing and future recovery plan actions and recommendations into treatment design.
5. Identify habitat requirements necessary to maintain viable populations of focal species.
6. Map current distribution of invasive plant focal species and invasive vertebrate species.

**Fire**

1. Map natural fire regimes; analysis to be designed with fire-researchers.
2. Map firescapes – discrete geographic areas, or Fire Management Units/Zones, within which strategically placed and sequenced treatments facilitate safely managing planned and unplanned ignitions for resource benefit.
3. Model maximally efficient configurations of ecological restoration treatments that would slow the spread of large scale crown fire under 97$^{th}$ percentile conditions.
4. Identify area where ecological restoration treatments would reduce crown fire behavior under the 97$^{th}$ percentile fire weather conditions.
5. Identify areas where ecological restoration treatments would reduce crown fire behavior under moderate (85$^{th}$ percentile) fire weather conditions.
6. Identify areas where ecological restoration treatments would facilitate the operational management of planned and unplanned ignitions.
7. Plan wildland fire suppression tactics that are operationally effective to protect life and property and community infrastructure.
8. Update CWPPs to identify co-operative funding options, jurisdictions, and responsibilities to fund implementation strategies outside of Federal and State jurisdictions.
9. Evaluate utilization of all policies, authorities and outcome objectives, to meet desired protection outcomes

**Restoration**

1. Develop landscape scale forests consisting of a range of size and age classes dominated by larger, older trees. Use forest and remote sensing data to characterize and plan treatment areas.
2. Develop forest structure that reestablishes natural range of variability, maintains/enhances heterogeneity, and consists of groups and clumps defined by openings. Use forest and remote sensing data to characterize and plan treatment areas.
3. Develop understory habitat that includes native shrubs, grasses and forbs. Plan overstory treatments to release understory vegetation.
4. Restore micro-habitat features. Account for specific habitat features (e.g., springs, grasslands, late-successional conditions) while planning overstory treatments.
5. Identify areas potentially impacted by terrestrial operations or areas benefiting from treatments.

6. Use climate change models and forest and remote sensing data to characterize vulnerable areas, identify snow retention areas, etc.

**Utilization/Economics**

1. Understand existing and innovative tree harvest, wood and biomass utilization. Refresh analyses of products and markets and enlist the assistance of the Forest Products Lab.
2. Identify and provide support for federal contracting approaches that encourage investment with a focus on longer contract lengths.
3. Identify current infrastructure, businesses and markets that support wood harvest.
4. Identify areas available for mechanical harvest.
5. Analyze different contract tools and approaches to achieve DCs.
6. Work with the USFS to identify key places where administrative efficiency can be achieved.
7. Explore partnership opportunities with utilities or other entities that benefit from healthy forests.
8. Quantify the number and economic importance of non-wood based businesses.
9. Understand the economic value of water derived from northern Arizona forests and map watersheds and municipalities using the water. Attach economic value to the water
10. Consider the value of sequestering and off-setting carbon emissions.

h/o on 11/06/09

DRAFT 10.17.07

# Desired Ponderosa Pine Forest Conditions for Wildlife in the Southwest

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## *Introduction*

NOTE: THIS DOCUMENT IS DRAFT ONLY AND SHOULD NOT BE DISTRIBUTED OR CITED ELSEWHERE. THERE ARE MANY CITATIONS IN HERE THAT NEED TO BE VERIFIED, THERE ARE NEW STUDIES THAT NEED TO BE INTEGRATED, AND THEREFORE CONTENT IS SUBJECT TO ADJUSTMENT. PLEASE VIEW THIS AS A WORKING DOCUMENT.

Southwestern ponderosa pine (*Pinus ponderosa*) forests have undergone substantial changes in structure and function since the late 1800's (Cooper 1960, Covington and Moore 1994, Swetnam and Baisan 1996). Among the pressures of contemporary forest management, fire regime alteration has played the greatest role in shaping current forest conditions (Fulé et al. 2002). Pre-1900 fire return intervals in southwestern ponderosa pine forests ranged from 4 – 36 years, at most (Swetnam and Baisan 1996, Grissno-Mayer et al. 2004); however, fire has been effectively excluded from much of the landscape for the last 100 years or more. The lack of fire in these forests has resulted in increased tree densities, decreased average tree diameter, and an increased risk of uncharacteristic, high-severity wildfires. Ultimately, the best method for returning forest conditions to within the natural range of variability is to restore a frequent fire regime (Allen et al. 2002). However, many forests are currently too dense to accommodate the reintroduction of fire without mechanical thinning. Therefore, to reduce the risk of uncharacteristic fire and increase the ability of a forest to withstand fire occurrence, managers use a variety of forest treatments, including thinning to reduce surface fuels, increase the height to live crowns, and decrease crown density. Fire-risk reduction is of immediate concern in the wildland urban interface (WUI), that area of forested lands adjacent to communities. Because ponderosa pine landscapes were naturally heterogeneous (Covington and Moore 1994, Allen et al. 2002, Fule et al. 2002), we believe the spatial pattern of retained trees can play an important role in determining the value of the landscape for wildlife habitat, even when managing primarily to reduce fire risk. Though the resulting spatial patterns created through management practices have generated discussion, little has been done to better understand how these spatial patterns specifically affect native wildlife species or how to better influence forest pattern and function to meet wildlife habitat needs in the interim period before fire can be used to shape forest structure and pattern.

Therefore, in an effort to better communicate wildlife habitat needs to forest managers and silviculturists, the Arizona Game and Fish Department and U.S. Fish and Wildlife Service have created this document to define our request that fuels-reduction and forest-restoration projects

create a "heterogeneous, multi-aged, clumpy/groupy forest structure." The following discussion is intended to describe a desired future ponderosa pine forest pattern, using combinations of clumps, groups, and openings, to attempt to address wildlife habitat needs and forest restoration objectives. The description was built with data from research regarding "natural" forest structure within an ecological framework (e.g., historic range of variability and reference stand conditions). In addition, the description is supplemented with published wildlife habitat responses to those conditions in southwestern ponderosa pine forests. The information provided is not intended to be prescriptive, but rather descriptive of forest condition and structures we believe need to exist immediately following treatment and into the future, to provide for a variety of short- and long-term wildlife needs. The ultimate goal of incorporating defined clumps, groups, and openings, is to create "landscapes within landscapes" that have variable patterns of live and dead trees, and downed woody debris, over space and time and meet multiple species habitat requirements.

It should be stressed that this discussion is an attempt to better describe how to incorporate spatial design and pattern into forest restoration treatments. In reality, forest structure is greatly affected by bio-physical factors we have no control over, including soils, moisture availability, elevation, aspect, current climate, "old" tree persistence, and future regeneration, to name a few. The factors we can manage, such as livestock grazing, fuel-wood collection, etc. also influence forest structure at many scales.

We recognize that modifications to forest composition and structure will benefit some wildlife species and adversely impact others. There is no specific prescription or forest condition that will maximize habitat value for all species, therefore tradeoffs are unavoidable. Some species of concern may have benefited from forest conditions that are now viewed as ecologically unsustainable. Ganey et al. (1999) noted that closed-canopy ponderosa pine forests, used heavily by Mexican spotted owls (*Strix occidentalis lucida*) are relatively rare and would require special management, as the dense habitat conditions might conflict with efforts to restore more open ponderosa pine forests. In general, however, wildlife population dynamics (competition, predation, reproduction, survival) will equilibrate more rapidly when forest conditions are composed of a greater percentage of clumps, groups, and spatial heterogeneity at multiple scales.

Group, clump, interspace, and opening are defined in the following table. Please refer to the two figures for spatial arrangement of defined terms. Note: 'openings' should not be confused with meadows. Meadows are characterized by soil type, thinner O horizons, thinner A horizons, and higher pH, and historic evidences (Kerns et al. 2003). Openings and interspaces differ from meadows because they shift from a treeless state to a treed state, in the same dynamic process by which clumps and groups shift from a treed state to a treeless state

***Figure 1. Example of the desired spatial configuration of clumps, interspaces, groups, and openings within a ponderosa pine site in a wildland (or equivalent word) setting. Clumps of trees with interlocking canopies vary in size and are separated by interspaces. Groups of clumped trees vary in size, and larger groups are oriented perpendicular to the prevailing wind vectors and are separated by large openings up- and downwind. Not drawn to any scale.***

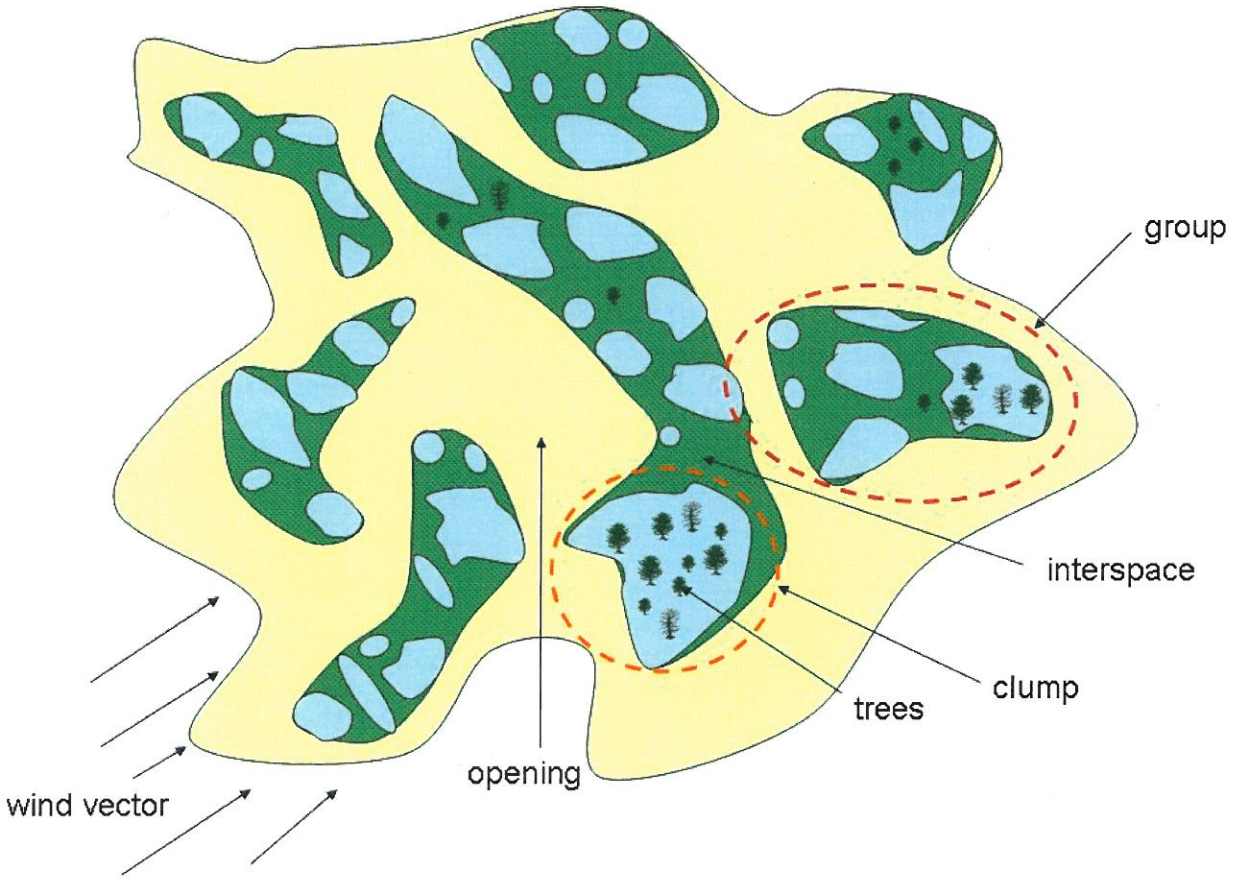


***Figure 2. Example of the desired spatial configuration of clumps, interspaces, groups, and openings within a ponderosa pine site in an urban interface setting (e.g., City Wellfield, Flagstaff). , Clumps of trees with interlocking canopies vary in size and are separated by larger interspaces compared to sites outside the interface. Groups of clumped trees may be smaller in size compared to sites outside the interface, and large groups, where appropriate, are oriented perpendicular to the prevailing wind vectors and are separated by large openings up- and downwind. Tree density may be lower near dwellings and structures. Not drawn to any scale.***

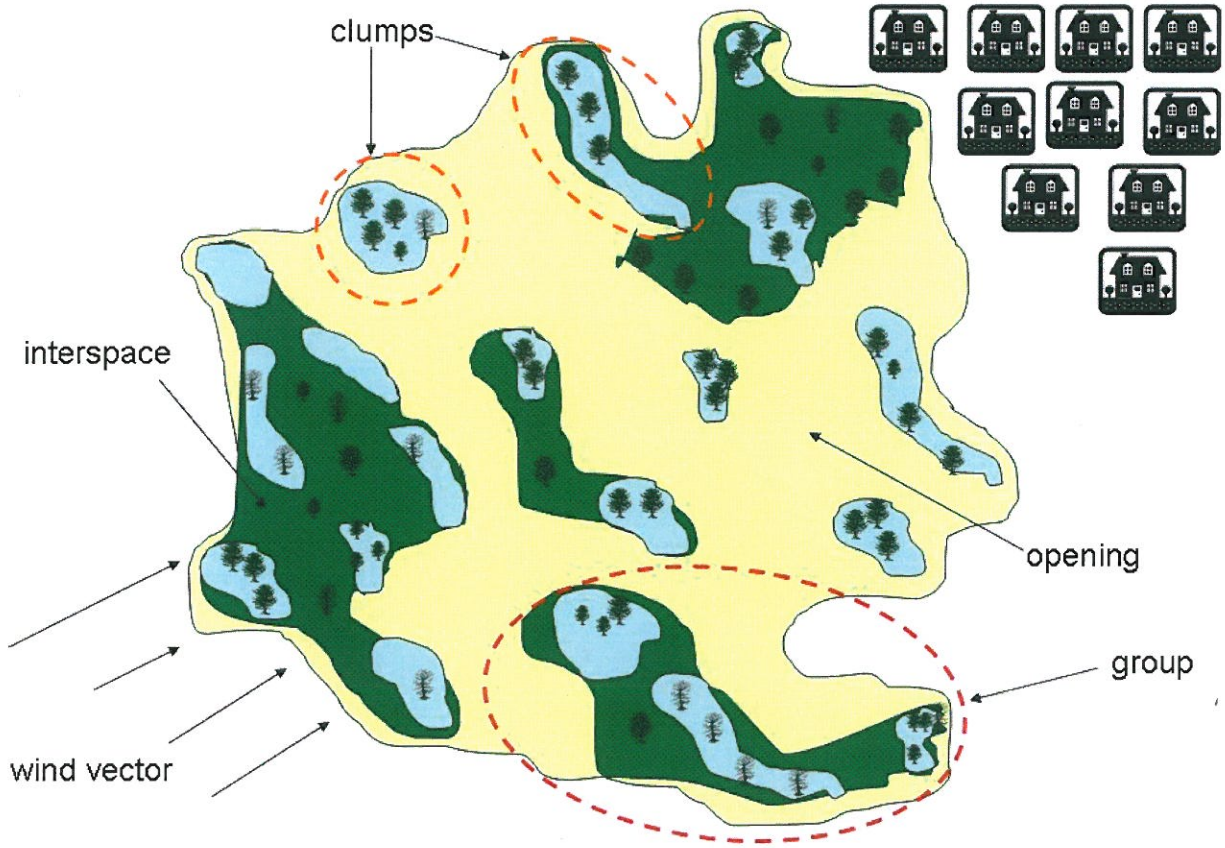


***Table 1. Structural elements of the desired ponderosa pine forest condition for wildlife in the southwest. Ranges of numbers are provided for each structural element to demonstrate variability; the intent is not to have one number drive implementation. Structural elements are referenced from published ecological studies of the historic range of variability in southwestern ponderosa pine forests. Wildlife responses to those structural elements are also referenced from published wildlife ecology studies in southwestern ponderosa pine forests, and are supplemented with un-cited management recommendations that may enhance heterogeneity in wildlife habitats. (There are inconsistencies in the period vs. no period within the bullets in the table—no biggy, but will need to be cleaned up)***

DRAFT

| Structural Elements | Aggregation | Age structure | Interlocking canopies | Separation | # trees/aggregation | Area (acres) | Recommendations* | Wildlife References |
|---|---|---|---|---|---|---|---|---|
| Clump | • Small size and relatively dense aggregation.<br>• Can be approx. 2x height of mature trees [32]<br>• Should be based upon the size and frequency distributions of natural disturbances [17] | • Can be similar (e.g., a clump of yellow pines), but uneven age structure desirable[18, 19, 25, 36]<br>• Snags retained[23]<br>• Regeneration in along edge of clump, in 'safe sites' (micro-sites with reduced overstory and herbaceous competition, e.g., the ash bed of a consumed log where seedlings establish above lethal flaming zone)[19] | • Desired for all trees in the clump.<br>• Must be maintained for older, larger trees.<br>• Can allow for some growth in clumps with smaller trees | • Break in canopy (inter-spaces) | • 3-44 trees if dbh >36 cm or yellow-bark*[36]<br>• Some clumps of smaller trees may have >44 stems<br>• 88% of leave trees should be in clumps[36] | • 0.05 – 0.74[18]<br>• 0.14 – 0.35[5]<br>• 0.49[31]<br>• 0.49 – 0.71[36] | • Manage for a range of sizes and # stems in clumps, not just the minimum.<br>• Retain existing clump structure informed by pre-settlement evidences and natural disturbance regimes when available[1, 11]<br>• Avoid removing trees within the clump that encourage vertical diversity[8, 27]<br>• Retain snags and down woody debris within clumps[4, 9, 26, 38]<br>• Retain some percentage of trees with dwarf-mistletoe brooms[12]<br>• Retain shrub and oak components [11b, 13, 22, 30, 30] | • Turkey – 4-150 trees/clump[34, 35]<br>• Breeding birds – uneven aged within clump[30]<br>• Foliage-gleaning songbirds – favor denser clumps[30]<br>• Tassel-eared squirrels - ≥5 trees/clump , smaller trees included in clump[7, 8]<br>• Mule deer - ≥ 0.10 acres (range 0.05-0.10)[13] , ≥ 0.98 acre[3]<br>• Down woody debris – lizards[14], small mammals[3, 29], bears[25]<br>• Small mammals – 30% of clumped residuals as mature and old live trees[9]<br>• Interspersion of age classes within clump: American robin – high, band-tailed pigeon – moderate, chipmunks – moderate, cottontails – high, mourning dove – high, northern flicker – high, tassel-eared squirrel – moderate[27]<br>• Oak retention – songbirds[30, 31 37b], bear [22, 25], deer[13] |
| Group | • Large in size & more loosely aggregated.<br>• Contains 2 or more clumps and some individual trees nested within groups.<br>• Number of groups may vary, but fewer & larger groups are often desirable. | • Multi-age & multi-structure across the group[19]<br>• The goal should be toward at least 3 age classes intermingled intimately on the same area.<br>• Snags retained[23]<br>• Regeneration in 'safe sites' (see definition in clump) [36] | • In clumps embedded in the group, but not across the group | • Openings | • Varies based on spatial arrangement of clumps | • Varies based on spatial arrangement of clumps but must create a random aggregation pattern across the stand[31]<br>• Should be > 0.75 acres up to any acreage.<br>• Larger groups downwind of larger openings. | • Create a mosaic of groups.<br>• Retain snags and down woody debris within groups[4, 9, 26, 38]<br>• Feather groups into openings.<br>• Retain shrub and oak components [11b 13, 22, 30, 25] | • Breeding birds - ≥5 acres in size, high density of VSS6[30]<br>• Bears <1 acre for female bedding[22]<br>• Bats – larger, older, denser groups[9]<br>• Down woody debris – lizards[10, 14], small mammals[2, 29], bears[25]<br>• Oak retention – songbirds[30, 31 37b], bear [22, 25], deer[13] |

* Thinning projects should emphasize the rare VSS classes and ages within the clump, group, and stand, and focus fuels reduction on the most common VSS class.

| Structural Elements | Opening, relative to aggregation | Age structure | Interlocking canopies | Separation | # trees | Area (acres) | Recommendations | Wildlife References |
|---|---|---|---|---|---|---|---|---|
| Inter-space | • Small in size.<br>• Break in canopy between clumps | • None<br>• Little to no regen., area maintained by frequent fire | None | • Break in tree canopy | • None – should remain treeless[24] | • Should depend on historic fire severity, where landscapes with mixed severity fire regimes have larger interspaces and openings[15]<br>• ≤ 0.03 acres[16] | • Enhance inter-spaces between existing clumps.<br>• Maintain many small inter-spaces between clumps[15]<br>• Retain down woody debris [4, 9, 26, 38]<br>• Retain shrub and oak components [11b 13, 22, 30, 25] | • Tassel-eared squirrels - < 2.47acres[7, 8]<br>• Small mammals – high interspace-to-clump ratio[9]<br>• Raptors – increased small mammal forage availability with high interspace-to-clump ratio [25]<br>• Ground-foraging songbirds – high interspace-to-clump ratio [25]<br>• Oak retention – songbirds[30, 31 37b], bear [22, 25], deer[13] |
| Opening† | • Large in size.<br>• Break in canopy between groups | • None<br>• Some regeneration, limited by frequent fire[moore, andy]<br>• Snags retained[23] | None | • Outer canopy of the trees on the boundary of the group | • None<br>• Regeneration events controlled by restoration of a more frequent fire interval. | • 100' to 150' wide, 0.25-0.5 acres [24]<br>• Opening estimates much larger than 0.5 acres exist in multiple Forest Plans, however, we are currently seeking the literature citations to substantiate those estimates | • Create a mosaic of openings, with larger openings surrounding and upwind of large groups.<br>• Orientation should be perpendicular to prevailing wind.<br>• More & larger openings desireable.<br>• Can be larger than 10% of stand.<br>• Can be > 200 ft wide.<br>• Create irregular shapes.<br>• Feather groups into openings.<br>• Retain down woody debris [4, 9, 26, 38]<br>• Retain shrub and oak components [11b 13, 22, 30, 25]<br>• Maximize herbaceous species diversity | • Mexican Spotted Owls – ¼ to 2 acres[38]<br>• Northern Goshawks – ¼ to 4 acres[27]<br>• American robin – 2-4 acres<br>• Band-tailed pigeon - >4 acres<br>• Chipmunks – 2-4 acres<br>• Cottontails – 2-4 acres<br>• Ground squirrels – 2-4 acres<br>• Northern flicker <2 acres[27]<br>• Turkeys - ≤ 1.2 acres[29]<br>• Bears - ≤ 1 acre, <25% in openings[22]<br>• White-tailed deer – high edge ratio[9]<br>• Oak retention – songbirds[30, 31, 37b], bear [22, 25], deer[13] |

† Very little information is available on the historic range of variability for forest interspaces and openings, particularly in terms of size and proportion of the stand or landscape. However, a preponderance of literature exists on wildlife use and selection for forest openings on the landscape scale. If a particular spatial arrangement of groups does not meet fuel-reduction objectives, we recommend increasing the size of openings rather than decreasing the size of heterogeneity of clumps and groups.

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2011-03-14
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COCONINO N.F.

GREATER FLAGSTAFF FORESTS PARTNERSHIP

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001

March 11, 2011

Mike Williams
Supervisor, Kaibab National Forest
Earl Stewart
Supervisor, Coconino National Forest

**RE: Four Forest Restoration Initiative, 1st Phase Proposed Action**

Dear Mike and Earl:

Thank you for the opportunity to provide comments on the proposal to conduct restoration activities on ponderosa pine ecosystems within a 750,000-acre portion of the Coconino and Kaibab National Forests as part of the Four Forest Restoration Initiative (4FRI) (Letter of January 21, 2011, File Code: 1950). We applaud the Forest Service (FS) for this bold initiative and for willingness to work collaboratively on the planning of such a large and innovative project.

General

As you are aware, the Greater Flagstaff Forests Partnership (GFFP) has been working on forest restoration and community protection activities throughout the Greater Flagstaff landscape for more than 12 years. As such, several Partners from GFFP have been heavily engaged in the 4FRI since the inception of this historic landscape scale restoration project. Working directly with the FS 4FRI Team and, as members of the 4FRI Stakeholder Group, the GFFP has been greatly encouraged by the efficiency and depth of your approach to this dynamic effort. As members of the 4FRI, we have reviewed the letter that will be submitted on behalf of the Stakeholders to the FS regarding this Proposed Action (PA) and agree and concur with the comments provided in that letter under the eight headings of: 1) Detail; 2) Strategic Placement of Treatments; 3) Old Growth; 4) Managing with Fire; 5) Ecological Restoration; 6) Economics and Utilization; 7) Monitoring; and 8) Adaptive Management. We therefore reinforce those comments with this letter.

General

We also provide the following comments directly from the GFFP Board of Directors:

1) Based on the section of the PA (page 3) and on the FS 4FRI Team presentations made at the recent Public Workshops regarding treatment options or approaches for the PA, we are concerned regarding the limited number of treatment types as presented. We hope that there will be a variety of treatments that actually could be implemented within any one of the treatment options identified. GFFP looks forward to working with you to develop the treatment scenarios into more specific treatment options based upon site specific resource considerations.

50-1

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We want to ensure that the PA results in a diversity of thinning and fire treatments that provide the full natural range of variability of forest structure, composition and function necessary to meet all resource objectives and that will support natural fire regimes across the landscape.

2) We are encouraged by your discussion of "strategic placement of treatments would maximize the ability to reduce fire risk" in the PA section (page 3, paragraph 3). The GFFP believes that the Lake Mary Watershed (LMW) is a priority treatment area (municipal water supply source prioritized in the local CWPP). In utilizing a strategic placement of treatments approach, we recommend the LMW is prioritized as one of the first treatment implementation areas. GFFP would like to work with the FS, City of Flagstaff (a GFFP Partner) and other stakeholders to designate the LMW as a priority area and assist in designing a treatment approach and an aggressive timeline that reduces the potential negative effects of a severe fire on this critical watershed that so many citizens cherish and rely on. 50-2

3) As stated above relating to the 4FRI Stakeholder Group comment letter, the GFFP is concerned about a lack of specificity in the PA and during Public Workshop presentations about where, when and what type of treatment action will take place. Related issues are: determining where treatments, especially silvicultural and fire-based, fit into a trajectory of achieving restoration objectives outlined in the Desired Future Conditions (DFCs); how stakeholder "filters" (such as Candidate Areas or the Old Growth Protection and Large Tree Retention Strategy) may affect treatment placement and intensity; and how various other "filters" are applied and prioritized to potentially modify and refine proposed treatments at the project level. To that end, GFFP commits to working with the FS to develop a Landscape Restoration Matrix that can be incorporated into the final PA; one that could be used at the Treatment Area, Firescape or full Analysis Area level. 50-3

4) The GFFP worked with the FS and 4FRI Stakeholders in development and submission of the Collaborative Forest Landscape Restoration Program (CFLRP) proposal, which was ranked first nationwide and funded with $2M. We were surprised the CFLRP was not mentioned in the PA, as well as how the two projects fit together. 50-4

5) Lastly, we look towards implementing an effective adaptive management program. To this end, an essential component is an efficient, cost effective monitoring program that will directly inform management decisions. GFFP is committed to this process and will strive to work with the FS to provide a systematic and pragmatic approach that will ultimately improve project planning, reduce conflict and increase trust. It is our expectation that both the 4FRI Stakeholders and the FS commits the resources to this process. Without adaptive management in the forefront, the potential success of the 4FRI project will be compromised. 50-5

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Finally, we commend the FS on your efforts to date, and on your approach to such an ambitious project traveling an uncharted course. Your work to date has been excellent and we appreciate the collaborative engagement provided!

We look forward to working with you on this PA throughout the NEPA process as appropriate to collaboratively develop an effective and socially acceptable landscape restoration plan and project. Then hopefully the hard work begins – implementation!

With Warm Regards,

Paul Summerfelt
President, GFFP Board of Directors

Enclosure: Landscape Restoration Matrix

cc: GFFP Board of Directors & Partnership Advisory Board
Henry Provincio & Paula Cote, 4FRI Team, USFS
Ethan Aumack & Steve Gatewood, Co-Chairs, 4FRI Steering Committee

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2011-03-14-43

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Eastern Arizona Counties Organization
P.O. Box 2010, Payson, AZ 85547
Ph: 928-472-5377 Fax: 928-472-5379 Cell: 928-587-1322

March 9, 2011

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001

Dear Four Forests Restoration Initiative Planning Team:

The Eastern Arizona Counties Organization ("ECO") welcomes the opportunity to submit comments on the U.S. Forest Service's "Notice of intent to prepare an environmental impact statement" for proposed restoration work on the Kaibab and Coconino National Forests, i.e., the "Proposed Action" ("PA") for the first phase of the Four Forests Restoration Initiative ("4FRI"). This PA was published in the Federal Register, January 25, 2011, pp. 4279-4281. The respective counties within ECO are Gila, Graham, Greenlee, Apache, and Navajo.

general

ECO has long been involved in the movement that culminated in the 4FRI Stakeholders' Group and the Forest Service's 4FRI response. We are particularly interested in having finally come to fruition the long-talked-about "appropriately-scaled industry" capable of thinning and beginning to restore 30,000 (or more) acres of ponderosa pine forest per year for many years. The profit motive inherent in American capitalism must be channeled toward utilization of woody biomass from our overgrown national forests, in fair exchange for the thinning and restoration objectives outlined within 4FRI. We recognize that the days of heavy federal subsidies in exchange for thinning activities in our national forests are over and that we are seeking a new paradigm.

general

The comments that ECO has on the PA are twofold: 1) comments on the "Purpose and Need for Action," and 2) comments on the actual "Proposed Action."

Purpose and Need for Action

A. This section was silent about the need for economic partners, e.g., that "appropriately-scaled industry" and the contract necessary to attract such industry. Successful implementation of most of 4FRI's ambitious restoration objectives has all along been based on the assumption of a large-scale industry partner that would economically utilize the thinned forest material in exchange for restoration services. Without this, 4FRI becomes just another planning exercise with little chance for implementation at the landscape-scale envisioned.

1

B. There is no mention of the need for a large-scale, long-term contract in order to accomplish the ambitious goal of 4FRI. The essential concept central to the 4FRI effort is that the status quo (i.e., small-scale, short-term contracts) has not worked in restoring Arizona's ponderosa forests to healthy conditions. Rather than a few small contracts,

2

there is widespread acknowledgement and agreement that there must be a large-scale, long-term contract of sufficient size and time frame to attract an industrial user of the biomass. This contract needs to be for a 20-year time period. Surely this is a "need" which can be expressed in a "Purpose and Need for Action" statement without getting into contractual specifics.

C. The only explicit mention of the term "thinning" is for "Gambel oak, aspen, and grasslands." Ponderosa pine definitely should be thinned from these areas, but they represent only a very small portion of your 750,000 acre project. You need to be specific about all the types of areas that will require "thinning," not just the minority areas in terms of volume.

3

D. Regarding the maintenance of the forests over time, you only noted the use of fire. While fire may be the ideal preferred method, given the current conditions that exist – and which you attempt to describe – there will also be a need for mechanically thinning. Already there is a demonstrated need (and call by some groups) to "re-enter" portions of the landscape that have previously been mechanically thinned. Both fire and mechanical thinning should be available tools to maintain our forests in a healthy condition.

4

Proposed Action

A. The statement is made that the Forest Service intends to conduct restoration activities over approximately a 10-year period. This statement should be changed to a 20 to 30 year period for at least two reasons. First, the 10-year time frame grossly understates the complexity of the amount of thinning and restoration needed within the project area. Given that this is a new way of accomplishing needed restoration, a longer time parameter is needed. Second, and in keeping with the above-comments, is the absolute need for a long-term contract well beyond the "approximately a 10 year period" currently being considered by the Forest Service, e.g., a 20-year contract. If the contract is the basis for the restoration work, then the restoration and contract terms should be closely linked and reflect reality.

5

B. The statement that "Trees cut would be mechanically piled, burned, lopped and scattered or removed" is indicative of the old model of Forest Service, whereby contractors were subsidized to "pile and burn" the results of thinning efforts. If 4FRI truly represents a new model whereby the forests are thinned and set on a path toward restoration because of the recognized economic value of the woody biomass available to industry partners, then any "Proposed Action" should be absolutely clear on this point and not hide behind old tired "pile and burn" verbiage.

6

C. Just what is meant by "Cut trees using a range of treatment methods including group selection, intermediate and pre-commercial thinning."? Pre-commercial thinning implies removing trees of less than merchantable size from a stand so that the remaining trees will grow and increase in value, and therefore profit. Does the Forest Service really want to do pre-commercial thinning in Arizona's ponderosa forests? It would seem that this

7

activity would be contrary to your stated policy to manage for old age (and hence larger) trees.

If this is to be the only explicit statement to cutting trees, then there is a serious flaw in the "Proposed Action." There needs to be a clear, unequivocal statement about the extent and amount and types of cutting, a statement that does not hide behind "treatments." If there is expected to be commercial thinning and harvest – read "cutting" – then that needs to be a very real part of the "Proposed Action," especially if the desired restoration work is dependent upon such commercial activity.

8

The above comments have a common theme: Be willing to acknowledge the need for and usefulness of industry partners to work on the ambitious restoration goals, and be open and clear about the need to commercially cut a large amount of ponderosa pine in order to achieve a healthy forest capable of withstanding fire.

general

In other responses from our fellow 4FRI Stakeholders (and others) you will no doubt hear detailed comments about various aspects of your proposed restoration activities. The restoration planning will consume an enormous amount of detail about a very fine-scale geography. Yet without a viable means to implement such planning, it will all be for naught. ECO therefore has chosen to focus its comments not on restoration but rather on what it will realistically take to accomplish this well-planned restoration at the landscape-scale.

general

Thank you for your consideration of these comments. We look forward to continuing to work toward the vision of 4FRI.

Respectfully submitted,

Mark C. Herrington, Chairman
Eastern Arizona Counties Organization
Supervisor, Graham County

Richard Lunt, Vice-Chairman
Eastern Arizona Counties Organization
Supervisor, Greenlee County

Tommie Martin, Board Member
Eastern Arizona Counties Organization
Supervisor, Gila County

David Tenney, Board Member
Eastern Arizona Counties Organization
Supervisor, Navajo County

R. John Lee, Board Member
Eastern Arizona Counties Organization
Supervisor, Apache County

2011-0307-44

March 7, 2011

Earl Stewart, Supervisor
Coconino National Forest
1824 South Thompson St.
Flagstaff, AZ 86001

Re: 4 Forests Restoration Initiative

I would like to participate in the public comment period concerning the proposed 4 Forests Restoration Initiative, by bringing to your attention the fact that, although the restoration of the health of Arizona's forests is a worthy goal in which all of us can participate, the excessive use of prescribed fire to bring this about presents a real threat to the health of northern Arizona residents and is, in the long run, counter-productive to the long range goal of preserving our air and water quality at as high a level as possible.

Granted that, as stated in the 4FRI proposal, "high-intensity wildfires and subsequent insect and disease outbreaks" from a build-up of organic residue on the forest floor and crowded growing conditions have caused damage to the forests as well as threatening communities located near them, a program such as the proposed initiative that calls for "multi-decade" use of mechanical thinning followed by prescribed fires can only lead to a worsening of the air quality of the Northern Arizona environment. Such a program will, during the burning part of the process, release large amounts of PM10 particulates, greenhouse gasses, various petrochemical accelerants used to start the fires, and possibly dioxin and other harmful chemicals accumulated in the trees themselves into the air. At a time when climate change and the need to control greenhouse gas emissions is of critical import, it does not make sense to put massive amounts of carbon and particulates into the air through widespread use of prescribed burns.

As a case in point, the recently proposed Arizona Department of Environmental Quality (ADEQ) Arizona State Implementation Plan (SIP) Regional Haze, Section 308, is intended to bring Arizona into compliance with the Environmental Protection Agency Clean Air Act and restore visibility to the Class I national parks in Arizona. As stated in the proposed Regional Haze SIP "Across the country, regional haze has decreased the visual range from 140 miles to 35-90 miles in the West, and from 90 miles to 15 -25 miles in the East. Regional haze is air pollution that is transported long distances, causing reduced visibility in national parks and wilderness areas. This haze is composed of small particles that absorb and scatter light, affecting the clarity and color of what we see. The pollutants that create this haze are sulfates, nitrates, organic carbon, elemental carbon and soil dust. Human-caused (anthropogenic) sources include industry, motor vehicles, agricultural and forestry burning, and windblown dust from roads and farming practices." (My underlining.)

Arizona has 12 Class I areas: Chiricahua National Monument, Chiricahua Wilderness, Galiuro Wilderness, Grand Canyon National Park, Mazatzal Wilderness, Mount Baldy Wilderness, Petrified Forest National Park, Pine Mountain Wilderness, Saguaro National Monument, Sierra Ancha Wilderness, Superstition Wilderness, and Sycamore Canyon Wilderness. A number of these are in the area that will be affected by the smoke from prescribed burns implemented as part of the 4FRI. This will further reduce visibility, and, therefore, visitor enjoyment of the national parks which are one of the major attractions bringing tourists and revenue to northern Arizona. As stated in the proposed SIP "The goal of the Regional Haze Rule is to eliminate human-caused visibility impairment in Class I areas across the country. It contains strategies to improve visibility over the next 60 years, and requires states to adopt implementation plans." Large-scale prescribed burns in the Four Forests would, in the long run, be counter-productive to this goal as

well as detrimental to the health of the forests, the economy of the region, and the well being of northern Arizona residents.

I would like to present my own experiences with smoke from the wide-spread use of prescribed burns in the Apache-Sitgreaves National Forest as an example of the likely results if prescribed burns are used extensively as part of the 4FRI:

I live in an area (Snowflake, AZ) that is negatively affected by the smoke from the many prescribed burns and managed wildfires (wildfires in remote areas that are allowed to burn, sometimes for months at a time, as a part of "resource enhancement" management practices) connected with the White Mountain Stewardship Contract (WMSC). The WMSC is the first and largest forest stewardship contract in the nation, and the forest management model on which the 4 Forests Restoration Initiative is to be based.

When I first moved to this area (because of respiratory problems), the WMSC had not yet begun, the air was clean, and my respiratory difficulties abated shortly after my arrival. But in the past several years, due to increased, nearly year-round, long-duration, prescribed burns I have had a return of asthmatic symptoms and, in addition, developed Chronic Obstructive Pulmonary Disease (COPD), which I did not have when I moved here. Many of my neighbors are also now afflicted with chronic coughing, shortness of breath, wheezing, fatigue and other symptoms of respiratory distress that they didn't experience until the WMSC prescribed burns became so massive and frequent. The WMSC is currently treating up to 15,000 acres of forest per year whereas the proposed 4FRI will plan to treat 30,000 acres per year, twice that amount. The 4FRI acreages are mostly located to the West, South and Northwest of Snowflake and other communities on the Colorado plateau. This means that, since we are located at a lower elevation than the surrounding forests, our air flow is generally from the West and Southwest, and we commonly have Northwest breezes during the winter months, much of the smoke from the 4FRI will tend to come down on our communities (particularly at night), worsening our air quality and creating an increased health hazard.

3

With childhood asthma already on the rise, as well as increased incidents of emphysema and other respiratory problems in the general population, it only makes sense that we should find some other method than the use of massive prescribed burns to restore the health of Arizona's forests, unless we want to risk destroying the health of area residents in the process.

4

Thank you for your attention to this letter.

Sincerely,

Susan E. MacKay

Susan MacKay
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cc: Senator John McCain
Senator Jon Kyl
Representative Paul Gosar
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State Representative Chester Crandall
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2011-0314-45

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Mar 7th, 2011

RECEIVED
MAR 14 2011
COCONINO N.F.

Henry Provencio
Four Forests Restoration Initiative Team Leader
Coconino National Forest
1824 S. Thompson Street
Flagstaff, AZ 86001

SUBJECT: Rio de Flag Watershed - Firescape #5

Dear Henry:

The City of Flagstaff is appreciative of the discussion that occurred at the public meeting here in Flagstaff on Feb 16, 2011 regarding inclusion of the Schultz Creek and Ft. Valley areas - both primary contributors to the Rio de Flag Watershed (RFW) - into the 4FRI's forest treatment strategy. As you are aware, the RFW is of critical importance to our community. We therefore strongly support this inclusion and pledge our active engagement toward successful implementation.

1-2 The Ft. Valley area was the first focus area of the Greater Flagstaff Forests Partnership (GFFP). Dating back over a decade, NEPA planning was completed and some initial treatments were completed. As such, this area may be outside the specific scope of the 4FRI, but forest treatments in the area nonetheless need to be expanded and/or maintained.

1-3 The Schultz Creek area was likewise part of a GFFP planning area, completed roughly five years ago. Forest treatments in that area have not been implemented. As with Ft. Valley, this area may be outside the specific scope of the 4FRI, but forest treatments in the area nonetheless need to be implemented and maintained over time.

A severe wildfire in these areas would seriously impact our community's quality-of-life and economic vitality. The fire itself would be a challenge, but the secondary effects that would result from the inevitable flooding would likely:

- Close Hwy 180 immediately north of town and Hwy 66 within town;
- Put much of our downtown business district, and the NAU campus, under water;

- Impact our 9-1-1 system and hamper emergency response due to telecommunication damage and road closures;
- Damage or destroy many homes in numerous areas adjacent to the Rio channel;
- Temporarily impact our ability to conduct city business from City Hall;
- Decrease impacted property values; and
- Hamper our ability to market the community both during the flooding event(s) and for some time thereafter.

To illustrate these effects, all one need to do is consider last year's Schultz fire, and the subsequent flooding which continues into this year and beyond.

To further support our interest in this area, the Greater Flagstaff Area Community Wildfire Protection Plan (GFA-CWPP), authorized by the Healthy Forest Restoration Act of 2003, was completed in 2004. It was subsequently adopted by both the Flagstaff City Council and Coconino County Board of Supervisors in 2004, and approved by the AZ State Forestry Division in 2005. It clearly identifies the RFW as a priority area for future forest treatments. It is noteworthy that the GFA-CWPP was the result of an eight-month public process spearheaded by the Greater Flagstaff Forests Partnership (GFFP) and the Ponderosa Fire Advisory Council (PFAC) and relied heavily upon data provided by Northern Arizona University's Forest Ecosystem Restoration Analysis (Forest ERA) team.

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Finally, in closing, we are currently working with the US Army Corps of Engineers to reduce and mitigate flood impacts in the Rio de Flag drainage, a project that has been underway for several years. The engagement of the USFS, and the 4FRI stakeholder group, to promote and extend ecological restoration is necessary to ensure these efforts are ultimately effective. We trust that all recognize that inclusion of the RFW in 4FRI's treatment strategy is vitally important. We look forward to working with all on this effort.

general

Sincerely,

Sara Presler
Mayor, City of Flagstaff

CC: Congressman Paul Gosar
Forest Supervisors - Coconino, Kaibab, Tonto, and Apache-Sitgreaves National Forests
Flagstaff City Council members
Kevin Burke - Flagstaff City Manager
Coconino County Board of Supervisors
Steve Peru - Coconino County Manager
4FRI Stakeholder group

2011-0314-46

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March 14, 2011

Coconino National Forest
Attn: 4FRI
1824 South Thompson Street
Flagstaff, Arizona 86001
4FRI_comments@fs.fed.us

Dear Forest Supervisors Stewart and Williams:

general On behalf of the Ecological Restoration Institute (ERI) I would like to comment on the Proposed Action ("PA") and Notice of Intent to Prepare an Environmental Impact Statement for the Coconino and Kaibab national forests, Four Forest Restoration Initiative (4FRI), as released on January 21, 2011 and published in the *Federal Register* at 76 Fed. Reg. 4279 on January 25, 2011.

general The ERI is an active participant in the 4FRI collaborative process. We take very seriously the agency's commitment to use the best available science to inform land management. To this end we strive to provide the research and scholarship that is needed to restore frequent-fire forests of the West. The ERI is nationally and internationally recognized for peer-reviewed research that meets the highest standards of academic rigor. Equally as important, we are dedicated to interpreting and transferring science for the land managers and stakeholders who design, implement or influence restoration treatments.

general The Four Forest Restoration Initiative (4FRI) represents an exciting breakthrough in land management. In 1997 I testified before Congress urging that we begin immediately to restore frequent fire forests at the landscape scale. Based on my research and that of others, I predicted that we would have 15 to 30 years to restore forests before either catastrophic fire or unanticipated ecological changes would significantly alter the function and resilience of these ecosystems. Since that time, new research indicates that climate change is likely to lead to longer fire seasons and hotter temperatures. The convergence of these factors reinforces the need and urgency to think and act at the landscape scale.

general The 4FRI provides an equally important opportunity to test NEPA implementation at a large scale and in a highly collaborative framework. Building support among stakeholders while analyzing more acres per planning dollar could achieve greater economic and time efficiency. However, given that: 1) successful challenges to NEPA are most commonly caused by procedural issues (not science), 2) that forest restoration projects proposing mechanical treatments are more often challenged when compared to other restoration treatments, and 3) that a successful challenge to the first assessment could unravel years of collaboration, private investment in wood utilization, and all the innovation and forward progress that 4FRI represents, it is critical that the agency does an impeccable job of following procedure. My comments address both process and science.

1. **The Proposed Action (PA) must ultimately provide more specificity.** We understand that the 4FRI Team plans to provide greater specificity following public workshops. In addition, we appreciate that the Forest Service is experimenting with a more inclusive process to develop proposal details. However, we remain concerned that the next step in the Proposed Action process be sufficiently consistent with established policy that it is not vulnerable to challenge.

general

2. **Greater specificity is needed in several areas.**
   a. The project objective is to re-establish forest structure, pattern and composition, which will lead to increased forest resiliency and function. However, the PA does not define the parameters for those components or the basis for establishing those components.

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   b. With respect to the basis for re-establishing forest structure and pattern we urge that the best available science (including climate science), combined with the natural range of variability (as defined by site characteristics and reference conditions) be used to inform treatment design for the following reasons:

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      - A survey of the scientific literature indicates a broad consensus that reference conditions provide an objective and necessary guide to restoring natural variability.
      - Reference conditions are a manifestation of the evolutionary environment that shaped the forest and provide a picture of how a healthy, resilient forest looks. They are much like the results of a baseline physical for a healthy person.
      - Reference conditions and historic evidence provide an objective, practical and repeatable way for markers to implement treatments. Using historic evidence eliminates subjective and unpredictable choices on the ground and results in an approximation of the natural variation which occurred under natural conditions.
      - By using a "reading the land" approach it is more likely that the kind of landscape diversity that is characteristic of the evolutionary environment can be achieved—and then maintained as fire is allowed to play its natural self-regulatory role.
      - By using historic evidence management will follow the precautionary principle in deciding how to mark stands for restoration thinning because it will track natural tendencies. There may be reasons which we do not now understand that explain historical patterns, so, in keeping with the precautionary principle of conservation biology, it may prove to be a wise choice to emulate them where possible.
      - Because mechanistic approaches to restoring ecological health and function will not work in the long-term. Silvicultural approaches that strive solely to

create a regulated forest or the rigid use of diameter caps will undermine effective, long-term ecological restoration and resiliency.

c. Clarify where and when mechanical treatments will take place. What criteria will be used to establish priorities? This should be transparent in order to build support. We urge that those ecological attributes that are most difficult to replace (e.g., critical habitat and old-growth trees) receive priority attention. Articulating the process used to establish priorities will be important to explain actions and justify appropriations in the future.

d. Restoring fire to a safe role in management is critical. The agency should clarify how, where and when planned and unplanned ignitions will be used as a management tool.

e. Identify what will be monitored in order to evaluate if treatments are achieving desired outcomes and how it will inform adaptive management. These two elements are crucial for two reasons: 1. So we proceed using the best available information; and 2. So that people can support this effort in the face of uncertainty knowing that changes will be made as new information develops.

3. **Reinforce commitments to Ecological Restoration and the protection of Old-Growth Trees.**

   a. Although the Proposed Action borrows definitions and language from the Forest Service Handbook definition of Ecological Restoration a definitive statement of commitment to ecological restoration as the goal of the project would make the Agency's intent clearer.

   b. Old-growth trees are widely recognized as under-represented in the contemporary forest when compared to other age classes. In addition, emerging research suggests that old-growth trees are manifesting accelerated decline due to climate changes. With the exception of hazard trees, cutting of old-growth trees cannot be scientifically justified at this time.

The ERI is committed to making the 4FRI a success. We look forward to working with the Forest Service and the stakeholders to provide assistance through all phases of the Initiative.

Sincerely,

W. Wallace Covington
Executive Director and Regents Professor
The Ecological Restoration Institute
Northern Arizona University

2011-03-14-47



**Ethan Aumack**
**<eaumack@grandcanyontrust.org>**

03/14/2011 07:43 PM

To 4FRI_comments@fs.fed.us

cc marcus selig <mselig@grandcanyontrust.org>, matthew williamson <mwilliamson@grandcanyontrust.org>

bcc

Subject Grand Canyon Trust comments on 4FRI PA



GCT_PA_Comments_3_11_11.doc

2011-0314-49

COMMENTS OF THE GRAND CANYON TRUST

ON THE PROPOSED ACTION AND NOTICE OF INTENT TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT FOR THE FOUR FOREST RESTORATION INITIATIVE:

COCONINO AND KAIBAB NATIONAL FORESTS, ARIZONA

## I. INTRODUCTION

On January 21, 2011, through correspondence, the Kaibab and Coconino National Forests released a proposal to conduct restoration activities within a 750,000 acre ponderosa pine ecosystem over approximately 10 years (the "Project"). This correspondence included a brief description of the purpose and need for the Project and the proposed action for the Project ("Proposed Action"). On January 25, 2011, the U.S. Forest Service ("USFS") published in the Federal Register, at 76 Fed. Reg. 4279, a Notice of Intent to Prepare an Environmental Impact Statement for the Project ("NOI"), which also included a description of the purpose and need for the Project and the Proposed Action. The Proposed Action for the Project would implement treatments – mechanized operations to cut trees and prescribed burns to maintain desired openings and interspaces between trees – across the Williams and Tusayan districts of the Kaibab National Forest and the Flagstaff, Mogollon Rim, and Red Rock districts of the Coconino National Forest.

general

The Grand Canyon Trust ("GCT" or the "Trust") respectfully submits these comments on the Proposed Action and the scope of the analysis to be conducted in the environmental impact statement. The Trust is a nonprofit organization that focuses on the protection and restoration of the Colorado Plateau – its spectacular landscapes, flowing rivers, clean air, diversity of plants and animals, and areas of beauty and solitude. Since 2009, the Trust has been an active member of the Four Forest Restoration Initiative Stakeholder Group (the "Stakeholder Group"), a collaborative group of more than 30 organizations, municipalities, institutions, and agencies focused on carrying out landscape-scale forest restoration efforts across 2.4 million acres of the Mogollon Rim in Northern Arizona, including the Project area. Additionally, GCT staff and members regularly use and enjoy areas of the National Forests within the Project area.

general

## II. COMMENTS

The Trust strongly supports the USFS's desire to reestablish the resilience and function of northern Arizona's ponderosa pine ecosystems and commends it on taking monumental steps towards achieving this goal. We believe it is vital that forest structure be restored to these ecosystems, thereby allowing for the reintroduction of fire into wildland forests in a way that is safe, socially acceptable, and protective of wildlife and native biological diversity. To be successful, GCT believe that restoration efforts must be ecologically, economically, and socially viable.

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The Trust believes that the Proposed Action provides a general framework for accomplishing successful forest restoration efforts. However, the Trust encourages the USFS to elaborate and refine its plan for forest restoration activities by completing a revised Proposed Action prior to beginning its analysis of the Proposed Action. Specifically, GCT respectfully requests that the USFS develop a revised

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Proposed Action that includes (1) a plan for strategically locating mechanical treatments, (2) a more detailed description of how mechanical treatments will modify forest structure and accommodate reintroduction and/or management of fire, (3) an explanation of how silvicultural decisions regarding the removal of large and old-growth trees will be made (integrating recommendations offered within the Old Growth Protection and Large Tree Retention Strategy), and (4) an explanation of how heterogeneity of forest structure will be achieved at various scales across the landscape.

A. Strategic Placement of Treatments

broad-scale application of rule-based silvicultural treatments in the Proposed Action places potential mechanical treatments across a majority of the landscape and is not representative of a more socially acceptable desire to implement strategically placed mechanical treatments across approximately 300,000 acres of the landscape. In 2007, a 20-member collaborative working group held a series of meetings using a participatory GIS process to develop ecologically appropriate and socially acceptable treatment scenarios for forest restoration activities.[1] This working group determined that the most socially acceptable approach for implementing mechanical thinning treatments across the landscape, the "consensus scenario," involved strategically placing treatments in a manner that protected valuable resources and created a fire-permissive landscape. Using this approach, the group identified approximately 330,000 acres of ponderosa pine forests in the project area that could receive mechanical treatments.

Not including projects already planned in the Project Area, the Proposed Action identifies approximately 656,000 acres of additional ponderosa pine forests for mechanical treatments. Based on acreage alone, this is approximately twice the amount of area that was previously found to be socially acceptable for receiving mechanical treatments. Furthermore, the placement of the mechanical treatments in the Proposed Action is not explicitly driven by considerations relating to the protection of valuable resources or the creation of a fire-permissive landscape. Therefore, GCT is concerned that the current amount and placement of mechanical treatments in the Proposed Action does not reflect a social license generated over the previous several years, and will not be socially acceptable.

The Trust suggests that the USFS revise its Proposed Action by identifying a more socially acceptable level of strategically placed mechanical treatments across the landscape. Going beyond the Proposed Action's broad-scale application of rule-based silvicultural treatments, we suggest that the USFS identify and propose treatments in areas where mechanical treatments would protect resources of value, reduce the risk of occurrence of crown fires larger than 500 acres, and create a landscape that can safely accommodate natural and prescribed fire. Additionally, we believe that the USFS should analyze, as an alternative approach, a less-intense mechanical approach that would focus on mechanically treating those forest stands that, in their current state, cannot be safely treated with fire as an initial tool. We believe this alternative approach may accomplish much of the purpose and need of the Project at a

[1] Hampton, H.M., S.E. Sesnie, B.G. Dickson, J.M. Rundall, T.D Sisk, G.B. Snider and J.D. Bailey. 2008. Analysis of Small-Diameter Wood Supply in Northern Arizona. Forest Ecosystem Restoration Analysis Project, Center for Environmental Sciences and Education, Northern Arizona University.

lower cost, with a greater degree of social acceptability, and with fewer potentially negative environmental consequences.

Additionally, we understand that logistical constraints may require the USFS to identify more acres for potential mechanical treatment than are actually expected to be treated. To address this issue, we believe that it could be appropriate for the USFS to expressly state that it will only mechanically treat a specific percentage of the area identified for potential mechanical treatments in the Proposed Action.

B. Forest Structure Modification

The Proposed Action proposes 14 different mechanical treatment approaches in ponderosa pine forests: (1) intermediate thinning with 10-25% residual openings; (2) intermediate thinning with 25-40% residual openings; (3) intermediate thinning with 40-55% residual openings; (4) intermediate thinning with >55% residual openings; (5) stand improvement with 10-25% residual openings; (6) stand improvement with 25-40% residual openings; (7) stand improvement with 40-55% residual openings; (8) stand improvement with >55% residual openings; (9) uneven-aged treatment with 10-25% residual openings; (10) uneven-aged treatment with 25-40% residual openings; (11) uneven-aged treatment with 40-55% residual openings; (12) uneven-aged treatment with >55% residual openings; (13) savanna restoration; and (14) grassland restoration. Although GCT appreciates that these various mechanical treatments types identify the general treatment approach and the amount of area that will remain in forest cover, they do not discuss how treatments will modify the structural or spatial characteristics of the forest cover. The Trust believes that knowledge of the structural and spatial characteristics of the remaining forest cover are crucial to understanding how mechanical treatments will affect ecosystem processes, wildlife populations, and social acceptability of the Project.

The Trust suggests that the USFS revise its Proposed Action by providing a more detailed explanation of how various treatment approaches would modify the structural and spatial characteristics of remaining forest cover. Specifically, we suggest that the revised Proposed Action clarify information for each treatment approach regarding (1) the size of tree groups and openings; (2) the range of basal areas and tree densities remaining within tree groups; (3) the distribution of tree size classes within groups, stands, and treatment areas; and (4) the range of canopy cover at the group level, stand level, and treatment area level. We believe that these structural and spatial descriptions of the forested areas or tree groups would provide the public with a better understanding of the result of mechanical treatments and allow for a more comprehensive analysis of the effects of mechanical treatment on wildlife populations and ecosystem processes.

C. Large and Old-Growth Trees

The Trust appreciates the USFS's desire to "promote large trees" and that treatments under the Proposed Action would be "designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape." However, GCT is concerned that these aspirational statements do not provide sufficient clarity or assurances regarding one of the most socially contentious issues associated with forest restoration projects. We believe that the Proposed Action should be revised to clearly and unambiguously state that a collaboratively developed strategy will be

implemented and operationalized to protect all old-growth trees and retain as many large trees as possible across the landscape.

The Stakeholder Group has collaboratively developed and submitted to the USFS an Old Growth Protection and Large Tree Retention Strategy. This document reflects agreement between a diverse group of environmental conservation organizations, scientists, agencies, and industry representatives on how old-growth trees should be protected and large trees should be retained during the implementation of this Project. The document identifies the actions that should be taken to protect and retain large trees in almost every situation that would be encountered during the implementation of this Project.

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The Trust believes that the incorporation of the Old Growth Protection and Large Tree Retention Strategy into the Proposed Action will greatly enhance the social acceptability and ecological appropriateness of the Project, and its overall success. We therefore urge the USFS to revise the Proposed Action to include this collaboratively developed document or explicitly state that the document would be implemented and operationalized through the Project.

D. Heterogeneity

The Proposed Action states a goal of attaining "greater diversity (heterogeneity) in spatial patterns and size class distribution." The Trust strongly supports the goal of creating heterogeneity at all scales across the landscape (e.g., within and among tree groups, stands, treatment areas, firescapes, and the Project area). We believe that heterogeneity is crucial to sustaining biodiversity and provides a necessary foundation for adaptation and resilience. We also believe that scientific uncertainty regarding the effects of landscape-scale restoration projects on ecological processes and wildlife populations demands the creation of a heterogeneous landscape, which can be monitored for treatment effects. The consequences of over applying an "incorrect" treatment approach to a large area are substantial.

To achieve heterogeneity at all scales across the landscape, GCT believes that the Proposed Action should be revised to redistribute mechanical treatments across the landscape for the express purpose of creating a heterogeneous landscape. Currently, the Proposed Action proposes to treat several large areas of the Project Area with mechanical treatments that have similar resulting forest structures (e.g., treatments with the same level of residual openings). This current placement of mechanical treatments is likely to create a homogenous forest structure across large swaths of the Project area.

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The Trust recognizes that additional landscape-level heterogeneity will be introduced through specific wildlife treatments (i.e., Mexican-spotted owl treatments), deferral areas (e.g., Wilderness areas and steep slopes), mixed landownership, and other factors; however, we believe that heterogeneity should be an affirmative goal at all levels and not just a result of exclusion circumstances. As the Proposed Action is refined, we believe that the USFS should continually reevaluate the effect of the Proposed Action's mechanical treatments on heterogeneity at all scales to ensure that it is achieved.

III. CONCLUSION

The GCT appreciates the opportunity to comment on the Proposed Action. We believe that the completion of a revised Proposed Action that includes the elaborations and refinements discussed above will help the USFS conduct an environmental analysis for forest restoration activities that enjoys a greater level of social acceptability.

Sincerely,

/s/

Ethan Aumack

/s/

Marcus Selig

/s/

Matt Williamson




**March 11, 2011**

# Old Growth Protection & Large Tree Retention Strategy

Comments are on the hard copy

## Contents

I. Old Growth Protection & Large Tree Retention Strategy (OGP&LTRS) Overview ..... 4
II. OGP&LTRS Rationale: The Historical Debate Regarding Diameter Caps in the Southwest and the 4FRI's Large Tree Retention Policy ..... 6
III. Exception Process for Large Post-Settlement Tree Retention ..... 9
IV. Exceptions ..... 10
Seeps & Springs ..... 10
Riparian ..... 12
Wet Meadows ..... 14
Encroached Grasslands ..... 16
Aspen Forest & Woodland ..... 18
Ponderosa Pine/Gambel Oak Forest (Pine-Oak) ..... 20
Within Stand Openings ..... 22
Heavily Stocked Stands with High Basal Area Generated ..... 24
By a Preponderance of Large Young Trees ..... 24
V. Description of Desired Next Steps and Ongoing Collaborative Clarification of OGP&LTRS 25
VI. References ..... 26
Appendix 1 – Reservations ..... 34

# I. Old Growth Protection & Large Tree Retention Strategy (OGP&LTRS) Overview

The goals of the Four Forests Restoration Initiative (4FRI) are to restore healthy, diverse stands, supporting abundant populations of native plants and animals; to protect communities in forested landscapes from destructive wildland fire; and to support sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values. In short, we seek to re-establish largely self-regulating forested landscapes including their associated fire regimes through a process of ecological restoration that benefits communities, economies, ecosystems and biodiversity.

Ecological restoration will require thinning post-settlement ponderosa pine trees[1] in unnaturally dense stands. While there is broad agreement for reducing small diameter tree densities, where and how this should be done has often been the subject of social and scientific debate. The purpose of this document is to affirm recommendations of the 4FRI Stakeholder Group relating to the retention of large post-settlement and old growth trees—recommendations that are critical to moving beyond those debates—and to provide specific, science-based recommendations for incorporation into 4FRI restoration plans and projects.

**Retention of Old Growth and Large Post-settlement Trees**

"The Path Forward"—a foundational document of the 4FRI—calls for blanket old growth protection, regardless of tree size. It states that, "No old-growth trees (pre-dating Euro-American settlement) shall be cut." The document also includes broad recommendations for retaining large post-settlement trees with some carefully specified exceptions.

In southwestern ponderosa pine forests, old-growth trees are important to ecosystem structure and function. They increase genetic diversity on the landscape; old trees have greater genetic diversity than even-aged groups of young trees (Kolanoski 2002) and, thus, may have a better chance of adapting to changing climatic and environmental conditions, an ability they can pass on to their progeny. In addition, when not surrounded by large amounts of fuel, the thick bark of old-growth trees makes them largely resistant to low-intensity surface fire (Agee 1998). Old-growth trees also increase forest structural diversity, which, in turn, provides more wildlife habitat. For example, large trees provide additional structure for bats, which roost under slabs of bark; nest trees for northern goshawks and Mexican spotted owls; continuous canopy for tassel-eared squirrels; and foraging habitat for bark-gleaning birds (Bull and Hohmann 1994, Humes et al. 1999, Dodd et al. 2003). In addition, old trees often become long-lasting snags when they die, which benefits many species of cavity-nesting birds and mammals (Chambers and Mast 2005). Old, large trees also serve as long-term carbon stores (Harmon et al. 1990) and preserve a record of the past that can inform future research about insect outbreak, fire history, and climate change (Fulé et al. 1997, Soulé and Knapp 2006). Finally, old-growth trees enhance the

[1] Large and old growth tree recommendations offered in this document refer specifically to ponderosa pine trees.

aesthetics of forests (Brown and Daniel 1984) and, thus, increase public support for restoration projects. Old-growth trees are present on the landscape at similar or lower densities compared to presettlement times (Mast et al. 1999, Moore et al. 2004), depending on how many trees have been removed postsettlement by forest management practices (e.g., clearcut, thinning, seed tree, etc.). The three main threats to old-growth trees are high-severity wildfire, competition from mid- or under-story trees, and drought and subsequent bark beetle attacks (Kolb et al. 2007). Restoration treatments (thinning and prescribed burning) around old-growth trees can cause some mortality. However, this threat can be reduced through careful management (Hood 2010). In addition, restoration treatment should result in a reduced threat of wildfire, a release from competition, and increased tree growth (Fajardo et al. 2007, Fulé et al. 2007).

The Path Forward also calls for retaining large post-settlement trees (defined by the socio-political process as those greater than 16 inches diameter-at-breast height [dbh]) throughout the 4FRI landscape, except: (1) as necessary to meet community protection and public safety goals within the Community Protection Management Areas identified in the Analysis of Small Diameter Wood Supply in Northern Arizona and where stakeholder agreement identifies priority areas within approved CWPPs; and (2) when best available science and stakeholder agreement (as defined in the 4FRI Charter) identify sites where ecological restoration and biodiversity objectives cannot otherwise be met – specifically wet meadows, seeps, springs, riparian areas, encroached grasslands, aspen groves or oak stands, within-stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees.

We recognize that there are multiple causes of ecological degradation that may not be affected by mechanical thinning and different types of burning. The exceptions articulated in the following section are intended to be part of a more comprehensive and concurrent approach to treating causes (rather than just symptoms) of ecological decline. To that end, we are asking the Forests to work collaboratively on a comprehensive restoration assessment that identifies possible management actions to stem/reverse ecological decline. We believe this restoration assessment should focus on a wider range of forest resources than just timber and fire; such as hydrology, range, recreation, and wildlife. We ask the four National Forests to initiate this assessment with the 4FRI Stakeholders, upon release of the Draft EIS for the first project area.

The intention of the exception process is to increase landscape heterogeneity and conserve biodiversity. Thus we do not support implementing any exceptions where removing the trees would conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat. We also recognize there may be additional areas and/or circumstances where large trees need to be removed to achieve restoration. These circumstances should be identified through a site-specific, agreement-based, collaborative process as described in the 4FRI Charter.

# II. OGP&LTRS Rationale: The Historical Debate Regarding Diameter Caps in the Southwest and the 4FRI's Large Tree Retention Policy

**Introduction**

Diameter caps for tree cutting have been used in forest management efforts across the West. They have been and continue to be the subject of much debate. In this section of the Large Tree Retention Strategy document, two different perspectives on diameter caps are presented. Recognizing that the 4FRI Large Tree Retention and Old Growth Protection Strategy is not meant to serve as a strict diameter cap, these perspectives are offered here to illuminate elements of the historical debate that have led to the 4FRI's formulation of the existing Large Tree Retention and Old Growth Protection Strategy.

**Arguments in Favor of Diameter Caps**

There is a generally recognized need to retain larger trees and protect old growth in southwestern ponderosa pine forest restoration. Some proponents of large tree retention have suggested that a 16" diameter cap is both ecologically and socio-politically warranted given the scarcity of mature and old growth forest cover in the region; the need to quickly re-establish lost mature and old forest structure; the necessity of retaining trees larger than 16" dbh to recruit new trees into regionally-underrepresented VSS 5, 6 and ~~–o~~ld growth" structural stages; and the regional rarity of trees larger than 16" (approximately 96% of ponderosa pine trees in northern Arizona and New Mexico are smaller than 16-inch dbh).

Such proponents have proposed diameter caps as a means to (1) prevent large-tree logging for production-oriented, uneven-aged silvicultural goals, (2) discourage large-tree logging to pay for small-tree thinning or other activities, (3) favor small-diameter-specific industries over large-tree-dependent ones, (4) avoid population-level effects to imperiled species and wildlife that are associated with larger live and dead trees and denser canopy, (5) mitigate unforeseen large tree mortality during and following restoration treatments, (6) mitigate unknown rates of future large tree mortality resulting from re-establishing natural fire regimes and future climates, (7) mitigate under-estimates of historical tree densities owing to evidence undercounting and loss to fire, logging and decay, (8) accommodate differing reference scales, choices of reference attributes, restoration objectives and desired degrees of precision or rates of change, (9) mitigate uncertainty about future national forest policy, timber and wildlife habitat management, and (10) facilitate a restoration approach that reduces immediate crown fire threat while incrementally moving the forest toward its natural range of variability through a combination of thinning and natural fire.

Diameter limits and exception-thresholds for tree cutting are a common strategy for achieving ecological objectives in western forest landscapes. In their recommendations to Congress and the President, the Eastside Forests Scientific Society Panel proposed a 20" diameter limit for trees younger than 150 years old to protect late-successional and old-growth dry forests of eastern Oregon and Washington. They cited the ecological importance and scarcity of large and old trees and the need to retain them to replenish regionally-depleted supplies of large and old trees, snags, logs and associated wildlife habitat. Those recommendations formed the basis for interim management direction amending nine national forest plans and establishing a 21" diameter limit in dry forests which in turn carried forward into an exception-threshold of 21"

diameter in legislation proposed to restore dry forests of eastern Oregon. The Sierra Nevada Framework set forth a 20" diameter limit for tree cutting to conserve late-seral forests across national forest land in the Sierra Nevada. Larger diameter limit and exception-thresholds in these examples reflect more productive forests and larger mean diameters than in southwestern forests. Diameter limits in Region 3 forest plans restrict large tree cutting in habitat for Mexican spotted owl and northern goshawk for their viability and in ~~"o~~ld growth"; diameter-based ~~"v~~egetative structural stages" guide management of those species' habitats.

**Arguments Against Diameter Caps**

Arbitrary diameter thresholds (or ~~"c~~aps") may assure that trees of a certain size are retained, but they do not guarantee that short- or long-term ecological restoration goals will be achieved. In fact, diameter caps can actually prevent attainment of ecological restoration objectives because they can have unintended consequences such as interfering with the restoration of herbaceous openings and, where unnaturally dense stands of larger, post-settlement trees predominate, caps can limit fuel reduction and, therefore, undermine the agency's ability to re-establish surface fire (Abella et al. 2006, Sanchez-Meador 2009). A diameter threshold also creates a ~~"o~~ne-size-fits-all" guideline which can lead to treatments that are inconsistent with site-based conditions.

In general caps are arbitrarily chosen to achieve socio-political objectives that do not necessarily support comprehensive ecological restoration. Contemporary diameter caps, even as an informal agreement, have become the condition that allows fuel reduction and restoration to move forward without lengthy delays due to appeals and litigation. Examples of their arbitrary application include:

- In order to test restoration treatments in the Grand Canyon, a 5-inch cap was required by environmental advocates (Fulé 2006).
- For restoration to proceed in the White Mountains, a 16-inch cap was required (Abrams and Burns 2007).
- A 12-inch cap was employed to define forest biomass appropriate for generating renewable energy (Arizona Corporation Commission, 2006).
- On the Coconino National Forest, a 16-inch cap was imposed to allow restoration projects proposed by the Grand Canyon Forest Partnership to proceed (Friederici 2003).

Further evidence that caps undermine ecological restoration goals is reflected in a recent decision on the Marshall Fuel Reduction and Forest Restoration Project (USFS 2010). The Forest Service rejected an alternative that proposed a 16-inch diameter cap because, ~~"A~~ 16-inch cap would prevent the restoration of natural openings and more natural spatial distribution of clumps of trees important for wildlife habitat and forest health." When administrative and legal challenges to forest thinning and restoration projects prevail it is generally because of issues related to agency compliance with law and policy (Brown 2009)—not because there is a scientific basis for a diameter threshold.

Finally, a static diameter cap fails to account for the fact that trees grow, that restoration will occur over decades while those trees are growing, and that over time, retention of excess trees may undermine efforts to restore ecosystem resilience in the face of drier conditions associated with climate change (Glicksman 2009, Westerling et al. 2006).

**Conclusions**

Recognizing a need to move beyond the historical debate and move forward with landscape-scale restoration that is ecologically, socially, and economically viable, the 4FRI Collaborative has agreed that the 4FRI effort should implement large tree retention and old growth protection strategies that are not based on strict diameter limits, but are based upon a 16" diameter threshold that limits the cutting of trees larger than 16" to circumstances and criteria set forth in pre-defined exception categories that follow. In addition, we are committed to monitoring the outcomes of treatments that follow this guidance to determine if they achieve our ecological restoration goals. If they do not we are committed to adapting this policy to achieve better ecological outcomes.

It is our hope and expectation that this approach will balance the approaches and opinions expressed above, and will serve as a policy mechanism for supporting comprehensive ecosystem restoration while addressing stakeholders' needs for protecting old growth and large ponderosa pine trees.

## III. Exception Process for Large Post-Settlement Tree Retention

The following section outlines a problem statement, specific identifying circumstances, ecological objectives and selection criteria for instances in which large post-settlement trees may be cut to meet restoration objectives. At specific locations, large trees may need to be removed, felled, or girdled for purposes of ecological restoration and biodiversity conservation. The purpose of this section is to provide sufficient specificity to translate those exception categories—where stakeholder agreement exists to do so—into management actions and tree-marking guidelines. For eight of the nine exception categories programmatic recommendations describe the circumstances and criteria in which large post-settlement trees may need to be removed. For the "Heavily Stocked Stands with High Basal Area Generated by a Preponderance of Large Young Trees" (or "Large Young Tree") exception category, getting to a higher level of social and scientific agreement entails more complexity and challenges, so we propose the initiation of additional collaborative discussion and planning that we hope will bolster restoration efforts by increasing confidence and knowledge-sharing, maximizing agreement and minimizing disagreement.

## IV. Exceptions

### Seeps & Springs

**Suggested Tree Marking Exception Code**: "S"

**Identifiable Circumstance**

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock, where standing or running water is infrequent or absent and that exhibit vegetation and other biological diversity adapted to mesic soils.

Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water, wet or moist soils and that exhibit vegetation and other biological diversity adapted to mesic soils or aquatic environments (Feth and Hem 1963).

**Problem Statement**

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. Due to the absence of frequent fires in the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of these trees may constitute a relatively small part of an overall seep and spring restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore seeps and springs (Thompson et al. 2002).

**Ecological Objectives**

(1) Conserve and restore the biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted and aquatic native biological diversity depend.

**Criteria**

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of seeps & springs according to these criteria:

(1) Where large trees' roots are encroaching on mesic soils associated with a seep or spring, or such trees' drip lines are overlapping or nearly overlapping a seep or spring

such that its shading compromises the integrity of a spring's unique biophysical attributes, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said seep or spring in the past, leave an equivalent number of large replacement trees.

# Riparian

**Suggested Tree Marking Exception Code: "R"**

**Identifiable Circumstance**

Riparian areas occur along ephemeral or perennial streams or are located down-gradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

**Problem statement**

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted or aquatic biological diversity. Riparian areas and the streams, springs and seeps connected to them often harbor imperiled species and can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial wildlife. In the absence of frequent fires and in the presence of livestock grazing, water development projects and other factors, large post-settlement trees may have established and grown within riparian areas such that they compromise available soil moisture or light that support those unique biophysical conditions. However, it is likely to be a very rare circumstance that trees of any size will need to be removed from forested riparian zones.

Cutting of any trees within riparian areas should minimize impacts by following Best Management Practices (BMPs).

Whenever possible, large trees identified for cutting should be left onsite as snags or downed logs.

Removal of these trees may constitute a relatively small part of an overall riparian area restoration effort when compared to addressing fundamental causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore riparian areas.

**Ecological Objectives**

Conserve and restore the biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depend.

**Criteria**

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of riparian areas according to these criteria:

(1) Where large trees are growing (rooted) within a riparian area and compromising available soil moisture or light that support that area's unique biophysical conditions, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Notes: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said riparian in the past, leave an equivalent number of large replacement trees.

There may be additional areas and/or circumstances identified for riparian restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

# Wet Meadows

**Suggested Tree Marking Exception Code**: —WM"

**Identifiable Circumstance**

High-elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1% of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 ha of wet meadows occur on national forests in Arizona and New Mexico.

These areas may be referred to as riparian meadows, montane (or high-elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (*Carex* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (Salix) and alder (Alnus) species often occur in or adjacent to these meadows (Long 2000, 2002, Maschinski 2001, Medina and Steed 2002). High-elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

**Problem statement**

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations, most notably the lowering of their water tables due to stream downcutting, surface water diversions, or groundwater withdrawal (Neary and Medina 1996, Gage and Cooper 2008). In the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Removal of these trees may constitute a relatively small part of an overall wet meadow restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore wet meadows.

**Ecological Objectives**

Conserve and restore the biophysical conditions of wet meadows upon which terrestrial native biological diversity depend.

**Criteria**

Large (>16”dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of wet meadows according to these criteria:

(1) Where large trees are growing (rooted) in a wet meadow, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said wet meadows in the past, leave an equivalent number of large replacement trees.

# Encroached Grasslands

**Suggested Tree Marking Exception Code**: "E"

**Identifiable Circumstance**

Encroached grasslands are herbaceous ecosystems that have infrequent-to-no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils, which are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and to a lesser extent by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (Festuca arizonica) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands are the most naturally fragmented grasslands in the region, ranging from thousands of acres in size (e.g., in the White Mountains, Baker 1983) down to only a few acres. They generally occur in small (<100 ac.) to medium-sized (100 to 1000 ac.) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings.

Identification of grasslands in this region should use a combination of the Terrestrial Ecosystem Survey, Southwest Regional GAP Analysis, Brown and Lowe Vegetation Classification (Brown and Lowe 1982; TNC GIS Layer 2006) among other existing vegetation and soils data.

This exception category will require an iterative process of collaborative mapping, field verification, and refinement. There is debate about where and how much the grassland-forest mosaic shifts over time and space. There are also questions about whether some recently-burned areas are early seral forests or stable grasslands, whether or how they may be surrogates for historical grasslands, and if or how that should factor into the overall retention of forest cover. Recognizing the importance of montane grassland restoration, we encourage all parties to seek resolution to these issues on a case-by-case basis through field visits, literature review, and/or discussion.

**Problem statement**

Prior to European settlement, pine trees rarely established in grasslands because they were either outcompeted by production of cool-season grasses or killed by frequent fire (Finch 2004). In

the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, releasing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Allen 1984, Moore and Huffman 2004, Coop and Givnish 2007).Pine encroachment into grasslands has contributed to a significant loss of biodiversity (Stacey 1995) and wildlife habitat particularly for grassland-dependent species such as pronghorn. Plant diversity is particularly important in grassland ecosystems: grassland plots with greater specie diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994); this resilience will become even more important in a warming climate. Pine tree removal, restoration of fire, and complementary reductions in livestock grazing pressure are all necessary to restore structure and function of native grasslands.

**Ecological Objectives**

(1) Enhance, maintain, and restore naturally functioning grasslands.

(2) Ensure native grassland composition, increase native species diversity, improve resilience to drought.

(3) Restore natural fire regime.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be cut and/or removed to restore the unique biophysical attributes of grasslands according to these criteria:

(1) Where existing grasslands are being encroached, and large trees are interfering with overall restoration objectives, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: There may be additional areas and/or circumstances identified for grassland restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

# Aspen Forest & Woodland

**Suggested Tree Marking Exception Code: "AF"**

**Identifiable Circumstance**

Quaking aspen (*Populus tremuloides*) occurs in small patches throughout the 4FRI area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. Almost all of the aspen occurring within ponderosa pine forests of the 4FRI area exists as seral aspen, and regenerates after disturbance both through root sprouting and rarely from seed production (Quinn and Wu 2001). Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire 4FRI area and map layers are available from existing databases.

**Problem Statement**

Aspen occurs within ponderosa pine forests, and is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finch and Reynolds 1987, Griffis-Kyle and Beier 2003). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio and others 2005). However, aspen is currently declining at an alarming rate (Fairweather and others 2008).

The loss of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen-dominated lands to succeed to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing by livestock and introduced and native wild ungulates in the absence of natural predators like wolves (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1994, Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with 90% mortality occurring in low elevation aspen sites and over 60% mortality observed in mid-elevations. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather and others 2008) that have served as the "final straws" for already compromised stands.

Removal of encroaching pine trees constitutes part of an overall aspen restoration effort. Thinning alone without addressing other sources of degradation, such as excessive herbivory is unlikely to successfully restore aspen forests.

Some stakeholders expressed that considerable uncertainty exists around fire regimes for aspen in ponderosa pine, and that research questions remain unanswered around the prevalence of mixed-severity fire and its ecological role as a driving force for aspen stands at the top of its elevational range, and on steep slopes within this vegetation type.

**Ecological Objectives**

(1) Conserve and restore aspen forests and woodlands within 4FRI area by restoring appropriate fire regimes and decreasing competition from ponderosa pine.

(2) Protect regeneration, saplings, and juvenile trees from browsing.

**Criteria**

Large (>16”dbh) post-settlement trees may be cut in conifer-encroached seral aspen stands according to the following criteria:

(1) Where current post-settlement ponderosa pine tree numbers are above and beyond residual targets (identified using pre-settlement conifer tree evidences), and

(2) Where fire cannot be used safely and effectively to regenerate or maintain aspen, or

(3) Where site visitation and/or data collection and analysis indicates the need for encroachment mitigation, and

(4) Where removing large trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat

Note: There may be additional areas and/or circumstances identified for aspen restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

# Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

**Suggested Tree Marking Code**: —PO"

**Identifiable Circumstance**

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak trees in locations throughout the 4FRI area in a habitat association referred to as PIPO/QUGA (USFS 1997, USDI FWS 1995). Specifically, any stand within the Pinus ponderosa series where ≥10% of stand basal area consists of Gambel oak (*Quercus gambelii*) ≥13 cm (5 in) diameter at root collar (drc) is considered to be pine-oak within the 4FRI area (USDI FWS 1995). In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Brown 1958, Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number of varying wildlife species (Neff and others 1979, Kruse 1992).

Gambel oak provides high quality wildlife habitat in its various growth forms, and is a desirable component of ponderosa pine forests (Neff and others 1979, Kruse 1992, Bernardos et al. 2004). Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI FWS1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular fuelwood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

**Problem Statement**

Although management on public lands with regard to oak has changed to better protect the species, illegal fuelwood cutting of Gambel oak and elk and livestock grazing negatively impact oak growth and regeneration (Harper et al. 1985, Clary and Tiedemann 1992, Rick Miller, 1993, unpublished report) and continues to result in the removal of rare, large diameter oak trees (Bernardos et al. 2004).

A literature review by Abella and Fule (2008) found that Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium-diameter stems (<8" dbh). Chambers (2002) found that Gambel oak on the Kaibab and Coconino National Forests was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 cm dbh) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 cm) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fule (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

**Ecological Objectives:**

(1) Maintain and restore all growth forms of Gambel oak, focusing on enhancing and maintaining larger, older oak trees.

(2) Restore frequent, low intensity surface fire to ponderosa pine-Gambel oak forests.

(3) Restore and maintain brushy thicket, pole and dispersed clump growth forms of Gambel oak by allowing natural self-thinning, thinning dense clumps, and/or burning.

(4) Protect Gambel oak growth forms from fuel wood cutting, damage during restoration treatments including thinning and post thinning slash burning.

**Criteria**

In pine-oak, which occurs when ≥10% of the stand basal area consists of Gambel oak >13 cm (5 in) diameter at root collar, large (>16 dbh) post-settlement ponderosa pine trees may be removed to conserve oaks according to these criteria:

*In MSO restricted habitat*:

(1) Within MSO habitat and designated critical habitat, the Recovery Plan for the Mexican spotted owl should be followed to improve key habitat components and primary biological factors, which includes Gambel oak, or

*Outside MSO restricted habitat*: where large post-settlement trees' drip lines or roots overlap with those of Gambel oak trees exhibiting drc of >12"; and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

# Within Stand Openings

**Suggested Tree Marking Exception Code**: "WSO"

**Identifiable Circumstance**

Within Stand Openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sanchez-Meador et al. 2009). Pre-settlement openings can be identified by the lack of stumps, stump holes, and other evidence of pre-settlement tree occupancy (Covington et al. 1997). These openings are most pronounced on sites with heavy textured (e.g., silt-clay loam) soils (Covington and Moore 1994). Current openings include fine scaled canopy gaps. It is not necessary that desired within stand openings and groups be located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees. The within stand opening criteria described here are distinct from and should not be considered as guidance relating to regeneration openings. The stakeholder group does not support the cutting of large trees to create regeneration openings.

**Problem Statement**

Within stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sanchez-Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997). These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within a stand opening as soon as herbaceous vegetation was removed by overgrazing (Sanchez-Meador et al. 2009). Contemporary within stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within stand heterogeneity.

**Ecological Objectives**

(1) Conserve and restore openings within stands to provide natural spatial heterogeneity for biological diversity.

(2) Break up fuel continuity to reduce the probability of torching and crowning.

(3) Restore natural heterogeneity within stands.

(4) Promote snow-pack accumulation and retention to benefit groundwater recharge and watershed processes at small scale.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to restore the unique biophysical attributes of within stand openings according to these criteria:

(1) When the presence of such trees would prevent the re-establishment of sufficient within stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives, and

(2) Where desired openings are tentatively identified as ≥0.05 acre (these openings should be established wherever possible by enlarging current within stand openings or where small diameter trees are predominant), and

(3) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: It is not necessary that within stand openings and groups be located in the same location that they were in before settlement. That is, trees might be retained in areas that were openings before settlement, and openings might be established in areas that had previously supported pre-settlement trees.

## Heavily Stocked Stands with High Basal Area Generated

## By a Preponderance of Large Young Trees

**Suggested Tree Marking Exception Code**: "LYT"

**Identifiable Circumstance**

The stakeholder group could not identify with sufficient clarity and agreement the identifiable circumstances under which large removal would take place. We aim to have this completed by early May 2011.

**Problem Statement**

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and BA would be desirable, large post-settlement pines may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. In stands where evidences indicate that higher tree density and BA would have occurred pre-settlement, only a few large pines may need to be removed. Many of these areas would support crown fire, and thus require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

**Ecological Objectives**

(1) Restore natural heterogeneity of forest, savannah and grasslands at the landscape scale.

(2) Restore natural heterogeneity within stands.

(3) Break up canopy fuel continuity to reduce the probability of torching and crowning and restore herbaceous fuel continuity to carry surface fire.

**Criteria**

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to meet restoration objectives according to these criteria:

(1) The stakeholder group could not identify with sufficient clarity and agreement the criteria under which large tree removal would take place. We aim to have this completed by early May 2011.

## V. Description of Desired Next Steps and Ongoing Collaborative Clarification of OGP&LTRS

Eight of the exception categories listed in this document have been clarified such that they can be operationalized ―programmatically", that is, the process of mapping and selecting areas for exceptions is ready to be tested with real data in specific areas. This means that the stakeholder group considers the guidance offered for these exception categories sufficient to operationalize large tree retention/removal per these criteria across the 4FRI area. This process will require the participation of stakeholders and USFS team members to ensure that the suggested process in this document achieves the stated restoration objectives, and is not burdensome in its approach and mechanics.

The ―Large Young Tree" exception category listed in this document will require additional collaborative analysis and clarification. Thus far, the group has discussed an opportunity and a need to carry these discussions forward with a combination of additional site visits to representative areas, analysis of USFS stand data, and further exploration of ForestERA remote sensing data that could inform our collective sense of the distribution and extent of areas exhibiting circumstances necessitating large tree removal, and an efficient means of analyzing data and selecting areas for treatment.

Recognizing the importance of finding additional clarity and agreement for these exception categories, the group intends to pursue additional field and data-centered explorations of these exception categories in 2011, working closely with the Forest Service to ensure that additional analysis occurs in a coordinated fashion, and that additional recommendations can be operationalized in a straightforward fashion. Analysis and visitation schedules are intended to be developed by March, 2011, and completed by May 6, 2011.

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**Appendix 1 – Reservations**

From Scott Harger, Coconino NRCD
From: Scott Harger [mailto:cannonbone@msn.com]
Sent: Friday, March 04, 2011 6:57 PM
To: Windy Greer
Subject: Re: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Dear Windy, and LTRS Sub-Group of the LSWG:
I appreciate the accelerated effort to push this document for timely delivery to the USFS.
I like the descriptions captured here for the large tree strategy overview and rationale for the document and the 8-of-9 exception categories whose language appear to be resolved. Except for some very turgid prose in section V that can be edited, I can support this draft as a partial or preliminary version, subject to review of the 9th exception. Otherwise, I can support approval of this final draft without conditions. I would also support it if "Problem Description" were changed to "Management Issue" or "Concerns driving the Exception" or something that doesn't suggest that habitats are problems.

Scott Harger
Range Conservationist
Coconino NRCD
Flagstaff, AZ
928.527.9050

From Scott Hunt, Arizona State Forester
From: Scott Hunt [mailto:ScottHunt@azsf.gov]
Sent: Friday, March 11, 2011 12:00 PM
To: Windy Greer; 'Ethan Aumack'; Ed Smith
Cc: Kevin Boness
Subject: RE: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Thank you Ed and Ethan for the dedicated work on this strategy. The State Forestry Division agrees with reservations on this large tree retention policy. The arguments against diameter caps that you provided in the policy capture most of our reservations. We have two additional items we wish to offer for consideration:

-In the category "Seeps and Springs" under criteria: there should be an allowance for removal of large trees a considerable distance from the seep or spring to help invigorate infiltration and flow. Distance will need to be determined by the effective area that benefits the seep or spring.

-We believe a consideration needs to given for stands that may have a healthy understory of regenerated ponderosa pine with an overstory of trees that are heavily infected with dwarf mistletoe. Objectives for

this type of stand may encourage and favor the vigorous, healthy understory. Removal of the larger trees that are infected would be required to meet the stand objectives.

We will look forward the opportunity to comment on the Larger Young Tree removal category when it is developed. Thanks again for all your time and effort.

Scott Hunt

Final Report

# Analysis of Small-Diameter Wood Supply in Northern Arizona


FCSFP


S. Joy


S. Allred


FCSFP


FCSFP

***May 2007– February 2008***

NORTHERN ARIZONA UNIVERSITY
*College of Engineering & Natural Sciences*

ForestERA
Forest Ecosystem Restoration Analysis



For more information on the ForestERA Project, please contact:

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# Table of Contents


1 Executive Summary ..... 1
2 Project Background ..... 3
3 Building Agreement on Treatment Location and Type ..... 5
3.1 Wood Supply Steering Committee ..... 5
3.2 Wood Supply Working Group Meetings ..... 5
3.3 Keeping Stakeholders and Elected Officials Informed of Project Progress ..... 8
3.4 Working Group Treatment Scenario ..... 9
3.4.1 Landscape Features Considered Not a Source of Wood Supply ..... 10
3.4.2 Landscape Management Areas ..... 12
3.4.2.1 Community Protection Management Areas ..... 13
3.4.3 Desired Post-Treatment Conditions ..... 14
3.4.3.1 Wildlife Considerations in Developing Desired Post-Treatment Conditions ..... 15
3.4.4 Review of Recently Planned and Completed Restoration Projects ..... 16
3.4.5 Range of Agreement ..... 17
4 Estimating Wood Volume and Supply ..... 19
4.1 Methods ..... 19
4.1.1 Developing Forest Structure and Wood Volume Layers ..... 19
4.1.2 Estimating Amount of Wood Byproducts from Restoration Treatments ..... 22
4.1.2.1 Wood supply volume ..... 22
4.1.2.2 Wood supply biomass ..... 24
4.1.2.3 Wood supply from small-diameter trees ..... 25
4.2 Results ..... 26
4.2.1 Forest Structure and Wood Volume Layer Accuracy ..... 26
4.2.2 Current Levels of Wood Volume in the Analysis Area ..... 27
4.2.3 Predicted Wood Supply Based on Treatment Scenarios ..... 28
4.2.3.1 Wood supply volume ..... 28
4.2.3.2 Wood supply biomass ..... 29
4.2.3.3 Wood supply from small-diameter trees ..... 31
5 Existing Harvesting Contractors, Mills and Manufactures ..... 31
6 Additional Considerations ..... 33
6.1 Fire as an Initial Treatment Option ..... 34
6.2 Tree Mortality and Climate Change ..... 36
6.3 Old-growth Trees ..... 36
6.4 Forest Growth Review and Recommendations ..... 37
7 Concluding Remarks ..... 40
8 Acknowledgements ..... 42
9 References ..... 42
Tables ..... 47
Figures ..... 65
Appendices ..... 75

## List of Appendices

Appendix A. Letter from Regional Forester on Utility of Wood Supply Analysis

Appendix B. Meeting Agendas and Summaries

Appendix C. Estimated Pre-Treatment and Desired Post-Treatment Basal Area Distributions for Overall Analysis Area and each Landscape Management Area

Appendix D. Summary of Presettlement Tree Densities in Southwestern Ponderosa Pine

Appendix E. Wood Supply Working Group Meeting Handout on Nov. 29, 2007 with Grand Canyon Trust Environmental Assessment Analysis

Appendix F. Tree biomass estimates in oven dry tons per acre from the a) consensus treatment scenario and b) majority treatment scenario.

Appendix G. USDA Forest Service timber cruised data from White Mountain Stewardship contracts on the Apache-Sitgreaves National Forest.

Appendix H. Fire Information for Wood Supply Analysis Group

Appendix I. Potential Follow-on Studies to Wood Supply Analysis

# 1 Executive Summary

Forest management to restore fire-adapted ponderosa pine ecosystems is a central priority of the Southwestern Region of the USDA Forest Service. Appropriately-scaled businesses are apt to play a key role in achieving this goal by harvesting, processing and selling wood products, thereby reducing treatment costs and providing economic opportunities. The manner in which treatments occur across northern Arizona, with its multiple jurisdictions and land management areas, is of vital concern to a diversity of stakeholder groups. To identify a level of forest thinning treatments and potential wood supply from restoration byproducts, a 20-member working group representing environmental non-governmental organizations (NGOs), private forest industries, local government, the Ecological Restoration Institute at Northern Arizona University (NAU), and state and federal land and resource management agencies was assembled. A series of seven workshops supported by Forest Ecosystem Restoration Analysis (ForestERA; NAU) staff were designed to consolidate geographic data and other spatial information and to synthesize potential treatment scenarios for a 2.4 million acre analysis area south of the Grand Canyon and across the Mogollon Plateau. A total of 94% of the analysis area is on National Forest lands. ForestERA developed up-to-date remote sensing-based forest structure data layers to inform the development of treatment scenarios, and to estimate wood volume in three tree diameter classes of <5", 5-16", and >16" diameter at breast height (dbh, 4.5' above base). For the purposes of this report, the group selected a 16" dbh threshold due to its common use within the analysis landscape as a break point differentiating "small" and "large" diameter trees in the ponderosa pine forest type. The focus of this study was on small–diameter trees, although wood supply estimates include some trees > 16" dbh where their removal was required to meet desired post-treatment conditions.[4] There was no concurrence within the group that trees over 16" dbh should be cut and removed from areas outside community protection management areas (CPMAs).

Participants successfully defined desired post-treatment conditions within five landscape management areas that included: communities, municipal and aquatic species watersheds, Mexican spotted owl (MSO) restricted habitat and wildlands. Consensus was reached across two-thirds of the analysis area. The group unanimously agreed that 26% of the 2.4 million acre

[4] Desired post-treatment conditions refer to the working group's preferred conditions following restoration treatments. They are not equivalent to desired conditions defined in the National Forest Management Act.

analysis area should not be considered a source of wood supply from mechanical restoration treatments, due to institutional and biophysical constraints. Consensus was also reached on the appropriateness of restoration treatments involving mechanical thinning across 41% of the landscape, resulting in a total of 850 million $ft^3$ of wood byproducts from tree boles alone (defined as the tree's main stem, from the ground to top of tree), and an additional 8.0 million green tons from branches and other tree crown biomass. All mechanical thinning treatments were assumed to be followed by controlled burning for ecosystem restoration and maintenance of fire-adapted conditions. The amount of potential wood byproducts from restoration treatments and small-diameter trees from this analysis exceeds current market demand. In 2006 existing wood products businesses in the analysis area removed and utilized 1.2% of the bole biomass (or 12% extrapolated over 10 years) that would potentially be generated from consensus scenario treatments.

There is a high level of agreement, but not consensus, that an additional 33% of the analysis area might also be available as a source of wood supply from mechanically-based restoration treatments. When added to the byproducts from the consensus scenario, this would result in a total of 1,015 million $ft^3$ from boles and 9.6 million green tons from tree crowns. The difference between the two scenarios was relatively small in terms of wood volume and largely driven by preferences for varying levels of restoration treatments, such as the preference of some stakeholders for prescribed burn-only treatments, wildland fire use[5] and non-commercial thinning (or thinning that would not add to wood supply). The analysis also revealed that where wood harvest included only trees under 16" in diameter, 19% of the landscape with restoration treatments would not fully achieve desired post-treatment conditions, as identified by the working group. These thinning areas were primarily within CPMAs where objectives called for more aggressive thinning.

The group considered incorporating future tree growth in wood supply assessments, but ultimately did not pursue this analysis, however a review of forest growth models was conducted to assist with future projections. Consequently, the numbers presented in this report represent a "snapshot" of currently available wood supply. Lack of complete data on current road access, the presence of archeological sites, and other site-scale considerations introduce some uncertainty in

[5] "Wildland fire use is the management of naturally ignited fires to achieve resource benefits, where fire is a major component of the ecosystem" (source: http://www.fs.fed.us/fire/fireuse/wildland_fire_use/use_index.html).

wood supply estimates. Potential changes to future wood supply due to climate change and disturbances such as wildfire, insect outbreaks, and drought-related mortality were also acknowledged. The results of this study will be used to assist in the development of multi-year forest stewardship contracts to attract new industrial users and to supply wood fiber to existing local wood product businesses.

## 2 Project Background

The Analysis of Small-Diameter Wood Supply in Northern Arizona (referred to as the "wood supply analysis") was initially called for in the fall of 2006 by an *ad-hoc* group of forest restoration professionals in Arizona and New Mexico. Concerns were mounting over the lack of funding for restoration treatments and a need for information regarding the volume of wood that might become available to existing and proposed wood utilization facilities, as byproducts from forest restoration. At the request of the *ad-hoc* group, our applied research team in the Forest Ecosystem Restoration Analysis (ForestERA) Project at Northern Arizona University submitted a proposal, later funded by the USDA Forest Service, Southwestern Region (Region 3), to estimate the supply of wood byproducts stemming from one or more ecologically appropriate treatment scenarios. Treatment scenarios were to be developed collaboratively by a diverse stakeholder group. Five members from the *ad hoc* group formed a steering committee to advise the collaborative process, public outreach, and other aspects of the project.

This report summarizes the work completed on the project, which officially began in May of 2007. Project deliverables specify that the ForestERA Project:

- Fully engage agency representatives and stakeholders in a collaborative process to build agreement on ecologically appropriate map-based treatment scenarios
- Mobilize the best-available science to quantify wood volume by size-class across the analysis area
- Estimate the volume of wood byproducts removed following each treatment scenario
- Review and recommend methods for estimating future net growth
- Prepare a database of existing wood harvesters, processors, and users

The analysis area includes ponderosa pine-dominated lands within selected National Forest boundaries in north-central Arizona (Figure 1); it does not include mixed conifer, pinyon-juniper, or other forest types. The area is located south of the Grand Canyon and spans the full

extent of the Mogollon Plateau to the border of New Mexico. The extensive and contiguous ponderosa pine-dominated areas on White Mountain Apache lands south of the analysis area are not included in this study, although they constitute a potential future source of wood byproducts.

This study offers a snapshot in time (year 2006) of both wood volumes across the study area and the range of wood byproducts that stakeholders agree could potentially be harvested. The wood supply working group (described below) decided early in the process to consider only treatments harvested mechanically as a source of wood supply, in order to simplify the development of their treatment scenarios, given that the vast majority of thinning treatments would likely be carried out with mechanized equipment. In addition, all mechanical thinning treatments were assumed to be followed by broadcast burns for the purposes of ecosystem restoration and maintenance. Analysis of wood supply for this assessment was implemented at a semi-regional scale (2.4 million acres of ponderosa pine dominated lands embedded within the proclamation boundaries of all or part of 4 USDA National Forests covering a total of 5.9 million acres) and should not be considered as a proposal for National Environmental Policy Act (NEPA) analysis. Site-specific analyses will be required to address the complexity of land planning issues that arise as thinning projects are developed on a case-by-case basis.

The overall objectives of the working group's treatment scenarios match the USDA Forest Service "Central Priority" for the southwest of restoring the health of fire adapted ecosystems. It supports the second and third components of the strategy to "reduce the threat of catastrophic wildfire to communities" and "reduce treatment costs by fostering private sector involvement to create the infrastructure to utilize excess biomass" (USDA Forest Service Southwestern Region, "Southwestern Region Central Priority: Restoring the Functionality of Fire Adapted Ecosystems", p. 23). It is also consistent with Arizona Governor Napolitano's "Statewide Strategy for Restoring Arizona's Forests" (Governor's Forest Health Councils, 2007). The Southwestern Region plans to use this study to assist them and others in assessing the appropriate scale and scope of restoration treatments and the infrastructure for utilizing forest biomass produced as a byproduct of these treatments (Forsgren, 2007a; see Appendix A of this report).

# 3 Building Agreement on Treatment Location and Type

A primary goal of the wood supply analysis was to build agreement among stakeholders in the region on the location and type of restoration treatments to improve forest health and protect communities from wildfire. To accomplish this goal, we formed a 20-member working group and held a series of meetings using a participatory geographic information system (GIS) process to develop map-based treatment scenarios. We also provided opportunities for a much larger group of interested parties from outside the working group to record their comments in the meeting summaries and make a case for various aspects of scenario development of importance to them.

## 3.1 Wood Supply Steering Committee

Five stakeholders served on a project steering committee, which guided the preparation of the funding proposal and the design of the collaborative process. The committee met once between each working group meeting to review meeting progress and advise planning for the next meeting. This project would not have been initiated or possible without the interest and perseverance of this committee and the *ad hoc* group from which they originated; the creative and helpful ideas this group contributed are too numerous to list.

The steering committee selected 15 additional working group members (Table 1) to create a broader and more representative team of individuals and organizations. Collaborative meetings were held approximately monthly from June 4 through November 29, 2007. The committee used several criteria to select a sufficiently diverse group with the necessary background to participate in the collaborative process including: 1) expertise, 2) representation from a variety of organizations, 3) geographic purview (range) and 4) availability.

## 3.2 Wood Supply Working Group Meetings

The working group met seven times as a full group (see Appendix B for agendas and detailed summaries of each meeting), and held several subcommittee meetings that were organized by our team when an issue of interest arose that could not be sufficiently explored by the larger working group, due to time constraints. Attendance at working group meetings was high, ranging from 14 to 18 participants (Table 2). Meetings were open to the public and rotated between three locations spread across the analysis area. We used a "fish bowl" process at each meeting, in which members of the public were welcome to attend the entire meeting, and could ask questions

or provide comments during a scheduled period. We distributed "Work Books" with background materials to each working group member at the first meeting, which were updated with additional materials throughout the process. Each meeting followed up on working group discussions, requests for additional information and decisions made at previous meetings. The subcommittees developed proposals which they presented to the full working group on the following topics: community protection management areas (CPMAs), "fire-only treatments" where controlled burning might be used in place of mechanical thinning, and treatment scenario attributes. ForestERA transformed detailed subcommittee discussions into spatial data layers that were integrated with the objectives and needs of the broader wood supply analysis process. Topical experts from academia, research institutes, and land management agencies provided additional background information to the group on wildlife issues, treatment impacts on soils, hydrological considerations, conditions favorable to fire-only restoration treatments, and pre-settlement and post-treatment forest conditions.

Meetings were facilitated by Rosemary Romero[6], a professional with extensive experience on a variety of contentious natural resource topics in the southwest including forest biomass utilization. Ms. Romero provided guidance to maximize working group participation and for defining a consensus-based decision making approach, which was refined and agreed upon by the working group. A scribe took notes and prepared summaries of approximately 15 pages in length to record working group discussions at each meeting. We distributed a draft of the summary to all working group members in attendance for review, incorporated many suggested edits, and distributed the final version to approximately 300 stakeholders, as well as posting it on the ForestERA web site (http://www.forestera.nau.edu/).

At the first meeting, held in June of 2007, we provided background and foundational information to the group. Each steering committee member commented on wood supply and utilization issues related to their respective organizations, and described how they hoped this analysis would aid in these issues (for details, see pp. 3-5 of the June 4, 2007 meeting summary in Appendix B). ForestERA summarized the importance of landscape-scale forest restoration assessments and reviewed the main task of developing one or more treatment scenarios that was the focus of the working group. We also provided background information to the group on previous landscape assessments in the analysis area, leaving the question open to them on how

[6] Dexter Albert, Intrinsic, filled in for Rosemary at the last meeting on Nov. 29, 2007.

they would like to use and/or adapt previous products and processes for the wood supply analysis. The USDA Forest Service Director of Forestry and Forest Health for the Southwestern Region described the importance of the study and how the Forest Service intended to use project results. Agency experts provided the group with information on how treatments might be constrained or influenced by regulations and guidelines related to wildlife, soils, and hydrological factors.

At the second meeting, held in July, ForestERA provided detailed information on how other collaborative groups in northern Arizona have built scenarios for previous landscape assessments (Hampton et al, 2006; Sisk et al, 2006). Methods to characterize and strategically place treatments across the landscape were presented to the working group. Building on the presentations by agency experts at the June meeting, ForestERA presented maps depicting technical methods to incorporate treatment guidelines and regulations relevant to siting treatments. For selected landscape conditions (e.g., steep slopes, northern goshawk nest areas) we reviewed data layers and estimates describing how each factor might influence a treatment scenario. The group found this map-based presentation of various options useful and requested that we continue depicting progress in this manner. At the end of this meeting, the working group developed the following "road map" for the process they would like to use to develop their treatment scenario for the purposes of determining potential wood supply:

1. Identify areas appropriate for restoration treatments that recover wood byproducts (i.e., "What's on the map?")
2. Define management objectives (i.e., "target conditions")
3. Select appropriate landscape-level treatment characterizations

The working group also discussed the utility of prioritizing treatment locations to convey their preference of how treatments should be sequenced in time. Some individuals expressed that it is the spatial and temporal heterogeneity of forest structural features that prevent large-scale stochastic changes in wildlife habitat and allow for transitional shifts in wildlife distributions in response to treatments. However, the group decided that there was insufficient time to pursue a prioritization assessment with the current wood supply analysis.

At the third through sixth meetings, held between August and November, the working group defined specific components of their scenario, such as the desired post-treatment forest conditions, following the road map they had developed previously. At the final meeting, on Nov.

29, a proposal to place thinning treatments on approximately 40% of the full analysis area (partitioned within the landscape as 70% within the CPMAs and between 30% and 40% within the remaining management areas, for a total of 41% overall; see details in section 3.4.5) was offered by a minority of participants as the greatest area that they felt would be broadly acceptable for mechanical restoration treatments. This minority preferred other restoration options be used where feasible in the remaining areas, including fire-only treatments, wildland fire use (WFU), non-commercial thinning (or thinning that would not add to wood supply). This precipitated a spirited discussion by the group that included concerns about whether this level of mechanical treatments would achieve the USDA Forest Service Southwestern Region's objective of restoring the functionality of frequent-fire forests. After considerable debate the group accepted this level of thinning as the consensus scenario. However, a majority of participants were adamant that the final report reflect that a large number of working group members felt that mechanical thinning was appropriate on up to 74% of the landscape. We scheduled time at this meeting to discuss potential economic analyses that might be pursued in the future, as a follow-up to this supply analysis, however, the group required this time to finalize their treatment scenarios.

Throughout the process, special topics came up requiring more time than available at the full working group meetings. For example, several working group members identified the need for better information on the parameters that affect the timing, placement, and application of prescribed and/or wildland fire use practices within the wood supply study area. Complex questions about the location and intensity of treatments in areas defined by the wildland-urban interface (WUI) also arose. Subcommittees of working group members worked between full group meetings to study these issues in greater detail and draft spatial data products to assist the working group in their collective decision making concerning these and other topics demanding special consideration.

### 3.3 Keeping Stakeholders and Elected Officials Informed of Project Progress

We used several modes of communication to update stakeholders of the progress made throughout the wood supply analysis. The most comprehensive were meeting summaries posted on the wood supply analysis web site (http://www.forestera.nau.edu/project_woodsupply.htm). We also developed a Wood Supply stakeholder list with approximately 300 email addresses, drawn from previous ForestERA efforts, that was updated with recommendations from working

group members, Forest Service public affairs officers and requests from individuals. Stakeholders received agendas prior to each meeting inviting them to attend as observers, and they were sent summaries following each meeting. A time was reserved at the end of each meeting for observers to ask questions or provide comments. We also announced in each email and on our web site how to provide comments via voice mail, email or U.S. post. Comments and questions provided were addressed at subsequent meetings.

Based on advice from the working group, we selected meeting locations distributed throughout the analysis area to encourage public attendance. We also prepared a one-page handout and distributed these at our first meetings, to assist working group members as they informed their colleagues and constituents who were not part of the working group. At the request of an observer at our first working group meeting on June 4, we expanded the wood supply analysis web site to include the contents of the Wood Supply Work Book that had been provided to working group members. To keep elected officials and other key players in the region informed of project developments, the steering committee developed a list of contacts to whom they provided periodic updates on project progress and products.

### 3.4 Working Group Treatment Scenario

One of the main goals of the wood supply analysis, and the primary task of the working group, was to build agreement on the location and type of ecologically appropriate treatments across the analysis area to improve forest health. This map-based product is referred to in this analysis as a "treatment scenario." The overall objectives of the group's scenario were, first, to restore fire-adapted (ponderosa-pine) ecosystems and protect communities from destructive fires, while mitigating adverse impacts of treatments on soils, surface water and wildlife. Secondly, based on restoration needs, the scenario defines the intensity and location of potential mechanical thinning treatments used to estimate the supply of wood byproducts. To accomplish these objectives, the group divided the landscape into areas where restoration byproducts were not available from mechanical tree thinning and those that were a potential source. They further divided the potential source areas into the five landscape management areas for which they developed various management objectives and desired post-treatment conditions, based on the "informed judgment" of experienced restoration practitioners from land management agencies and other organizations within the group (Table 3; Figure 2). Working group meeting summaries (Appendix B) contain detailed discussions on the development of treatment scenarios.

### *3.4.1 Landscape Features Considered Not a Source of Wood Supply*

The working group agreed that areas associated with seven landscape features were not considered a source of wood supply, ranging from slopes too steep for most mechanical harvesting equipment, to various soil, hydrological and wildlife habitat conditions (Tables 3 and 4). However, the group agreed that MSO protected activity centers (PACs) and other sensitive species habitats might be thinned lightly from below in some cases. The seven landscape features covered 26% of the 2.4 million acres of ponderosa pine-dominated lands in the analysis area (shown in black in Figure 2), leaving 1.8 million acres available as potential supply (Table 5). In addition, even though no changes were made numerically to the acres or volumes in either scenario based on road access, the group wanted to express that they had low confidence that areas further from ¼ mile from existing roads (constituting an additional 241,000 acres outside of the seven landscape features not considered a source of wood supply) would be a source of restoration byproducts in the near-term, due to limits of harvesting technologies in common use in the region, and to concerns over environmental impacts associated with both the road improvements necessary for harvesting and new road construction. An increase in the use of forwarders was looked on favorably by the working group to extend the yarding distance from ¼ to ½ mile from roads. A USDA Forest Service transportation engineer informed the group that many current roads were not adequate for transportation of wood in large trucks. Many of the areas with roads may not be available for wood supply or would need improvements. It was impossible to quantify the net impacts of these various access issues, given existing roads data.

On a separate issue, the group decided not to discuss or identify wood supply associated with severely burned areas. Salvage logging is controversial, and the group recognized that revisiting this debate could detract from the goal of the study to find common ground.

MSO PACs are 600 acre areas within which owls have been found to be nesting. Trees < 9” dbh may be removed in these areas, but it is minimal, so the working group decided not to include these areas as potential wood supply for the purposes of this study. Specially Designated Areas found in the analysis area include Wilderness Areas, National Game Preserves, Research Natural Areas, Primitive Areas and Inventoried Roadless Areas. For our analysis, a northern goshawk nest area was defined as a 180-acre circular area (i.e., total area was computed as six nests areas each encompassing 30 acres) geometrically centered on an individual goshawk post-fledgling area (PFA). These 180-acre areas were not considered a source of wood supply. Six

unique goshawk nest locations, for which PFA data were not available, were also buffered at an extent that totaled 180 acres. Soils with mechanical treatment limitations due to factors such as erodibility and rocky conditions were identified by USDA National Forest soil scientists. Areas with soil conditions that could be mitigated using best management practices (BMPs) were not included in this landscape feature. The working group considered the various management practices of the four National Forests and other lands in the analysis area in terms of restricting treatments directly adjacent to streams in order to maintain and protect these "filter strips" from potentially negative impacts of mechanical treatments. We determined from contacting Forest Service hydrologists and other staff that the Apache-Sitgreaves is the only National Forest in the analysis area that precludes mechanical treatments from areas next to streams. The other National Forests specify BMPs to mitigate damage, but have no rules that specifically restrict equipment from these areas. In order to maintain consistency across the landscape, the working group decided not to consider areas as a source of wood supply that are within 100 feet of perennial streams throughout the analysis area, and on both perennial and intermittent streams in the Apache-Sitgreaves National Forests due to the availability of data on intermittent streams.

The "treated areas" landscape feature includes areas the USDA Forest Service identified as having moderate to high intensity thinning treatments completed or contracted in the last 10 years,[7] including 30,000 acres as part of the White Mountain Stewardship Project (WMSP) contract. These areas warrant special attention due to data limitations and because they do not include the majority of areas contracted to the WMSP. The USDA Forest Service estimates that there are upwards of 120,000 acres remaining in the WMSP contract, however specific locations for these thinning treatments have not been defined, so could not be included in the "treated areas" landscape feature. This is important to consider in developing new stewardship contracts as the wood volume estimates provided in this analysis include byproducts from remaining WMSP restoration treatments.

Incomplete treatment information, in combination with disturbance-related mortality (e.g., wildfire, insect outbreaks, drought) over the past 10 years lead to our decision to develop updated forest structural information based on 2006 Landsat imagery. The compilation of data on previous forest treatments in the wood supply analysis area required contacting and visiting

[7] As this study focused on year 2006 conditions, working group members did not discuss or indicate preferences for the type or intensity of future restoration treatments within areas thinned in the past ten years.

an interdisciplinary team of GIS, timber, fuels, managers, and silvicultural staff at the four National Forests.[8] During the course of this analysis, the National Forests in the study area were in transition between two databases, Rocky Mountain Resource and Information System (RMRIS) and Forest Activity Tracking System (FACTS). This transition complicated data access and, in some cases, rendered the most current data unavailable. Also, spatial data often resides in multiple locations, such as individual district offices, and the attribute or tabular data resides elsewhere (databases or individual digital or hard copy documents) requiring more than one person with knowledge of the data and the correct expertise to access, query, or compile the various data sources. In addition to the incomplete nature of this data layer across the study area, the standards for tracking forest treatment data have changed over time.

### *3.4.2 Landscape Management Areas*

Among the five landscape management areas that were considered a potential source of wood supply, the community protection management areas (CPMAs) received the highest ranking for tree thinning from the working group. The group's ranking meant that management objectives for CPMA's took precedence wherever they overlapped another management area (see rank of each management area in column 1 of Table 3). Although, the working group ranked the management areas for purposes of reconciling spatial overlap and defined procedures resulting in varying areal extents for each, they did not prioritize them in terms of a preferred sequencing over time for restoration. The MSO restricted habitat management area (rank 2) is defined by areas with pine-oak vegetation and used in tandem with the group's basal area management objectives is designed to follow MSO Recovery Plan guidelines for other restricted habitat and target/threshold conditions at the semi-regional scale. The municipal watersheds management area (rank 3) contains 6$^{th}$ level watersheds with surface water supplies for communities.[9] The

[8] We either met in person or otherwise contacted the following Forest Service employees from the Kaibab NF: Jerry Drury**,** Bob Richardson**,** Bruce Higgins (contractor and former FS employee), Mark Herron, Tim McGann, Dave Mills, Woody Rokala; from the ASNF: Susan N Lee**,** Gayle Richardson, Monica Boehning**,** Joseph A Hamrick, Laura A Mounce, William H Ripley, Georgia Morris, Margaret Kirkeminde, Nancy Loving, Pamela Klein-Taylor, Stacey L Weaver, Steven Richardson, Dan Mindar, James Pitts, Robert S Taylor, Kerry Nedrow**,** Raymond Rugg, Deryl Jevons**,** Elaine Zieroth, Patti O'Connor**,** Margaret Kirkeminde; from the Coconino NF: Pat Key, Mike Manthei, Frank Thomas **,** Kim Newbauer**,** Jeffrey Thumm**,** Joe Luttman**,** Carl Beyerhelm**,** Andy Stevenson**,** Patty Ringle**;** and from the Tonto NF: David Bailey, Carolyn Williams, Don Nunnelly and Pam Rule. In addition on fire and vegetation mapping issues, we contacted: from the Missoula Fire Lab: Laurie Kurth, Chuck McHugh, and Rob Seli; from Region 3: Gilbert Zepeda, Linda Wadleigh, Wayne Robbie, Jack Triepke, Tom Mellin, Jeff Hogg, Georgie Porter, and Bill Krausmann; and from FIA Ogden, UT: Michael Wilson, Ron Tymcio and John Shaw.

[9] Municipal watersheds are also referred to as community "source water supply" by the USDA Forest Service.

working group defined the aquatic species watersheds management area (rank 4) as 6th level watersheds in which native fish are known to occur. The wildlands management area (rank 5), which was a catch-all for areas not defined by the other four, covered the largest area at 788,000 acres, or 33% of the 2.4 million acre ponderosa pine-dominated analysis area (Table 5).

#### 3.4.2.1 Community Protection Management Areas

A working group subcommittee developed several options for defining the CPMAs, which they presented to the full group. A total of six Community Wildfire Protection Plans (CWPPs; Tusayan, Flagstaff, Williams, Rim Country, Apache and Sitgreaves), encouraged by the Healthy Forests Restoration Act of 2003, have been developed and approved by local governments in the wood supply study area. In evaluating WUI zones defined in the CWPPs to develop proposed treatments for the wood supply analysis, it became apparent that not all CWPPs were developed in the same manner, and this variability precluded consistent application of analytical techniques across the analysis area. For example, some plans identified high priority treatment areas as subsets within their community's CWPP boundary, while other plans assigned high priority to the entire area contained within their CWPP boundary. The working group struggled to incorporate and honor the boundaries and recommendations established in the various community-sponsored CWPPs in the analysis, but decided for consistency to apply the same treatment scenario approach within all CWPP analysis areas as was applied through the study area. This should not be construed as an attempt by the working group to reestablish the boundaries designated by communities, but rather as necessary in order to create consistency across the analysis area. Specifically, the full group decided to define CPMAs by assigning a ¼-mile protection buffer around all private lands, with an additional ½-mile protection buffer, extending to 1½-mile in the upwind direction, of all private property within "high priority" areas identified in CWPPs. This resulted in a CPMA, aggregated across the study area, that is approximately 600,000 acres smaller than the area identified in the various CWPP's, and proposed treatments that differ slightly from some CWPPs. The wood supply volumes derived could be adjusted, if adequate information on volumes generated by specific CWPP recommended treatment scenarios is developed through alternate techniques, however, only four of the six CWPPs defined recommended treatments. Therefore, the working group agreed that current estimates be developed from consistent application of the same techniques throughout the study area while presenting the treatment information available in completed CWPPs (Figure 3).

### *3.4.3 Desired Post-Treatment Conditions*

For each landscape management area, the working group specified a post-treatment basal area distribution appropriate for the area's management objectives (see column 2, Table 3) and designed to generate heterogeneous forest structural conditions at the landscape scale (Figure 4). Basal area distributions were derived through informed judgment and group negotiation. The group endeavored to balance key land management issues that included: 1) the desire to reduce the threat of catastrophic fire; 2) concerns about aggressive or intensive thinning in wildland areas; 3) the need to both protect wildlife habitat from unnaturally-severe fire while simultaneously proceeding with caution to minimize any potential negative impacts of treatments on wildlife and their habitats; and 4) a desire to maintain landscape heterogeneity. Scenario and wood supply outcomes reflect this balancing act. For example, the proposed thinning for the CPMAs is more aggressive than the thinning goals in wildland areas, while desired post-treatment distributions in MSO restricted habitat allow for 10% of the forest to have a basal area > 150 $ft^2$/acre to promote MSO target/threshold habitat. These are not precise determinations or prescriptions; rather, they are assumptions that allow for the estimation of wood supply, as requested in this semi-regional scale analysis.

From the total basal area layer (described below and shown in Figure 5), a scenario algorithm was used to fit the existing distribution for each landscape management area to a desired post-treatment condition, while maintaining the original order of low to high basal area conditions (Figure 4). In other words, lower pre-treatment basal areas were "matched" to lower post-treatment basal areas and higher initial values were matched to higher post-treatment values according to the shape of each curve. The pre-treatment basal area was shifted downward (Appendix C) unless it was below a minimum desired condition (e.g., < 40 $ft^2$/acre in wildlands) in which case the values were left unchanged. The dominant thinning level ranged from heavy in the CPMAs to light in MSO Restricted Habitat (Tables 6 and 7) and match the guidelines for these levels developed by the group (column 4, Table 3). The modeled treatments in the management areas, especially the high intensity treatments in the CPMAs, interspersed with the untreated areas removed from consideration as a source of wood supply, create a heterogeneous pattern of potential post-treatment basal areas across the landscape (Figure 6).

#### 3.4.3.1 Wildlife Considerations in Developing Desired Post-Treatment Conditions

Ponderosa pine forests in northern Arizona are naturally heterogeneous in structure (Covington and Moore 1994, Allen et al. 2002, Appendix D: table supplied by ERI to working group on pre-settlement conditions in Woolsey plots and other sites), and provide habitat for a diversity of wildlife species. Although the effects of thinning and burning on forest over- and understory vegetation are fairly well understood, we do not completely understand how changes in forest structure and function impact, modify, and/or change habitat for individual wildlife species, their population dynamics, or community organization (Governor's Forest Health Councils, 2007, p.19). It is likely that the spatial arrangement of retained trees following forest restoration treatments plays an important role in determining habitat value at the landscape scale. Wildlife are ecologically and socially important components of the forest ecosystem, and management interventions should be designed to provide the diversity of habitats needed to support and sustain wildlife populations (as recommended by Chambers and Germaine, 2003). Therefore, the working group recommends implementation of a variety of thinning and/or burning treatments juxtaposed across the landscape, including areas with untreated forest. The timing of treatments should also vary across the landscape to allow for transitional shifts in wildlife distribution in response to treatments.

The broad target range of basal area and the distribution of different treatments included in the working group's scenario (Figure 4), interspersed with areas having no mechanical thinning treatments, afford a variety of future potential conditions for wildlife. Beier and Maschinski (2003) point out that our current knowledge of pre-settlement conditions is likely incomplete as it does not fully account for portions of the landscape that had dense stands with large snags, prior to EuroAmerican settlement. They also note that Threatened, Endangered, and Sensitive (TES) species may specialize in habitats "atypical" of those described by current pre-settlement reconstructions. They recommend that we increase our understanding of the spatial heterogeneity of pre-settlement conditions, while noting that, given the relatively small areas occupied by TES species, their consideration will likely not seriously constrain restoration efforts (see also Prather et al., 2007, for a closer look at the MSO). In addition, Beier and Maschinski (2003) reason that ecosystem changes in the last century (climate change, loss of top carnivores, the spread of invasive species, anthropogenic edge effects and fragmentation) may preclude full restoration of structure and function, and "ecosystems may as a result take

unexpected trajectories after restoration treatments, justifying a cautious approach." The working group targets for basal area distributions outside of CPMAs include some areas of higher tree densities to provide a variety of habitat conditions for TES and other wildlife species, such as tassel-eared squirrels.

### *3.4.4 Review of Recently Planned and Completed Restoration Projects*

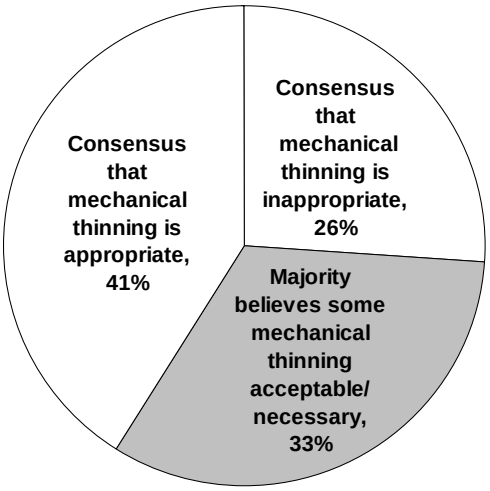
The amount of ponderosa pine (PP) that is thinned mechanically in recently planned and completed restoration projects in the analysis area is influenced by both biophysical and institutional constraints. These include the presence of archeological and historical sites, steep slopes, wildlife habitat concerns, access on suitable roads, streamside management zones, erodible soils, and administrative removals (e.g., Research Natural Areas). The effect of these factors on areas thinned shift over time to varying degrees given forest growth, vegetation disturbances and other changes. This study is focused on year 2006 conditions. The consensus and majority scenarios identified 26% of the study area as being inappropriate as a source of wood byproducts from restoration thinning treatments, based on spatial analysis using available map-based data. Since it was not possible to include all factors known to affect treatment placement at the landscape scale due to data limitations, it is reasonable to expect that a higher percentage of the total area would not be thinned. To explore this hypothesis we reviewed a sample of current treatment projects and interviewed Forest Service personnel.

We reviewed eight National Environmental Policy Act (NEPA) approved restoration projects on the Coconino and Apache-Sitgreaves National Forests as described in the Environmental Assessments (EAs). All projects had successfully gone through the NEPA process and all special considerations (e.g., riparian areas, slope, MSO PACs) were included within the original NEPA planning area. In combination with 19 additional EAs analyzed by the Grand Canyon Trust, an average of 37% of project areas were found not to have been thinned (Table 8; see Appendix E for more details). A similar review by a Timber Staff Officer on the Kaibab National Forest (NF) of recently sold and closed timber sales, all NEPA approved, found 38% of the project areas were not thinned (personal communication with Jerry Drury, 2007) and Forest Service personnel on the Apache-Sitgreaves NF estimated that perhaps 40-50% were not thinned (personal communication with Elaine Zieroth, 2007). These figures indicate a value in the high 30s up to mid- 40s may be a reasonable estimate of the average percent of acres within a NEPA planning area which would not receive mechanical treatment. However, a larger sample

size distributed throughout the study area would be required to provide a range with greater certainty.

### *3.4.5 Range of Agreement*

The group reached consensus that 26% of the 2.4 million acre analysis area should not be considered a source of wood supply for various reasons (see section 3.4.1) and that 41% should be considered a potential source of material generated by mechanical harvesting as part of the restoration or fuel reduction treatment. In addition, a majority of working group members believed that some portion of the remaining 33% of the landscape (up to a total of 74%) should be considered for mechanical thinning. The following pie chart represents the level of agreement among stakeholders as a percentage of the entire analysis area:




In the above pie chart, areas in white represent consensus over a total of 67% of the landscape. Areas in gray represent the remaining 33% of the landscape where there is a lack of consensus, but the majority of working group members believed that some mechanical thinning would be acceptable and/or necessary.

Although there was consensus among working group members that 26% of the analysis area was not a potential source of wood supply, as described in section 3.4.1, this value is less than the average value we observed from a sample of actual projects (37%) and estimated by Forest Service staff (high 30s to mid 40s). It was reasoned that the value derived via spatial analysis (26%) is an underestimate because site-scale factors known to limit the extent of treatments were not accounted for by this semi-regional scale analysis, such as archeological sites, historical sites, wildlife movement corridors, and areas with insufficient road access, that

were stated in EAs as reasons for limiting the amount of area thinned. It was not possible to adequately determine the magnitude of these factors without more detailed study of the EAs and more detailed map-based data. The reason that the majority finds mechanical thinning acceptable on some, and not all, of the remaining 33% of the landscape is due both to the unknown influence of factors that affect the total amount of area treated, but also the fact that the group ran out of time to more thoroughly discuss this topic. Therefore the group did not decide under what conditions these additional acres might be considered appropriate for mechanical treatment yielding wood supply.

Working group members who recommended the consensus scenario maintain that if mechanical treatments were placed strategically across the 41% of the landscape identified in the consensus scenario, unnatural fire behavior might be significantly curtailed at the landscape level. They envision that the remaining areas could be left open for additional restoration treatment options, such as wildland fire use, prescribed fire-only treatments, and non-commercial thinning. The strategic aspect of this approach is recommended in the Statewide Strategy for Restoring Arizona's Forests (Governor's Forest Health Councils, 2007): "Federal and state land management agencies should collaboratively and strategically place treatments in order to increase efficiency and maximize benefits." However, others hold the view that thinning provides more "control" in terms of determining which trees will remain and reducing fire threat.

The working group partitioned the area to be restored using mechanized thinning for the consensus and majority scenarios into to the following proportions of each landscape management area:

| Landscape management area | Consensus (% / acres) | Majority (% / acres) |
|---|---|---|
| Community protection | 70% / 316,000 | 74% / 335,000 |
| MSO restricted habitat | 30% / 114,000 | 74% / 237,000 |
| Municipal watersheds | 40% / 35,000 | 74% / 60,000 |
| Aquatic species watersheds | 35% / 184,000 | 74% / 334,000 |
| Wildlands | 35% / 339,000 | 74% / 788,000 |
| FULL ANALYSIS AREA TOTALS: | 41%[10] / 988,000 | 74% / 1,775,000 |

These proportional breakdowns for the consensus scenario were based on informed judgment, without mention of specific, area-by-area rationale during the collaborative meetings,[11] whereas the 74% for the majority scenario was based simply on the portion of the analysis area remaining after areas deemed not a source of wood supply in the consensus scenario (Table 4) were removed from consideration. Note that the 74% figures for each management area in the majority scenario are only approximations, as some of these areas already meet desired post-treatment conditions, and each management area had different proportions of steep slopes and other factors contributing to the 26% of areas across the full landscape considered not to be a source of wood supply.

# 4 Estimating Wood Volume and Supply

## 4.1 Methods

### *4.1.1 Developing Forest Structure and Wood Volume Layers*

Data to perform the wood supply analysis were developed using modern statistical tools and remotely-sensed data outlined in the following section. Principle data layers developed were for

[10] The proportional breakdowns for each landscape management area resulted in a total of 41% of the overall landscape dedicated to mechanical thinning treatments in the consensus scenario.

[11] As part of comments received during working group review of a draft version of this final report, the following rationale was put forth by the minority who proposed the proportional breakdown. The proportional breakdown is part of a three-tiered comprehensive landscape restoration strategy in which: 1) intensive mechanical thinning treatments are placed across 70% of the CPMA, 2) additional mechanical thinning treatments are placed strategically to significantly reduce uncharacteristic fire behavior across 30-40% of each of the remaining landscape management areas (informed in part by the work of Mark Finney at the USDA Forest Service Missoula Fire Sciences Lab, e.g., Finney 2006 and Finney et al. 2007), and 3) other restoration options are used where feasible and needed in the remaining areas, including prescribed burn-only treatments, wildland fire use (WFU) and non-commercial thinning (or thinning that would not add to wood supply). In addition, this approach provided a surrogate for explicit fire treatments and other thinning treatments that wouldn't result in wood supply during the process (see Section 6.4). The individual components of this strategy were discussed during the collaborative process, however, they were not presented to the group as a cohesive strategy.

total wood volume and basal area per acre. Additional layers for basal area and wood volume were developed for trees <5", 5 to16" and >16" dbh. Three broad diameter classes were selected by the working group as an appropriate range for estimating wood volume at the scale of the analysis area with available data. Tree density and percent canopy cover were additional forest structural layers derived for the wood supply analysis area. A total of 10 principal data layers developed are listed as follows:

- Volume
    - Total wood volume ($ft^3/ac$)[12] (Figure 7)
    - Wood volume ($ft^3/ac$) for classes <5", 5-16" and >16" dbh (Figures 8-10)
- Forest structural parameters
    - Tree density (trees per acre)
    - Canopy cover (%)
    - Total basal area ($ft^2/ac$) (Figure 5)
    - Basal area ($ft^2/ac$ ) for classes <5", 5 to16" and >16" dbh

A total cubic foot volume layer was used for comparison with three diameter class layers to assess potential computation errors within each category. We developed basal area layers by diameter class to estimate whether the amount of wood byproducts[13] resulting from restoration treatments could meet post-treatment objectives by harvesting small-diameter trees (<16" dbh) further discussed below. Three primary data sources were integrated for mapping forest structure and volume across the study area to estimate wood supply, 1) USDA Forest Service Forest Inventory and Analysis (FIA) permanent plots for the ponderosa pine type established from years 1995 to 2005, 2) twelve Landsat 5 Thematic Mapper (TM) scenes from "leaf-on" (September 2006) and "leaf-off" (October 2006) image dates and 3) a 30m digital elevation model (DEM). We resampled all digital data to a 90m pixel resolution to adjust for potential spatial displacement between FIA plots and grid cells.

We used FIA plots and coordinates to create a ground reference dataset of forest structural attributes from plot locations with no evidence of disturbance (e.g., fire, tree harvest, insect attack, etc.) prior to Landsat image dates. Plots were selected using a change detection

[12] Cubic foot volume includes all portions of the tree bole or main stem **without** deductions for top and stump material above or below a diameter limit. Crown material such as limbs, foliage and bark are not included for this estimate.

[13] Byproducts are defined as all woody material removed from a site as a result of forest restoration treatments.

analysis and the Normalized Vegetation Difference Index (NDVI) derived from Landsat image years 1999, 2004 and 2006. NDVI is calculated as Landsat (*Band 4 – Band 3)/(Band 4 + Band 3)*, which is sensitive to changes in plant biomass (Jensen 2000). Plots showing no negative departure in NDVI values over time in the ponderosa pine type were retained for the reference dataset (n = 420).

Forest structural variables and wood volume for each plot were then estimated for year 2006 using the Central Rockies Forest Vegetation Simulator (FVS) growth model to match image dates. FVS was used to project FIA plots and forest structural variables up to 2006 using growth simulations. To implement growth simulations compatible with FVS assumptions, site indices taken from FIA plots and tree cores were first converted from a base age of 50 to 100 years using equations obtained from the USDA Forest Service-FVS support group at the Forest Management Service Center in Fort Collins, Colorado. No tree regeneration was added to simulations as short growth cycles were used ranging from 1 to approximately 11 years depending on the plot establishment date.

Wood volume was calculated from the ground reference dataset (FIA plots) in FVS using total cubic feet for the ponderosa pine type in the study area with equations by Hann and Bare (1978) for southwestern tree species. A total volume measurement for tree boles was chosen for this scale of analysis and technical constraints as they apply to the ground data and the remote sensing applications used. Wood volume and biomass estimates, further discussed below, were derived from images acquired by the Landsat TM satellite sensor that observes forest canopy from overhead. Deductions or separate quantifications for portions of the stem such as tree tops and stumps above and below a diameter limit were not feasible at the spatial and spectral resolution of TM data. Nevertheless, tree tops and other parts of the tree are also potentially utilized with increased market demand for these materials (Rummer et al. 2005). Other methods were employed to determine restoration byproducts from tree crown material (limbs, bark and foliage) outlined in section 4.1.2.2. Thus, estimates for crown weight in addition to wood supply from tree boles were derived separately.

From leaf-on and leaf-off Landsat imagery, we derived 34 spectral variables (e.g., TM bands 1-5, 7, corrected NDVI (NDVIc), wetness, greenness, brightness, etc.) potentially related to forest structure and ponderosa pine wood volume. NDVIc applies a middle infrared correction to NDVI (Nemani et al. 1993) that has been shown to be a better predictor of leaf area index and

sensitive to differences in coniferous forest biomass (Pocewicz et al. 2004). Terrain corrected images from the USGS Earth Resources Observation and Science Data Center were used to assure minimal registration error. Landsat bands were converted to top of atmosphere (TOA) reflectance from image calibration data following (Chander and Markham 2003). Additional predictor variables related to the biophysical environment; elevation, surface roughness, slope and cosine transformed aspect, were derived from the DEM.

To estimate forest structural parameters and wood volume across the study area via digital data layers, we used *k*-nearest neighbors (*k*-nn) imputation statistics. Summary forest structural variables from the reference dataset were predicted using spectral variables associated with each plot, and then used to interpolate values across the entire study area. Each data layer was evaluated for accuracy (Table 9) using a "second nearest neighbors approach" that compares forest structure values from FIA reference plots to imputed values (also see Ohman and Gregory 2002). To implement this approach, the "yaImpute" package (Crookston and Finley 2007) in R statistical software v. 2.5.1 (R Foundation for Statistical Computing 2007) was used. Ohmann and Gregory (2002) provide a recent example of *k*-nn methods that were enhanced for the wood supply analysis using the Random Forest decision tree algorithm (Breiman 2001). Comparisons between Random Forest and other modeling techniques have demonstrated superior performance, flexibility and accuracy (Gislason et al. 2006, Culter et al. 2007). Modifications to Random Forest for *k*-nn imputation and deriving forest structural variables are further discussed in Crookston and Finley (2007).

Data layers developed using the above methods considers forest conditions for the 2006 Landsat imagery and FIA reference dataset. Volume accumulation for the ponderosa pine type in northern Arizona averages ~40 $ft^3$/ac/yr (see section 6.4) that contribute additional wood volume and supply over time. The present analysis limits wood supply predictions to volume levels determined from the 2006 dataset only (Table 10). Further analysis is warranted to include assumptions about annual treatment and growth rates to estimate forest growth and additions to wood supply over a specified planning period.

### *4.1.2 Estimating Amount of Wood Byproducts from Restoration Treatments*

#### 4.1.2.1 Wood supply volume

Forest restoration treatment scenarios for each landscape management area (Figure 2) were applied as reductions in existing total basal area by the wood supply working group. Restoration

objectives for the ponderosa pine type and desired post-treatment conditions developed by the working group are outlined for each of five landscape management areas in Table 3. The group wished to limit their assumptions on how restoration treatments might be applied at a local-scale and no guidance is being given with this report for designing site-level silvicultural treatments.

Assumptions for implementing restoration scenarios were functionally applied to accommodate data layers and analyses developed at a semi-regional scale. Manipulation of stand tree lists and size-class distributions were not feasible at this scale. A desired distribution or range of post-treatment conditions is based on total basal area (Figure 4). Therefore, post-treatment basal area and the amount removed from treatments was the variable of interest used to guide scenarios and generate wood supply estimates (Figures 5 and 6). Moreover, it was acknowledged that treatments should focus on removing small-diameter trees as the central objective of the wood supply analysis, but no diameter limitation was placed on restoration scenarios or supply calculations.

To obtain wood volume harvested as a byproduct of treatments, a non-linear regression model was used to determine cubic foot volume from the amount of basal area removed. To establish these relationships, we used basal area and total wood volume from FIA plots in the reference dataset (n = 420). All values were log transformed to meet variance and normality assumptions. A final model showed a good fit to the data ($r^2 = 0.81$, $p < 0.0001$) resulting in the following equation:

**Eq. 1 f = y0 + a*x**

where, f = cubic foot volume, y0 = 0.9770, a = 1.118 and x = log(basal area). Results from the regression model demonstrate a strong relationship between total basal area and total cubic foot volume in the ponderosa pine forest type for this landscape.

From the total basal area layer, a scenario algorithm was used to fit the existing basal area distribution for each management area to post-treatment conditions (Figure 4). Locations within a management area that were already at or below a minimum basal area specified in Table 3 were left untreated and did not contribute to wood supply. Locations with a basal area above the minimum value were assumed treated (i.e., thinned) and used to determine wood supply with regression Equation 1. Thus, the total amount of basal area removed from each grid cell was the principle explanatory variable used for wood supply calculations. A range in wood supply volumes were estimated for each management area, integrating working group scenarios from a

consensus level (100% agreement) to a level where the majority of the participants were in agreement (Table 11). In the consensus scenario, locations with the highest basal area within the specified fraction of each landscape management area (see section 3.4.5) were assumed to be treated (41% of landscape). These areas were also included in the majority scenario as well as remaining lands deemed appropriate for thinning (74% of landscape). Pre- and post-treatment landscape conditions (basal area) for the majority scenario are shown in Figures 5 and 6.

#### 4.1.2.2 Wood supply biomass

The working group wished to augment cubic foot volume estimates of potential wood supply from tree boles with forest biomass in terms of weight (i.e., tonnage). For this report on wood supply, biomass was defined as the weight of all above ground material generated as a result of the consensus or majority restoration scenarios. Tree bole and crown weights are useful measurements when all parts of the tree are potentially utilized or disposal costs of non-merchantable portions of the tree are important (Rummer et al. 2005). Biomass estimates for this analysis were calculated in green tons that include all above ground portions of the tree partitioned into tree boles and crown material. Biomass was calculated by using a simple factor to convert from cubic foot volume[14] to green tons for tree boles generated as wood byproducts from each restoration scenario. Therefore, calculations for crown weights were in addition to wood supply estimates for tree boles. Crown biomass estimates included material from foliage or needles, bark and limbs that were calculated by developing a relationship between tree bole and crown weights with the following procedures:

1. FIA plots from 1995 to 1997 (n = 482) in the ponderosa pine type were used to develop a relationship between tree bole and crown weight from regression estimation. For each plot, tree bole and crown weights were calculated using the tree biomass function in FVS ("Treebio" FVS event monitor function)[15].
2. Total cubic foot wood supply estimates from tree boles for each restoration scenario (i.e., consensus and majority) were converted to green tons using a factor of 0.0315 (0.0315

[14] Cubic foot volume and tree bole weights from the wood supply estimate include all material from entire length of the main tree stem. Bole weight supply estimates are equivalent to cubic foot volume estimates and are the result of a unit conversion.

[15] FVS equations for tree boles and crown weights are from the USDA Forest Service Wood Products Laboratory (1999) and Brown and Johnston (1976) respectively.

green tons = MCF)[16]. This was a simple unit conversion and does not contribute additional wood supply above that from tree bole volume estimates derived for each restoration scenario.

3. To estimate crown biomass that is in addition to wood supply from tree boles, a relationship between bole and crown weights from FIA plots was developed via non-linear regression. Values for stem and crown weight were square root transformed to meet normality and variance assumptions. The regression resulted in an $r^2 = 0.69$ ($F = 1078$, $p < 0.0001$) and equation:

   **Eq. 2 f = y0 + a*x**

   where, f = crown weight (green tons), y0 = 0.5997, a = 0.5432 and x = sqrt(stem biomass). Stem weight was generally three times greater than biomass comprising crown material.
4. Data were summarized by total and average per acre bole and crown biomass for treatments in each landscape management area (Table 12). We compared green tons to USDA Forest Service timber cruise estimates from White Mountain Stewardship Project (WMSP) contracts (n = 31) on the Apache-Sitgreaves National Forest from years 2004 to 2007. WMSP contracts are referred to as "stewardship contracts" for discussing results below.
5. Biomass estimates are also presented in oven dry tons for tree boles and crown material (Appendix F).

#### 4.1.2.3 Wood supply from small-diameter trees

The working group also wished to examine the amount of land area and volume where thinning could meet post-treatment conditions by harvesting only small-diameter trees (i.e., trees <16" dbh). For the purposes of this report, the group selected a 16" dbh threshold due to its common use within the analysis area as a break differentiating "small" and "large" diameter trees in the ponderosa pine forest type. Although wood supply estimates include trees >16" dbh to meet post-treatment conditions, the focus of this study was on small-diameter trees. There was no concurrence within the working group that trees >16" dbh should be cut and removed outside of CPMAs.

[16] A wood volume to biomass conversion factors were obtained from "Monitoring and Measuring Wood Carbon" by Sampson (http://www.sampsongroup.com/Papers/papersdocuments.htm).

To perform this analysis, we estimated the extent and location of areas where post-treatment basal area conditions were met by cutting only trees <16" dbh and locations where cutting trees >16" dbh would be necessary to match basal area distributions in Figure 4. A rule set developed by the working group for identifying these locations follows that 10% and 20% of the basal area per acre must be retained after thinning from trees <5" dbh and 5 to 16" dbh respectively to allow for uneven-age or heterogeneous forest structural conditions[17]. Principle data layers for existing basal area from trees <5" dbh and trees 5 to 16" dbh were used, subtracting them from the amount of basal area harvested from a location (grid cell). A minimum of 10 and 20% of the basal area was assumed un-harvested for each diameter class and pixel. This has the computational form of:

**Eq. 3 Basal area removed – (BA <5" dbh * 0.9 + BA 5 to 16" dbh *0.8)**

Pixels with negative values represent areas with sufficient basal area for trees <16" dbh to meet post-treatment basal area conditions. Positive values indentified the amount of basal area that would be necessary to harvest from larger trees (>16" dbh) to meet these conditions. Regression Equation 1 was used to estimate the amount of cubic foot volume potentially derived from small and large diameter trees (i.e., trees <16" dbh and >16" dbh) with the majority restoration scenario only. The number of acres and wood supply volume in each post-treatment condition was then summarized by management area and included with results (Table 13).

## 4.2 Results

### *4.2.1 Forest Structure and Wood Volume Layer Accuracy*

We derived volume and forest structural layers from TM imagery representing conditions up to the fall of 2006. FIA plots were used to validate imputed forest structure and volume layers. The *impute* function of the yaImpute R package provides a practical method to determine layer accuracy by estimating the value of a reference plot (e.g., basal area, cubic foot volume, canopy cover, etc.) from other references in the dataset. Reference data were compared to imputed values via coefficients of determination ($r^2$) from a linear regression with the intercept set to one. An analysis of residual errors between observed and predicted values (i.e., |observed – predicted values|) was used to estimate accuracy for 50% of the predicted values and then 80% of the

[17] For this analysis, no formal assumptions were made about post-treatment tree size class distributions. However, the working group wished to retain trees <5" dbh (10% of existing basal area) and 5-16" dbh (20% of existing basal area) to allow for spatially heterogeneous forest conditions with a diversity of tree age and size classes.

predicted values (Table 10). For example, the average difference between observed and imputed basal area values is ±5 $ft^2$ for 50% of the data (Table 9).

Structural layers for total basal area and tree density showed the highest $r^2$ values (0.77 and 0.74). Imputed values for all structural layers had accuracies which were considered adequate to assess forest conditions at the scale of the wood supply analysis area. Results for the total wood volume estimate showed the highest $r^2$ value (0.87) overall and low residual error relative to average volume (Table 9). Volume within diameter categories (Figures 8 - 10) showed lower accuracy with available data inputs (Table 9). Nevertheless, total cubic foot volume imputed for the ponderosa pine forest type was quite similar to volume summed over the three diameter classes at 4,561 million $ft^3$ vs. 4,526 million $ft^3$ respectively (Table 10). Volume summed for two diameter categories, above and below 16" dbh, was nearly equal to the total volume layer estimate at 4,559 million $ft^3$. These comparisons identify the <5" dbh class as the greatest source of error among the cubic foot wood volume layers.

Overall, methods used to produce digital data layers showed better than expected accuracy levels. Forest structural data layers showed similar or improved accuracies compared with structural estimates by Ohman and Gregory (2002) who used similar methods and data. Volume estimates within diameter categories were lower than the actual volume in locations with high biomass or canopy cover. Scatter plots for observed and imputed values within diameter classes showed greater variability for FIA plots with volumes >2000 $ft^3$/ac and basal area >110 $ft^2$/ac (data not shown). Landsat imagery's overhead view and spatial and spectral resolution likely reduces accuracy for pixels more fully saturated by overstory tree canopies. A stronger relationship between spectral values and overstory trees, that contribute a larger proportion of the total volume and basal area, potentially explains greater accuracy for these layers.

### *4.2.2 Current Levels of Wood Volume in the Analysis Area*

We calculated bole wood volume for the ponderosa pine type across the entire analysis area, 4,561 million $ft^3$, from the total cubic foot volume layer (Figure 7, Table 10). Average wood volume per acre was 1,890 $ft^3$ across the entire analysis area. A total of 3,263 million $ft^3$ was estimated for the ponderosa pine type after areas such as steep slopes, MSO PACs and other locations unlikely to be treated by mechanical thinning were removed (Table 10). A total of 26% of the analysis area was removed from the wood supply assessment for the reasons stated

above and 74% was considered to be within forest management areas where restoration treatments could potentially take place. Wood volume per acre was only slightly lower (1,830 $ft^3$/ac) for management areas after removing 26% of the area unlikely to be thinned.

We also estimated volume for each of the three tree diameter classes for the entire analysis area and within each landscape management area considered in the two treatment scenarios (Table 10). A roughly even proportion of the total wood volume was estimated for tree diameter classes <16" dbh (45%) and trees >16" dbh (55%) within management areas (Table 10). The wildlands management area represents the largest land area (33%) with 30% of the wood volume across the entire study area. All five forest management areas showed a similar proportion of wood volume to the size of the area included within the area (Table 10). For example, municipal watersheds were only 3% of the total area and contained 3% of the volume.

### *4.2.3 Predicted Wood Supply Based on Treatment Scenarios*

#### 4.2.3.1 Wood supply volume

Each landscape management area represents a portion of the analysis area where a level of mechanical thinning can potentially be implemented, therefore contributing to wood supply. The proportion of wood supply from a management area was determined by working group members (section 3.4.5). Management areas treated under the consensus scenario generated a total wood supply of 847 million $ft^3$ from 41% of the entire analysis area (Table 11). Thinning treatments under a scenario agreed upon by the majority of working members generated greater wood supply (1,015 million $ft^3$) from 74% of the analysis area (Table 11). Note that the full 74% of the analysis area is not treated under this scenario because 5% of the area was already at or below a minimum basal area condition for management areas (Table 3).

Wood volumes from the two supply scenarios did not range widely even though 33% more area was covered with potential restoration treatments under the majority scenario. Additional acres included in the majority scenario add areas with lower pre-treatment basal area yielding a lower amount of wood byproducts from mechanical thinning. Average supply volumes ranged from 611 $ft^3$/ac (majority) to 858 $ft^3$/ac (consensus) and also reflect differences due to more heterogeneous forest conditions over the larger area. It is likely that actual thinning contracts will range in supply values as with WMSP thinning contracts which removed between 109 $ft^3$/ac and 1,281 $ft^3$/ac (n = 31) for trees >5" dbh (Appendix G). Nevertheless, stewardship contracts removed 611 $ft^3$/ac on average (Appendix G) and were identical to the majority

scenario supply estimates (Table 11) that likely cover similar landscape-level forest structural variability. The consensus scenario wood supply estimate was also well within the range of per acre volumes and resulting wood byproducts from stewardship contracts (Table 11, Appendix G).

These figures represent wood supply from the analysis area up to the fall of 2006. Accordingly, estimates for the amount of area treated annually and tree growth during the life-span of forest restoration projects (e.g., a 10 to 30 year planning period) will be necessary to up-date wood volume estimates and yield over time.

A total of 94% of the ponderosa pine forest in the analysis area was on USDA Forest Service land and only 5% of the area distributed among private, state and BLM jurisdictions. The analysis area does not include all lands with extensive ponderosa pine forest in northern Arizona. Tribal forest jurisdictions have the potential to contribute to regional wood supply though estimates could not be obtained for these lands during the analysis period. Accordingly, the estimated wood supply for either scenario was predominately generated from four USDA Forest Service jurisdictions (Table 14).

#### 4.2.3.2 Wood supply biomass

We calculated biomass estimates for crown material in addition to tree boles as a potential source of wood supply as market demand for these materials increases in the southwest. Total biomass weights (tree bole and crown) summarized for the wood supply analysis were similar for the consensus and majority scenarios ranging from 34.8 to 41.8 million green tons respectively (Table 13). Separate biomass estimates for tree bole[18] and crown byproducts from thinning treatments are reported in Table 13. From either of the two restoration scenarios, 23% of the total above ground biomass generated by treatments was from crown material and 77% from tree boles. That is, approximately 23% additional biomass is derived from tree crowns with restoration treatments. The amount of biomass harvested in each management area was dependant on the number of acres and level of treatment. CPMAs showed the highest biomass

[18] Tree bole weight is the cubic foot bole volume converted to green tons using a factor of 0.0315 green tons = 1000 cubic feet. Tree bole cubic foot volume or weight in green tons includes the entire length of the tree with **no** deduction from the main stem for stumps or tops at specified diameter. Crown weights from restoration byproducts include all tree foliage, limbs and bark from limbs.

removals per acre and MSO restricted habitat the lowest, parallel to supply patterns observed with cubic foot volume estimates (Table 13).

Biomass estimates from the wood supply scenarios were compared to timber cruise data from stewardship contracts that reflect recent thinning treatments in the analysis area. On average, the total above ground biomass estimated from stewardship contracts (27.9 green tons/ac) was quite similar to biomass removed from treatments simulated with the majority scenario (25.2 green tons/ac). The consensus scenario showed somewhat higher per acre supply estimates on average (35.5 green tons/ac) as treatments were targeted to areas with highest pre-treatment basal area. The majority scenario covered an additional 33% of the landscape which had lower initial basal area which decreases average per acre estimates.

Comparisons of separate crown and stem weights from wood supply estimates and WMSP cruise data must account for the different methods used for calculating biomass weights from stewardship contracts. According to contract cruise data, average green tons for harvest "residues" include all "non-merchantable"[19] trees < 5" dbh, tops and crown material from larger diameter trees and tree bole weight is for merchantable trees >5" dbh minus top and crown material (Appendix G). Crown biomass from the wood supply estimate includes only limb, bark and foliage weights that is in addition to bole weight, from the total length of the tree's main stem. Average green tons estimated as tree residues from stewardship contracts were approximately 10.7 tons/ac in comparison with 5.8 tons/ac from crown material from the majority wood supply scenario (Table 13). Tree bole material averaged 17.2 tons/ac from stewardship contracts and 19.4 tons/ac in the majority wood supply estimate. As anticipated, biomass calculations for wood supply resulted in lower estimates for crown weight and higher estimates for tree bole weight. Tree bole weights from wood supply calculations include small-diameter material (e.g., trees <5" dbh and tops <3" diameter) that were categorized as residual or non-merchantable biomass in timber cruise data from stewardship contracts.

Therefore, contracts with no thinning of trees < 5" dbh (n = 4) resulted in an average of 5.4 tons/ac in residues which more closely approximate crown weights calculated for the wood supply analysis (5.8 tons/ac). These comparisons suggest that the above biomass calculations provide a reasonable estimate of tree bole and crown weights that could potentially be generated

[19] "Non-merchantable" or "residues" refer to all harvest materials that were not considered to have a market value for the WMSP contracts.

with either of the wood supply scenarios. Biomass estimates for this report do not account for materials separated into sub-merchantable thinning byproducts (trees <5" dbh), tree tops and other categories more readily determined from site-scale assessments and timber cruise data.

Weight values reported here are general approximations for above ground biomass that would potentially be removed as a result of forest restoration treatments in the wood supply analysis area. To improve accuracy of future biomass estimates, we recommend that digital data layers be derived for both tree boles and crown biomass using the *k*-nn imputation approach. These methods would provide information on the spatial distribution of tree biomass across the study area, similar to cubic foot volume and forest structural layers. These data would afford follow-on assessment and spatially explicit analyses of wood biomass utilization, treatment costs, present and future markets and distance to processing facilities.

#### 4.2.3.3 Wood supply from small-diameter trees

From the majority scenario, we estimated the proportion of the total area that would not attain target post-treatment basal area conditions by harvesting only trees <16" dbh. This analysis assumes 10% and 20% of the basal area is retained from trees in the <5" dbh and 5 -16" dbh classes respectively. Summaries of all forest management areas indicate that 19% of the area treated with the majority scenario (74% of landscape) would require thinning for trees >16" dbh to match the basal area distributions in Figure 4. Conversely 81% of the area treated showed that sufficient basal area can be harvested from small-diameter trees accounting for 90% of the total wood supply volume (917 million $ft^3$) in the majority scenario. Community protection areas had the greatest amount of area where post-treatment basal area was in surplus of what could be harvested from small-diameter trees (Table 13). The higher level of forest thinning in communities would require cutting trees >16" dbh in over half of the CPMAs though this represents only 7% of the analysis area (74% of study landscape). This analysis was conducted for only the majority scenario as even fewer acres would require thinning trees >16" dbh in the consensus scenario, which applies to a subset of the lands in the majority scenario.

# 5 Existing Harvesting Contractors, Mills and Manufactures

One of the tasks of this wood supply study was to define and describe the existing wood harvesting utilization industry in the analysis area. As pointed out by the Regional Forester, future multi-year stewardship contracts "will be structured to not only attract new, large

industrial users that can achieve landscape-scale treatment objectives, but also continue to supply fiber to existing local industries that have been purchasing timber sale and service contracts for many years and have been the foundation of our forest restoration programs" (Forsgren 2007b). To this end, it is important to know how much wood from what areas is supporting current utilization industries and how this affects overall supply and potential for development of additional wood utilization infrastructure for small-diameter trees.

We began the analysis of existing wood harvesting and utilization industries by collecting lists of firms thought to be operating in the region[20] from the following sources: Wood Processing Facility History and Summary in Arizona and New Mexico, 2007 (provided by USDA Forest Service Regional Office 3); Wood Product Harvesters, Processors, and Users (ERI); and White Mountain Stewardship Partnership Economic Assessment (Gibson 2007). These documents included the names and locations of about 135 firms in Arizona and New Mexico. The information gathered from these sources included everything from large logging operators and mill facilities to small firewood lots and custom woodworking shops. They also included firms that were in no way affiliated with the study area or were thought to no longer be in existence. A winnowing process was conducted whereby only those firms that were directly involved in the harvesting and processing of small-diameter ponderosa pine on the Coconino, Kaibab, and Apache-Sitgreaves National Forests remained in the analysis. The winnowed list of harvesters, mills and manufacturers was completed in consultation with staff members from the three NFs above as well as the White Mountain Stewardship Project (WMSP) administrator (Future Forest, LLC) and the Southwest Forest Products representative in Flagstaff, Arizona.

A draft set of tables were produced and sent to the three Forests, WMSP administrator, and SW Forest Products for review. We incorporated review comments in the wood volume estimates (Tables 15-18) and materials flow charts (Table 19). Harvesters removed a total of 174,200 green tons of wood byproducts from Apache-Sitgreaves National Forests in year 2006 (7.4% or 12,900 green tons of these materials were residual biomass) and another 158,500 green tons from the Coconino and Kaibab National Forests. Additional material was treated and left on site. This value may be larger for the full analysis area as non-Forest Service lands (5% of the analysis area) and two Ranger Districts on the Tonto National Forest were not included. The

[20] We contacted the following Forest Service employees for information on utilization industry and project level considerations: Carol Boyd and Kim Newbauer (Coconino NF); Jerry Drury (Kaibab NF); Kerry Nedrow, Elaine Zieroth, Mitchell White, and Ed , Collins (ASNF); and Jeff Hogg and Marlin Johnson (Regional Office 3).

total of 319,800 green tons of non-residues and 12,900 green tons of residues removed are equivalent to 1.2% of the total bole biomass and 0.2% of the total crown biomass that would potentially be generated from treatments in the consensus scenario (Table 12). These values extrapolated over 10 years would be 3,198,000 and 129,000 green tons, which is 12% and 1.6% of the respective bole and crown biomass from the consensus scenario. Uncertainties in future wood supply including tree growth or disturbances such as wildfire influence projected values.

There are two primary organizations driving utilization in the White Mountains (Apache-Sitgreaves National Forests; ASNF) and Western Mogollon areas. On the ASNF side, treatment and utilization is driven by the WMSP. The WMSP is managed and administered by Future Forest, LLC which is comprised of WB Contracting (Walker Bros. Logging) and Forest Energy. In some cases other harvesting contractors (e.g., Tri-Star Logging / S. Reidhead, Renegy) sub-contract to WB Contracting. The third harvesting contractor working in the area is Nutrioso Logging operated by J. Reidhead. The primary consumers of wood in the area are Forest Energy (WMSP/Future Forest) and Reidhead Lumber. On the western Mogollon Plateau, treatment and utilization are driven by Southwest Forest Products (SWFP). SWFP is a vertically integrated company providing over two-thirds (91K tons) of its wood requirements to itself at its facilities in Phoenix and Ash Fork. The remaining 42K tons are harvested by three other contractors (Perkins from nearby Williams, Colorado Wood from Snowflake, and Hurd Bros. from Chama, NM).

# 6 Additional Considerations

Several analyses were performed as part of this project that did not explicitly affect wood supply estimates based on year 2006 conditions, including a review or forest growth models and several fire modeling exercises designed to identify locations appropriate for fire-only treatments. However, existing levels of harvesting and utilization are important to consider in developing new stewardship contracts. In addition, several factors were discussed that are likely to impact wood supply estimates, such as climate change, however due to high levels of uncertainty and lack of data, they were not quantified. We summarize these topics and modeling efforts in this section.

## 6.1 Fire as an Initial Treatment Option

With the collaborative process deciding to look at the entire study area and identify areas that would be excluded from mechanical thinning treatments, the issue of where prescribed and/or wildland fire could or should be used as the initial treatment option to restore fire-adapted ecosystems was raised. A "fire" subcommittee was formed to evaluate approaches to address this issue, although several working group members did not believe it was appropriate to address the subject of fire in the wood supply analysis. It should be noted that virtually all mechanical thinning treatments are followed by broadcast burns for ecosystem restoration and maintenance. The fire group focused solely on locating areas on which fire-only was the preferred restoration treatment.

Initially, the fire subcommittee considered using spatial data provided by the interagency LANDFIRE program and the fire behavior modeling program FlamMap to identify specific areas (i.e., 30-m pixels) on the landscape where existing forest structural conditions (e.g., crown-base height, crown bulk density, canopy cover) would permit the safe application of prescribed fire as a first treatment option. Specifically, it was the hope of the subcommittee that areas predicted by fire models to be representative of a surface fire condition would allow fire to be safely reintroduced without fuel reduction by mechanical means. To develop predictive models of fire behavior over the large spatial extent of the wood supply study area, the ForestERA team collaborated with researchers (Chuck McHugh and Laurie Kurth) from the USDA Forest Service Fire Sciences Lab in Missoula, Montana. The resultant fire behavior models and GIS-based maps were implemented under multiple weather scenarios (e.g., $95^{th}$ and $97^{th}$ percentile weather conditions for the central Mogollon Plateau). Appropriate weather and forest structure parameters were also vetted by regional fire behavior experts (e.g., Pete Fulé (Appendix H), NAU/ERI and Linda Wadleigh, Region 3 Forest Service). Model results and group-defined iterations were presented over the course of several subcommittee and full working group discussions. Given these results, many members of the working group believed that agreement could not be reached regarding the threshold values at which existing forest structure conditions would permit a safe and reasonable reintroduction of fire on the landscape. When maps of predicted fire behavior across the study area were presented, a few members were able to identify that specific areas modeled as exhibiting surface fire behavior, for example, had instead exhibited crown fire behavior during recent wildfire events. Even under less-than-extreme

weather scenarios, it was difficult for some members to consider models of predicted fire behavior as an acceptable tool for identifying areas appropriate for fire-only restoration methods. Time constraints added to the difficulty of using the fire models to effectively identify thresholds for prescribed burning and wildland fire use as an initial restoration treatment. Additional work in this area is warranted.

Beyond spatial models of predicted fire behavior, other approaches to defining fire-only treatment areas were also considered during subcommittee discussions and presented to the working group, including: 1) identifying areas with a specified basal area derived from pre-settlement conditions where fire would be a ground fire; 2) identifying areas where both medium to high basal areas and low numbers of trees per acre exist (assuming this would be mature, open forest conditions with a few large trees); 3) applying a percentage reduction to the landscape derived from an analysis of acres where mechanical thinning verses fire-only treatments were proposed for completed or pending Forest Service projects; and 4) using a percentage (65%) of the landscape that is burned, verses mechanically thinned, modeled after the Gila National Forest in western New Mexico, which has an aggressive fire management program.

As with the fire modeling approach described above, determining numeric threshold values (e.g., basal area and/or tree density) where forest structure attributes conducive to surface fire could be reasonably defined became problematic for the group to reconcile. A complicating factor threaded throughout the discussions was the applicability, acceptability and predictable effects of fire and smoke in CPMAs, wildlands, and MSO habitat. Concerns were raised that adverse health effects of smoke and exceeding air quality thresholds will limit prescribed burning activities. Smoke production is expected to be greater where fire is used an initial treatment than when prescribed burning follows thinning. Thus, the subcommittee decided to not recommend a specific approach or number (i.e., value(s) for basal area and/or tree density) to the entire working group. Instead, the subcommittee advocated a) that there are areas of the landscape where fire only will be the preferred treatment and mechanical thinning is not desirable, b) that decisions about these areas are project specific and determined during NEPA analysis, and c) that resulting wood supply volumes will need to be adjusted downward to accommodate the realistic and observed impact of fire-only treatments on the landscape.

The full group also discussed that the review of 27 Environmental Assessments found that 33% of NEPA planning areas (part of the 37% assigned no thinning treatments, Table 8)

either had been burned or were approved via NEPA to be burned. There was some acknowledgement, however, that these areas do not often actually receive fire-only treatments for various reasons. The full working group acknowledged that fire-only treatment are currently being planned and carried out, however they did not agree on a specific level or locations. It was noted from the discussion that the consensus scenario affords additional land areas over the majority scenario for potential prescribed fire-only treatments or Wildland Fire Use (WFU).

### 6.2 Tree Mortality and Climate Change

There are several factors that could not be included in the wood supply analysis due to lack of data or uncertainty about the magnitude of their impacts, for example the inability to predict the timing and location of large events, such as crown fire, drought, and insect outbreaks. It is likely that wildfires and WFU fires will burn some percentage of the estimated wood supply, but the working group agreed that there was no adequate information to quantify the risk or likely consequences of these stochastic events. Similarly, the working group expects that pest infestations, drought, and climate change may also -- either singularly or by exacerbating the effect of one another -- reduce the amount of wood supply available for mechanical treatment, but did not have sufficient predictive ability to include in this analysis. This anticipated reduction of supply should be considered when interpreting the wood supply estimate and adjustments to the estimate will be necessary in the future, as the extent of climatic factors – and progress in implementing treatments or other forest disturbances – become known. In this respect, the working group strongly recommends that the harvest of small-diameter timber from these forests be conducted in an adaptive management framework.

### 6.3 Old-growth Trees

Old-growth trees (those that became established before Euro-American settlement or currently exhibit old-growth structural characteristics e.g., yellow platy bark) are rare and under represented in the ponderosa pine forests of the Southwest (Moir and Dietrich 1988, Kaufman et al. 1992), therefore it is imperative to take action to conserve and manage them to stave off further attrition. In addition, forest management that leads to the recruitment and development of old-growth trees and the structural attributes that characterize old trees is important for overall forest health and the persistence and vitality of biodiversity (Kaufman et al. 1992).

No reliable methods have been developed to assess old-growth trees at the scale of the wood supply analysis area, with the remote sensing and GIS applications applied with this study.

Old-growth forest conditions were not specifically addressed with the wood supply analysis. Therefore, the collaborative group has chosen to express qualitatively what they believe should be management activities with respect to old-growth old trees. The group recognizes that unnatural, crown fire and competition from small trees are two of the biggest threats to old-growth survival in Arizona today (Covington and Moore 1994). Old-growth trees are typically surrounded by irruptions of younger and smaller trees that act as ladder fuel during fire. Old-growth trees also suffer from competition with these dense younger trees for water and nutrients. Consequently, the group supports management action that seeks to restore old-growth structure by retaining all pre-settlement trees (no matter what their diameter), thins and removes post-settlement trees from below, and carefully reintroduces fire taking precautions to remove excess fuels from around old trees before burning.

### 6.4 Forest Growth Review and Recommendations

A project deliverable for the wood supply analysis was to identify region specific forest growth models and provide technical information about their use. Forest growth modeling was not explicitly integrated into analyses of future wood supply for this report. A tree growth model (i.e., FVS) was used to project ground reference plots forward to match Landsat TM image dates and impute forest volume and structural layers for year 2006. The objective of the following section is to outline major forest growth model types and their potential application for projecting future wood supply in the present analysis area.

Forest growth models fall into two major categories of empirically derived growth and yield models and mechanistic process-based models. The former category has been widely used by forest managers while the latter is more commonly applied for scientific research. Mechanistic models that integrate climate data, nutrient cycling and plant respiration processes to predict forest growth have received less attention by forest managers. Nevertheless, adaptations to include biogeochemical cycling (BGC) as an extension of empirical models have been recently developed (Peng 2000). A BGC extension to forest growth models currently used in the southwest is discussed below.

Peng (2000) provides a thorough review of past, present and future growth modeling approaches applied to uneven-aged forest systems, that includes models commonly applied to North American forest types. For this report, we provide a brief overview of empirical models used for making forest growth predictions in southwestern forest types, their inputs, assumptions

and extended capabilities (e.g., disturbance, BGC and forest management extensions). We distinguish "traditional" forest growth models from succession models which are used to project forest development stages and composition changes. While succession models are useful to determine the status of forest development, they are less frequently applied to determine tree growth and changes in wood volume. Linkages between empirical growth models and simulating forest succession are, nevertheless, important to landscape planning (Teck et al. 1996, Sesnie and Bailey 2003). Data requirements for integrating empirical and landscape succession models for predicting large area forest changes may limit these approaches. Nevertheless, data integration and remote sensing applications are quickly being developed to fill such information voids (Remmel et al. 2005, Lefsky et al. 2002, Vanclay 2003).

The Forest Vegetation Simulator (FVS), a forest growth modeling framework currently maintained by the USDA Forest Service, is highlighted in this review due to its widespread application and support (Teck et al. 1996). FVS contains over 20 region specific variants of forest growth models accessed through a common interface, SUPPOSE (Crookston 1997). While FVS and the SUPPOSE interface is a relatively new forest modeling toolkit, its predecessor Prognosis has been in use since the 1970s (Stage 1973) and iteratively improved (Wykoff et al. 1982). Tree population data from forest plots with measurements such as tree diameter, crown ratio, age and site index serve as inputs to FVS. Therefore, implementing growth simulations with FVS relies on forest inventory data that is typically collected on the ground. The USDA Forest Service Forest Inventory and Analysis Program (FIA) currently provide inventory data in a format utilized by FVS to facilitate plot summary and simulation modeling. FVS software (http://www.fs.fed.us/fmsc/fvs/) and FIA data (http://www.ncrs2.fs.fed.us/4801/fiadb/fim21/wcfim21.asp) can be freely downloaded via the internet and provide a base set of information used for regional forest biomass and carbon assessments (Fried et al. 2005, Hickey et al. 2007). From a practical standpoint, FVS is capable of quickly processing several thousand forest plots at a time with database features to link outputs to spatial data layers in a GIS (Peng 2000).

For southwestern coniferous forests, the Central Rockies FVS (CR-FVS) variant accesses the GENGYM stand table projection system (Edminster et al. 1991). GENGYM and model relationships are calibrated with tree data taken from plots established in major southwest forest types to predict tree diameter growth, height, crown ratio and mortality. GENGYM and its

adaptation to FVS have several features important to modern forest management applications in the southwest. Forest measurement plots and tree data used for developing tree growth regression equations were collected from even and uneven-aged stands on the Apache-Sitgreaves, Lincoln, Carson, Kaibab and Santa Fe National Forests (Edminster et al. 1991). It is a distance-independent, individual tree model calibrated for each tree species, or species groups in the case of hardwood trees and shrubs (Edminster et al. 1991). Therefore, it is capable of predicting growth in both even and uneven-aged forest conditions and in pure and mixed species compositions. As a distance-independent model, it does not require coordinates for individual trees that are typically unavailable from forest inventories. These innovations are clearly an advantage over earlier whole stand models such as RMYLD (Edminster 1978) and ASPNORM (Mowrer 1986) that are designed for even-age forest structure and homogeneous species composition.

A potential limitation of FVS, as with many forest growth models, is the deterministic manner in which trees are grown into the future (Vanclay 2003). Calibration data for models are derived from tree core data reflecting past forest growth, though tree rings are expected to contain variation in growing conditions due to soil factors, inter-annual climate shifts and temporal changes in water availability (e.g., periodic drought). Nevertheless, tree growth and mortality assumptions may not reflect future climate conditions and subsequent changes tree growth. Net growth can be influenced by a number of factors including climate, soils, insects and disease, fire and mortality (Vanclay 2003, Abella and Covington 2006). To address these issues, a BGC extension the FVS empirical models incorporates daily climate data and its effect on individual tree physiology (http://www.fs.fed.us/foresthealth/technology/bgc_model.shtml). The FVS-BGC extension is currently under evaluation and requires daily temperature and precipitation data as inputs in addition to tree measurements. Once calibrated, processes based models are anticipated to enhance empirical model relationships to further incorporate climate change and its impact on tree growth. Disturbance extensions that include fire occurrence, insect outbreaks and tree disease factors have also been incorporated into FVS and can be integrated to simulation scenarios. As a practical tool to perform forest management simulations, tree harvest and prescribed burning can also be implemented to determine impacts on future forest growth and yield.

For the present wood supply analysis, we used FVS model runs with FIA plot data (n = 327) to estimate future growth in ponderosa pine forest type. Plots from years 1995 to 1997 for the Coconino, Apache-Sitgreaves, Kaibab and Tonto National Forests were projected to 2007 and 2027. Tree growth from these runs averaged 40 $ft^3$/ac/yr up to 2007 and 38.9 $ft^3$/ac/yr between 2007 and 2027, minus volume was lost due to mortality (Table 20). Quadratic mean diameter (QMD) increment averaged 0.076 in/yr and ranged from 0.013 to 0.202 in/yr. These figures are comparable to diameter growth increments from 66 plots in Northern Arizona on a range of soil conditions reported by Abella and Covington (2006) that showed 0.091 to 0.169 in/yr in predominantly open ponderosa pine stands. For our analysis, a large number of FIA plots were used crossing a greater diversity of site and forest conditions, which likely explains a wider range in annual growth increment.

Average volume and mortality accumulation from FVS runs within the three tree diameter categories used for the wood supply analysis are also included in Table 20. These data reflect the difference in total cubic foot volume for live and dead standing trees in each diameter class at the end of 10- and 20-year FVS cycles.

From these cursory evaluations, we consider FVS growth predictions with FIA data capable of producing an accurate estimate of future wood volume. Relatively short 10 and 30-year simulation cycles can potentially avoid some uncertainty about future forest growth conditions and climate changes. Applications to project forest growth across the entire wood supply study area and ponderosa pine type would necessarily require additional assumptions for making landscape- or region-scale projections. Forest growth estimates incorporating information such as an estimated annual rate of tree thinning and prioritized treatment locations would enhance wood supply estimates over a specified planning period. Differing site conditions such as soil type, topography, elevation, climate and solar radiation will likely need to be integrated into future growth estimates at this scale (Abella and Covington 2006).

# 7 Concluding Remarks

A primary goal of the wood supply analysis was to build agreement on ecologically appropriate forest restoration treatments, across the study area, which could supply wood byproducts to new and existing businesses and markets. The fact that the working group reached consensus over 67% of the landscape (26% not appropriate as a source, 41% appropriate for mechanical

thinning) is remarkable. The group also agreed that community fire protection was important and agreed on the intensity of mechanical treatments that could be applied within five landscape management areas. Where a difference of opinion occurred on the method by which an additional 33% of the landscape should be restored, such as with the use of natural or prescribed fire-only treatments versus mechanical thinning, the estimated bole volume of wood byproducts potentially available differed by only 16% (ranging from 850 to 1,015 million $ft^3$).

The values derived in this study present a snap shot of currently available wood supply, however, a review of forest growth models was conducted to assist with future projections. Including forest growth would increase supply estimates over time, however the study also identified several factors which could lower the estimated wood supply, including lack of complete data on current road conditions and access, presence of archeological sites, and other project-level considerations. In addition, uncertainty in actual future wood supply due to climate change and disturbances such as wildfire, insect outbreaks and drought-related mortality were recognized. Because many factors are considered in choosing treatment locations, the group did not specify or prioritize project boundaries for their treatment scenarios, and actual wood supply values will shift according to decisions made during the NEPA process. Also, when developing new stewardship contracts it should be taken into consideration that these estimates include restoration byproducts from some remaining areas already dedicated to the White Mountain Stewardship contract, which is estimated to treat upwards of 120,000 additional acres. As the exact contract treatment areas were not available at the time of this analysis, it was not possible to exclude their contribution to wood supply estimates. The amount of potential wood byproducts from restoration treatments and small-diameter trees exceeds current market demand. In 2006 existing harvesters, mills and manufacturers in the analysis area removed and utilized 1.2% of the bole biomass (or 12% extrapolated over 10 years) that would potentially be generated from consensus scenario treatments.

Over the course of the project, additional studies and planning efforts, such as those needed to prioritize treatments and specify their preferred sequencing over time, and to assess wood supply from pinyon-juniper ecosystems, were discussed and recommendations were made (see Appendix I). As indicated in communications from the USDA Forest Service, Region 3, the results of this study will be used to assist in management decisions and the development of

multi-year forest stewardship contracts to attract new industrial users, and to supply wood fiber to existing local wood product businesses.

## 8 Acknowledgements

This analysis was funded by the Southwestern Region of the USDA Forest Service and 95% of the analysis area includes USDA Forest Service lands. Any decisions on these lands must be consistent with the National Forest Management Act (NFMA) and NEPA requirements. The wood supply analysis does not meet the requirements of the NFMA for timber suitability analysis; this will be done in the appropriate Forest Plan revisions. Future projects will conduct NEPA analysis and will be consistent with the Forest Plans.

Individuals from the USDA Forest Service Intermountain West Forest Inventory and Analysis group in Ogden, Utah Michael Wilson, John Shaw and Ron Tymcio contributed data and logistical support critical to the wood supply analysis. Support from the USDA Forest Service Region 3 FIA coordinator, Jeff Hogg, was all essential to the project.

We'd like to thank all of the working group members for the significant time and effort they put into this analysis, as well as the land management and academic experts who contributed, and stakeholders who observed meetings and provided comments. We give thanks to our main contact at the USDA Forest Service Southwestern Region, Gilbert Zepeda, Deputy Regional Forester, for always providing guidance and assistance when needed and the Directors at the Southwestern Regional Office for their insightful comments on report drafts. We are grateful to Harv Forsgren, former Regional Forester and Corbin Newman, the current Regional Forester, Southwestern Region, for allocating funds to this novel study and collaborative approach which promotes deliberation on restoration issues important to many stakeholders. It is our hope that the stakeholder agreement built during this process and the wood supply estimates we provide will be useful tools for informing landscape-scale stewardship contracts.

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Table 1. List of wood supply working group members and affiliations.

| Name | Position | Affiliation |
|---|---|---|
| Ethan Aumack | Director of Restoration Programs | Grand Canyon Trust |
| Pascal Berlioux | President and Chief Executive Officer | Arizona Forest Restoration Products Inc. |
| Kim Newbauer | Timber Sale CO | Coconino National Forest |
| Rob Davis* | President / Owner | Forest Energy / Future Forests |
| Paul DeClay | Tribal Forester | White Mtn. Apache Tribal Forestry |
| Jerry Drury | Timber Staff Officer | Kaibab National Forest |
| Steve Gatewood* | Owner / Consultant | WildWood Consulting, LLC representing Greater Flagstaff Forests Partnership |
| Bill Greenwood | City Manager | Town of Eagar |
| Shaula Hedwall | Senior Fish and Wildlife Biologist | U.S. Fish & Wildlife Service |
| Scott Higginson | Executive Vice President | NZ Legacy, LLC / Snowflake White Mountain Power / Renegy, LLC |
| Herb Hopper | Community-based forest and wood products advocate | Little Colorado Plateau Resource, Conservation & Development |
| Robert LaCapa | Forest Manager | Fort Apache Agency, Branch of Forestry, Bureau of Indian Affairs, Department of the Interior |
| Sarah Lantz | Urban Wildlife Planner | Arizona Game & Fish Department, Region II, Flagstaff Office |
| Lisa McNeilly | Northern Arizona Program Director | The Nature Conservancy |
| Keith Pajkos | Timber Staff | Arizona State Lands Department, Forestry Division |
| Chuck Peone, Jr. | | Fort Apache Timber Company |
| Molly Pitts | Community-based forest and wood products advocate / consulting forester | Northern Arizona Wood Products Association |
| Todd Schulke* | Forest Programs Director | Center for Biological Diversity |
| Larry Stephenson | Executive Director | Eastern Arizona Counties (ECO) / Economic Environmental Counties Organization (EECO) |
| Diane Vosick* | Associate Director | Ecological Restoration Institute |
| Elaine Zieroth* | Forest Supervisor | Apache-Sitgreaves National Forests |

* Steering Committee Members

**Table 2.** Working group meeting schedule and level of attendance at each meeting.

| Meeting No. | Date | Time | Location | No. of Participants |
|---|---|---|---|---|
| **1** | June 4, 2007 | 9am - 4:15pm (PST) | Northland Pioneer College, Painted Desert Campus, 2251 N. Navajo Blvd., Holbrook, AZ | 16 |
| **2** | July 18, 2007 | 9am - 4:15pm (PST) | AZ Game and Fish Dept. Pinetop Regional Office Conference Room 2878 E. White Mtn. Blvd. Pinetop, AZ (Directions) | 16 |
| **3** | Aug. 17, 2007 | 9am - 4:15pm (PST) | Northern Arizona University, Applied Research & Development, 1298 S. Knoles Drive, Bld. 56, Large Pod Conference Room, University Drive, Flagstaff, AZ | 18 |
| **4** | Sept. 17, 2007 | 9am - 4:15pm (PST) | Northland Pioneer College, Painted Desert Campus, 2251 N. Navajo Blvd., Holbrook, AZ | 14 |
| **5** | Oct. 15, 2007 | 9am - 4:15pm (PST) | AZ Game and Fish Dept. Pinetop Regional Office Conference Room 2878 E. White Mtn. Blvd. Pinetop, AZ (Directions) | 15 |
| **6** | Nov. 16, 2007 | 9am - 4:15pm (MST) | Northern Arizona University, Applied Research & Development, Bld. 56, Large Pod Conference Room, University Drive, Flagstaff, AZ | 16 |
| **7** | Nov. 29, 2007 | 9am - 4:15pm (MST) | Northern Arizona University, Applied Research & Development, Bld. 56, Large Pod Conference Room, University Drive, Flagstaff, AZ | 17 |

**Table 3.** Management objectives, desired post-treatment conditions, management actions, and criteria layers used by the working group to define land management areas, areas not considered a source of restoration byproducts and areas of special consideration.

**Overall objectives of working group treatment scenarios:** 1) Restore fire-adapted (ponderosa-pine) ecosystems[21] and protect communities from destructive fires while mitigating adverse impacts of treatments on soils, surface water and wildlife. 2) Based on restoration needs, define potential mechanical thinning treatments for use in estimating the supply of wood byproducts. Note: The USDA Forest Service's adoption of the "Management Recommendations for the northern goshawk in the southwestern United States" under the 1996 Regional Forest Plan Amendments guide management actions on all forest lands outside of Mexican spotted owl (MSO) or other federally listed species habitat.

## POTENTIAL RESTORATION BYPRODUCTS FROM LANDSCAPE MANAGEMENT AREAS

| Rank[22] | Landscape management areas: Management objective | Desired Post-Treatment Conditions[23] | Management Action[24] | Criteria Layers[25] |
|---|---|---|---|---|
| 1 | **Community protection management area (CPMA)**: In areas close to communities where tolerance for fire is low, reduce predicted fire behavior to acceptable levels (achieve low end of surface fire). Maintain a range of forest conditions (e.g., basal area) across the landscape. To define CPMA assign a ¼-mile protection buffer around all private lands with an additional ½-mile protection buffer extending to 1½-mile upwind of all private property within "high priority" areas identified in CWPPs. Protect infrastructure from severe crown fire by following FERC guidelines for power and gas line fire protection. Follow ADOT guidelines for right of way safety zone on either side of roads. | Basal area: 30-60 $ft^2$/ac (distributed according to a skewed bell-shaped curve more heavily weighted to lower values with a high point, or mode, at 40 $ft^2$/ac)<br>Density: 40-60 trees/ac (50 avg)<br>Canopy cover: 30-40% (35% avg) | Heavy thinning followed by prescribed fire[26] (light burn) near communities.[27] Feather intensity with distance from communities (higher intensity thinning immediately adjacent to communities). Apply heavy thinning in areas near power lines (50 ft from high voltage lines), gas lines, and roads (42 ft from highways, 30 ft from other roads) as stated in FERC and ADOT guidelines for fire protection of these features. | Community Wildfire Protection Plan (CWPP) priority areas, private lands, state and federal highways and utility corridors (power lines). Gas line data was not available. |

[21] Areas once dominated by ponderosa-pine that mixed-conifers have expanded into are not considered in this study.
[22] Factors with higher rank (lower value) trump factors with lower rank. For example, a factor with a rank of one takes precedence over another with rank 2 occurring in the same location. Areas not considered a source of wood supply are given a rank of zero and take precedence over all landscape zones.
[23] Desired post-treatment condition expressed in terms of ranges of forest structural attributes. Basal area is the attribute of most interest. Density and canopy cover are guidelines.
[24] Goshawk guidelines (RMRS General Technical Report, RM-217, 1992) dictate management actions on all forest lands outside of MSO or other federally listed species habitat. The desired post-treatment conditions in column 2 take precedence over the thinning levels in this column as the group ended up choosing basal area distributions to define post-treatment conditions.
[25] Criteria layers used to represent landscape feature.
[26] Burn where appropriate following ponderosa pine thinning in riparian areas.
[27] Where smoke concerns are high or difficult to mitigate, haul wood off-site.

## POTENTIAL RESTORATION BYPRODUCTS FROM LANDSCAPE MANAGEMENT AREAS (Cont.)

| Rank[22] | Landscape management areas: Management objective | Desired Post-Treatment Conditions[23] | Management Action[24] | Criteria Layers[25] |
|---|---|---|---|---|
| 2[28] | **MSO Restricted Habitat:** Implement current (1996) Forest Plans and 1995 MSO Recovery Plan.[29] Follow MSO Recovery Plan guidelines for restricted habitat. See Recovery Plan Table III.B.1 for target/threshold conditions. | Basal area: 45-190 $ft^2$/ac (100 mode) | Light to moderate in other restricted. | Pine-oak habitat |
| 3 | **Municipal watersheds:** Protect watersheds (6th order) containing municipal surface water supplies from the effects of high severity crown fire (including increased sedimentation risk). Allow torching (passive crown fire). | Basal area: 40-120 $ft^2$/ac (60 mode)<br>Density: 20-300 trees/ac (160 avg)<br>Canopy cover: 30-60% (45% avg)<br>(ranges are more heavily weighted to lower values) | Apply light to heavy thinning treatments followed by prescribed fire (light burn) | Watersheds containing municipal surface water supplies (6th level watersheds) |
| 4 | **Aquatic species watersheds:** Protect watersheds (6th order) containing sensitive (special consideration) aquatic species and directly feeding into their perennial water habitat from the effects of high severity crown fire (including increased sedimentation risk). | Basal area: 40-120 $ft^2$/ac (60 mode)<br>Density: 20-300 trees/ac (160 avg)<br>Canopy cover: 30-60% (45% avg)<br>(ranges are more heavily weighted to lower values) | Apply light to heavy thinning treatments thinning followed by prescribed fire (light burn) | TNC native fish layer and 6th level watershed boundaries |
| 5 | **Wildlands**: Reduce the occurrence of high severity fire (unnaturally severe; uncharacteristic for the site). Reduce predicted fire behavior in areas predicted to actively or passively crown to a mix of surface and low intensity passive fire throughout the analysis area. Maintain a range of forest conditions (e.g., basal area) across the landscape to support wildlife and other forest resources. | Basal area: 40-160 $ft^2$/ac (80 mode)[30]<br>Density: 20-300 trees/ac (160 avg)<br>Canopy cover: 40-80% (60% avg)<br>(ranges are more heavily weighted to lower values) | Light to heavy thinning followed by prescribed fire (light burn) in wildlands (defined as areas outside of community protection management areas and other landscape features). | "Wildlands" are defined as all parts of study area not in one of the other four management areas. |

[28] Where community fire protection goals are not met in WUI, the USDA Forest Service may increase thinning levels in MSO habitat following consultation with the U.S. Fish and Wildlife Service.

[29] US Fish and Wildlife Service uses an ESA mandated layer for "MSO Designated Critical Habitat" based on coarser and older vegetation layers than available currently. Purpose is to maintain and enhance the primary constituent elements within designated critical habitat that meets the definition of protected or restricted habitat.

[30] Although not modeled spatially, the working group recommends applying the lower end of wildlands DPTC range (40-60 $ft^2$/ac) to top edges of canyons to reduce the rate of spread of fire in these areas and increase suppression effectiveness.

## AREAS NOT CONSIDERED A SOURCE OF RESTORATION BYPRODUCTS

| Rank | **Landscape feature:** Management Objective | **Management Action** | **Criteria Layers** |
|---|---|---|---|
| 0 | **MSO PACs:** Minimize treatment impacts on Mexican spotted owl Protected Actively Centers[31] (MSO PACs) and follow MSO Recovery Plan guidelines to avoid treatments on at least 90% of PACs until more is known of impacts.[32] | Do not consider PACs a source of wood supply (do not specify treatments in these areas) as they are expected to contribute little to overall wood supply.[4] | MSO PACs |
| 0 | **Specially Designated Areas:** Follow existing land mgmt regulations for SDAs and Inventoried Roadless Areas (e.g., restrictions on road building and use of mechanized equipment). | Do not consider Specially Designated Areas and Inventoried Roadless Areas a source of wood supply (do not specify a particular treatment in these areas). | Specially Designated Areas and Inventoried Roadless Areas |
| 0 | **Steep slopes:** Minimize the impact of mechanized equipment on soils and consider the need for specialized equipment, operator training and administrative approvals on steep slopes. | Do not consider areas with steep slopes (slope > 40%) a source of wood supply (do not specify a particular treatment in these areas as little wood will realistically be removed from them). | Slope |
| 0 | **Treated areas:** Use completed/under contract treatment location, type and intensity to inform where and how forest structure has changed. Consider areas where treatments are planned or marked as a source of wood supply.[33] | Do not consider areas with completed or under contract treatments of moderate intensity or greater that have taken place in the last 10 years as a source of wood supply. | Treatments completed and under contract |
| 0 | **Northern goshawk nest areas:** Follow goshawk guidelines. | Six nest areas, each 30 acres in size for a minimum 180 acres should be identified within each post-fledgling area (PFA). Do not consider these areas a source of wood supply. | Goshawk nest sites and PFAs |
| 0 | **Soils with mechanized treatment limitations:** Avoid mechanized management activities on sensitive soils. | Do not consider soils with limits on mechanical treatment a source of wood supply. | Terrestrial Ecosystem Survey units |
| 0 | **Streamside management zones:** Maintain and protect filter strips next to streams from potentially negative impacts of mechanized equipment. | Do not consider areas within 100 feet of perennial and intermittent streams a source of wood supply. | Perennial and intermittent[34] streams |

[31] Mexican spotted owl Protected Actively Centers (PACs) are 600 acre areas within which owls have been found to be nesting.
[32] Trees < 9" dbh may be removed in PACs, so there is potential wood supply from PACs, but it is minimal.
[33] Planned and marked Stewardship contract areas will be considered a source of wood supply, but tallied separately as they have already been allocated.
[34] Place streamside management zones around perennial streams (not intermittent) for all Forests, except the ASNF, as data that differentiates between intermittent and ephemeral streams exist only for the ASNF.

## AREAS OF SPECIAL CONSIDERATION

| Landscape feature: Management Objective | Management Suggestions | Criteria Layers |
|---|---|---|
| **Use fire as a restoration tool where practicable:** Minimize short term ecological costs of thinning treatments which decrease resilience of the system (e.g., soil compaction and erosion, wildlife disturbance) in areas where burn only treatments are potentially feasible. | Consider fire-only treatments where feasible. | n/a |
| **Areas not accessible from current roads:** Areas greater than ¼ mile from existing roads are difficult to access with harvesting equipment in common use in the study area. New roads would likely need to be constructed to reach these areas with associated environmental impacts, however harvesting technologies used in the area may shift over the next 20 years resulting in increased access to the entire area with minimal new road construction and thus lowered environmental impacts. The working group has less confidence that these areas will be a source of wood supply. | Minimize environmental impacts associated with new road construction and road improvements necessary for harvesting. | Forest Service and TIGER roads |

**Table 4.** Areas not considered a source of wood byproducts from mechanical restoration treatments and areas of special consideration (PAC = Protected Activity Center).

| | Acres |
|---|---|
| 1. Mexican Spotted Owl PACs | 182,000 |
| 2. Specially Designated Areas | 177,000 |
| 3. Steep slopes (>40%) | 147,000 |
| 4. Contracted and completed treatments | 113,000 |
| 5. Northern goshawk nest areas | 63,000 |
| 6. Soil restricted from mechanized treatment | 126,000 |
| 7. Streamside management zones | 52,000 |
| Total Acres (including overlap) | 860,000 |
| Spatial overlap among all layers | -222,000 |
| Total Acres (excluding overlap) | 638,000 |
| Ponderosa-pine lands in study area | 2,413,000 |
| Ponderosa-pine lands remaining | 1,775,000 |
| Areas of Special Consideration | |
| Areas over ¼ mi. from existing roads[35] | 241,000 |
| Remaining White Mountain Stewardship Contract Areas[36] | 120,000 |

**Table 5**. Landscape management areas and percent of full analysis and wood source areas occupied by each.

| Landscape management areas | Areas w/o removals (acres) | % of Wood Source Area | Areas w/ removals (acres) | % of Analysis Area |
|---|---|---|---|---|
| Not considered source of wood | n/a | n/a | 638,000 | 26% |
| Community protection | 451,000 | 20% | 355,000 | 15% |
| Mexican spotted owl restricted habitat | 381,000 | 13% | 237,000 | 10% |
| Municipal watersheds | 86,000 | 3% | 60,000 | 2% |
| Aquatic species watersheds | 527,000 | 18% | 334,000 | 14% |
| Wildlands | 968,000 | 46% | 788,000 | 33% |
| Ponderosa-pine dominated lands in full analysis area | 2,413,000 | | 2,413,000 | 100% |
| Ponderosa-pine dominated lands that are a potential source of restoration byproducts | 1,775,000 | 100% | | |

[35] Group has low confidence of these being a source of wood supply, however no changes in wood supply volume or biomass estimates were made to account for lack of current road access.

[36] ASNF estimate of areas remaining to be treated, however no upper acreage is specified in contract. As the exact location of these areas within the NEPA Analysis Areas has yet to be determined, no wood supply volume estimate has been made. These 120,000 acres are in addition to the 113,000 acres listed in Table 5, which include areas already that have already been thinned as part of the Stewardship or other contracts.

**Table 6.** Treatment characterizations which consider a level of forest "fuels reduction" and restoration for the ponderosa pine type in the study area.

| Thinning Level | Stem density[1] (% reduction) | Basal area[1] (% reduction) | Canopy closure[1] (% reduction) | Description |
|---|---|---|---|---|
| 1/ Heavy thinning followed by prescribed burning | 80 (70-90) | 60 (50-70) | 40 (25-55) | Representative of a "full" restoration, heavy fuels reduction, multi-age group selection, or WUI-based treatment. |
| 2/ Moderate thinning following by prescribed burning | 65 (55-75) | 40 (30-50) | 30 (15-45) | Representative of a "moderate" or "full" restoration, moderate fuels reduction, or WUI-based treatment. |
| 3/ Light thinning following by prescribed burning | 50 (40-60) | 20 (10-30) | 20 (15-25) | Representative of a "light" restoration or fuels "maintenance" treatment. |

[1]Forest structure metrics and mean percent reduction values used to parameterize landscape-scale treatment alternatives. Minimum and maximum values in parentheses are derived from published studies and expert opinion.

**Table 7.** Percent reduction in basal area following application of desired post-treatment basal area distributions

| Landscape Management Areas | Thinning Range (Table 7) | Dominant Thinning Level | Average | Median | StdDev | Min | Max |
|---|---|---|---|---|---|---|---|
| Community Protection | Light to Heavy | Heavy | 60% | 64% | 14% | 3% | 79% |
| MSO Restricted | Light to Moderate | Light | 19% | 20% | 5% | 2% | 35% |
| Municipal Watersheds | Light to Heavy | Moderate | 41% | 45% | 11% | 2% | 53% |
| Aquatic species watersheds | Light to Heavy | Moderate | 41% | 43% | 11% | 2% | 58% |
| Wildlands | Light to Moderate | Light to Moderate | 25% | 25% | 8% | 2% | 44% |

**Table 8.** Areas not thinned in 27 completed or planned projects in the analysis area based on a review of Environmental Assessments.

| | Project Name | Planning Area (acres) | Area not thinned (acres) | Area not thinned (%) | Fire-only Areas (acres) | Fire-only Area (%) |
|---|---|---|---|---|---|---|
| **1** | Eastside* | 19,977 | 12,356 | 62% | 12,356 | 62% |
| **2** | Mormon Lake | 2,799 | 293 | 10% | 301 | 11% |
| **3** | Kachina* | 6,229 | 1,429 | 23% | 1,429 | 23% |
| **4** | Munds Park* | 2,980 | 1,998 | 67% | 1,988 | 67% |
| **5** | Mountainaire | 13,979 | 1,476 | 11% | 1,476 | 11% |
| **6** | Rocky Park* | 13,678 | 8,000 | 58% | 8,000 | 58% |
| **7** | Woody Ridge | 11,543 | 2,945 | 26% | 2,945 | 26% |
| **8** | Smith/Schultz* | 11,700 | 1,103 | 9% | 700 | 6% |
| **9** | Upper Beaver* | 44,694 | 27,072 | 61% | 30,414 | 68% |
| **10** | Victorine* | 8,678 | 6,922 | 80% | 6,922 | 80% |
| **11** | Huffer* | 1,146 | - | 0% | - | 0% |
| **12** | Elk Park | 6,485 | 1,785 | 28% | 1,700 | 26% |
| **13** | East Clear Creek* | 16,228 | - | 0% | - | 0% |
| **14** | Ft. Valley* | 6,960 | 2,900 | 42% | 1,800 | 26% |
| **15** | Blue R. MSO* | 16,282 | 8,124 | 50% | 2,399 | 15% |
| **16** | Chitty Creek* | 13,076 | 11,676 | 89% | 12,600 | 96% |
| **17** | Greer* | 19,629 | - | 0% | - | 0% |
| **18** | Eager South | 17,543 | 3,816 | 22% | 3,233 | 18% |
| **19** | Nutrioso[37] | 37,171 | 8,595 | 23% | 5,687 | 18% |
| **20** | Long Jim* | 1,375 | 662 | 48% | 462 | 34% |
| **21** | Twin* | 14,900 | 14,518 | 97% | 14,518 | 97% |
| **22** | Jacob Ryan* | 33,103 | 9,149 | 28% | 9,149 | 28% |
| **23** | East Rim* | 9,630 | 4,307 | 45% | 1,440 | 15% |
| **24** | Dogtown* | 7,317 | 2,250 | 31% | 2,000 | 27% |
| **25** | City* | 12,359 | 3,780 | 31% | 3,263 | 26% |
| **26** | Nagel* | 18,770 | 5,751 | 31% | 5,751 | 31% |
| **27** | Los Burros* | 23,798 | 4,262 | 18% | 3,790 | 16% |
| | **Average:** | | | **37%** | | **33%** |

* Acres not thinned and treatment areas provided by Grand Canyon Trust.

[37] Nutrioso: A total NEPA areas (FS lands) excluding meadows & riparian/water & PJ of 31,094 acres was used in fire-only % calculation

**Table 9**. Summary and error statistics for each forest structure and volume layer comparing reference and imputed values from FIA plots (n=420) in the ponderosa pine type. Data ranges are from a minimum of ~0 to the maximum value reported in the table.

| Response variable | **Mean** | **Range** | **SD** | **$r^2$** | **Mean residual error 80% of data** | **SD** | **Mean residual error 50% of data** | **SD** |
|---|---|---|---|---|---|---|---|---|
| Basal area ($ft/ac^2$) | 118 | 234 | 51 | 0.77 | ±9 $ft^2/ac$ | 4.5 | ±5 $ft^2/ac$ | 2.8 |
| Density (tpa) | 675 | 5724 | 831 | 0.74 | ±62 trees/ac | 46.2 | ±31 trees/ac | 19 |
| Canopy cover (%) | 42 | 83 | 15 | 0.56 | ±2.7% | 2.1 | ±1.4% | 1.0 |
| | | | | | | | | |
| Total volume ($ft^3/ac$) | 2091 | 8135 | 1221 | 0.86 | ±189 $ft^3/ac$ | 132 | ±96 $ft^3/ac$ | 59 |
| | | | | | | | | |
| Vol. <5" dbh | 63 | 798 | 105 | 0.46 | ±15 $ft^3/ac$ | 16 | ±4 $ft^3/ac$ | 6 |
| Vol. 5 - 16" dbh | 1069 | 3139 | 675 | 0.41 | ±197 $ft^3/ac$ | 140 | ±104 $ft^3/ac$ | 70 |
| Vol. >16" dbh | 959 | 6479 | 968 | 0.68 | ±184 $ft^3/ac$ | 115 | ±97 $ft^3/ac$ | 78 |
| | | | | | | | | |
| Vol. <16" dbh | 1132 | 3206 | 695 | 0.53 | ±180 $ft^3/ac$ | 126 | ±96 $ft^3/ac$ | 61 |

**Table 10**. Wood volume estimates summarized by total volume and three diameter classes for year 2006[1]. The total wood volume layer was used to summarize cubic foot volume for the ponderosa pine type and each landscape management area in the study area.

| **Wood volume category** | **Total (million ft$^3$)[2]** | **Vol.%** | **Acres (million)** | **% of total ac** |
|---|---|---|---|---|
| Total volume | 4,561 ft$^3$ | 100% | 2.4 ac | 100 % |
| Vol. by dbh class | | | | |
| <5" dbh | 118 | 3 | | |
| 5 to 16" dbh | 2,442 | 54 | | |
| > 16" dbh | 1,966 | 43 | | |
| Sum | 4,526 | | | |
| Vol. not considered in supply | 1,302 | 28 | 0.6 | 26 |
| Total vol. in management areas | 3,263 | 72 | 1.8 | 74 |
| Vol. in management areas by dbh class | | | | |
| <5" dbh | 79 | 2 | | |
| 5 to 16" dbh | 1,394 | 43 | | |
| > 16" dbh | 1,764 | 55 | | |
| Sum | 3,238 | | | |
| Volume by management area | | **% of total vol.** | | **% of total ac** |
| Community protection | 643 | 14 | 0.35 | 15 |
| MSO restricted habitat | 504 | 11 | 0.24 | 10 |
| Municipal watersheds | 128 | 3 | 0.06 | 3 |
| Aquatic species watersheds | 668 | 15 | 0.31 | 13 |
| Wildlands | 1,317 | 30 | 0.79 | 33 |

[1]Total cubic volume estimates for the ponderosa pine type are from a single data layer and volume by diameter class is from three separate data layers. Discrepancies between estimates derived from the total volume layer those summed over diameter classes is a primarily result of lower computation accuracy in the <5" dbh volume layer.
[2]Tree bole cubic foot volume includes the entire length of the tree, with **no** deduction from the main stem for stumps or tops at specified diameter.

**Table 11**. Wood supply estimates derived from the consensus and majority treatment scenarios as of year 2006[1]. Potential treatments occur in the ponderosa pine type on 41% of the total analysis area acres for the consensus scenario and on 74% of the area for the majority scenario. The majority scenario was applied to all 74% of the area considered for restoration treatments however, 5% was below a minimum amount of basal area and did not have thinning treatments.

| **Management area** | **Consensus scenario** | **Wood supply ($ft^3$)[2]** | **Acres treated** | **Ave $ft^3$/ac harvested** |
|---|---|---|---|---|
| Community protection | 70% of area | 368,975,519 | 314,017 | 1,175 |
| MSO restricted habitat | 30% of area | 56,832,525 | 113,076 | 503 |
| Municipal watersheds | 40% of area | 37,448,212 | 34,471 | 1,086 |
| Aquatic species watersheds | 35% of area | 189,626,094 | 187,157 | 1,013 |
| Wildlands | 35% of area | 194,426,007 | 338,486 | 574 |
| | **Sum** | 847,308,357 | 987,206 | Ave 858 |

| Management zone | **Majority scenario** | | | |
|---|---|---|---|---|
| Community protection | 74% of area | 371,401,419 | 335,206 | 1,108 |
| MSO restricted habitat | 74% of area | 83,647,154 | 225,773 | 370 |
| Municipal watersheds | 74% of area | 47,206,561 | 58,031 | 813 |
| Aquatic species watersheds | 74% of area | 242,247,408 | 323,531 | 749 |
| Wildlands | 74% of area | 270,810,528 | 718,927 | 377 |
| | **Sum** | 1,015,313,070 | 1,661,467 | Ave 611 |

[1]Wood supply estimates are from 2006 data and have not been projected forward with forest growth information. Restoration treatments will be implemented over several years and tree growth will likely contribute additional wood supply than is shown in the figures above.

[2]Tree bole cubic foot volume includes the entire length of the tree, with **no** deduction from the main stem for stumps or tops at specified diameter.

**Table 12**. Tree bole[1] and crown biomass estimates (green tons) for consensus and majority scenarios for the ponderosa pine type and each landscape management area. Wood supply for tree boles in cubic foot volume units is added for comparison.

| Landscape zone | Tot. bole[1] (tons) | Wood supply[1] ($ft^3$) | Tot. crown[2] (tons) | Total area | Ave bole[3] (tons/ac) | Ave crown[3] (tons/ac) |
|---|---|---|---|---|---|---|
| **Consensus scenario** | | | | | | |
| Community protection | 11,713,509 | 368,975,519 | 3,479,963 | 314,017 | 37.3 | 11.08 |
| MSO restricted habitat | 1,804,207 | 56,832,525 | 536,384 | 113,076 | 16.0 | 4.74 |
| Municipal watersheds | 1,188,832 | 37,448,212 | 355,581 | 34,471 | 34.5 | 10.32 |
| Aquatic species watersheds | 6,019,876 | 189,626,094 | 1,788,160 | 187,157 | 32.2 | 9.55 |
| Wildlands | 6,172,254 | 194,426,007 | 1,831,347 | 338,486 | 18.2 | 5.41 |
| **Sum** | 26,898,678 | 847,308,357 | 7,991,436 | 987,206 | 27.2 | 8.09 |
| **Majority scenario** | | | | | | |
| Community protection | 11,790,521 | 371,401,419 | 3,503,137 | 335,206 | 35.2 | 10.45 |
| MSO restricted habitat | 2,655,465 | 83,647,154 | 789,558 | 225,773 | 11.8 | 3.50 |
| Municipal watersheds | 1,498,621 | 47,206,561 | 448,773 | 58,031 | 25.8 | 7.73 |
| Aquatic species watersheds | 7,690,394 | 242,247,408 | 2,284,993 | 323,531 | 23.8 | 7.06 |
| Wildlands | 8,597,160 | 270,810,528 | 2,550,706 | 718,927 | 12.0 | 3.55 |
| **Sum** | 32,232,161 | 1,015,313,070 | 9,577,167 | 1,661,467 | 19.4 | 5.76 |

[1]Tree bole weight is the cubic foot wood volume converted to green tons using a factor of 0.0315 green tons = 1000 cubic feet. Tree bole cubic foot volume or weight in green tons includes the entire length of the tree with **no** deduction from the main stem for stumps or tops at specified diameter.

[2]Crown weights from restoration byproducts include all tree foliage, limbs and bark from limbs.

[3]Averge tons of bole and crown material per acre for differ between consensus and majority scenarios because the majority scenario covers an additional 34% of the landscape with generally lower pre-treatment basal area.

**Table 13.** The amount of the analysis area and ponderosa pine type where a desired post-treatment basal area was not met by the majority scenario by removing only small-diameter trees (<16" dbh). Wood volumes reported in the table are from trees >16" dbh. A total of 81% of the area treated in the majority scenario (74% of landscape) showed that sufficient basal area can potentially be harvested from small-diameter trees accounting for 90% of the total volume (917 million $ft^3$). This analysis assumes 10% and 20% of the basal area is retained from trees in the <5" dbh and 5 -16" dbh classes respectively.

| Management area | Acres | % of management area condition not met[1] | % of total area condition not met | Vol. for trees >16" ($ft^3$) | % of total volume from trees >16" |
|---|---|---|---|---|---|
| Community protection | 190,870 | 53.9 | 10.8 | 70,964,198 | 7.0 |
| MSO restricted habitat | 7,496 | 3.2 | 0.4 | 787,812 | 0.1 |
| Municipal watersheds | 70,397 | 27.4 | 0.9 | 3,467,404 | 0.3 |
| Aquatic species watersheds | 16,465 | 21.1 | 4.0 | 15,201,905 | 1.5 |
| Wildlands | 46,838 | 5.9 | 2.6 | 7,591,187 | 0.8 |
| Sum | 332,066 | | 18.7 | 98,012,506 | 9.7 |

[1]Desired post-treatment basal area condition is not met by harvesting only trees <16" dbh.

**Table 14**. Treatment scenarios in the ponderosa pine type summarized by level of treatment on national and non-national USDA Forest Service (USFS) lands.

| Land type | Treatment | Total area (acres) | Total volume ($ft^3$) | Ave $ft^3$ harvested/ac |
|---|---|---|---|---|
| USFS lands | Consensus | 886,531 | 742,492,760 | 838 |
| Non-USFS lands | Consensus | 100,578 | 104,734,206 | 1,041 |
| USFS lands | Majority | 1,541,262 | 906,795,594 | 588 |
| Non-USFS lands | Majority | 120,013 | 108,407,979 | 903 |

**Table 15.** Restoration byproducts harvested and removed by White Mountain area (Apache Sitgreaves National Forest) harvesting contractors in year 2006.

| Harvesting Contractors | Harvested materials | | |
|---|---|---|---|
| | (thousand green tons) | (million ft$^3$) | (% of total) |
| Walker Brothers | 110.8 | 3.17 | 63.6 |
| Tri Star Logging | 44.6 | 1.27 | 25.6 |
| Nutrioso Logging | 12.3 | 0.35 | 7.1 |
| Renegy | 6.5 | 0.19 | 3.7 |
| TOTAL | 174.2 | 4.98 | 100.0 |

**Table 16.** Restoration byproducts utilized by White Mountain area (Apache Sitgreaves National Forest) mills and manufacturers in year 2006. [1]

| Mills and Manufacturers | Utilized materials | | |
|---|---|---|---|
| | (thousand green tons) | (million ft$^3$) | (% of total) |
| Forest Energy (pellets) | 95.9 | 2.74 | 55.1 |
| Reidhead[2] (lumber) | 24.4 | 0.70 | 14.0 |
| Renegy (biomass) | 9.8 | 0.28 | 5.6 |
| Western Renewables[3] (biomass) | 14.1 | 0.40 | 8.1 |
| Southwest Forest Products[4] (pallets, mulch, cut stock) | 13.3 | 0.38 | 7.6 |
| Other (post, poles, logs, etc.) | 16.7 | 0.48 | 9.6 |
| **TOTAL** | 174.2 | 4.98 | 100.0 |

Source: Apache-Sitgreaves NF, Forest Energy, and SW Forest Products

[1] Conversion rate = 3.5 tons per ccf (70lbs/cf).
[2] The 24K tons to Reidhead was distributed between the Eagar lumber mill (21K tons) and the Nutrioso mill (3K tons).
[3] Western Renewable is no longer in business.
[4] Southwest Forest Products is no longer operating in the White Mt. area.

**Table 17**. Restoration byproducts harvested and removed by Western Mogollon area (Coconino and Kaibab National Forests) harvesting contractors in year 2006.

| **Harvesting Contractors** | **Harvested materials** | | |
|---|---|---|---|
| | **(thousand green tons)** | **(million ft$^3$)** | **(% of total)** |
| SW Forest Products | 91.0 | 2.84 | 57.4 |
| Hurd Brother's Logging | 24.1 | 0.75 | 15.2 |
| Perkins Timber | 15.2 | 0.48 | 9.6 |
| Colorado Wood Co. | 2.8 | 0.09 | 1.8 |
| High Desert Inv. Co. | 25.0 | 0.78 | 15.8 |
| Other | 0.4 | 0.01 | 0.2 |
| Total | 158.5 | 4.95 | 100.0 |

**Table 18**. Restoration byproducts utilized by Western Mogollon Area (Coconino and Kaibab National Forests) mills and manufacturers in year 2006.

| Mills and Manufacturers | **Utilized materials** | | |
|---|---|---|---|
| | **(thousand green tons)** | **(million ft$^3$)** | **(% of total)** |
| SW Forest Products (pallets, mulch, cut stock) | 133.5 | 4.17 | 84.2 |
| Canyon Fuels (Zellner's Firewood) | 25.0 | 0.78 | 15.8 |
| | 158.5 | 4.95 | 100 |

Source: Coconino and Kaibab NF, and SW Forest Products
Conversion rate = 3.2 tons per ccf (64lbs/cf). Original values provided in CCF.

**Table 19**. Flow of wood from specific harvesting contractors operating on USDA Forest Service lands processing facilities for the White Mountains and Western Mogollon Plateau in Arizona.

| **Western Mogollon area (Coconino and Kaibab National Forests), 2006** | | | |
|---|---|---|---|
| **Harvest contractor** | **Green tons** | **Processing facility** | **Products** |
| Southwest Forest | 91,000 | SW Forest Products | Pallets, cut stock, timbers, misc. landscape |
| Hurd Bros. Logging | 24,100 | SW Forest Products | Pallets, cut stock, timbers, misc. landscape |
| Perkins Timber | 15,200 | SW Forest Products | Pallets, cut stock, timbers, misc. landscape |
| Colorado Wood Co. | 28,000 | SW Forest Products | Pallets, cut stock, timbers, misc. landscape |
| Other | 4,000 | SW Forest Products | Pallets, cut stock, timbers, misc. landscape |
| **High** Desert | 25,000 | Canyon fuels | Fire wood |
| | | | |
| **White Mountains area (Apache-Sitgreaves National Forest), 2006** | | | |
| Future Forest (Walker/WMSP) | 79,000 | First Energy | Pellets |
| Future Forest (Walker/WMSP) | 16,400 | Reidhead | Lumber |
| Future Forest (Walker/WMSP) | 14,100 | West. Renew. | Biomass |
| Future Forest (Walker/WMSP) | 1,300 | Other | Posts, poles, logs etc. |
| Nutrioso Logging & Renegy | 7,400 | Reidhead | Lumber |
| Nutrioso Logging & Renegy | 6,500 | Renegy | Biomass |
| Nutrioso Logging & Renegy | 4,900 | Other | Posts, poles, logs |
| Tri Star Logging | 16,900 | Forest energy | Pellets |
| Tri Star Logging | 14,100 | Other | - |
| Tri Star Logging | 300 | Renegy | Biomass |
| Tri Star Logging | 13,300 | SW Forest Products | - |

**Table 20**. Forest growth estimates from 10 and 20 year FVS cycles using FIA plots in the ponderosa pine forest type (n = 327).

| Years | Diameter class[1] | Mean growth[2] | SD | Max/Min[1] | Mean mortality[1] | Net growth[1] |
|---|---|---|---|---|---|---|
| **1997-2007** | All | 42.9 | 17.8 | 4/125 | 2.9 | 40.0 |
| **2007-2027** | All | 44.2 | 20.8 | 4/144 | 5.3 | 38.9 |
| **1997-2007** | | | | | | |
| | <5" dbh | 1.2 | 6.3 | 0/28 | 0.40 | 0.76 |
| | 5 to 16" dbh | 16.5 | 20.6 | 0/74 | 1.5 | 15.0 |
| | >16" dbh | 25.0 | 21.2 | 0/185 | 0.39 | 24.6 |
| **2007-2027** | <5" dbh | 0.18 | 5.9 | 0/36 | 0.15 | 0.02 |
| | 5 to 16" dbh | 13.1 | 17.9 | 0/69 | 0.90 | 12.2 |
| | >16" dbh | 26.7 | 18.9 | 0/129 | 0.27 | 26.4 |

[1]Tree growth and mortality for diameter classes is what has accumulated during a 10- or 20 year growth period using FVS models. Trees diameter increment sufficient to move a tree to the next larger diameter class after 10 years will be counted as growth in that category. Some tree mortality is unaccounted for in diameter classes between years 2007 and 2027 because of an FVS programming limitation.
[2]Units are in $ft^3$/ac/yr

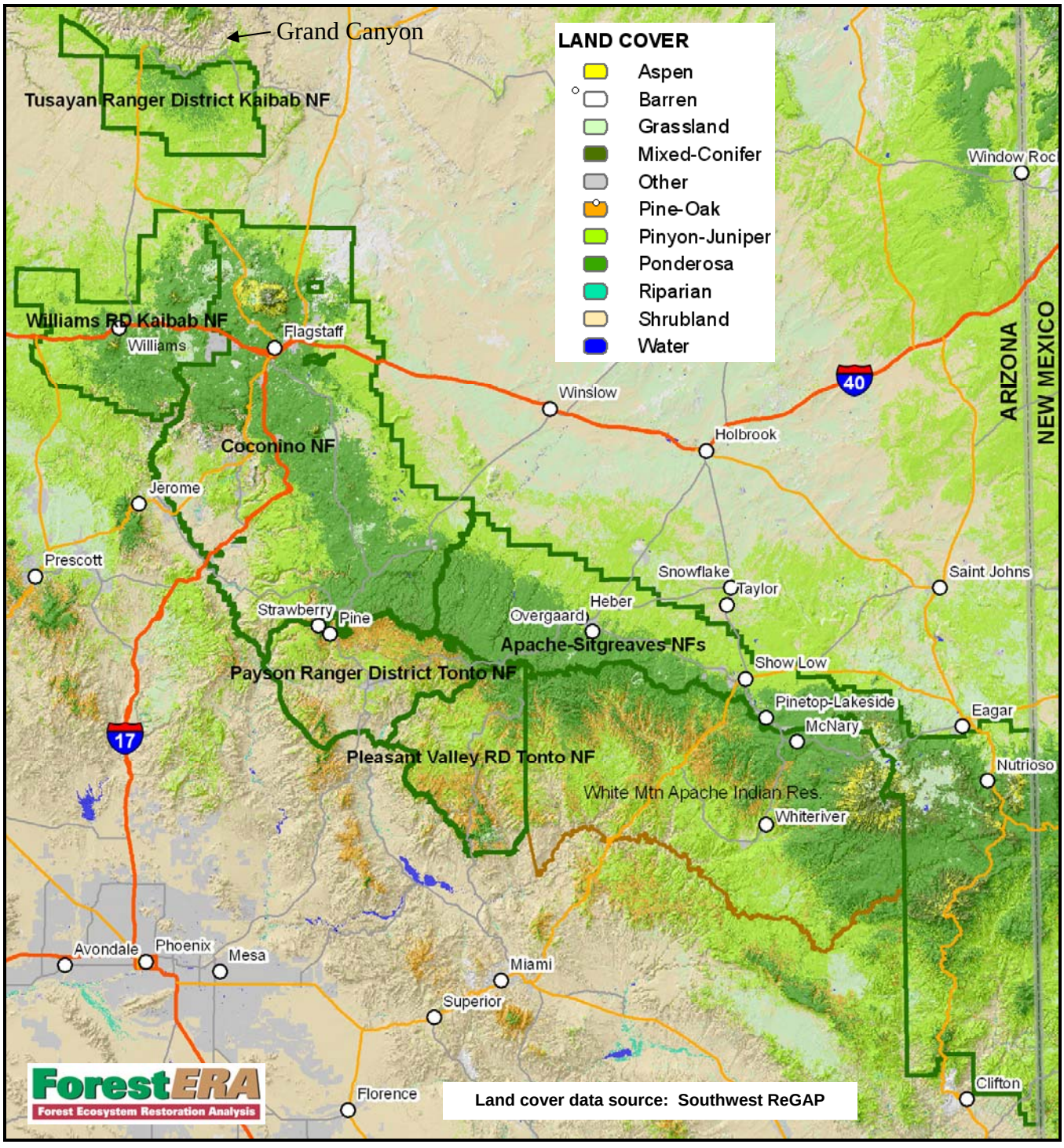



**Figure 1**. Map detailing the 2.4 million acre wood supply analysis area in northern Arizona. The study area includes ponderosa pine and pine-oak vegetation south of the Grand Canyon and across the Mogollon Plateau to the border of Arizona and New Mexico within the proclamation boundaries of the Kaibab (south of Grand Canyon), Coconino, and Apache-Sitgreaves National Forests, and the Payson and Pleasant Valley Ranger Districts of the Tonto National Forest (outlined in green).

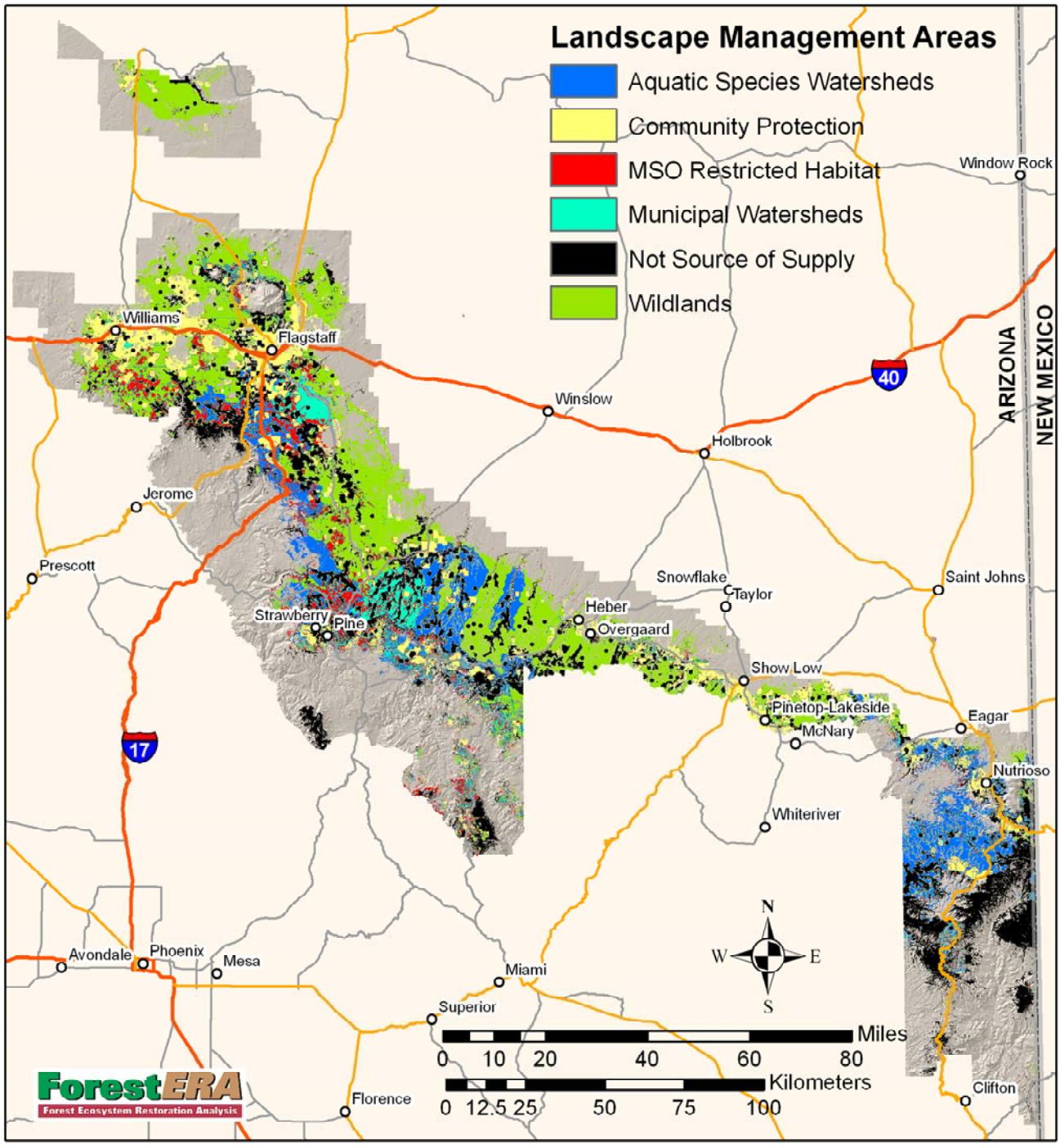



**Figure 2**. Map depicting areas not considered a source of wood supply from mechanical thinning treatments (black) and landscape management areas (various colors) used to define various desired post-treatment conditions in working group treatment scenarios.

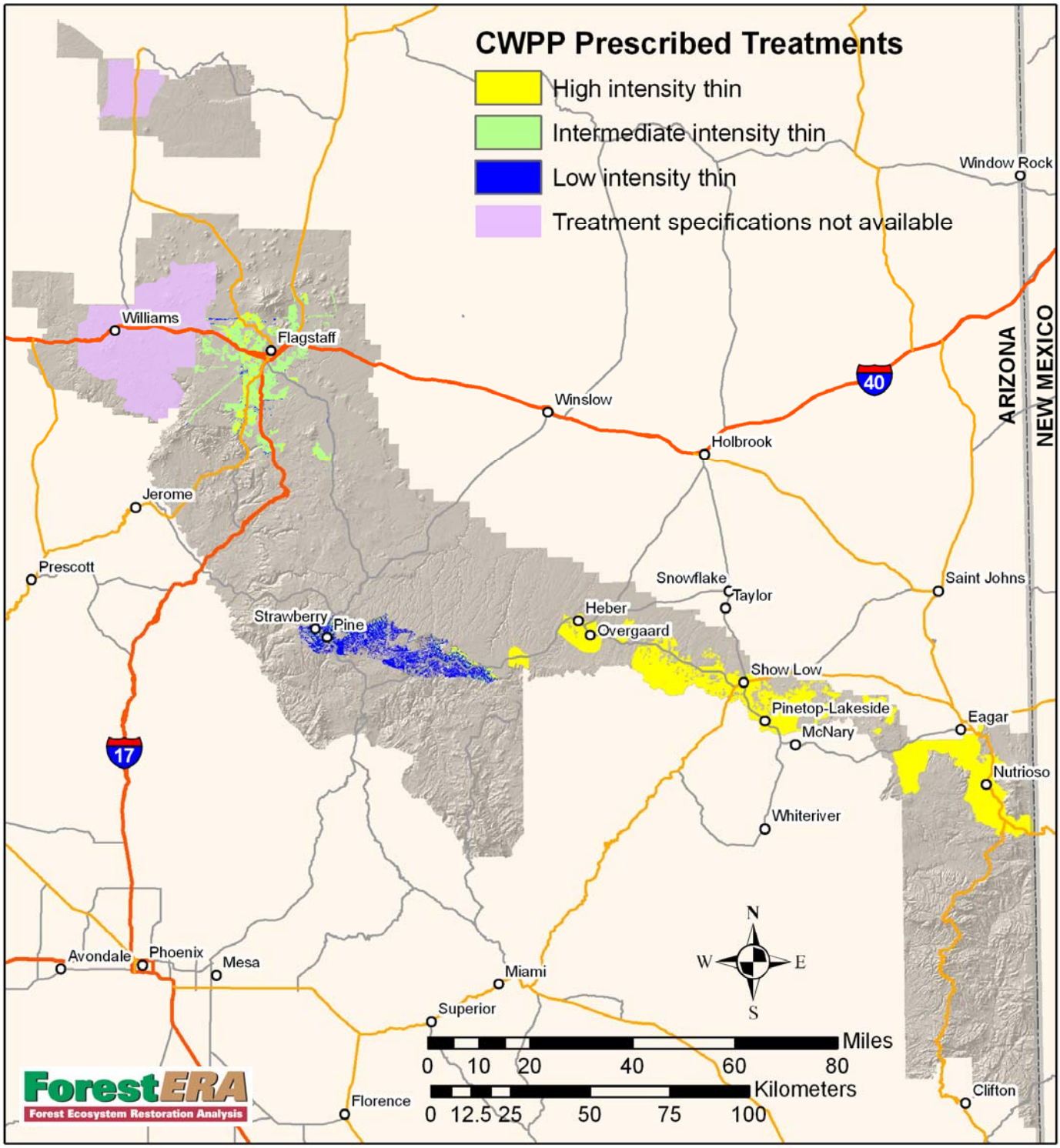



**Figure 3.** Map of mechanical treatment levels defined in Community Wildfire Protection Plans in the analysis area.

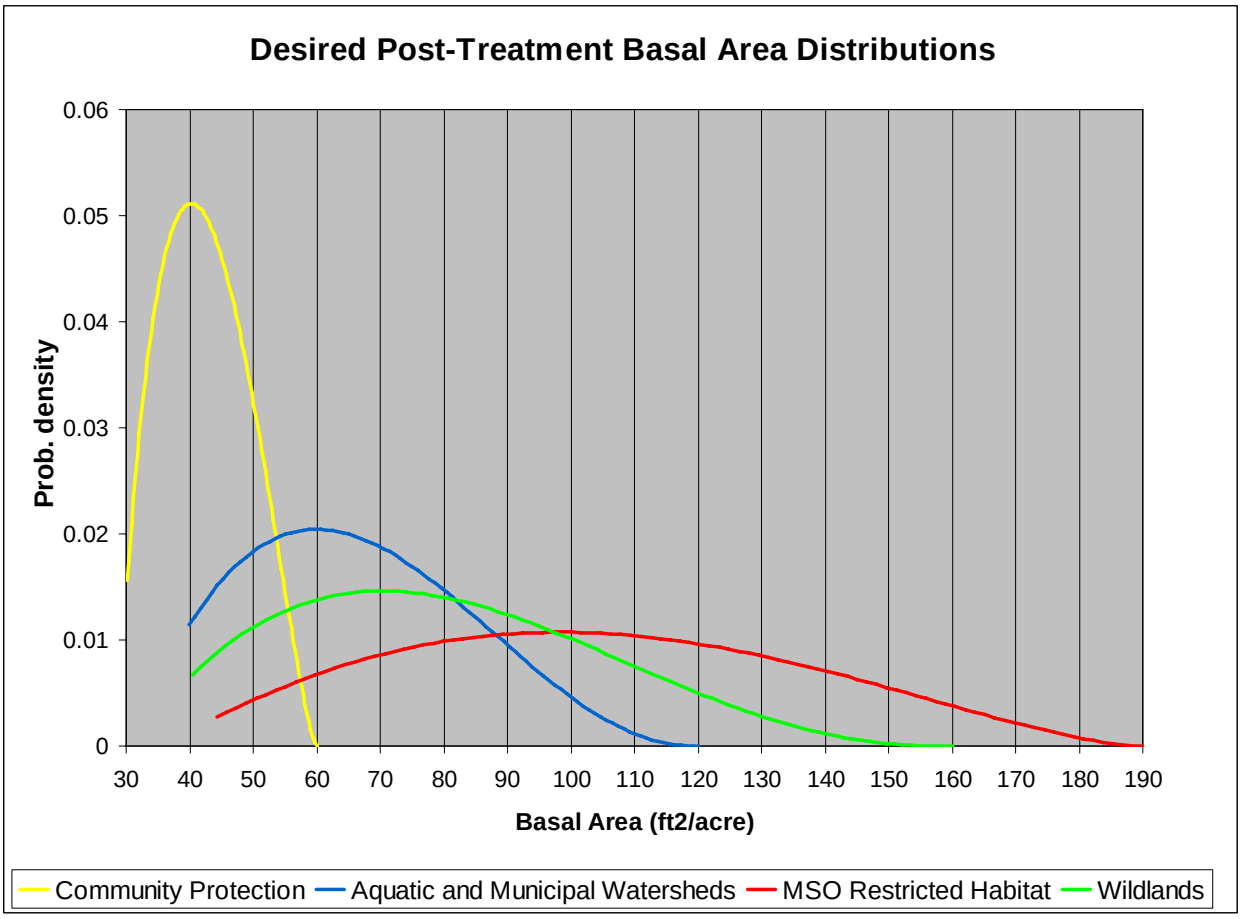



**Figure 4**. Desired post-treatment ponderosa pine basal area distributions for each landscape management area used in consensus and majority scenarios. Locations with pre-treatment basal areas lower than informed by curves were not decreased following potential treatments.

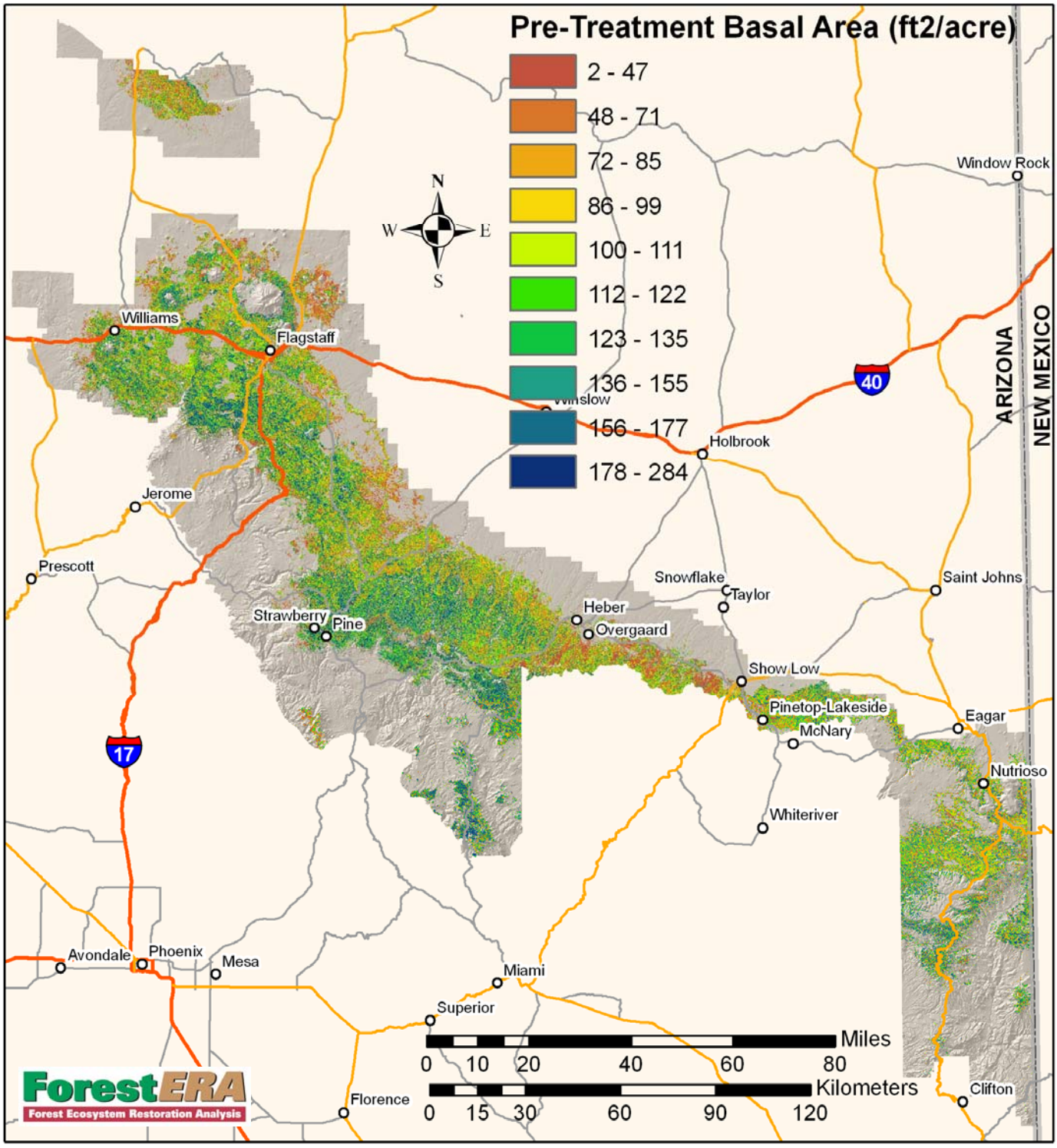



**Figure 5**. Map of estimated ponderosa pine basal area in year 2006 across the analysis area.

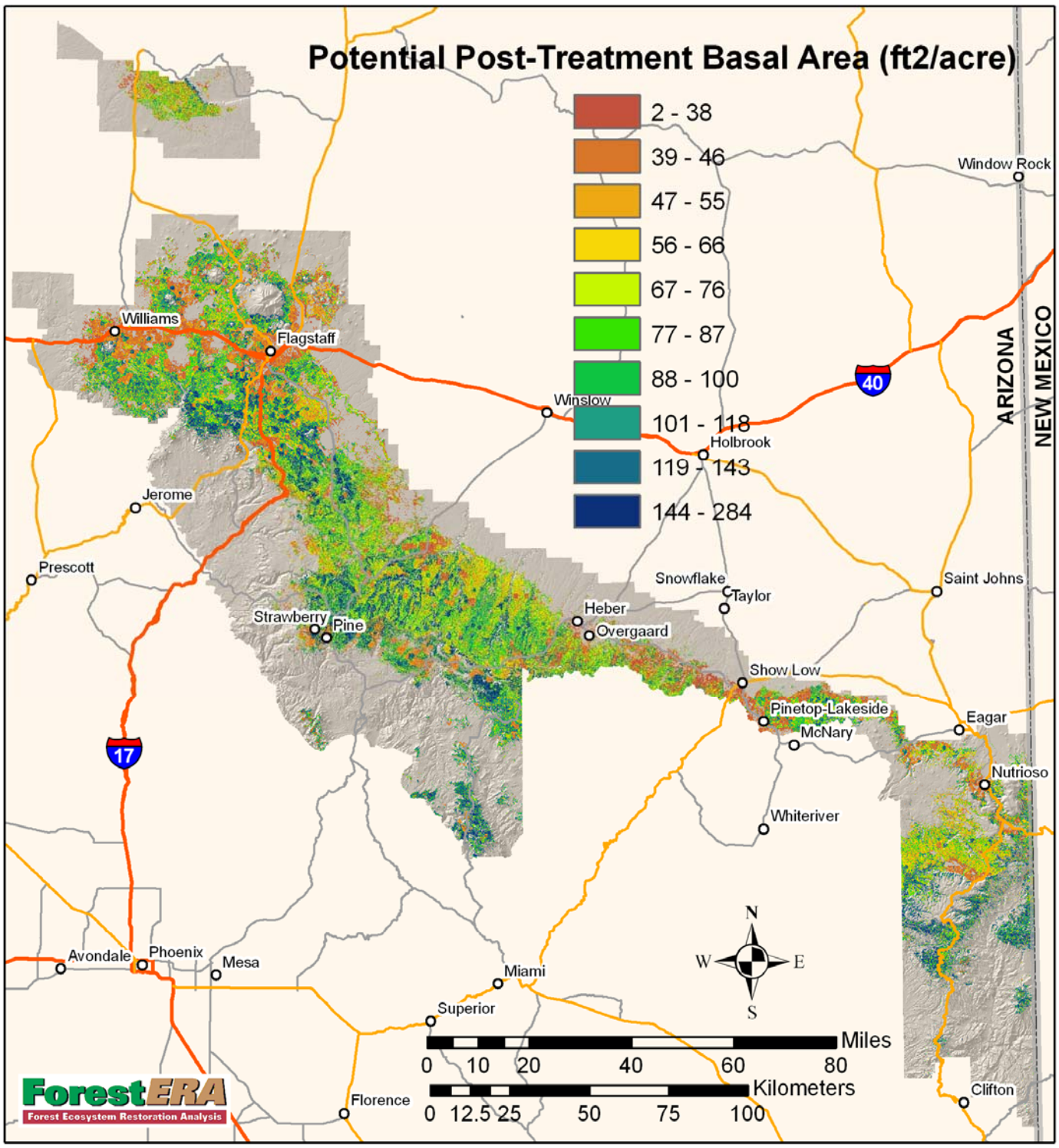



**Figure 6**. Map of estimated ponderosa pine basal area across the analysis area following potential treatments defined in the majority scenario.

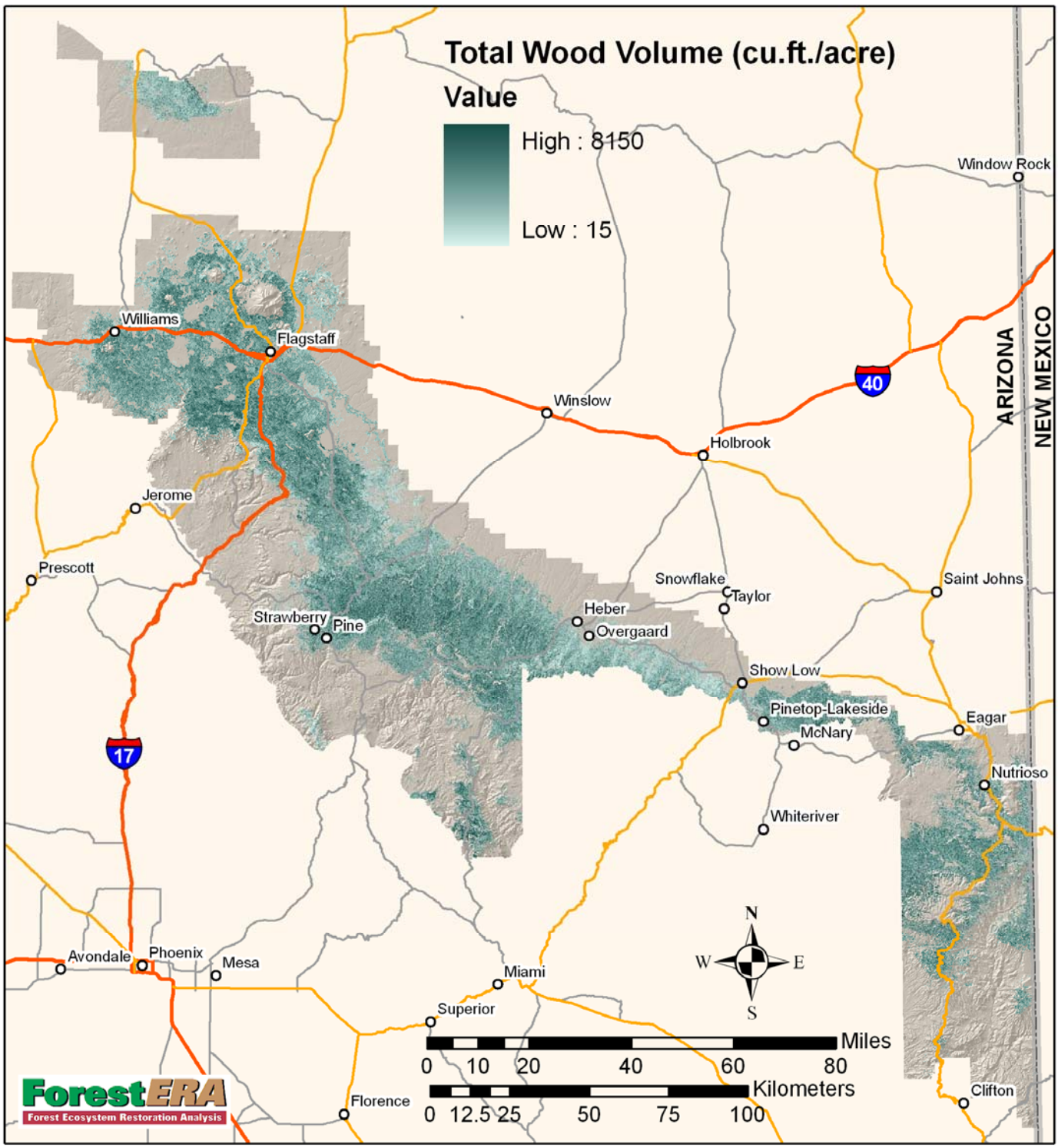



**Figure 7**. Map of estimated total ponderosa pine bole volume for year 2006 across the wood supply analysis area.

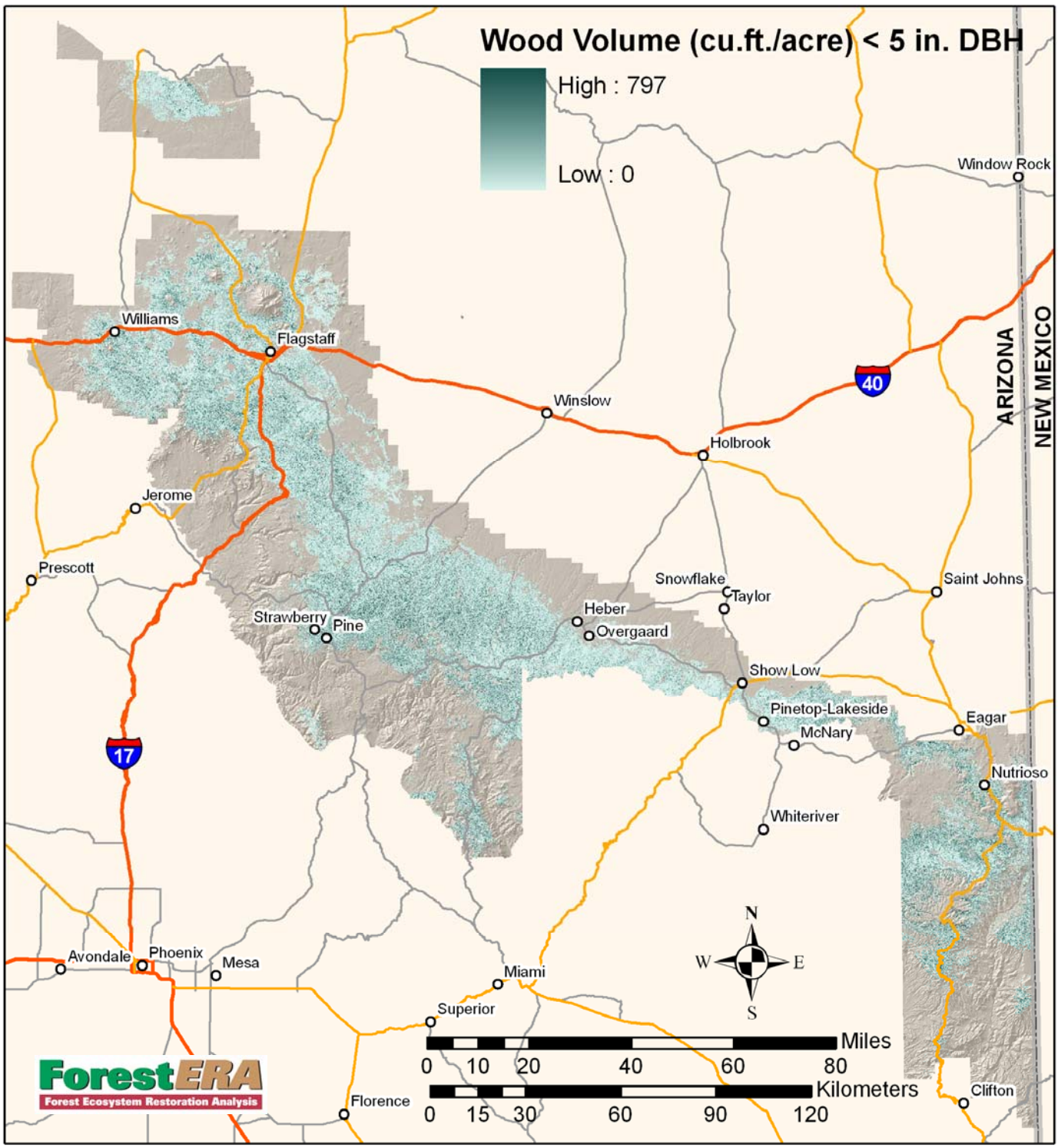



**Figure 8**. Map of estimated ponderosa pine bole volume for trees <5" dbh for year 2006 across the wood supply analysis area.

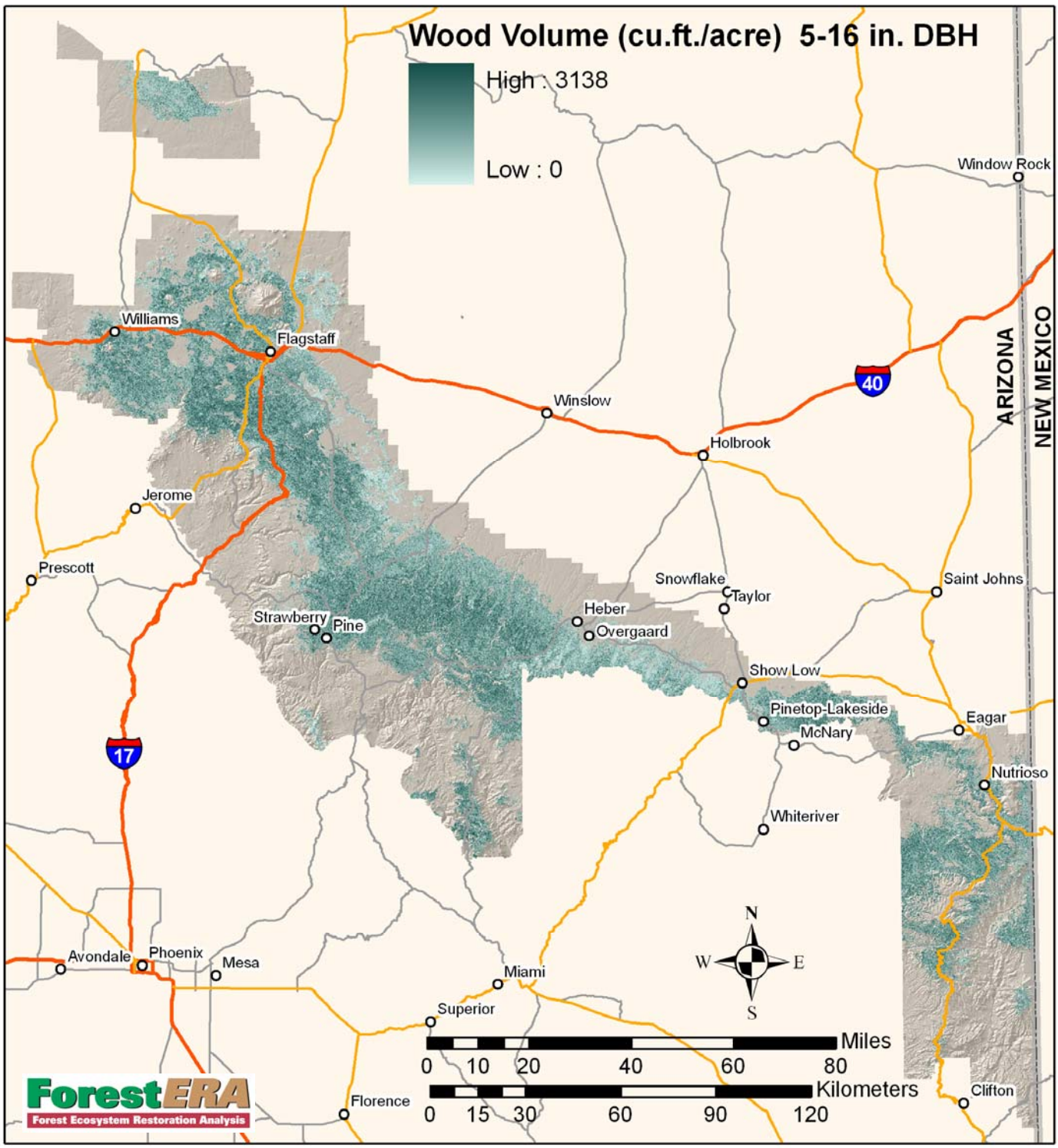



**Figure 9**. Map of estimated ponderosa pine bole volume for trees ranging from 5 to 16” dbh for year 2006 across the wood supply analysis area.

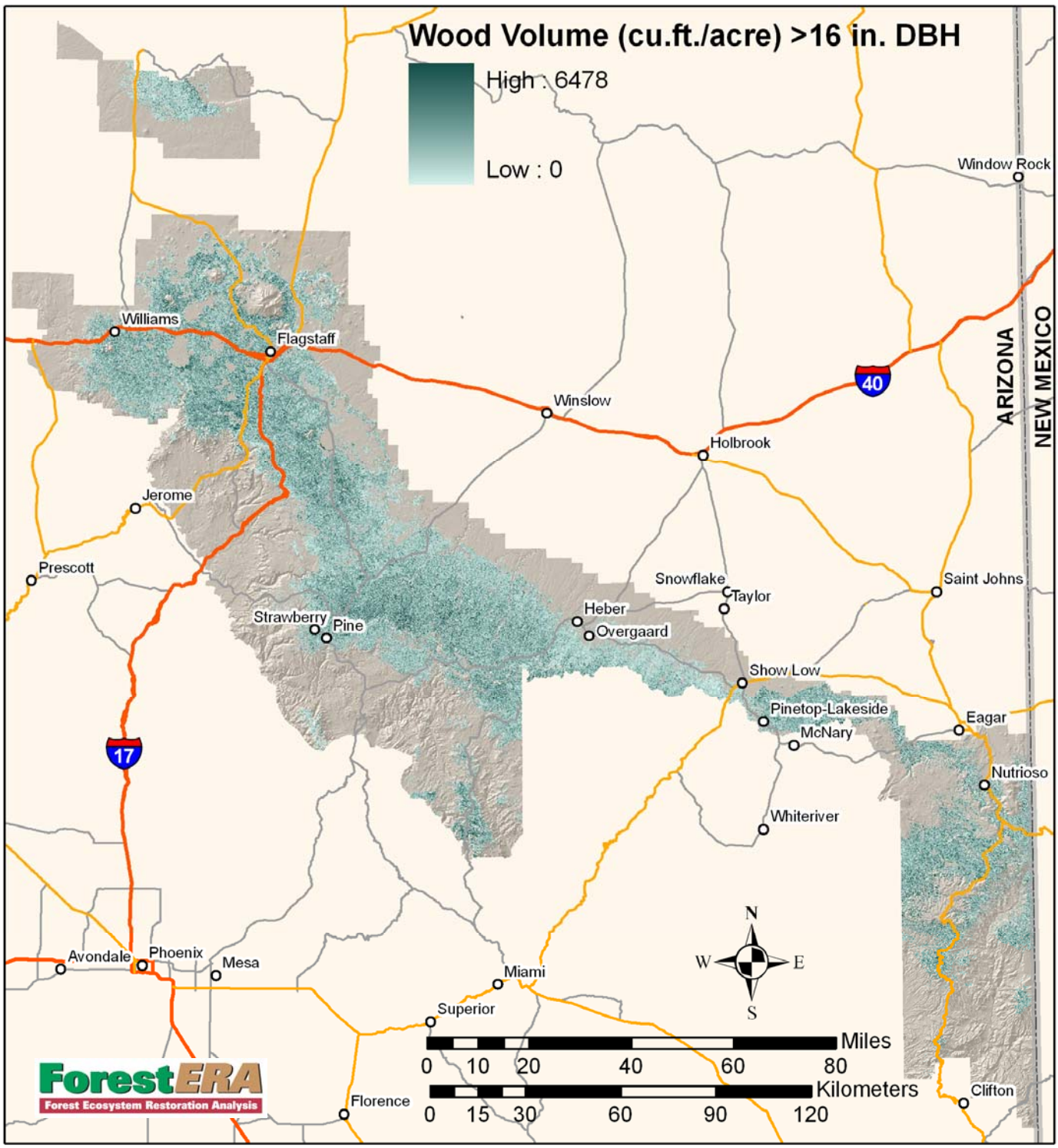



**Figure 10**. Map of estimated ponderosa pine bole volume for trees >16” dbh in year 2006 across the wood supply analysis area.

# Appendices

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**Appendix A.** Letter from Regional Forester on Utility of Wood Supply Analysis

USDA United States Department of Agriculture
Forest Service
Southwestern Region
Regional Office
333 Broadway SE
Albuquerque, NM 87102
FAX (505) 842-3800
V/TTY (505) 842-3292

File Code: 2400
Date: July 19, 2007

Haydee M. Hampton
Research Associate
Center for Environmental Sciences and Education,
Northern Arizona University
NAU Box 5694
Flagstaff, AZ 86011-5694

Dear Haydee:

We understand that at the first working group meeting for the Arizona Supply Study, the working group asked for some clarification on how the Southwestern Region would use the results of the study.

We believe the study will prove to be a valuable tool in advancing our efforts to restore the functionality of fire adapted ecosystems through treatments that simultaneously improve forest health and reduce the threat of wildfire to communities. Central to accomplishing this work is fostering the development of industries that can capture the economic value of the excess biomass and reduce treatment costs.

The utility of the study is threefold. First, it will provide us a better understanding of the zone of conceptual agreement across the broad spectrum of stakeholders of the range of available biomass resulting as a byproduct of various restoration treatment scenarios. Secondly, it will provide an additional dimension to build on our discussions at the local level as to the scale and scope of restoration treatments. Thirdly, it will assist both us and potential private investors in assessing the appropriate scale of infrastructure development to utilize the biomass produced as a byproduct of restoration projects.

Please share this information with the working group and our encouragement to continue to ask for any additional clarification or information that will further enhance the success of this effort.

Sincerely,

*/s/ Abel M. Camarena (for)*
HARV FORSGREN
Regional Forester

## Wood Supply Working Group
## Analysis of Small-Diameter Wood Supply in Northern Arizona

**June 4, 2007, Northland Pioneer College, Holbrook, AZ**
**9:00 a.m. – 4:15 p.m.**

| | |
|---|---|
| 9:00 – 9:15 a.m. | **Welcome** - *Tom Sisk* (Professor, Environmental Sciences, Northern Arizona University) |
| 9:15 – 9:30 a.m. | **Agenda Review –** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 9:45 a.m. | **Group Introductions –** *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:45 – 10:30 a.m. | **Wood Supply Steering Committee presentations –**<br>*Steve Gatewood* (Consultant, Wildwood Consulting and Former Director, Greater Flagstaff Forests Partnership)<br>*Todd Schulke* (Forest Programs Director, Center for Biological Diversity)<br>*Diane Vosick* (Associate Director, Ecological Restoration Institute)<br>*Elaine Zieroth* (Forest Supervisor, Apache-Sitgreaves National Forests)<br>*Rob Davis* (President / Owner, Forest Energy / Future Forests) |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | **Wood Supply Analysis Goals and Objectives**<br><br>**Presentation –** *Gilbert Zepeda* (Director of Forestry, Forest Health, Cooperative Forestry, and International Forestry, Southwestern Region, USDA Forest Service)<br>The Region's interest in funding this project and how they intend to use analysis products in decision making (15-20 minutes with Q/A)<br><br>**Presentation –** *Tom Sisk*<br>Benefits of landscape-scale analyses in general and previous treatment scenario work accomplished during the Western Mogollon Plateau and White Mountains Landscape Assessments (20-30 minutes with Q/A)<br><br>**Presentation –** *Haydee Hampton* and *Gary Snider* (Forest Economist and Doctoral Candidate, School of Forestry, Northern Arizona University)<br>Description of Wood Supply Analysis objectives, methods, analysis area, and time line (20-30 minutes with Q/A) |

| | |
|---|---|
| 12:00 – 1:00 p.m. | Lunch |
| 1:00 – 1:15 p.m. | **Process Review –** *Rosemary Romero* |
| 1:15 – 2:30 p.m. | **Setting the Scene** |
| | ~~**Presentation** – *Herb Hopper* (Community-based Forest and Wood Products Advocate, Little Colorado Plateau Resource, Conservation & Development)~~ |
| | ~~Economic Considerations for Restoring Forest Health (15 minutes with Q/A)~~ (cancelled as Mr. Hopper could not attend) |
| | **Presentations –** *Shaula Hedwall*; US Fish and Wildlife, *Sarah Lantz*; Urban Wildlife Planner, AZGF, and *Jerry Drury*, Timber Staff Officer, Kaibab National Forest, *Jim Probst*, Hydrologist, Apache-Sitgreaves National Forest |
| | Treatment-related regulations and guidelines relevant to siting treatments at the landscape scale. What constraints need to be considered when developing treatment scenarios? (15-20 minutes each with Q/A) |
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:45 p.m. | **Data needs for developing treatment scenarios –** *Tom Sisk, Haydee Hampton and Jill Rundall* |
| | Treatment scenario development and data available for analysis area. Facilitated discussion and prioritization on need for and availability of additional spatial data |
| | Logistics for next meeting |
| 3:45 – 4:15 p.m. | **Public comment period** |
| 4:15 p.m | Adjourn |

**Meeting Summary**
**Wood Supply Working Group Kick-Off Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**
**June 4, 2007, Northland Pioneer College, Holbrook, Arizona**

## Introduction and Agenda Review

**Tom Sisk:** *Welcoming*
Sisk (Professor, Center for Environmental Sciences and Education at Northern Arizona University (NAU)) welcomed members of the Working Group and the public to the kick-off meeting. After mentioning recent and ongoing forest restoration studies wherein a consensus of public opinion had been reached, Sisk encouraged the group to consider ways in which they could take the next step of joining economic development with forest health. The working group draws from the perspectives of numerous organizations, interest groups and industries, and Sisk remarked that this diversity of opinion and interest makes for a radical approach to the forest restoration process in Arizona. In addition to the efforts of those involved, Sisk also stated that the large base of spatial science and research the group has to draw from may better reveal specific areas on the landscape where economic stabilization and forest restoration can exist harmoniously.

Sisk then turned the floor over to Haydee Hampton (Research Associate, Center for Environmental Sciences and Education at NAU), the Forest Ecosystem Restoration Analysis (ForestERA) Project Manager leading this collaborative effort.

**Haydee Hampton**: *Agenda, contents of workbook, and Wood Supply Team introductions*
Hampton presented the agenda for the kick-off meeting, went over possible dates for upcoming working group meetings, and explained sections of the workbook to those members present. She encouraged Working Group members to review materials included in the workbook. If members wish for information/documents to be included in the workbook for subsequent meetings, let Hampton know. Members requested that reference materials be made available online, and Hampton agreed to make these available on the ForestERA website (http://www.forestera.nau.edu/project_woodsupply_documents.htm). Hampton explained that the Working Group operates using a fishbowl method, meaning that stakeholders not on the Working Group are always welcome to submit comments for consideration both during meetings and between meetings by phone, email or post as detailed on the Wood Supply web pages.

Hampton introduced members of ForestERA's Project Team not present at the Working Group kick-off meeting: Brett Dickson (Ecologist), Yaguang Xu (Spatial Analyst, GIS Developer). She then introduced Jill Rundall, GIS Specialist, ForestERA; Jada Ach, Scribe; Rosemary Romero, Meeting Facilitator; and Gary Snider, Forest Economist and Doctoral student in the School of Forestry at Northern Arizona University.

**Rosemary Romero:** *Group Introductions*
Romero coordinated Working Group member introductions.

***Working Group members present at meeting (in order of presentation)*:**
1) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy
2) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forest
3) Diane Vosick, Associate Director of the Ecological Restoration Institute
4) Steve Gatewood, Director of the Greater Flagstaff Forests Partnership
5) Shaula Hedwall, representative of the U.S. Fish and Wildlife Service, Ecological Services
6) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
7) Keith Pajkos, Timber Staff for the Arizona State Lands Department Forestry Division
8) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization (ECO)/Economic Environmental Counties Organization (EECO)
9) Edward Smith, The Nature Conservancy
10) Kim Newbauer, Representative of Coconino National Forest
11) Jerry Drury, Timber Staff Officer for Kaibab National Forest
12) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest Restoration Products, Inc.
13) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
14) Bill Greenwood, City Manager for the Town of Eagar
15) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
16) Todd Schulke, Forest Programs Director for the Center of Biological Diversity

***Working Group members not present at meeting*:**
1) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
2) Chuck Peone, Fort Apache Timber Co.
3) Paul DeClay, Tribal Forester, Forestry Department, White Mountains Apache Tribe

***Meeting observers:***
1) Jessica Covey, FEC
2) Bob Baltes, BDA
3) Mary Beth Prior, BDA
4) Carol Boyd, Stewardship Staff Officer, Coconino National Forest
5) Paul Ferris, City Planner for City of Winslow
6) Tammy Mazzetti, Grant Forest Products

After introductions, Romero outlined the logistics of the meeting. She stated that it is her role to help move the conversation forward during this public process.

**Steering Committee Presentations**

**Steve Gatewood:** *Inception of This Process*

Gatewood spoke of how this collaborative process began and focused on the central question of what forest restoration projects generate in terms of wood supply. Gatewood repeatedly stressed that such a partnership calls for community-based forest restoration and utilization. He asked the Working Group to consider how to generate information that seeks to determine the available supply. He posed several additional questions for consideration, such as the following: What is the available supply? How much is available for utilization? What if the need exceeds the supply of these restoration projects? How will large users affect small users? Before coming to a resolution in this process, these issues need to be considered.

According to Gatewood, another major issue to consider during this process is the long-term product supply, of which he begged the following questions: What happens to growth, and how much of that growth can we rely on in the future? If we are successful at restoring fire-adapted ecosystems, how does that change future wood volumes? In conclusion, this group needs seek out ways of estimating the long-term supply.

In order to come closer to restoring Arizona's forests, this wood supply analysis must move forward so that industries have the information they need to determine supply.

**Todd Schulke:**

Schulke spoke on the need for a landscape-scale approach to the restoration or Arizona's forests. His two major questions for the group centered on the need for forest restoration efforts to pair successfully with economic development: what are the high priority areas in Arizona in terms of risk, and how will we pay for such work? It is time to merge these ideas of ecological restoration with economics, Schulke said, because paying for such restorative efforts will be critical.

Schulke says that he is confident in a landscape-scale approach to forest restoration. The success of such an approach has already been documented (Signal Peak Assessment Project) which uses LANDFIRE data, further convincing Schulke that such an approach to forest restoration is important.

Schulke also expressed confidence in the collaborative process adopted by this Working Group. The key for making such a collaborative process run smoothly is to find a zone of agreement between the members' diverse goals and interests. In conclusion, Schulke was excited about such a community-based approach to forest restoration that economizes on an economically sound approach to Arizona's ecological needs.

**Diane Vosick:**

Vosick spoke on obstacles that the Working Group may encounter when trying to develop a feasible restoration plan. The pace and scale of the group's work is not commensurable to the problem, she said, and therefore a better zone of agreement is

needed. She said that Arizona's economy would not survive unless we restore forest health.

Speaking on the economic side of the issue, Vosick stressed that people are a part of the landscape; so much of rural Arizona depends on tourism, water and other environmental services. Coming to a consensus on a restoration plan that runs concurrent with these economic values will be of the utmost importance during this collaborative process. Vosick hopes that this process, along with the Statewide Strategy, will provide lots of momentum for changing Arizona environmental policies. It will be important in the next 6 months, Vosick asserted, to seek out a solution that the entire group agrees is a good solution.

**Elaine Zieroth:**

Zieroth spoke on the tool of stewardship contracting, which may be an outcome of this process. She provided the group with background information on Stewardship contracting, noting that such contracts are based on authority passed by Congress; the Forest Service and the Bureau of land Management engage in long-term contracts where goods can be traded for services. In sum, under such contracts wood fiber can be traded for work needed on forests (thinning, restoration, etc.). If the wood has more value, the industries can pay for the restoration activities themselves. She added that the value of products alone might now be enough to generate work in some areas, which makes such pairing of restoration with economic development so important.

Zieroth posed several questions for the group to consider in regards to stewardship contracting: What treatment do our forests need? What is left in the forest, and what is the economic value of that? Is entering into a 10-year contract enough to stimulate the industry, or should we be thinking more long-term?

She commented on the success of stewardship contracts, citing the Vincent Fire as an example. This fire recently burned into units thinned under such contracts and went right to the ground; groups were able to put out the fire almost immediately. In addition to fire risks, Zieroth listed drought and climate change as other factors to consider when determining zones for contracting. Markets for smaller material, such as the products of the Apache-Sitgreaves Forest, need to be developed. To do this, we need to pick up the pace, she said, and look for both large industries and community-based industries for support.

**Rob Davis:**

Davis encouraged the group to consider ways to better utilize forest restoration products. Wood that remains on the ground after such restorative efforts (i.e. thinning) should not be considered waste, Davis argues, but a valuable resource. The value and cost of such a supply needs to be recognized.

There is a need, Davis said, to find people and industries that can pay for such efforts. After seeking out larger consumers to work under larger contracts, money can be put into smaller industries. Davis said that if they can't find industries to pay for restoration

products, then that restoration is not going to happen. While working with this group, Davis feels that the following questions will be necessary to answer if this process is to move forward: What is an appropriate landscape size for such efforts? What can be done in those prescribed areas? What is the available supply? What industries fit our resources economically and volume-wise? What projects will work for the long-term? Only when these economical questions can be answered will there be hope for Arizona's forests, Davis says. We are looking for a policy, Davis says of the group's mission, and if the community and state want to move forward on this then that is the reliability of the supply

Romero summarized questions and ideas remarked upon thus far in presentations: addressing community needs, seeking out an appropriate industry, estimating available supply, and accounting for needs of wildlife. She encouraged the group to untangle this complexity – to think about where members can find a zone of agreement.

**Wood Supply Analysis Goals and Objectives – Presentation by Gilbert Zepeda:** Zepeda (Director of Forestry, Forest Health, Cooperative Forestry, and International Forestry, Southwestern Region, USDA Forest Service) began his discussion by remarking on what he considered to be the central priority of forest restoration discussions: to restore functionality of fire-adapted forests. We must ground ourselves in that goal, he said, by seeking support across districts and forests.

Much of Zepeda's presentation focused on the efforts of forest restoration projects as they affect WUIs (Wildland Urban Interfaces). Until we are able to reduce the risk of uncharacteristic fires in communities, we're never going to be able to let fire run its natural course across the landscape in an effective way, he said. One possible solution is to perform strategically placed thinning treatments in these areas. With Zepeda citing the original estimate of WUIs at 2 million acres, he stresses the need to assess risk factors in those areas first and foremost. Treatments of WUIs are expensive, however, usually necessitating mechanical treatment. Funding for such efforts is therefore a key question.

The challenge lies between the need to restore 17 million acres of unhealthy forests in Arizona and the costs which would be associated with such a plan, Zepeda said. According to cited figures, to treat WUIs and non-WUIs would cost an estimated 1.5 billion dollars; Zepeda remarked that in no way would we be able to make such a dent without considering creative alternatives.

In an effort to reduce those costs, Zepeda encouraged the Working Group to consider private investment in excess biomass, noting, however, that such investment should be seen not as the end-all goal, but as a by-product of restoration efforts. The goal is to restore fire-adapted ecosystems – not to benefit industries, not economic development. This goal must be achieved at a faster rate and in a larger way.

Zepeda stated that he admires such a collaborative effort between diverse stakeholders and spatial scientists. This broader approach to forest restoration has always been missing

in previous studies and figures, and Zepeda stated that unless there's a collaborative effort in coming up with the necessary gross and net amounts of woody material, this could end up being just another study. All critical players that have a stake in Northern Arizona must have a voice in what comes out of this. In terms of agency capacity, Zepeda mentioned that those supporting restorative efforts for Arizona forests have lost a lot of institutional capacity in the last couple of years; the restoration needs exceed what such groups are capable of working on. If this group comes to a conceptual agreement of what large-scale restoration looks like while considering the support of biomass in a sustainable way, then there will be less of a need to run mechanical treatments. If such solutions are reached in this study, Zepeda believes that support can be garnered at the national level to build institutional capacity for facilitating such efforts.

While fire risk poses one of the largest threats to forest health, Zepeda urged the group to also consider such risk factors as drought and climate change. What are the long term consequences of these elements to forests? Unless we build resiliency in the system to the threat posed by fire, climate change will only exacerbate the current negative state of forest health.

Zepeda remarked that while Stewardship contracting is not an end-all, it is obviously a part of an overall restoration priority. Such contracts can be a tool we can use when appropriate, offering assurances to industries and communities. Zepeda concluded by asking the group to think about the high priority areas throughout this collaborative process. Focusing on key risk areas will lend more structure to restorative investments. When groups fail to look at high priority areas, then they are not employing a landscape-scale approach to the problem of forest health.

**Q**: Are you looking at applying stewardship contracts in different ways? Setting up a regional stewardship contracting program?

**A**: This is a business plan the Forest Service considers a central priority, Zepeda said. Do we invest in a lot of small contracts? One large one? On a regional scale? He is looking at it in multiple scales and is concerned that by going with one huge contract, the smaller guy would be aced out. Depending on local needs and type of utilization that's taking place, Zepeda said, there is a need for an array of industries. Zepeda also noted that the Working Group's activities do not satisfy the public process requirements that are initiated when a stewardship contract is officially considered by the Forest Service.

**Q**: Are the results of this process being institutionalized in any way?

**A**: Zepeda said that the issue of institutionalization is an ongoing discussion. When the initial proposal came forward, that was a concern. This study will hopefully be a springboard for looking at that zone of agreement across larger audiences. He stated that the Forest Service has no preconceived notions of what would come out of this study, nor is the Forest Service planning to use this information to analyze proposals from any one particular industrial user. At the beginning, the Forest Service questioned whether or not they should be involved in the Working Group dialogue. Zepeda wishes this process to be

a community-based approach without any preconceived notions coming from the Forest Service. Without a zone of agreement and a broad idea of what the available supply is, he doesn't think we can make the gains that we wish to make as a community at-large.

**Tom Sisk:** *The importance of a landscape-scale perspective in forest treatment planning and a review of previous collaborative landscape assessments in the analysis area (PowerPoint Presentation)*

Before beginning the PowerPoint presentation, Sisk wanted to make his role as a member of ForestERA clear to the Working Group. He stated that his aims are to help this process and to clarify three key elements of this group's aim: the idea of landscape, the collaborative process, and the scientific tools that can be utilized for reaching a consensus on risk areas and supply.

ForestERA uses a landscape-based approach to forest restoration analysis and planning, and in the following PowerPoint presentation (which can be downloaded from the ForestERA site), Sisk wishes to outline the benefits of such an approach. His portion of the presentation delved into how spatial analysis can determine priority areas, how such an analysis can be crafted to benefit the work of the Working Group, and what role Forest ERA can play in providing such an analysis.

*Note: Power Point slides from this presentation are available at the Wood Supply Analysis Documents web page at:*
http://www.forestera.nau.edu/docs/June04_07_Wood_Supply_Kick-off_Mtn_TDS.pdf

The first few slides defined what it means to approach forest restoration at a landscape scale. Sisk stressed that all analysis and planning should be conducted at scales that capture the key process that shape our forests, and there is therefore a need to conduct the planning and analysis on a larger scale. Such a large scale is able to assess such important determining factors as fire, wildlife habitat, and the utilization of supply. He noted that this group is taking the first swing at this utilization issue, emphasizing the fact that utilization needs to be a piece of the restorative process.

Fire, Sisk noted, is obviously a factor that determines what the landscape is. We just can't determine the precise size of the landscape at risk, Sisk said, but we must instead think of it as dynamic.

**Q**: For some people it is difficult to grasp what you mean when you say "landscape-scale." It is difficult to communicate that with people because people want something to hold onto specifically.

**A**: Tom responded to this question by saying that one cannot distill "landscape" into a specific acreage. As a public speaker on this issue, Sisk acknowledged that he must work to try to communicate to the public what, exactly, this means. He insisted, though, that the group must not get away from thinking about this process at a landscape-scale.

An issue for this group, Romero noted, will be how to distill this term and relay it to a broader audience. We must learn to give them enough information so that they may better understand this group's goals.

Sisk responded by saying that since this group is operating in a collaborative way, the goal for understanding what is meant by "landscape-scale" will be to give people the space to define this notion in their own terms.

When presenting the slide titled "Science-Based Public Process," Sisk emphasized the need to identify and prioritize landscape features in critical need of attention. He discussed examples of tools that ForestERA has been developing and noted that in addition to the available science, people play a key role in assessing regions of high risk. Not every place on the landscape has the same risk, Sisk noted, and by involving people in scientific assessments, we can get an idea of where the risk is the highest.

The greatest risk to forest health, Sisk said, is unnatural wildfire, but he also mentioned other notable risks for consideration: insect outbreaks and erosion-prone watersheds. ForestERA has been working on developing ways to rank landscapes according to vulnerability to these factors, in addition to the risk of fire.

Once risk has been assessed using GIS assessment tools, ForestERA can identify treatments on a map as well. Landscape constraints are taken into account, allowing for the determination of appropriate restorative treatments. Sisk says this type of spatial approach to forest restoration collapses traditional one-size fits all approaches, paving the way for healthier forests.

The GIS tools ForestERA has at their disposal can also predict possible effects/outcomes of treatments. Maps are available that show how a specific treatment would change the fire hazard or to reveal how different wildlife habitats could be improved or affected. On the flip-side, there is currently no data to reveal how treatments would affect small-diameter wood supply.

In conclusion, Sisk encouraged the group to feel confident about such a landscape-scale approach to restorative efforts. Even though the Working Group is comprised of stakeholders with different desires, he said, their goals merge in regards to forest restoration projects. Such goals reveal the "sweet spot" where restoration meets economic development.

Q: I thought the objective was not to develop a proposal, but to develop techniques and analysis. Is this the basis of a proposal? A plan to get this amount of wood?

A: Sisk answered by saying that it's not up to him to answer that question due to his technical role in the project. His role is to support the working group. There is no decision mandate. Sisk did say, however, that he hopes that this process will form a foundation for those decisions, but he did not comment further since he sees his role as more of a facilitator than a decision-maker.

**Haydee Hampton**: *Description of Wood Supply Analysis objectives, methods, analysis area and time line (PowerPoint Presentation)*

Hampton followed Sisk in discussing the scientific basis needed for such restorative efforts. She began by discussing the Wood Supply Analysis goals and objectives included in ForestERA's contract with Region 3, emphasizing the necessity to build agreement on the type and location of forest restoration treatments and estimate the wood supply following collaboratively developed treatment scenarios.

*Note: Power Point slides from this presentation are available from the Wood Supply Analysis Documents web page at:*
http://www.forestera.nau.edu/docs/June04_2007_WoodSupplyAnalysis_HH_GS.pdf

She also explained that ForestERA will be developing a prediction of the actual area and intensity of treatments versus the area and intensity planned. These factors often differ due to site-specific information not considered in coarser-level planning processes.

Hampton reviewed a map of the Wood Supply Analysis area, emphasizing that the reason we can move forward so quickly in this project (only a 7-month timeline) is that ForestERA has conducted landscape assessments of most of the ponderosa-pine dominated regions in the analysis area. ForestERA has already collected data for and supported two major collaborative processes in the White Mountains and Western Mogollon Plateau. The darker green areas on the basal area map, she noted, denote the presence of ponderosa pine and are the focus of the analysis.

On the slide titled "Build Agreement on the Type and Location," Hampton outlined the logistics involved in such a collaborative process. Hampton explained that the Working Group will meet a total of 6-8 times in Northern Arizona and that the public is always encouraged to attend. Announcements for meetings were sent to about 250 stakeholders. In choosing a location for this meeting, the Wood Supply Steering Committee recommended Holbrook as a good central location located conveniently on an interstate highway. Hampton asked the Working Group for input on locations of future meetings. Some members responded that it was a good central location. Other members thought that meetings should take place in various locations inside analysis area, including Flagstaff and Show Low, so that a greater number of stakeholders could observe.

Hampton then outlined a meeting timetable and explained methods for mapping wood volume layers. ForestERA will be using imputation methods, which link multiple vegetation layers and plot data to common descriptors of vegetation states. Uncertainty estimates will also be provided. Layers used in previous assessments and that will be soon available for the Wood Supply Analysis area from Region 3 include dominant vegetation and cover type, forest canopy cover, and mean tree diameter class.

Hampton then posed the question of which diameter-size ranges would be the most important for the analysis. Is it enough to have 2 DBH classes? Or is it 4 or nothing? She noted there is tradeoff as accuracy will decline as more classes are added, so it's important to assess which classes are most useful and necessary. A member of the Working Group noted the four potential classes shown on Hampton's slide (<5in, 5-9 in, 9-16 in., >16 in. DBH) were fairly standard. Others commented that a 12 in. cutoff, in place of or in addition to a 16 in. break, would also be of interest.

Sisk then responded by saying that ForestERA is breaking new ground in identifying these classes because it is a difficult task to map size-class information. He stated that it is their goal to come up with the best layers for these forests, and this was their first chance to get an initial reaction from the group.

Hampton then delved into how ForestERA develops their vegetation inventory for mapping basal area and other forest structure metrics. She stated that their inventory is based on a stratified random sample and will target under-represented vegetation states in new acquisition. ForestERA is compiling ground plot data from other sources, such as Forest Inventory Analysis (FIA) and Forest Service spatial data, for use in this Analysis and reviewing spatial data from LANDFIRE, Southwest ReGAP, and Region 3 Forest Service.

For more information on the Wood Supply Analysis, Hampton suggested visiting the ForestERA Wood Supply web pages: www.forestera.nau.edu/project_woodsupply.htm. The web pages contain a project summary, meeting information, a list of Working Group members, project updates, a link to a map server and information on how to participate.

**Gary Snider:**

Gary Snider concluded the presentation (slides 21-23) by discussing existing wood utilizers, framing the issue in terms of supply and demand (for small diameter wood). The demand side of the equation must be considered, Snider noted, meaning we must take wood harvesters, processors, and users into account. Snider will be gathering information on current levels of wood used and existing contracts, as well as capacity, from those on the demand side to include in a database.

Snider mentioned that Arizona forests are currently experiencing a lot of growth, but the question is how much and for how long? Growth affects buying estimates, and in an attempt to begin dissecting these issues for better understanding, Snider said he would put together an annotated bibliography of methods and assumptions, and then make recommendations on best methods. Finally, in order to assess the impact of fine-scaled changes to treatments when they are actually carried out versus planned, he will be reviewing past studies on this issue and interviewing two ID teams from different regions of the study areas.

**Gilbert Zepeda:**

Following lunch, Zepeda took the floor to share his thoughts about the collaborative process and to clarify for the group how the Forest Service would respond to such dialogue. This study, he remarked, is a result of an unsolicited proposal which can be a source of information to us as we evaluate proposals from wood utilizers. He explained to the Working Group that the Forest Service was not currently soliciting recommendations for restoration plans, so it is a delicate balance as to how this group should engage in this dialogue.

Zepeda asked the group to consider what would be an appropriate means and venue to bring forward recommendations once they reached a consensus. Since the Forest Service funded this study, he stressed that it is important for the group to consider the following question throughout the process: identify what restoration means and what the by-product of those efforts would be in terms of amounts. He further went on to say that the Forest Service will use the information generated from this study as a source of information born from the most contemporary science we have available which is set in a framework that represents a zone of agreement.

**Q**: Do you see us as making recommendations?

**A**: This group is not being paid to do a study, Zepeda answered. The information that results in this process will be a tool for the Forest Service to consider, but since the Working Group was not paid by the Forest Service to conduct such a study, FS is not obliged to implement the group's recommendations.

**Q**: Would getting something in writing help if we wish to later solicit the Forest Service to consider our recommendations? Could a letter or notes from meeting, etc. save time?

**A**: Sure, Zepeda answered. We could work on drafting a letter with Harv's consent.

**Setting the Scene**

**Shaula Hedwall**:

Hedwall, representative from the Fish and Wildlife Service, talked on the issue of wildlife considerations for a regional wood supply analysis. Along with Sarah Lantz from Arizona Game and Fish, she presented a Power Point presentation (which can be viewed on the Wood Supply Analysis documents web page) which delved into how wildlife considerations should be taken into account in this analysis. Her main question was this: how can we incorporate wildlife issues into these treatment plans?

The outline of Hedwall and Lantz's presentation is as follows: USFWS and AGFD Missions, laws and guidance, wildlife/forest treatment goals, and wildlife considerations for forest treatments. Hedwall and Lantz noted that the missions of their respective agencies are quite similar: to provide leadership for sustaining fish and wildlife across the board, not just endangered species.

Hedwall outlined several applicable laws and guidelines that both organizations use as a means of protecting wildlife, including the Endangered Species Act, the Bald and Golden Eagle Protections Act, and the Migratory Bird Treaty Act. Both Hedwall and Lantz stated that while there is no Forest Practices Act in the state of Arizona, both agencies still highly recommend the conservation of species' habitats.

Hedwall concluded her segment of the presentation by saying that FWS works hard to maintain, enhance, and restore habitats. They take a very comprehensive look at the habitat for multiple species' needs in these areas. She feels that the Working Group can fulfill both the supply goals and these FWS goals in creative ways. She encourages the group to consider the effects of widespread analysis and treatment on multiple habitats.

**Sarah Lantz**:

Lantz continued the PowerPoint presentation by encouraging the Working Group to take a multi-species approach to the question of forest restoration during this process. She proposes a mosaic approach when this group begins implementing treatments. According to Lantz, a mosaic approach would simulate a pattern that most closely resembles the diversity of habitats and wildlife needs.

Regarding the placement of treatments, Lantz listed several key habitat areas where treatments should not take place when considering the needs of wildlife: riparian corridors, canyon rims, steep slopes, north-facing slopes, seeps, springs, tanks, known movement corridors, and known nest sites.

Lantz asked the Working Group to think about what they considered to be the definition of WUIs. Such definitions mean a lot for wildlife as many species live and thrive in such areas. Restoration projects must take that into account before implementing treatment plans in those areas. While Lantz and Hedwall agree that strategic placement of treatments in WUIs is important for this group, they stress that the group must also consider wildlife habitats on equal grounds with other factors such as restoration, economics, and small diameter wood supply.

**Q**: How do you envision bringing your perspectives into this process?

**A**: Lantz responded by promoting a mosaic approach to restoration where different treatments would be implemented next to each other. Implementing treatments at different times and assessing species' responses to restoration treatments are other ways that wildlife considerations could be taken into account. Hedwall added that treatments should be modified to account for wildlife habitat.

Participants engaged in the ongoing dialogue by saying that there are two obvious places where the concerns of these wildlife agencies can enter the process. What places in the landscapes could be designed for wildlife? Can we design new types of treatments to fit wildlife needs? Lantz emphasized that she does not want the group to consider wildlife as a constraint to treatments but as a part of what the picture has to look like. Hedwall

remarked that the group should also consider how wildlife will be affected by specific treatments. Participants also remarked that there are prescriptions that can be placed in the WUI that provide for the needs of both wildlife habitats and healthy forest stand structure.

**Jim Probst**:

Probst (Hydrologist, Apache-Sitgreaves National Forest) encouraged the group to consider the effects of restoration and treatment efforts on soils and watersheds. In terms of watersheds, he addressed two main concerns: high erosion hazards on steep slopes that account for 33% of the project area, and matters of soil sensitivity when determining where to implement treatments.

Probst's advice for large-scale treatment implementation is to avoid restorative efforts during the wet harvest and to consider the impact of roads, landings and skid trails on the landscape, especially near watershed areas.

In conclusion, Probst hopes the Working Group will consider distance from private land, slope gradation, water proximity, and erosion hazards when assessing areas where treatments may be necessary.

**Data needs for developing treatment scenarios:** Tom Sisk began by discussing the timeline involved in gathering necessary data for reaching a consensus regarding wood supply and restoration needs. Previous analyses have looked at this entire area, he noted, which makes it possible for ForestERA to merge data into products that will be useful for this Working Group. He reminds the group that they are not starting from scratch in terms of research. A goal for the group, he said, will be to prioritize layers of spatial data. Layers available for analysis include basal area, stand density, canopy cover, and wildlife habitat.

His second slide outlined how wildlife habitat can focus efforts. A landscape-level analysis can result in strategizing how species-specific information can be utilized to focus restoration efforts. Sisk cited spatial research regarding the spotted owl and goshawks, illustrating how the Working Group could develop treatment scenarios to minimize the effect of treatments on wildlife.

**Haydee Hampton:** Hampton stressed that many GIS layers are available for this project, and data is already available for the Working Group to consider. Using spatial data made available to the group in the work book, Hampton reviewed several layers for this region of focus.

Some members of the group were concerned with the presentation of such data of which they have no technical expertise. They remarked that due to their lack of knowledge in the arena of spatial data, they were hesitant to participate in that aspect of the conversation. Sisk reassured the group that the presentation of this data is merely to inform them of what's available and that the goal of ForestERA is to get the group to the level where they can understand such data.

Hampton ended her presentation by informing the group that their spatial data will soon be available online due to a grant received by NAU's Geospatial Research and Information Laboratory (GRAIL). ForestERA will provide groups with various layers as they are created throughout the period of the meetings.

**Wrap-Up Discussion (facilitated by Romero):**
One group member found the phrase "type and location" to be too vague in the goal: "Build agreement on the type and location of forest restoration treatments". He went on to say that if the group cannot agree upon the operable acreage, then they were never going to find the total potential as a resource. On this point, another participant stated that treatments are linked to acreage – the approach ForestERA is proposing seems to include both the treatment approach and a number of acreage approach – from a methodology perspective he didn't see any disconnect between ForestERA's proposal and those who want a specific acreage amount.

Several members of the Working Group stated that it would be helpful to add more detail to the goal: "Build agreement on the type and location of forest restoration treatments." One participant reminded the group that the central priority is to restore fire adapted ecosystems, and that any estimate of wood supply available for industry use should be based on restoration by-products. She suggested the following steps as part of an iterative process to reach this goal:

1. Identify acres available and appropriate for restoration
2. Identify the restoration goals for those acres
3. Prioritize and assign treatments by size and location to reach the restoration goals
4. Estimate the volume of supply of those acres given these treatments.

Consensus would need to be reached at each step in this process.

The observation was made that these steps were the same as what ForestERA presented. Another participant suggested a similar plan:

1. Identify specific areas that are available and appropriate for restoration
2. Build agreement on forest restoration types for various locations
3. Develop a spatial layer that captures this information.

One participant recommended that we should only consider mechanical treatment in this study. Another countered that we need to consider what happens to areas without mechanical treatments as these will either have Wildland Fire Use or prescribed burning and that this information will be important in placing treatments strategically at the landscape scale.

One participant proposed working through multiple scenarios instead of attempting to arrive at just one scenario that the Forest Service would then have to work with. Some members of the Working Group felt uncomfortable with taking out the phrase "building agreement." One scenario has much more weight than multiple scenarios, they stated, and the group should not begin watering down that goal before even entering the process. Another member stated that the group needs to examine multiple scenarios – not a one-size-fits-all recipe, but a way of assessing problem areas and problem solutions. Sisk responded by saying that arriving at a consensus is the most powerful way to build agreement. The goal of the group is to try to find the sweet spot

upon which they can build agreement. Another Working Group member stated that this is a process, not a restoration plan. Ultimately the need of this group is to develop a map of at-risk places and general treatment plans for those places. "Treatment" was defined as an action that would happen in a specific place. "Treatment Scenario" was defined as consisting of multiple treatments of various types across an analysis area.

A member of the Working Group suggested that the group adopt a filter which would assess how much acreage is available for treatment. There is a need to narrow it down to something more practical, she said, because treatment types are tools. Another group member agreed that acreage and treatment need to go together. He suggested that the group go through each area and progress accordingly with each layer to determine availability. A member of the group expressed concern with such a desire for specificity of acreage and supply. Stakeholders who want certainty want it for political or economic reasons, he said. They want to go to their investors with those figures.

One member of the group stated that this analysis is already tied to a specific purpose, linked to a commissioned study – concerned with an issue of process – fulfill purpose of the study first and foremost – should be acknowledgement, we're only looking at step 1. People from industry need to know right away so they can go out and start working with this supply information. ForestERA staff emphasized that they must deliver an estimate of wood supply under one or more scenarios – hard for us to give estimation on supply without a scenario – we aren't trying to say how much should be taken out, but it involves the goal of restoring the forests – the supply is a by-product of the restoration. Another participant stressed that the focus should be on mechanized treatments, however another reasoned that all types of treatments should be considered. Another participant asked what's going to happen to the acres that aren't treated? Recognizing the reality that fire will play out one way or another will influence treatments.

**Public Comments**
A stakeholder observing the meeting encouraged the group to be more specific in regards to the goals and objectives. There need to be specific ways to tackle those goals and objectives.

**Meeting Locations:** Haydee Hampton noted that half the group was closer to Flagstaff while most of the remaining participants were in the White Mountains regions. The group thought the Holbrook location worked well, but hoped that other meetings could be held in Flagstaff and other parts of project area, perhaps Show Low. ForestERA will work on organizing the location in order to accommodate as many people as possible; keeping in mind that the Holbrook location will not be available for the next meeting. The dates of the meetings were organized as follows with locations TBD:

- Wednesday, July 18
- Friday, August 17
- Monday, September 17
- Tuesday, October 9
- Monday, October 15
- Monday, October 29
- Friday, November 16

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**July 18, 2007, Arizona Game and Fish Department, Pinetop, AZ**
**9:00 a.m. – 4:00 p.m.**

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|---|---|
| 9:00 – 9:15 a.m. | **Welcome** – *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:15 – 9:30 a.m. | **Agenda Review –** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 9:45 a.m. | **Group Decision-Making Process –** *Rosemary Romero* |
| | **Treatment Scenario Development** |
| 9:45 – 10:30 a.m. | Review: 1) stakeholder questions and comments submitted after June 4 Working Group meeting, 2) how other collaborative groups have built scenarios in previous landscape assessments 3) Working Group suggestions on building treatment scenarios **–** *Haydee Hampton*<br><br>Treatment characterizations and strategically placed treatments**–** *Brett Dickson* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | Suggested ways to account for treatment-related guidelines and regulations relevant to siting treatments at the landscape scale<br><br>▪ Guidelines regarding wildlife and wildland urban interface (WUI) **–** *Brett Dickson* (Assistant Research Professor, NAU)<br>▪ Guidelines regarding streams, soils, access, and mechanized equipment **–** *Haydee Hampton* |
| 12:00 – 1:00 p.m. | Lunch |

1:00 – 2:30 p.m. Factors important to identifying areas appropriate for restoration for the Wood Supply Analysis

- Vegetation types, Wilderness Areas and other primary factors *Jill Rundall* (Senior Research Specialist, NAU)
- Working Group brainstorming session to develop a list of on additional factors to consider in identifying areas appropriate for restoration **–** *facilitated by Rosemary Romero*
- Discussion of available spatial data representing priority factors **–** *Brett, Jill, Haydee and Working Group members*

2:30 – 2:45 p.m. Break

2:45 – 3:30 p.m. Optional Working Group Session (if time allows)

- Brainstorming session on restoration objectives for areas available and appropriate for restoration **–** *facilitated by Rosemary Romero*
- Discussion of ways to address restoration objectives in the Working Group's treatment scenario **–** *all*

3:30 – 3:45 p.m. **Updates on Wood Estimation Analyses**

- Wood utilizer database, ponderosa pine growth models, and actual acres/volume following planned treatments **–** *Gary Snider* (Forest Economist and Doctoral Candidate, School of Forestry, Northern Arizona University)
- Wood volume layer by tree-diameter class **–** *Haydee Hampton*

Logistics for next meeting

3:45 – 4:00 p.m. **Public Comment Period**

4:00 p.m. Adjourn

**Meeting Summary**
**Wood Supply Working Group Meeting #2**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**
**July 18, 2007, AZ Game and Fish Dept., Pinetop Regional Office, Pinetop, Arizona**

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## Introduction and Agenda Review

**Rosemary Romero:** *Welcome*
Romero (Meeting Facilitator) welcomed back the working group members and observers to the second of eight scheduled meetings (2 meetings may be cancelled if sufficient progress is made). She made several brief announcements concerning the meeting and had the working group and audience members introduce themselves.

***Working Group members present at meeting (in order of presentation)*:**
1) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy
2) Shaula Hedwall, representative of the U.S. Fish and Wildlife Service, Ecological Services
3) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
4) Molly Pitts, advocate for Northern Arizona Wood Products Association
5) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forests
6) Lisa McNeilly, Director of the Northern Arizona Program for The Nature Conservancy
7) Bill Greenwood, City Manager for the Town of Eagar
8) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest Restoration Products, Inc.
9) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
10) Jerry Drury, Timber Staff Officer for Kaibab National Forest
11) Herb Hopper, Advocate for Little Colorado Plateau Resource Conservation & Development
12) Diane Vosick, Associate Director of the Ecological Restoration Institute
13) Todd Schulke, Forest Programs Director for the Center of Biological Diversity
14) Chuck Peone, Fort Apache Timber Co.
15) Keith Pajkos, Timber Staff for the Arizona State Lands Department Forestry Division
16) Mary Stuever, Forestry Department, White Mountain Apache Tribe (alternate for Paul DeClay, Tribal Forester)

***Working Group members not present at meeting*:**
1) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
2) Steve Gatewood, Director of the Greater Flagstaff Forests Partnership
3) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization (ECO)/Economic Environmental Counties Organization (EECO)
4) Kim Newbauer, Representative of Coconino National Forest
5) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust

***Meeting observers:***
1) Penny Pew, Representative for Congressman Renzi
2) Bob Baltes, BDA
3) Greg Morion, USDA - FS
4) Scott Lockhard, USDA - FS
5) Stacey Hamburg, Sierra Club
6) Ed Martin, SFP
7) Sue Sitko, TNC
8) Dwayne Walker, Future Forest

Romero then turned the floor over to Haydee Hampton (Research Associate, Center for Environmental Sciences and Education at Northern Arizona University (NAU)), the Forest Ecosystem Restoration Analysis (ForestERA) Project Manager leading this collaborative effort.

**Haydee Hampton**: W*ood Supply Team Introductions and Agenda*
Hampton began by introducing new members of ForestERA's Project Team since the last Working Group meeting: Tony Becker, Scribe (PhD student in Linguistics at NAU) and Steve Sesnie, Remote Sensing Specialist (Post-doctoral Research Associate). Sesnie will begin attending Working Group meetings in August.

Hampton provided an overview of the agenda and briefly discussed the highlights for the day's meeting, including three points related to treatment scenario development. Furthermore, Hampton included an overview of the scheduled individual presentations about different treatment scenarios conducted in the past. She encouraged working group members to thoughtfully consider the treatment options presented and provide contributions to the treatment scenarios. Once the agenda was covered, "clickers" were distributed to working group members and Hampton provided a brief PowerPoint presentation to inform members on how to use the clickers, as well as a description of their function. Hampton explained that, if agreed upon, the clickers would be used by the working group to gauge agreement on decisions requiring consensus. The clicker technology will primarily be utilized for group members to indicate their level of agreement on certain issues covered throughout future meetings.

**Rosemary Romero:** *Group Decision-Making Process*
Romero reviewed a slide ("What leaders can do") that covered some characteristics of leadership and she explained how she envisioned the session would proceed. She encouraged participation from working group members, and explained that the use of clickers would enable rather quiet individuals to participate along-side those who are outspoken. Romero continued by explaining that the clickers were "an anonymous tool to gauge the level of agreement", and should prove effective to promote additional discussion.

In terms of the proposed group decision-making process, Romero commented that the ForestERA group is bringing data and analyses to inform group members, and she encouraged group members to propose ideas and add to the discussion until agreement is reached. She also encouraged group members to work towards an understanding on the issues related to treatment options, rather than simply stating disagreement. She explained that there is never 100 percent

agreement, but she hoped that this process would promote bargaining and eventually lead to language resulting in agreement among working group members.

Afterwards, several statements were presented to the working group members via PowerPoint presentation, in which they were asked to use the clickers to vote. Statement #1 – "The wood supply working group should use the consensus-based decision process described." The results were that five working group members strongly agreed, while five others agreed. At this point, one group member interjected and asked about formatting the voting process – "Can we have time to discuss the matters before we go straight to using the clickers?" Romero responded that this was a baseline question, used to familiarize group members with the technology and voting format. She and Hampton added that dialogue could either follow or precede the actual voting, so that people could express their concerns.

Then, statement #2 was presented – "The wood supply working group should use an online discussion forum." The results were not compiled via the clicker program, but instead were discussed as a group. A discussion of the online forum revealed that some members were opposed to the online forum, since they preferred small or large group discussions compared to the online forum. Another member was concerned that not everyone could participate online because of various reasons, such as time availability and access issues. Another member commented that the online system did not reflect the *fish bowl* process of discussion because it promotes debates that are not in the public forum. He felt that it was rather isolated.

Romero informed the group that the email discussions could work, especially to facilitate small group work. Large group discussions should be reserved for face-to-face meetings, where ideas could be more effectively discussed. The group came to an agreement that informal email discussions, and not a more organized on-line discussion forum, would be maintained as a tool for sharing ideas, but the majority of larger issues would be reserved for large-group meetings.

Lastly, statement #3 was presented – "The June 4th meeting summary is an adequate record of the meeting." The results were that most members strongly agreed or agreed, but several members did not vote, since they had not read the summary. At that time, Romero explained the nature of the summary as "a neutral document that enables people to recall what happened, as well as to reflect on the matters discussed." Afterwards, members voted on the "clicker" technology and it was unanimously approved for future use in facilitating decisions.

**Treatment Scenario Development –**

*Review - Presentation by Haydee Hampton*

First, Hampton briefly outlined the information covered from the last meeting, related to layer analysis, wildlife issues, treatment scenarios, spatial data, and guidelines. Then, she provided a working group meeting timetable for members: 6/4, 7/18, 8/17 meetings would be used for developing a draft of the treatment scenario(s) to be included in the 9/7 progress report; 9/17 would reflect the revised treatment scenario(s) and a discussion of the results of the forest growth review; 10/15 would include the finalized treatment scenario(s), a review of wood volume layer,

treatment definitions, and information regarding the wood user database; 11/16 would include a discussion of the wood supply results and the potential economic impact; 12/1 will focus on the final deliverables of the proposal.

Hampton then segued into the PowerPoint presentation about the treatment scenario development. She began by discussing the "Western Mogollon Plateau and White Mountains Landscape Assessments" – supported by NAU, covering approximately two million acres each. She encouraged members to evaluate the Work Book contents with information about the treatment scenarios developed during these landscape assessments. Furthermore, Hampton asked working group members, "Did you attend the Western Mogollon Plateau adaptive landscape assessment or the White Mountains landscape assessment?" Ten group members indicated that they did attend the meeting, while one group member responded that they did not.

Hampton then provided a slide of a wood supply analysis map that provided boundaries of the assessment for the current study. She also provided information about previous landscape assessments – (about 50 stakeholders attended the landscape assessment workshops in Pinetop and Flagstaff); Hampton discussed the conceptual approach for landscape prioritization and provided another map that showed the prioritized areas in need of management attention. She described how previous researchers identified and prioritized the landscape values and risks, as well as the spatial layers represented in the research (they applied weighting factors according to priority level). Hampton indicated that the spatial layers that receive priority ranks were considered, in terms of how they are identified, weighted and overlaid to construct a composite map.

Next, Hampton covered the findings from the research of the highest priority values and risks from the previous assessments in the analysis areas. She clarified that "values" included human communities and infrastructure, water features, biodiversity, and key forest indicator species, while "risks" included fire hazard and behavior, fire risk, post-fire erosion and sedimentation potential, and tree density. She provided three spatial layer maps that revealed the priority layer development process; there were three maps included to demonstrate how this process was done in the past. The development process was explained as a three-fold process:

- Define management objectives (e.g., reduce the risk of uncharacteristic wildfire)
- Select areas in need of management (e.g., areas predicted to experience crown fires in dry years)
- Recommend management action for those areas (e.g., plan intermediate intensity thinning followed by prescribed burning in areas predicted to possibly crown)

Following this, Hampton presented several examples of objectives from previous assessments in the analysis areas:

- Protect communities and important infrastructure
- Maintain water quality in municipal watersheds
- Protect and enhance habitat for endangered species and minimize treatment impacts
- Restore grasslands

- Protect and maintain the biological integrity of riparian and aquatic habitats
- Increase the quality and extent of special habitats, such as aspen stands and pine-oak woodlands.

In addition, a spatial layer of the management objectives for crown fire and interest in minimizing fire plus a thinning map were combined to equal treatment areas across the landscape. Hampton added that the team could take the high priority areas and move forward with them. At that point, she asked the working group members how they could use the previous assessments for the wood supply analysis. Working group members were encouraged to choose either, "Not use them at all", "Consider, select, and build on relevant components from previous scenarios", or "Use prioritization and/or management action layers from previous assessments". One comment from a working group member was to wait to use these previous assessments until data were collected for the current project. Two other members added that considering, selecting, and building on relevant components from previous scenarios would be relevant and useful for the future interests and progress of this group.

Then, Hampton encouraged a discussion into ways to evaluate potential sustainability over certain time periods while considering the following:

- Identify acres available and appropriate for restoration (e.g., thinning and prescribed fire treatments)
- Identify the restoration objectives for those acres
- Build agreement on the size and location of treatments necessary to reach the restoration objectives
- Estimate the volume of supply following recommended thinning treatments.

One group member emphasized the need to look at "what's off the table" in terms of acreage available. Another group member commented that he was not familiar with the prioritization process, adding that it may or may not be useful for issues the group is discussing. He thought this process could facilitate some decisions made about topics – "We need to start from scratch and move forward and see how the assessments unfold." In addition, a group member commented that, "other factors need to be considered in the decisions made about which areas to include or exclude."

Hampton continued her segment by acknowledging that three tribal representatives are on the wood supply working group. She mentioned that in discussions with these representatives she learned that the White Mountain Apache Tribe might consider providing reservation-wide wood volume figures to the wood supply analysis if prompted. At that point, one group member indicated that he doesn't usually deal with the small diameter class and thinning programs, as his logging company usually deals with larger diameter classes. Therefore, he felt he could not comment very much on this topic.

Hampton went on to indicate that she spoke with Susan Johnson of Region 2 Forest Service and found our from a working group member that there was a tribal land resolution that would allow Johnson to conduct her study (funded by the Ford Foundation) on their lands.

However, Hampton inquired about the wood supply analysis being conducted on tribal lands too; evidently, the tribes were not necessarily interested at this time.

*Treatment Characterizations and Strategically Placed Treatments – Presentation by Brett Dickson*

Brett opened his presentation with coverage of the treatment characterizations (Ponderosa Pine-dominated strands). He explained that he was going to cover the various treatment alternatives and how they are developed and quantified. The treatment alternatives included 1) high-density thin (i.e., light burn); 2) intermediate intensity thin + light burn; 3) low-intensity thin + light burn; 4) heavy burn only; and 5) light burn only. He indicated that all the treatments were further explained in Tab 9 of the workbook.

Next, Dickson discussed the tools that were utilized in building a management action scenario, which covers the treatment alternatives of the landscape. He also reviewed the treatment effects on forest structure, to include before basal-area treatment and after basal-area treatment. He presented spatial data on the treatment effects on fire hazard (before) and heavy burn (after). Lastly, he included another option, within the FlamMap fire behavior program (in cooperation with USFS RMRS Missoula Fire Lab). This option included key LANDFIRE-derived input maps for:

- Crown bulk density
- Crown base height
- Canopy cover
- Canopy height
- Elevation
- Slope
- Aspect
- Fuel model (includes 21 different models)

Dickson also provided several additional slides, which included information about the predicted heat output if a fire occurred (fire hazard), crown fire behavior (when a fire transitions from a ground fire to passive to active crown fire), and the Treatment Optimization Model (TOM). He explained that TOM is a FlamMap-implemented algorithm used to optimize the placement of treatment units that limit and interrupt the movement of large fires, given user defined ignition points. He followed this with data related to current fuel conditions and potential fuel conditions after treatment. He explained that the data from the TOM model identifies major fire travel routes and their intersection with user-identified areas for treatment.

Dickson reviewed a “straw man” process that the group might use to develop their treatment scenario, using FlamMap’s TOM. This process consisted of several steps:

- Develop layer of priority areas across analysis area
- Develop layer showing potential treatments
- Run TOM to select optimal areas (e.g., 10 or 20% of total area) for treatment
- Use prioritization process to provide preferred sequencing within TOM areas

Q: How can you convert percent reduction in forest structure metrics to actual values such as a basal area goal?
A: Dickson responded that other programs are available to convert these values, but they were not used for the purposes of this study.
Q: Is there information about what we end up with (target objectives) instead of the percent reduction values?
A: Dickson indicated that the literature was constrained and therefore the best metric was percent reduction instead of looking at target objectives.
Q: How is the use of the FlamMap model with and without TOM related?
A: Dickson explained that TOM is an alternative to using the fire hazard and behavior FlamMap outputs and he just wanted to make it apparent to the members; TOM is geared to minimizing fire spread.
Q: Is there a program that would allow members to look at what the existing conditions are and what they desire for that acre?
A: Dickson indicated that it wouldn't be a difficult exercise, as long as the parameters are explicit.
At that time, one member indicated that she agreed that it is a challenge to think about percent reductions in stem density, basal area and other metrics, but instead would rather consider the desired conditions – easier to consider for foresters. Dickson added that he has 10-12 relevant citations that he can point people towards.
Romero presented an idea to provide a list of citations that will be available for group members, either on the website or in a handout.
Q: Is this going to be an effective tool for us to look at areas from the SW?
A: Dickson alluded to the fact that there is existing data that dates back to the 1970's that includes tribal information, for fuel characteristics and fire structure – federal data exists about fire risk too.

Dickson continued the presentation by relating the information provided at the June 4 Wood Supply Working Group meeting by Sarah Lantz and Shaula Hedwall and in some follow up meetings indicating that there are certain areas where not to target treatments that he has worked on modeling spatially:

- Canyon rims
- Steep slopes
- Seeps and springs
- Known nest sites

He reviewed how canyon features were discriminated using a method that entails partitioning the landscape into the following elements: canyon bottoms, ridgelines, and areas of gentle and steep slopes. He showed a map dividing the analysis area into locations with <40% slope and >40% slope; the members of the wildlife small group indicated that steep slopes are associated with greater diversity of wildlife and are thus relevant to the current research. One group member commented that steep areas should not be excluded, but included as potential future sources of small diameter wood. Another group member commented that very rarely do treatments occur in areas with over 40% slopes.

Dickson also included a map outlining the springs and seeps in the area of focus, as well as database results of raptor nest locations throughout the area. He explained that the wildlife team was working with people to acquire more data on the nest locations – "it is an ongoing process".

*Guidelines Regarding Wildlife and Wildland Urban Interface (WUI) – Presentation by Brett Dickson*

Dickson indicated that they would like to form a small group to help come up with ideas to quantify information on WUI areas. At that time, the team did not have complete information about the CWPP priority areas (e.g., Williams and Blue Ridge); Dickson suggested that further discussion about this issue needed to come from the working group members. He went on further to say that the two WUI definitions could be used to form a complete WUI layer across the analysis area: CWPP priority areas and where CWPP have not been completed 0.5 and 1.5 mile buffers around private lands, but that requires more consideration too. A map of the USFS R3 15-year WUI areas was also presented.

Tom Sisk told members that the team wasn't sure how these models fit into the wood supply analysis quite yet, but he acknowledged that this is where the working group fits in – to help find ways in which this information can be used. One working group member then noted that the group needs to discuss "what is acceptable/not acceptable" for treatment, and to find ways to address this. Dickson then told members that he can use the data to provide applicable findings to inform the group about making decisions, although he made it clear that he was not trying to trump the group member's decision-making process. Rather, the support team wanted to respond to what was indicated last meeting and make sure they could find ways to incorporate as much as possible into the wood supply analysis. Another working group member indicated concern that the same things should not be done in every situation.

*Guidelines Regarding Streams, Soils, Access, and Mechanized Equipment – Presentation by Haydee Hampton*

Here, Hampton wanted to focus on a discussion of the treatment guidelines for soils and steep areas. More specifically, she highlighted two major points provided by ASNF staff:

- Avoid treatments on highly erodible soils (datile and cinder soils in this area)
- Mechanical treatment on slopes >40% requires specialized equipment – for example a TIMCO can go up to 60% slope.

A working group member explained that the cost and lack of availability of the specialized equipment restricts mechanical treatments' use in steep slopes. Another member added that the economics determine what treatment options are available and are used.

Next, Hampton commented on streamside management zones (Tab 9 in the workbook) delineated by ASNF staff to protect stream water quality. She explained that ASNF recommend avoiding mechanical treatment within "filter strips" 75 to 300 feet of certain streams depending on several factors. Hampton showed GIS layers that could be used to define variable width streamside management zones according to slopes and stream types, and the presence of native

fish species in the area. She is working on obtaining information from other Forests and jurisdictions. The State lands working group member indicated they used guidelines provided by the Coconino and Kaibab NFs.

Hampton moved on to describing the access options available to treatment areas, but relayed that working group members have indicated that roads are widespread, but it is their condition that can limit access. Also, she explained that the BioSum roads layer was built from Forest Service roads (core and CFF) and ALRIS TIGER street files. One working group member noted that areas where there aren't any roads should also be considered in the analyses. Another member added that the reservations have considered the 40% slope, but the costs are not feasible to include this factor. Finally, another group member commented that the working group should maintain whether the issue is economic or environmental – these issues/considerations should be kept separate from each other, and if it's an economic issue, it needs to be dealt with differently.

*Vegetation Types, Wilderness Areas and Other Primary Factors – Presentation by Jill Rundall*

Rundall wanted to address the study area (5.5 million acres), including the four relevant forests and two Native American areas as well.

Q: Why was the Young area (Pleasant Valley Ranger District, Tonto NF) not included in the ponderosa pines area?
A: Hampton answered that there wasn't really an effort to exclude it -- the ad-hoc committee didn't recommend it be included in the study.
At that time, a working group member commented that it was likely just an oversight. Another member commented that the Clifton district could likely be excluded because it didn't garner a large ponderosa pine inclusion. Hampton suggested that the Clifton District will be essentially removed as this process in focused mainly on ponderosa pine.

Rundall continued with her presentation by examining the different vegetation types in the analysis area. Rundall showed a layer of the dominant vegetation. She stated that there was approximately 2.2 million acres of ponderosa pine dominated areas found in the designated research area. Other group members considered removing Special Designated Areas (e.g., primitive areas, Wilderness areas, and Inventoried Roadless Areas), but Rundall explained that these areas would likely fall under the category of not being able to be treated mechanically. Furthermore, she added that if Specially Designated Areas were removed from the group's treatment scenario that 1.87 million acres of ponderosa area remained of the initial 2.2 acres. A series of map layers illustrated the ponderosa pine areas remaining after these various considerations were removed.

Rundall then explained that she is collecting many different types of information, including planned and historical treatment types and treatment dates, for use by the group to determine if another treatment is/was needed. She explained that the treatment layer for the ASNF was not up to date at that moment, and as a result contains 2001-2004 data for its most current information. She is in the process of requesting more recent data from the Forests and other jurisdictions in the analysis area. Other layers available to the group for use in their scenario include estimates of burn severity, which is related to vegetation death, following a particular fire. She also explained

that the USDA provides insect and drought related tree mortality estimates throughout the area; these layers may help to narrow down the available areas to which we can apply treatment. Rundall encouraged members to provide any additional GIS information that would help with this process, and she noted that there are still many layers that the team is in the process of acquiring information (e.g., fuel treatments/Stewardship contracts; tree mortality 2006+, ADEQ impaired waters from A-S; Coconino, Kaibab, Tonto, and others). Two group members commented that Flagstaff City and the AZ state government could provide a fair amount of this information. Randall included that she was researching a system in which she could avoid pursuing 2 different sources and could instead find one combined source for this information.

Rundall also indicated that she is in the process of acquiring information concerning wildland fire use (WFU), fire history, riparian areas, stand exam, and roads. At this point, she has only received information from the Coconino NF for WFU. Also, Rundall tried to get information from the Forests concerning streams and relevant to northern goshawk/Mexican spotted owl and other raptor nest locations; N. Goshawk PFA's/MSO PACs; Wildlife corridors; CWPP (Williams, Blue Ridge, ACWPP, and SCWPP). Hampton made it known to the group that the current information indicated those layers that the team is in the process of acquiring, but they do have lots of other layers already available.

Q: What is your estimate of how many acres of ponderosa pine would be left after all the layers you presented are included in the treatment scenario?
A: Rundall explained that she couldn't guess because it would depend on how each layer would be used in the group's scenario.
Q: How much might the group decide?
A: Sisk explained that it's pretty hard to guess on such a matter. He added that the answer might be to decide which areas the group is less willing to treat. He reiterated that the information about those layers hasn't been acquired by the team just yet.
Two group members informed the others that there has been very little treatment in Tonto, Coconino, and Kaibab NFs. They explained that there is likely to be very little change. Romero suggested that group members contact Rundall in the future to help located up-to-date information and to uncover the "gaps" in the acquisition process.

*Brainstorming Session – Facilitated by Rosemary Romero*

At that time, Romero opened the floor to the group members to provide information that would pertain to Rundall's presentation. Hampton suggested Working Group members look for information about layers available to them in the White Mountains Landscape Assessment data atlas available in the workbook as 80 to 90 percent of the layers we've discussed are in that document.

Romero suggested a bulleted list of additional factors to consider for the analysis:

- Mining claims – has no bearing on this analysis
- Grazing leases – has no bearing on this analysis
- Existing contracted timber sales
- Stewardship contracts
- Culturally significant sites

- Private wells/tanks
- Municipal watersheds

The group members decided that the mining claims and grazing leases have no bearing on the analysis, while Hampton also added that the team already had some data available on the municipal watersheds.

A group member then asked about the steps that are needed to go through to get all of these things accomplished. This group member acknowledged that the spatial data was comprehensive, but felt that a road map on how to proceed needed to be reached by consensus. The group member commented that they didn't feel that the group knew where it was going. Romero clarified that the actual approach "road map" was not yet decided. She reiterated that the team provided the data and located the gaps, and it was the responsibility of the working group to decide which approaches to follow. Hampton added that the team had data from what other groups had done and one possibility was to follow what other groups had done or NOT do what those groups did. Similarly, another group member commented that the group needed to prioritize these areas and come up with categories that will help the group to decide the treatments and the products that the treatments will generate. At that time, both Hampton and Romero suggested going through the layers and thinking about which layers can be eliminated or kept.

Q: Should we eliminate Wilderness Areas from the group's treatment scenario?
Group discussion: One group member felt that Wilderness areas did need restoration, but that the group didn't need to go there first. Instead, the member suggested a two-tier approach for prioritization. Another group member indicated that they disagreed with a 1-2-3 prioritization approach, and the group should try another approach instead.
Q: What do we mean about treatment (mechanical or something else)?
Group discussion: One group member responded to this question by commenting that the group needed to think about the treatment in relation to the wood supply production, since that was the whole basis for the working group formation. Another group member agreed that the objective of the group is a wood supply analysis. This member added that the group should focus on the wood that could potentially produce a product. A third group member expressed their agreement on this issue and added that the objective is to figure out the tons of wood that can come out of these areas. This member added that the group needed to focus on these areas of treatment that will help production, and that a discussion about treating areas with steep slopes using cables was off the table and a non-starter for the conservation community.

Q: Is there something that the team has that suggests to us that those areas are good candidates for mechanical treatment because they're overstocked?
A: Dickson responded by claiming that the tree density layer could be included in the decision process. He concluded that the ForestERA team could assist with its use.
Q: How do we determine which areas are best treated with prescribed fire? Can we identify these areas where burning is going to be most effective?
A: Tom Sisk answered these questions by explaining that there are two different approaches:

1) identify the areas that are off the table and the areas that are suitable for mechanical treatment, and 2) identify those areas where mechanical treatment is possible, but determine which treatment type is most suitable.

One group member expressed their concern about the accessibility issues. They felt that it was difficult to accomplish the road mapping, but they also felt that it was a key point in determining what is possible. Two group members indicated their desire to discuss what restoration means to the group and what the group's objectives are.
Q: What are we considering "roads"?
A: To this, one group member concluded that road building is a flash point, since temporary roads are being added all the time. This group member expressed their interest in developing some agreed-upon road network, and that experts can be consulted about the road mapping.
Q: How much wood do we have? How much underbrush will be thinned out and how much will replace itself?"
This same group member explained that their organization spends about 40,000/month on roads, and there were problems when working with the Forest Service.
Q: What is the potential availability for forest growth/replacement in the model? Can the model do that? Hampton responded that Gary Snider is researching forest growth assumptions as part of this analysis.

At that time, Romero transitioned to the brainstorming session on restoration objectives for areas available and appropriate for restoration. Romero proposed the idea of having a small group discussion concerning road mapping. To this idea, one group member expressed their opposition to small groups, because they felt that format didn't necessarily mean that group members would come to an agreement as a large group. This group member also expressed that there was a dichotomy with what was mapped and the wooded area in the White Mountain Apache Reservation, because it is part of the regional supply and should be actively engaged in the supply line. In response to this, Hampton turned the discussion over to a representative from a local tribe group. This representative commented that the tribe has some desires to keep their data confidential, but would consider working with the team, if they felt their data could be protected; they just need a clearer idea and then they can take that proposal to the tribal council and see if it can get approval.

The issue of agreement about defining "restoration" was left for the next meeting, since two working group members, who were proponents of defining it, had to leave early.

*Wood Estimation Analyses – Presentation by Gary Snider*

Snider (Forest Economist and Doctoral Candidate, School of Forestry, NAU) explained that he has provided several resources for group members, including a handout for the current session and some additional materials in the workbook. Included in the materials are sources from Dwayne Walker, which includes how much material will be taken and where it will be delivered. Snider reiterated that he will provide a comprehensive list of what is being extracted, where it's going, who is receiving what, and so on. Snider also indicated that he would include information

related to growth rates. These materials will be sent out to group members at some point. His handout provided information about the primary, secondary, and tertiary wood producers within the realm of the present study.

*Wood Volume Layer by Tree-diameter Class – Presentation by Haydee Hampton*

Hampton provided information that focused on wood volume layer development, which may incorporate imputation methods that link multiple vegetation layers and plot data to common "vegetative states" (e.g., similar to R1 vegetation mapping project (VMP) methods). This is only one of several methodologies ForestERA is considering. She highlighted the spatial and plot data updates that had been made since the June 4th meeting. The data included a US Forest Service Region 3 image segmentation layer with several attributes including canopy cover and dominant tree size. She explained that there are several additional steps that need to take place:

- Combining and arranging plot information in one database, planning additional plot data acquisition, and testing various diameter class breaks
- The selection of diameter classes will be a combination of what is possible given available data and what is of interest to the working group and the stakeholders
- Stakeholders have expressed interest in the following classes: (<5 or 6 inches DBH, 5-9, 9-12 or 9-16, >12 or >16, 16-24).

Hampton said that they are aiming to get sufficient accuracy for three, possibly four classes, but again this has not been decided. She emphasized that it is not possible to provide detailed information for all class breaks.

Romero and the support team then took a few minutes to develop language with the working group defining a "Road Map" for use in developing treatment scenario(s):

- Identify areas appropriate for restoration treatments that recover wood byproducts (i.e., "What's on the map?")
- Define management objectives (i.e., "target conditions")
- Selection of appropriate treatments.
- Prioritization? (No definitive answer on how to address this emerged.)

In addition:

- Calculate supply produced by applying the appropriate treatments across the map.
- Once forest growth recommendations are available, discuss as group how to use them in this study.

The group and team members also asked if there were any volunteers from the Working Group to serve on small topic groups, which would bring straw man ideas to the larger group for consideration:

- Small group formation (ForestERA is looking for volunteers)
  - Wildlife – Brett (so far includes Shaula and Sarah)
  - WUI information– Brett (Steve Gatewood was recommended to be in this group)

- Roads – Haydee (other members TBD)
  1) What road layers are out there?
  2) What are they used for?
  3) What are the appropriate methods for restoration?

*Comments from Observing Public*

- Ruling out areas because there are no roads on the Forest Service's roads GIS layer would be wrong as this may or may not mean there are existing roads. Leave all ponderosa areas in the analysis, I guarantee there will be roads there, unless it's really steep, regardless of whether there are current roads there or not.
- Include existing NEPA and treatment plans that have been made. Include the collaborative efforts over the last 10 years of the Greater Flagstaff Forest Partnership for the 180,000 acres surrounding Flagstaff
- The cleanest way to deal with roads is not to exclude any areas due to road access; assume an appropriate method will be found to access any area.
- In one area there are tens of thousands of wood piles sitting in the forest today. What are you going to do with it? If you burn it, it will create smoke and global warming issues.

**Note:** The next meeting is in Flagstaff, Friday, August 17th. Directions to the facility will be provided. Draft meeting summaries will be sent out to Working Group members and members will be given two weeks instead of one to provide comments at the request of one working group member.

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**August 17, 2007**
**9:00 a.m. – 4:15 p.m.**
**Applied Research and Development (AR&D) Building**
**Northern Arizona University, Flagstaff, AZ**

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|---|---|
| 9:00 – 9:15 a.m. | Welcome – *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:15 – 9:30 a.m. | Review meeting agenda and "road map" developed by Working Group at July 18 Wood Supply meeting **–** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 10:30 a.m. | **ACTION ITEM 1: Select areas appropriate for restoration treatments**<br><br>Working Group decision-making session to identify areas appropriate for restoration treatments that recover wood byproducts **–** ForestERA technical support by *Jill Rundall* (Senior Research Specialist, Environmental Sciences, NAU), *Brett Dickson* (Assistant Research Professor, Environmental Sciences, NAU), *Steve Sesnie* (Postdoctoral Research Associate, Environmental Sciences, NAU) *and Haydee Hampton* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | Select areas appropriate for restoration treatments (cont.) |
| 12:00 – 1:00 p.m. | Lunch<br><br>*** Optional Applied Research & Development building tour 12:40 – 1:00 p.m., *Richard Baron*, AR&D Building Manager) *** |
| 1:00 – 2:30 p.m. | **Restoration options**<br><br>Presentation on recommendations for restoring ponderosa pine forests from the Statewide Strategy for Restoring Arizona's Forests and other sources **–** *Tom Sisk* (Professor, Environmental Sciences, NAU)<br><br>Facilitated discussion on fuel and restoration treatments of interest to Wood Supply Working Group **–** *Rosemary Romero* |

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|---|---|
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:45 p.m. | **ACTION ITEM 2: Select treatments based on management objectives**<br><br>Brainstorming session on the selection of treatments of interest to Working Group **–** *facilitated by Rosemary Romero*<br><br>Optional additional information: Map-based treatments recommended by collaborative groups in the Western Mogollon Plateau Adaptive Landscape Assessment (WMPALA) and the White Mountains Landscape Assessment (WMLA) **–** *ForestERA staff* |
| 3:45 – 4:00 p.m. | Updates on available spatial data and wood estimation analyses and logistics for next meeting |
| 4:00 – 4:15 p.m. | Public comment period |
| 4:15 p.m. | Adjourn |

**Meeting Summary**
**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**
**August 17, 2007, Applied Research and Development (AR&D) Building**
**Northern Arizona University, Flagstaff, AZ**

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## Introduction and Agenda Review

**Rosemary Romero**: *Welcome*
Romero (Meeting Facilitator) welcomed back the working group members and observers to the third group meeting. She opened the meeting with reading the letter from Harv Forsgren, Forest Supervisor for the Southwestern Region of the US Forest Service, which was distributed to participants at the July 18, 2007, Working Group meeting in Pinetop and is posted on Documents page of Wood Supply Analysis web site: http://www.forestera.nau.edu/project_woodsupply.htm ) concerning how the Southwestern Region would use the results from this study. Afterwards, she asked everyone present to give brief introductions.

***Working Group members present at meeting (in order of presentation)*:**
1) Keith Pajkos, Timber Staff for the Arizona State Lands Department Forestry Division
2) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy
3) Molly Pitts, Executive Director of the Northern Arizona Wood Products Association
4) Herb Hopper, Community-based forest and wood products Advocate, Little Colorado Plateau Resource Conservation & Development
5) Steve Gatewood, Consultant, Wildwood Consulting Inc., representing the Greater Flagstaff Forests Partnership
6) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
7) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
8) Bill Greenwood, City Manager for the Town of Eagar
9) Bob Taylor, Supervisory Natural Resource Specialist for the Apache-Sitgreaves National Forest
10) Jerry Drury, Timber Staff Officer for the Kaibab National Forest
11) Kim Newbauer, Timber Sales Contracting Officer for Coconino National Forest
12) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest RestorationProducts, Inc.
13) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
14) Lisa McNeilly, Northern Arizona Program Director of The Nature Conservancy
15) Diane Vosick, Associate Director of the Ecological Restoration Institute (Wally Covington, Director of the ERI and NAU Forestry Department Regents' Professor filled in for Diane part way through meeting).
16) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization (ECO)/Economic Environmental Counties Organization (EECO)
17) Todd Schulke, Forest Programs Director for the Center of Biological Diversity
18) Shaula Hedwall, Ecological Services, U.S. Fish and Wildlife Service

***Working Group members not present at meeting*:**
1) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
2) Chuck Peone, Fort Apache Timber Co.
3) Paul DeClay, Tribal Forester, Forestry Department, White Mountains Apache Tribe
4) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forest (alternate present: Bob Taylor)

***Meeting observers:***
1) Wally Covington, Ecological Restoration Institute
2) Sue Sitko, The Nature Conservancy
3) McKinley-Ben Miller, BLM-AZ
4) Rich VanDemark, Southwest Forestry
5) Michael Smith, SW Forestry
6) Chelsea Lett, Congressional Liaison, Congressman Renzi
7) Stacey Hamburg, Sierra Club

Romero then turned the floor over to Haydee Hampton, the Forest Ecosystem Restoration Analysis (ForestERA) Project Manager leading this collaborative effort.

**Haydee Hampton:** *Wood Supply Team Introductions and Agenda*
Hampton formally introduced Steve Sesnie, a new ForestERA Project team member who received his Ph.D. from the University of Idaho and recently worked on the LANDFIRE project. She indicated that Sesnie will be working with the group for the remainder of the current project.

Hampton then began reviewing the meeting agenda and the "road map" developed by the working group at the July 18th Wood Supply Meeting in Holbrook. She presented information concerning the "roadmap to develop the treatment scenario". Hampton informed the working group members that the ForestERA Project Team developed the slides and presentation in response to comments given by group members, as well as the results of the small group discussions. She also indicated that the group members would have the "clickers" available again to determine group agreement and promote discussion on some issues.

Hampton continued her segment by explaining the conditions of the roadmap for group members. She presented a PowerPoint slide with the main points of the roadmap:

- Identify areas appropriate for restoration treatments that can recover wood byproducts (i.e., "What's on the map")
- Define management objectives (target conditions) to guide selection of treatments
- Select appropriate treatments. Several layers that might be useful include:
    - Fire hazard
    - WUI
    - Wildlife areas

- Prioritize areas in order to define preferred treatment sequence?
- Calculate supply produced by applying the appropriate treatments across the map

Hampton mentioned to group members that the ForestERA Project Team has acquired and developed map-based information for the analysis area, but she also wanted to make it clear that the working group should not feel constrained by those maps. She felt that the maps could act as a guide for helping group members in their decision-making process, but they should not be the sole source of information. Hampton also included a timetable for the group members, in order to let them see their progress and what lies ahead for future meetings:

- *June 4* – Provide background and description of wood supply analysis and discuss treatment scenarios available, spatial data, and agency guidelines
- *July 18* – Agree on workshop decision-making process and work towards developing treatment scenario. At each meeting, review and respond to stakeholder comments/questions submitted between meetings, review layer acquisition and provide analysis updates
- *Aug 17* – Develop draft treatment scenario to include in Sept.7th progress report
- *Sept 17* – Revise treatment scenario and discuss treatment characterization and results of forest growth review. Decide on need for Oct. 9 optional meeting.
- *Oct 15* – Finalize treatment scenario, review draft of wood volume layer and wood use database. Decide on need for Oct 29 optional meeting.
- *Nov 16* – Discuss wood supply results; discuss potential economic or other follow-up analyses

Hampton then moved onto discussing the expansion of the analysis area to include the Pleasant Valley Ranger District. She wanted to get back to group members about this issue to let them know that all new data collection will include the Pleasant Valley Ranger District. To illustrate this, Rundall displayed a map on screen to show the additional area that would be included in the new analysis.
Q: Has the White Mountain Apache Tribe been included in this analysis? What is the progress? Hampton responded by saying that the tribe may provide a reservation-wide wood volume estimate. She indicated that the ForestERA Project Team was talking with tribal members and that they would find out soon if tribes were willing to provide this information. One group member commented that the group should be careful when saying “putting wood on the market” because tribes’ wood isn’t on the market at this time. It’s just potential wood supply. Another group member added that they were not sure these tribes were willing to make these decisions, but that they have a lot of wood that is ready to be put on the market. This group member thought that this information could be added to the analysis as a footnote. Romero then added that the issue is a sidebar that the group could revisit.

Hampton moved forward and presented a slide with "Steps for reaching agreement on scenario components". She reminded group members about the use of clickers to gauge agreement and indicated that there were "hard-wired" questions on the Power Point (PPT) slides, but that the group could add impromptu or "verbal" questions at any time. Hampton also showed the clicker "response report" from the July 18th Working Group meeting for group members to see their responses and to highlight the information that could be included in project reports. Hampton then reviewed the analysis area, and referred to a slide outlining various areas under consideration for the Working Group treatment scenario. She discussed the treatment guidelines for steep areas, and mentioned that mechanical treatments on slopes > 40% generally require specialized equipment and that the Forests require special approval for use of mechanized equipment in these areas. Based on conversations from the group's previous meeting, Hampton then had the group register their votes on the following issue:

- Steep areas (>40% slope) are not a source of small diameter wood supply to be considered in the working group's scenario.

Eighteen group members indicated their level of agreement using the clickers: [Strongly Agree = 9 members; Agree = 6 members; Neutral = 2 members; Disagree = 1 member; and Strongly Disagree = 0 members]. One group member commented that although the group discussed briefly that they agreed on this issue, they wanted to encourage others to discuss contentious issues, especially if some group members disagree with particular issues. Another group member added that the group was not afforded sufficient time for discussion after using the clickers on the slope issue (one member had indicated disagreement on the issue), and if this continued that issues that really mattered would not get aired. Also, they thought displaying the clicker results in project reports would not promote discussion, which is what the group needs for this process. Here, Romero commented that there would be plenty of room for discussing the harder issues.

Hampton then transitioned into presenting information concerning erodible soils. She explained that the ForestERA Project team was collecting map-based information from the soil scientists at each of the four Forests in the analysis area on soil types on which the Forests have timber harvest limitations (that is, rated as too erosion prone for mechanical treatments). She explained that the Forests had indicated that these were conservative estimates since sometimes areas will be released to harvest after inspection. The ASNF provided a rough estimate of 20% of the areas mapped as off limits due to erosion hazard may be released. Hampton explained that ForestERA had acquired data on soils with timber harvest limitations from the Apache-Sitgreaves, Kaibab and Coconino NFs, but not yet from the Tonto NF. In addition to soil types with harvest limitations, Rory Steinke, Watershed Program Manager for the Coconino and Kaibab NFs, provided the level of difficulty (fairly easy, somewhat difficult, and difficult) of mitigating impacts from mechanized treatments with best management practices (BMPs). Steinke recommends the group only consider the soil types classified as difficult to mitigate in their scenario. Hampton displayed a map of soils with harvest limitations. Q: What percent of the ponderosa pine area have erodible soils? Hampton responded that ForestERA had not done this calculation, but offered a guess of about 3%.

Q: What's the difference between highly erodible, moderately erodible, etc.? Hampton responded that the Forests did not supply information in terms of levels of erodibility, only in terms of having timber harvest limitations. However, the Kaibab and Coconino NFs had provided information on the level of difficulty of mitigating impacts from mechanized treatments with best management practices (BMPs).
Q: Where will we draw the line? What is acceptable? Another working group member responded to these questions by saying, "Only highly erodible soil is where they would consider restricting mechanical treatment."
Q: Are you mapping the highly erodible sites? Hampton explained that the soil scientists gave the ForestERA Project Team information on specific soils types where mechanical treatments would be limited. She added that one of the Coconino/Kaibab soil scientist recommended that the team consider the most difficult areas to mitigate. A map was then projected that included the somewhat difficult areas, as well as the difficult areas shown previously.
Q: Should we consider both the highly difficult and somewhat difficult soil areas, or just consider the highly difficult areas?
One group member conveyed that they would like to remove from consideration those areas that are highly difficult. Another group member explained that highly erodible soils are a concern as the soil capacity can be removed rapidly in those areas, such as in the Red Rock areas. Romero then asked the group if erodible areas should be removed from the scenario. Group members agreed that these particular areas could likely be removed but they would like more discussion. One group member expressed their agreement in learning more about this issue; they claimed that they thought it might be informative to have some sort of gradation on those areas which would be included or excluded, in order to prioritize. Hampton suggested to group members that she could obtain additional information regarding this topic for the next meeting.
Q: Will we have understanding on topics in which there are definitive wood supplies and numbers about areas that are "possible" wood supplies? Hampton responded that it was up to the group as to whether they would like to define these types of supplies in their scenario.

Hampton continued with her presentation; she presented a new slide on treatment guidelines for "streamside management zones". The guidelines included the following information:

- SMZ are delineated to protect stream water quality
- ASNF recommends avoiding mechanical treatment within "filter strips" 75 to 300 feet of certain streams depending on several factors:
  - three erosion hazard levels based on slope
  - perennial, intermittent, and ephemeral streams
  - waterways identified by ADEQ as "unique" or "impaired"
  - presence of habitat for ESA listed aquatic species or other fish species

Hampton also mentioned that Coconino National Forest recommends 66 to 99 feet off stream courses, and she informed group members that the team was still collecting information from Kaibab National Forest and Tonto National Forest on these zones.

Hampton then moved onto viewing a map with streamside management zone slope classes and ASNF stream data. A group member indicated that they would like to make sure that in the calculation of total area removed that streamside mgmt zones are not double counted with steep areas (areas with > 40% slope). This group member added that information on the incremental change for each type of removal would help the group understand the impact of removing additional areas, for example over and above the 40% slope areas already out.
Q: Are we drilling down too deeply? How can we go in and find every land feature that the Forest Service won't let us go into? How do you calculate what is to be taken out? One group member added that the accessible areas could not be determined without going into these areas on foot. Hampton explained that the ForestERA Project team's approach is threefold:

- Map steep slopes, streamside mgmt zones, and other features using available spatial data
- Estimate the reduced treatment intensity, wood volumes or areal extent within project areas due to site-specific factors by developing a list of causes and interviewing ID teams
- Adjust predicted overall wood volumes if map-based data do not sufficiently capture project level factors

In response to this, one group member felt that soil and slope answers might help to answer this question, but moderate erodible areas are still questionable. They added that if the group can answer the first two concerns, then that would help inform the answer to moderately erodible soils. Another group member expressed that they were having trouble *not* seeing numbers, and she suggested that the working group could present acres or percentage changes for each factor considered. Hampton added that the team will continue defining these areas and mapping them out.
Q: Could you bracket the streamside management zones and provide a scale? One group member indicated that operations vary inside filter strips. This member suggested that the group was really talking about a reduction of volume in these areas; they felt that the group could talk about a reduction of these areas, rather than completely wiping them off the map.
Q: How will we get from what can possibly come off to what is actually coming off? Romero indicated that there are topics like this where a small group will be used and has been suggested to help come up with ideas and come back to the working group for the final decision-making.

**Jill Rundall:** *Select areas appropriate for restoration treatments*
Rundall discussed "treatment data sources", which included three main categories:

- Individual forests, districts and their departments/divisions (fire versus timber staff)
- National fire map – point data only
- Arizona fire map – minimal polygons.

Rundall explained that, as suggested by several group members, she was getting planned and completed treatment data from the Forests and other sources. She then presented a map with point data from Arizona Firemap (azfiremap.org) and explained that this site has minimal polygon data. She indicated that she is still in the process of speaking with an Arizona Firemap representative, as they have told her that more data exists, but it is likely not much.

Rundall then moved onto discussing the completed and planned treatments terminology. She then presented a slide that defined treatment terminology:

- *Planned* – NEPA has been completed
- *Marked* – Timber sale boundaries and trees marked but no buyer
- *Under contract* – timber sale cutting units established and bid accepted; these can be multi-year and extendable.
- *Completed* – treatment accomplished and wood has been removed.

Rundall also remarked about the marked–timber sale boundaries (contains multiple cutting units) and trees marked with no buyer (also called proposed). She explained that these data are relatively new for the forest and haven't been recorded with GIS data until recently.
Q: How does the group want to work with marked treatments? One group member explained that they would put it in the planned category. Several group members agreed to include it in that category as well.
Q: What is the difference between a timber sale and treatment? A group member explained that treatment includes wood that is nine inches or less, and timber sale includes wood that was not specified who is getting the wood, but rather concerns wood that will be sold. Another group member added that marked means that it is still open for sale (sometimes put out for contracts), but was not bid on. One group member asked to re-address the issue of timber sale and restoration, as it relates to those areas in which mechanical treatment might be used in the future. Rundall explained that her analysis was comprised mostly of past treatments. She added that she was just starting to gather the timber units at this time (up to 10 years in the past), and that she was also trying to find out what happened and when. A group member responded that it is complicated because people are taking out timber, but some of the smaller diameter wood just sits on the ground and the Forest Service has to come in and just burn it because it's not in use. Another group member added that they would consider the task orders under contract too, because they have been contracted but have not been cut yet; the task orders have been assigned but not carried out.

Rundall further explained that she was receiving data from multiple data sources (capturing 10 years of data). That data includes the following:

- Fuel, timber, and stewardship contracts
- Year of treatment
- Treatment type
- Treatment intensity (thinning prescription)
- Location in digital format

Rundall also provided a slide that outlined her progress to date:

- Everyone has tried to provide some GIS data
- A-S
  - All available data acquired
  - Stewardship data never completed
  - Request to districts for current cutting unit and stewardship info
- Coconino
  - No available treatment spatial data
  - Acquired some hard copy and acreages of current cutting unit
- Kaibab
  - All available data acquired

Q: Are you treating WUI similar to a completed restoration area? Is our discussion what land should be for analysis and what should not? One group member suggested that many of these areas do not need to be prioritized within the 10-year window. Another group member thought it should go way low on the priority list. Yet another group member explained that the interests of the working group might lead back into those areas treated within 5 years. The member added that the working group needed to get to what is being considered for re-treatment and they thought the WUI areas should be included, but not as a priority because they need to be treated differently. Another group member supported the notion of placing treated areas way down the priority list. This group member pointed out that the acreage that has been treated is much less than the area that needs treatment. In response to these comments about priority lists, one group member explained that they thought priorities weren't going to be talked about; their understanding was that the working group had decided to talk about what's available for the wood supply analysis. This member explained that there is wood available that should be considered because it can be counted towards the final wood supply, and WUI is still part of the supply, but it is not high on the list. Rundall commented that some of the information on treatments which the Forests have spatially is on the stand-level, so does not capture the exact boundaries of the treatments. She added that now, they are trying to capture exactly where the treatment is happening.

At this time, the working group members and the ForestERA Project Team decided that they should discuss whether or not recently thinned areas (completed in last 5 years) should be considered a source of wood supply in the working group scenario. One group member suggested that it could be taken off depending upon how it was treated.
Q: Does ForestERA have a sense of high-intensity treatments represented in your vegetation structure data? Dickson confirmed that the team did have a sense, but noted

that it's a matter of scale. He explained that they could pull out the higher and lower intensity levels. Sesnie added that there would be temporal issues because the data had been gathered from several sources, and the team needed this kind of data to gauge whether treatments have happened after their volume measures. He acknowledged that the data is roughly five to six years old. One group member exclaimed that there was one major issue as to why areas weren't treated - the percentage of landscape that has been treated versus the land that needs it. He added that it might be pointless to include areas that have been more recently treated (as defined by the imagery) because the working group didn't have data on them. Rundall also added that she had a good idea of defining planned and timber sale, and she explained that she would need to meet with people individually to discuss conditions further.

The ForestERA Project team then presented the working group with an issue in which their agreement was needed - "Specially designated areas (e.g., Wilderness Areas) and Inventoried Roadless Areas are not a source of wood supply." Several group members spoke up in agreement with this statement. The group maintained that this should not be included in the analysis.

Next, Steve Sesnie presented information to the working group on tree mortality and disturbance factors affecting wood volume estimates. Sesnie presented aerial sketch map data of forest insect outbreaks, as well as data on drought killed trees, and fire perimeters. He mentioned that data on fire severity is also available. He explained that it was his understanding that the team had data through 5 years. One group member responded by saying that standing dead trees are still usable for up to 3 or so years. Another group member commented that their organization hasn't had to deal very much with beetle salvage, and that it's probably under fire salvage. This member added that it doesn't seem to be very controversial. However, another group member iterated that "dead does not mean non-usable." Sesnie commented that the Forest Service sketch map data do not show high levels of mortality in many ponderosa pine areas, so it's not a large factor.

Rundall then presented map layers of fire perimeters. One group member commented that their only concern was the issue of methodology, so that the group wouldn't count the overlay of what is available and what is not available. Another group member commented that the whole area within the fire perimeters was not totally burned; the partially burned areas should be considered a source of wood supply, too. A group member responded to that by saying that one aspect is utilization, and the other aspect is the lack of consensus about what is salvageable and what is burned. This person felt that the working group should have a discussion of this idea. Another group member added that there isn't salvageable wood any longer in the Rodeo-Chediski area because it has deteriorated so much that it cannot be sold.

At this time, Romero suggested that wood from burned areas would not be included, and that this would be a side bar. A group member responded to this by stating that the group should not exclude the whole red area from treatment because there are lush green areas within that area. Dickson added that the map presented shows only the perimeter around

burned areas, but that spatial data on fire severity is also available. One group member suggested that it would be useful to depict areas with different severities.

Dickson then presented the group with the next PowerPoint slide - *Is protected or restricted Mexican spotted owl habitat to be considered a source of wood supply?* He commented that ForestERA was still stitching together spatial data, mainly on owl protected activity centers (PACs), which we are waiting to receive from Region 3. We have mapped known PACs in the past for the Western Mogollon Plateau and White Mountains Landscape Assessments back (these data goes back to mid to late 90s) and we mapped interpretations of the MSO Recovery plan protected and restricted habitat, which is a challenge to do since protected habitat includes PACs, as well as a composition of landscape characteristics that include steep slopes and pine-oak vegetation. Restricted habitat is a mix of pine-oak where oak contributes about 10% of BA of mixed vegetation component. This fine-scale basal area specification makes it tough to pin down using landscape scale data.

Dickson added that they were looking at developing a map for the entire study area to isolate the restricted habitat areas. You can treat within MSO restricted and protected habitats, but it depends on the forest you're on and the stand you're in too, and depends on how many other PACs have been influenced by disturbance or treatment, so it's a project-scale question. Dickson explained that the maps were important for context on where habitat does and may occur and to think about planning appropriate treatments. One group member clarified that PAC's are occupied habitat and restricted habitat is currently unoccupied habitat that potentially needs management to move towards MSO nesting and roosting habitat. All the forests have adopted the MSO Recovery plan as part of their 1996 Forest plans, so implementation shouldn't be different among forests, although these do come up.
Q: Have treatments been carried out within the PAC's? A group member explained that PAC's have not yet been treated (well only a few) even though the MSO Recovery plan since 1995 allows treatment within 10% of the individual PAC's within a given area (except for a 100 acre nest area), so we haven't been able to make recommendations for improving the management recommendations in the Recovery Plan. Another member offered that there are regulatory minimums on intensity of treatments in terms of BA and canopy cover that we cannot go below (also for goshawks), so we should depict these to make sure our scenario considers what the Forests restrictions are in these areas. A group member responded by stating that the only way to create new habitat is if there is activity in the adjacent areas where a "landscaping" or other minimal treatment can be done. The revised Recovery Plan will not make any major changes in recommendations. It will not be out by Oct. 1 as hoped. Dickson mentioned that the MSO map for the White Mountains Landscape Assessment is available in the handbook (p. 26 of Atlas).
Q: How many total acres do the PACs cover? A group member responded to this question by stating that one PAC is equivalent to 600 acres; there were about 200 PAC's, which equals about 120,000 acres. Another group member commented that there is a lot of debate about "desired" treatment on habitats. One group member then explained that 120,000 acres would not be removed in addition to what the group has already decided to remove, because steep slopes cover some of the same area and also PAC's occur in

mixed conifer and other non-ponderosa pine areas. Several group members then supported the idea to toss out PACs for simplicity sake, and then decide how to deal with the restricted habitat in some way, because there is very little wood that will come out of PACs. The group agreed to do so in their scenario.

Dickson then moved on to discussing the updates to the WUI data. He explained the status of the spatial data, and commented that he was still waiting for information from two Community Wildfire Protection Plans and that only then would the team have a complete picture on spatial data. He also asked working group members about participating on the WUI small group. Steve Gatewood, Sarah Lantz, Shaula Hedwall, and Ethan Aumack all expressed interest in being part of the WUI work group.

Hampton continued the meeting by discussing the availability of road data for this analysis. She acknowledged that the quality of the road data was considered fairly weak. She explained that she discussed the issue of roads with Chris Bielecki, Supervisory Transportation Engineer at ASNF, and he explained that roads are "everywhere"; it's rare that roads are adequate for today's treatment equipment; roads were built narrower and had tighter turns than today's equipment can handle; treatments have been thrown out after completing NEPA due to limited access and high cost to install roads; environmental impacts of upgrading roads can be significant; current road GIS layers are not complete and are only updated on a project by project basis. Hampton relayed to the group that Bielecki recommended that the group consider using a layer based on distance from arterial roads (roads already suitable for mechanized equipment). One group member commented that the group had to really look at the current level of system roads and use that information – don't anticipate other roads. This group member explained that their organization makes these decisions based on no further use, not just whether it will have future harvest use. Hampton also reminded the group that observers from the last meeting indicated that the working group should not consider road access in the wood supply analysis because it was an economic question; if the value of the wood was sufficient, a road to access it could be built.

Q: Is there a proposal on how to handle the road issue? One group member indicated that they didn't know if there was agreement on restoration and the construction of new roads; if so, then the working group could use that information to look at existing areas for harvesting. Another group member commented that it would be nice to see a map that looks at the distance from existing system (arterial) roads. Hampton indicated to group members that the ForestERA Project Team could bring that information to the next meeting. Another group member expressed their worry about relying solely on map layers to interpret the old system, because some subject-matter expertise people have said that it was not reliable. Rundall then provided a road map of the area. A group member commented that there is going to be road work done on roads that were closed before, particularly for semi-trucks that have larger turning radii. Another group member supported this statement and added that their organization had to widen roads, too. They did not see it as an issue. One group member indicated that the working group was focusing on the 3-4% of the area where there are contentious issues, and advised them to look instead at the 90% where there isn't any contention.

Q: Are we talking about enough to justify this area that is not much of a loss? A group member expressed that the working group was not qualified to make decisions about making roads. Romero indicated that the "how" is not an issue for this group, and that they should come back to this issue at a later date, if needed. However, the group consented to reviewing a map at the next meeting of distance from arterial/service roads.

**Tom Sisk:** *Restoration and Forest Treatments*
Sisk indicated that the key issue for the working group was locating appropriate treatments across the landscape for achieving Region 3's and many others' central priority of restoring fire adapted ecosystems and protecting communities. He explained that there are inherent tradeoffs between thinning (potential to supply small diameter timber and biomass) and burning (typically does not).
Q: Is there an agreed upon consensus for determining where the prescribed fire and Wildland Fire Use are most appropriate without initial thinning? Sisk acknowledged that the group did not have consensus, and that they only had consensus on the tools available for the restoration process. He explained that a wide array of perspectives of how to go about a wide-scale restoration was available.
Q: What conditions would warrant a fire treatment? One group member suggested that the forests evolved with fire historically, and sometimes it is appropriate. They also explained that FlamMap fire behavior and other models help to outline potential fire hazards.

Rundall then presented a map with predicted crown fire behavior (including surface fire only, passive crown fire, and active crown fire; *NOTE that this layer was not displayed properly and thus appeared to underpredict crown fire behaviors*). Sisk explained that these maps should help direct the group to see areas where the group agrees on areas that need thinning or prescribed burning. He mentioned that the working group didn't need to agree on these things now, but that the group needed to make some initial cuts in practical conditions in which the group would advocate fire treatments or heavy thinning. Sisk added that the group shouldn't focus primarily on maps, and advocated that they hold off on looking at the maps. He further explained that the maps could be helpful, but they could also divert the group from the guiding principles of what needs to be done. At this time, the group and team members agreed to turn off the map display. Dickson explained that ForestERA was working closely with the USFS Missoula Fire Lab to recalibrate forest fuel data from the interagency LANDFIRE dataset. These data are inputs in the fire behavior and hazard layers derived by ForestERA using the fire modeling program FlamMap. ForestERA is continuing to improve these layers based on information provided by experts and available ground data.

Sisk iterated that the team wants the group's guidance, as to what treatments should be used in the analysis area.
Q: What about condition class? Sisk responded by stating that condition class is one of the ways the group can go. He then turned the question around to the working group – "How would you use condition class?" One group member explained that the Forest Service uses condition class for determining where to conduct treatments. Dickson indicated that condition class is used on the ground (at a project level), while condition

class data appropriate for the scale of this analysis is not currently available, although the LANDFIRE project is in the process of developing it.
Q: Is there a model that could show us areas to burn (say a Class 1 burn) that will still fall within the parameters of the Clean Air Act? Sisk responded by saying that a one-to-one correspondence between the Clean Air Act and burning thresholds is difficult because those standards are changed day-to-day, dependent upon wind speed and drought conditions. He added that it's difficult to say that the decisions the group make would lead to violations of the CAA on a given day.

At this point, Sisk reiterated that the ForestERA team needed more guidance from the group so that the team could take that information and present it back to the group.
Q: How involved do we want to be in order to meet our restoration objective? One group member suggested that the group think about where they want to get to, and then look at which treatments will get them there. Another group member suggested that the group let the team go through the process that they are accustomed to and see what it can offer. This member also added that they would like prescribed fire too, but the trend is to look at lessening the use of fire. Sisk explained that the team could talk about steps towards describing the treatments used previously. However, one group member explained that they wanted to look at the existing conditions before the group began to think of treatments. This member suggested having a map that allows the working group to look at their predictions. Sisk responded to this by stating that the team had those maps and can do it, but it might be more productive to say that in areas where there is X conditions, treatment(s) Y and Z can take place. He added that the map should come out of the conditions and the treatments, instead of the other way around.

Romero then suggested two ideas: 1) Use the fire small group to discuss things, 2) Work between meetings to develop concrete language. The working group agreed with working over the break, but did not support the small group discussion. Sisk then reviewed a slide and encouraged the group to build their own map by looking at the different treatment types used in previous landscape assessments for the purpose of mapping out what is to be done in particular places. He asked the group whether or not they could come up with conditions on a landscape where one or more treatments are appropriate? He explained that this would give the group direction, as he heard interest expressed before. He added that the second pathway is to provide a set of overlays and go through those areas in a place-by-place manner. He also encouraged the group to have some ideas to brainstorm and make progress towards specificity after the break. One group member stressed the importance of making additions to the existing criteria, but added that the group needed to think about the density on the forest floor - We could add to each criterion something like, <u>(desired treatment condition)</u> if X number of trees per acre exists. Sisk expressed interest in the idea and told group members that they needed to develop ideas similar to this.

**ACTION ITEM 2: Select treatments based on management objectives**
Hampton began by introducing a new matrix to the working group. It was a scenario worksheet (simplified from what they have used in the past) to delineate information about scenarios and the different facets involved with those scenarios (i.e., criteria layers,

management objectives, and management actions). She then asked the group "Under what conditions would high-intensity thinning treatments be appropriate?"

**Working Group member 1:** *Management objective* = Places where the area of acceptable risk is lowest and could reduce fire hazard to a particular threshold (e.g., areas close to communities); C*riteria layer* = active crown fire; M*anagement action* = high-intensity thin followed by prescribed (light) burn near communities. Feathered in intensity with distance from communities.

**Working Group member 2:** *Criteria layer* = MSO PAC's; *Management action* = use high intensity thin followed by prescribed (light) burn 1 mile upwind of PACs; *Management objective* = protect PACs from fire and high-intensity thin followed by prescribed (light) burn in wildlands.

**Working Group member 3:** *Criteria layer* = rough terrain; *Management objective* = create fire breaks; *Management action* = high-intensity followed by prescribed (light) burn upwind of rough and significant topography. ALSO, *Criteria layer* = canyons; *Management objective* = reduce rate of spread of fire between canyons; *Management action* = high-intensity thin followed by prescribed (light) burn between. ALSO, *Criteria layer* = pronghorn and other open forest species; *Management objectives* = restore habitats of open forest species; *Management action* = high-intensity thin followed by prescribed (light) burn. ALSO, *Criteria layer* = historic meadows; *Management objective* = restore meadows; *Management action* = high-intensity thin followed by prescribed (light) burn.

Q: How can we accomplish our objectives? Dickson responded by stating that the group needed to establish associated criteria to add to the management actions. Romero then asked the group, "What is the language that should go in there then?" One group member suggested that the group could add language that includes what the area could be taken down to. Another group member thought it made more sense to come to terms with the concern about percent reduction. They indicated that the working group seemed to have a lot of comments about this particular topic. This member thought that the group needed to first define their objectives, and they felt as though the group wasn't doing a good job of identifying their future objective and the desired outcomes. Several other members consented that the desired condition was the main objective for agreement.

In response, one group member felt that the group kept discussing the means, but that they weren't really considering the ends (or desired conditions). Another group member added that the group needed to clearly define the desired condition (block-by-block), but that the group also needed to determine how to move from the existing condition to the desired condition. Another group member indicated that they hadn't yet decided what they wanted their areas to look like, but that this is one of the objectives outlined in the road map. This member felt that the group needed to do that before they decided the treatment types for those areas. Several group members agreed with this view, and one group member commented that the group needed to look at the existing conditions and figure out how they could get to the desired conditions. Sisk indicated that mapping out

the desired conditions and then subtracting those conditions was considerably difficult and not realistic. He explained that the more realistic option was to move towards the desired conditions, using real people and real methods for moving towards finding treatment options and outcomes.

Q: Do you have the time and resources to run both models to see if there is a real wide difference between the initial scenario (based on %) input and the output? Sisk responded by stating that doing so was very time consuming and that it was very difficult to say that they want different basal areas in different places. He stressed that this method was not practical when considering millions of acres. Another group member suggested instead of focusing on percentage, why couldn't the group just say what they wanted the area to look like. Sisk re-iterated that it was not realistic.

The working group members expressed interest in defining treatments that would reduce fire behavior to a particular threshold. Sisk explained that the team could look at a particular area's predicted active crown fire and explore whether it would be possible, given the tools available, to define the percent reduction needed to reduce crowning. He explained that the group was talking about preserving a range, and that this was an expansive, broad vision. He felt that the group needed to work in the broad perspective, but also target what they want things to look like after the target condition.

**Logistics for next meeting**
Sisk indicated that the team would take into account what has been discussed at the meeting and they would work on developing a "stepping stone" for where the group wants to go. Q: Can you provide one screen with a baseline and another screen with a map with layers that we can overlay and start checking things off to see if we like something? Sisk assured the group that the team could do so. He explained that the baseline will be the current conditions, and that the group could click a box (e.g., MSO habitats) and see how the change looks. He added that it would provide a useful visual for the group.

Romero reminded group members that the next meeting is in Holbrook on September 17. She explained that the group would need to agree about how much they have finished, in order to determine if they would need the optional meeting on Oct. 9 (location to be determined). Romero then asked who was working in small groups. *WUI*: Keith, Steve, Sarah, Ethan, Scott, Brett, and Shaula; *Fire*: Ethan, Todd, Pascal, Steve, and Brett; *Wildlife*: Sarah and Shaula

**Public comment period**
One audience member spoke to the group about thinking in concepts, and that he had done so with his own team for a previous project. He suggested to the group that they should consider different condition classes and treatment options one-by-one and that they should work on getting themselves closer to agreement one step at a time. He explained that while working on his project, his own team started to think about the treatments they would use to get there, as well as the amount of product that could come

off the land. He stated that by looking at the maps and listening to this group today, he could say that it does work and that it is possible.

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**September 17, 2007**
**9:00 a.m. – 4:15 p.m.**
**Northland Pioneer College, Holbrook, AZ**

| | |
|---|---|
| 9:00 – 9:15 a.m. | Welcome – *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:15 – 9:30 a.m. | Review meeting agenda, timetable and various project updates **–** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 10:30 a.m. | **Identify areas appropriate for restoration treatments that recover wood byproducts**<br><br>Review Working Group's efforts to date on identifying areas appropriate for restoration treatments using additive display of map-based scenario components followed by Working Group decision-making session to identify any additional areas **–** *Jill Rundall* (Senior Research Specialist, Environmental Sciences, NAU) *and Haydee Hampton* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | **Define management objectives and select treatments**<br><br>Presentation and group discussion (30 minutes each) on Wildland-Urban Interface (WUI) and Fire small group efforts. Review Working Group draft management objectives and treatments. **–** *Brett Dickson* (Assistant Research Professor, Environmental Sciences, NAU), *Jill Rundall and Haydee Hampton* |
| 12:00 – 1:00 p.m. | Lunch<br><br>*** Lunch will be on site. Sandwich fixings available for $5 (check or cash only) or bring your own. *** |

| | |
|---|---|
| 1:00 – 1:45 p.m. | **Updates on wood estimation and other spatial data**<br><br>Presentation on methods for developing spatial data on wood volume and for predicting forest growth **–** *Steve Sesnie* (Postdoctoral Research Associate, Environmental Sciences, NAU)<br><br>Updates on spatial data collection **–** *Jill Rundall* |
| 1:45 – 2:30 p.m. | **Define management objectives and select treatments (cont.)**<br><br>Working Group decision-making session on the selection of treatments of interest to Working Group **–** *facilitated by Rosemary Romero*<br><br>Map-based treatments recommended by collaborative groups in the Western Mogollon Plateau Adaptive Landscape Assessment (WMPALA) and the White Mountains Landscape Assessment (WMLA) **–** *Haydee Hampton* |
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:45 p.m. | Define management objectives and select treatments (cont.) |
| 3:45 – 4:00 p.m. | **Updates on wood utilization database and logistics for next meeting**<br><br>Presentation on harvesters, mills and manufacturers in analysis area **–** *Gary Snider* (Forest Economist and Doctoral Candidate, School of Forestry, Northern Arizona University)<br><br>Group discussion on need for Oct. 9 meeting (location to be announced). |
| 4:00 – 4:15 p.m. | Public comment period |
| 4:15 p.m. | Adjourn |

**Meeting Summary**
**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**
**September 17, 2007, Northland Pioneer College, Painted Desert Campus**
**2251 N. Navajo Blvd., Holbrook, AZ**

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## Introduction and Agenda Review

Rosemary Romero (Meeting Facilitator) welcomed back the working group members and observers to the fourth group meeting. She opened the meeting by having working group and audience members introduce themselves.

***Working Group members present at meeting (in order of presentation)*:**
1) Bill Greenwood, City Manager for the Town of Eagar
2) Molly Pitts, Executive Director of the Northern Arizona Wood Products Association
3) Herb Hopper, Community-based forest and wood products advocate, Little Colorado Plateau Resource Conservation & Development
4) Bob Taylor, Supervisory Natural Resource Specialist for the Apache-Sitgreaves National Forest
5) Steve Gatewood, Consultant, Wildwood Consulting Inc., representing the Greater Flagstaff Forests Partnership
6) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization (ECO)/Economic Environmental Counties Organization (EECO)
7) Todd Schulke, Forest Programs Director for the Center of Biological Diversity
8) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
9) Kim Newbauer, Timber Sales Contracting Officer for Coconino National Forest
10) Wally Covington, Director of the ERI and NAU Forestry Department Regents' Professor
11) Shaula Hedwall, Ecological Services, U.S. Fish and Wildlife Service
12) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
13) Lisa McNeilly, Northern Arizona Program Director of The Nature Conservancy
14) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy

***Working Group members not present at meeting*:**
1) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
2) Chuck Peone, Fort Apache Timber Co.
3) Paul DeClay, Tribal Forester, Forestry Department, White Mountains Apache Tribe
4) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forest (alternate present: Bob Taylor)
5) Keith Pajkos, Timber Staff for the Arizona State Lands Department Forestry Division
6) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
7) Jerry Drury, Timber Staff Officer for the Kaibab National Forest
8) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest

Restoration Products, Inc.
9) Diane Vosick, Associate Director of the Ecological Restoration Institute (alternate present: Wally Covington)

***Meeting observers:***
1) Sue Sitko, The Nature Conservancy
2) Penny Pew, Office of Congressman Renzi
3) Bob Baltes, Federal Development
4) David Dorum, AZGFD
5) Ed Martin, SW Forest Products
6) Dave Brewer, ERI

Romero then turned the floor over to Haydee Hampton, the Forest Ecosystem Restoration Analysis (Forest Ecosystem Restoration Analysis; ForestERA) Project Manager leading this collaborative effort.

**Haydee Hampton:** *Wood Supply Team Introductions and Agenda*
Hampton reviewed the agenda and covered the major points that were to be covered at the meeting. She indicated to group members that she believed the portion of the scenario identifying areas appropriate for restoration treatment could be finished today, and she also told group members that there would be two presentations that were not covered the previous meeting, from ForestERA team members Jill Rundall and Steve Sesnie. She also explained that the agenda provided 2 hours for the group to define additional management objectives.

Hampton then discussed details about the remaining timetable for the working group:

**September 17:** Revise treatment scenarios and discuss treatment characterization and preliminary results of forest growth review.

Hampton informed group members that the wood user database scheduled for Oct 15 would be moved up to be discussed at this meeting by Gary Snider. She also told group members that they would need to decide whether or not they need the Oct 9 meeting.

**October 15:** Finalize treatment scenario; review draft wood volume layer and wood use database; decide on need for Oct 29 meeting.

**November 16:** Discuss wood supply results; discuss potential economic or other follow-up analyses - December 1st for final deliverables.

Hampton reported to group members that they should have received the Wood Supply Analysis Progress Report. She also indicated that the ForestERA team would like to receive comments from the working group by Thursday, September 27, 2007. She then mentioned that Region 3 Directors viewed the progress report and some had some questions and comments. Regarding the time frame of study:
- The ForestERA team is estimating current wood supply for a snapshot in time. The “ad hoc” committee which initiated this study recommended that any projections on current conditions be conducted within a 20 year time frame. She indicated that the team was presenting initial growth estimates for this period.
- A Region 3 director commented that re-entry is highly unlikely within a 20 year period.

- She also told group members that decisions about prioritizing treatments, assumption on acres treated/yr could be included in the report.

Hampton reviewed comments ForestERA had received after the last meeting regarding the use of FRCC LandFire data. Linda Wadleigh, Region 3 Fire Ecologist, who ForestERA staff had met with after the Sept. 17 working group meeting, indicated that the National Level LandFire FRCC layer was due out soon, but was not yet available and that she would not recommend using the Rapid Assessment LandFire FRCC layer that is available.

Hampton pointed out that the landscape level treatment characterizations used in this study will allow the estimation of wood supply, while detailed prescriptions will involve public interaction at a local level. She then referred the working group to the letter they had requested at the June 4 working group meeting from Harv Forsgren (Region 3 Forest Supervisor) which pointed out that results from this study would be useful for local level discussions. Hampton continued her session by explaining that no wood byproducts would result from burn only treatments, so in effect they would be excluded from the scenarios similar to the decision made about steep slopes. To this, one working group member commented that the use of heavy burn treatment will kill trees that could be use for salvage logging (and biomass as well pointed out another member), and we should explicitly state in the final report that we're not including these as available wood supply in the study.

Hampton then presented a slide about the potential number of treatment scenarios developed by the working group. She explained that it was up the working group to decide how many scenarios of which type would result from this process as it unfolded.
She explained that there were several possibilities:

- One agreed upon scenario
- More than one on which there is agreement
- More than one showing various levels of agreement
- More than one showing a mix

She then reviewed a slide about treatment prioritization and indicated that the ForestERA team needed input (about priority areas – for sequencing treatments) by the end of the October 15th meeting to have sufficient time to include this type of analysis in this study. She also mentioned that this was not a required part of the wood supply analysis. Hampton then continued her segment by discussing that there were at least two methods for prioritizing areas in need of management attention. The first was the identification of values at risk that collaborative groups had used at the previous landscape assessments in the area. She also reviewed the Treatment Optimization Modeling (TOM) that Brett Dickson presented at the July 18th working group meeting, and one straw man plan for using it to prioritize treatment locations together with values at risk:

- Develop layer showing potential treatments
- Run TOM to select optimal treatment locations (e.g., 10 or 20% of total area)
- Develop layer of priority areas across analysis area using values at risk method

- Use values at risk prioritization process to provide preferred sequencing of treatments within TOM areas

Q: How would the approved Community Wildfire Protection Plans (CWPPs) fit into this? Hampton responded that the working group could handle this in several ways. At this point, one working group member explained that her WUI small group's talk fits into the where and when, as well as the treatment types, as far as prioritizations go. Another group member commented that they thought the prioritization might change, and they didn't believe the working group should go this route. Hampton explained that the working group could set out a specific time to discuss this topic. Romero suggested that the group could possibly do that after the presentations.

Hampton continued by saying that ForestERA was working together with working group members representing the White Mountain Apache tribe to develop methods and access to data to estimate reservation-wide wood volumes. She then commented that this had been identified by the Steering committee and others as important since there were significant volumes of ponderosa pines on the Mogollon Plateau located on reservation land.

Hampton moved onto a slide about identifying areas appropriate for restoration treatments that recover wood byproducts. She then outlined those areas that had been excluded by the layers:

- Initial acreage of ponderosa pine area = 2,030,195
- MSO – acres removed = 142,089; acres remaining = 1,888,106
- MSO,SDA – acres removed = 91,293; acres remaining = 1,796,813
- MSO,SDA, Slope – acres removed = 38,142; acres remaining = 1,758,671
- MSO,SDA, Slope, Soil with limited mechanized treatments – acres removed = 45,259; acres remaining = 1,713,412

Q: When you found 16% of the study area ponderosa pine removed, did you include areas of overlap? Hampton responded that the team counted areas only once, even if more than one factor (e.g., slopes and MSO PACs) occurred in the same location.

In addition to this information, Brett Dickson acknowledged that there might be a few PAC's missing from the A-S analysis, and a working group member commented that they didn't think it would be a significant portion of the PAC's. Hampton indicated that the group could come back to this slide and went ahead to the soil issue. She presented a slide with information about soils with mechanized equipment limitations

- Completed collection of soil information from four forests in analysis area
- ForestERA team members are checking back with soil scientists before finalizing layer
- Limitations based on a number of factors, including areas:
  - with erosion hazard
  - with shallow soils
  - with high rock content
  - prone to sheet and rill erosion once ground cover gets thin
  - prone to compaction when wet (secondary factor)

At this time, she referred to Dave Brewer about the soil survey information. He explained that the terrestrial soil survey data is useful because it is quite relevant for broad-based planning. He indicated that there are several good things about the soil survey including that the data goes through a detailed review process.

Hampton responded that the ForestERA team would continue working with soil scientists and refine the draft and then get back to the working group.
Q: You'll bring that back to us for recommendation, right? Hampton answered that the ForestERA team can do that.
Q: Can't soil damage be mitigated on the areas you have mapped? Brewer answered this by stating that some damage to sensitive soils areas can be mitigated, but that only the areas that were too difficult to mitigate damage from mechanized equipment were shown on the maps. Areas that could be mitigated were not included.

Hampton then moved forward with discussing completed and contracted (sold) treatments to check in with the group on how they were planning to proceed. She included several related points in her slide:

- Applies to treatments post-dating the remote-sensing imagery used to develop forest structure maps used in this process.
- For treatments with "exact" boundary information
  - Remove areas with intermediate and high intensity thinning treatments from scenario
  - Wood byproducts are assumed not available from these areas
- Include areas with light thinning or unknown treatment intensity in scenario
  - Wood byproducts are available from these areas

Hampton also commented that for areas in which treatment intensity data and boundary data do not exist (e.g., only stand exam data exists), the ForestERA team will account for these acres by adjusting analysis area wide volume and supply estimates.

Q: As far as your imagery dating, does that vary across the board? Hampton indicated that it does, and that the imagery acquisition dates ranged from 1997 to 2004.

**Jill Rundall and Haydee Hampton:** *Identify areas appropriate for restoration treatments that recover wood byproducts.*
Rundall indicated that she met with the different forests to discuss the areas with thinning treatments. She provided estimates about these areas, but acknowledged that some of the acres may have been treated more than once:

- Kaibab (1997-2006) 19,817
- Apache-Sitgreaves (1997-2007) Pending
- Tonto (2001-2007) 10,906
- Coconino (n/a) Pending

Rundall then presented a map of the Kaibab and Tonto treatment areas that she had made from data she had collected.
Q: So that 7,000 acres that you referred to do not include other forest areas? Rundall confirmed that they did not include non-ponderosa pine areas.

Hampton then went on to discuss the treatment guidelines for streamside management zones. She indicated that the team decided against carrying out a detailed analysis for several reasons. She indicated that there is a lack of finalized data for ADEQ's "unique" or "impaired" waters and the current version identifies few streams. Also, the ESA fish data are incomplete. She also presented that the ASNF is the only forest that precludes mechanized equipment from areas next to streams. The other Forests specify BMPs to mitigate damage, but no rules that specifically restrict equipment from these areas.
Q: Would it be useful to get an estimated percentage for what would be removed? Hampton commented that the Forest Service hydrologist on the ASNF was not able to give her a guesstimate, not even a ballpark number like 1% or 5%. One group member said that they had a feeling that when you take the steep slope out, streamside management zones wouldn't add very much. Another group member suggested doing a quick analysis by buffering streams throughout the study area by 100 feet, in order to gain a better understanding. Other group members agreed with applying this buffer to develop an estimate of streamside management zones. Hampton agreed that ForestERA would develop a layer of buffered streams to present to the group at the next meeting.

Hampton then returned to the areas removed from the group's scenario. She said the overlap among the layers was about 27% (119,242 acres). The total acres (considering overlap) were equivalent to about 324,105 acres.
Q: Does the overlap include the Clifton ranger district as well? Rundall answered that it only includes ponderosa pine areas, which are not prevalent on the Clifton RD.

Hampton moved onto discussing a last slide that included information about the Woody Ridge and other forest restoration projects reviewed for acres treated within the NEPA planning area. She indicated that the team found 2/3 of the areas had been thinned. She explained that 66% of Woody Ridge had been thinned, while Jerry Drury had conducted a study on the Kaibab NF and found that about 62% of areas were thinned.

Gary Snider commented that he was talking with Drury about how they got to the number 66%. Snider then referred to Kim Newbauer, and he indicated that the numbers included the areas he could think of. Hampton iterated that the idea here is to look at the project level to compare to the landscape level analysis being done for this analysis of wood supply. She expressed that this information could be used as a benchmark and it includes archeological sites and other factors that cannot be mapped out.

One group member commented that they felt the need for a more careful look at this. They indicated that on the Gila, they end up thinning more like 30-40% of the area, and that is dramatically less than 60%. This group member added that there's a pretty strong WUI objective that could possibly have an influence, and they also felt that it's a pretty important objective to address and decide how the group will deal with it. Another group member commented that they

would be reluctant to take a number and do anything, because the group needed to do an analysis instead, and get some numbers and ranges – instead of taking that 66% across the board. Romero suggested that the group could make sure to include a list of these factors in the report, as was mentioned by someone before. At this point, a group member commented that the group should not use a gross number that is not reality on the ground; they wanted the group to be very clear as to what the reality is that is done on the project level. To this, another group member commented that the working group has been talking about 6 factors today, but that they have other factors in their notes. This member wanted to clarify that the group wasn't saying only 16% is being taken off the map.
Q: We're not finalizing it at 16%; there are other factors, right? Hampton agreed that the working group could decide to add other factors as well.

One group member expressed that one of the things the group previously talked about was getting a supply estimate and a volume estimate. This group member explained that the group needed to think about the volume that is there and what will come out and how that will affect the supply. One group member responded that they thought the working group should account for northern goshawk nests. They suggested excluding 30-50 acres around goshawk nesting sites from sources of supply. Romero found that the group was in agreement on this issue and Hampton commented that ForestERA could map these areas and include them as additional acres removed. One group member thought that this data would provide a floor for the nesting treatments. Another group member felt that the group should pull out the areas where there is not treatment. Another group member explained that although it's a small number of thousands, when considering 30 acres for each nesting site it becomes more significant.

**Define management objectives and select treatments**

Working group member, Sarah Lantz, explained that a small group met the week before to discuss the WUI and some various approaches, and she indicated that they would present some mapping exercises that the working group could use to share some ideas. The small group was trying to depict areas of highest priority for community protection to guide decision-making. Lantz indicated that each CWPP (Flagstaff, Tusayan, Williams, Mogollon Rim, Apache and Sitgreaves) had extremely variable definitions for indicating the priority areas and these did not cover the entire study area. However, the small group was able to come up with several proposed options:

1. Place ¼ mile buffers around private lands
2. Only include areas that the CWPPs identified as being high priority
3. Place a wind-vector of ½ mile downwind and 1½ miles upwind of private lands. This is related somewhat to HFRA definitions.
4. Place a wind-vector of ½ mile downwind and 1½ miles upwind of private lands within CWPP high priority areas and ¼ mile buffers around private lands outside of CWPP areas.

After consideration, the last proposal option was the most widely agreed upon. One working group member commented there were some other factors that weren't figured into the small group's analysis, such as power line corridors, etc. Lantz explained that the small group included several political, social, and scientific considerations.

Q: What was the thinking in option 4? Why expand CWPP areas by adding on the buffer zones? Lantz explained that adding the buffer zones doesn't expand it; instead it really helps to narrow it down. One group member responded that the working group needed to be careful when addressing this issue in the report. This member indicated that, "CWPPs actually redefine the WUI for their community. We are taking their priority areas and applying this buffer – we might not want to label this as WUI."
Q: What designates an area as priority in a CWPP? Lantz explained that each CWPP is different. One group member expressed their agreement with a previous comment about municipal watersheds and power lines. This person felt that the working group should be diligent to address and consider such issues at some point. Another group member mentioned that the group was defining a heavier treatment, not prioritizing the treatment. Lantz agreed and said that, "This doesn't say that this area gets heavier treatment than other ones; that's for the group to decide." To this, one group member included that the small group was showing treatment in their map that the working group decided to exclude (around the Blue River). Lantz affirmed that those areas would remain excluded in the working group's scenario.

Working group member, Steve Gatewood, then presented the "fire" small group's discussion results. Gatewood explained that the small group had talked about fire, specifically about which areas might be taken out of consideration as sources of supply because they had been potentially treated using fire only. He indicated that the small group made the suggestion that wood be utilized when possible instead of burning it in piles, and that the small group wanted to talk about fire as a tool (e.g., broadcast burning). Gatewood further explained that output from the Landfire/FlamMap models included surface, passive crown fire, and active crown fire, but that this did not account for fire spread; it only refers to the fire behavior that would occur in a pixel if that area was ignited. He commented that the small group had Brett Dickson do a 500-acre analysis where Dickson would group pixels and apply a fire behavior level to the 500-acre block. He assured members that this was not a fire spread model.

Gatewood continued his discussion by referring to the second example on the small group's worksheet. He explained that that issue was really their "straw man". Gatewood commented that using FlamMap-generated data for the study area identifies patches characterized by predicted surface fire, passive crown fire, and active crown fire; He added that the group determined surface fire–dominated patches to be "areas where prescribed burning and/or wildland fire use [WFU] are likely to be a preferred first management". Then, he explained that the group identified active crown fire–dominated patches as "areas where prescribed burning and/or WFU are unlikely to be a preferred first management approach". Lastly, Gatewood added that the group identified patches largely contained within high priority community protection zones as "areas where prescribed burning and/or WFU are unlikely to be preferred first management approach".

Q: Are you running the models assuming a 95$^{th}$ percentile weather scenario? Dickson explained that this is a work in progress, and that the ForestERA team can run the model using various weather scenarios.
Q: If you're going back into these areas and burning after mechanical treatment, why would we prioritize these areas? Gatewood responded that currently the Forest Service operates with this because fire is the cheapest option. One group member commented that the working group is

basing this decision on budget constraints and lack of industry constraints. Gatewood responded by saying that he believes a previous working group member indicated that the group should do as much burning as possible where feasible to avoid potential negative impacts of mechanical treatment. He added that there was a desire to use fire where it can be used, even if there is supply there. Another group member explained that this is the policy preference of several organizations represented by the Working Group. Another member added that these are policy preferences that are based upon assumptions, and that these aren't really documented.

Another group member indicated that they had a high level of discomfort with using FlamMap outputs to determine those areas where fire only treatments are appropriate just because they are identified as such on this map. One group member added that there is a strong opinion for an approach where fire can be used as the primary restoration tool. They felt that the perspective of using fire wherever possible is something that this group should be sure to discuss. In response, a group member explained that if this model was torn apart pixel by pixel, the group would not be able to see what happens when fire is the first option and mechanical treatment could be used too.
Q: Has there been any effort to work with the individual forests to see if they would agree that these models are dependable? Dickson explained that LandFire is holding a meeting in Albuquerque, in which experts on the ground would look at the same models the team was using here and they would decide if they agree with the models. One group member felt that the working group had to think about something a bit smaller than the 500-acre fire unit.
Q: Is this model part of the next step to put a fire-spread overlay? Again, Dickson responded, saying that all the team did was impose a small fire spread effect, being very conservative; they then went through the 500-acre exercise based on the assumptions of the model.

Romero then commented that fire only treatment group still had some work to do for the next meeting, and she iterated that the group had to come back to the WUI discussion.
Q: Can the small groups create summary documents and then hand them out to working group members? The small group leaders responded that they could do this.

Romero began the second half of the meeting by providing additional information about the remaining meetings:

**October 9th** meeting (if it takes place) will be in **Holbrook**;
**October 15th** meeting in **Pinetop**;
**October 29th** meeting (if it takes place) will be in **Flagstaff**;
**November 16th** meeting in **Flagstaff**.

**Steve Sesnie:** *Wood volume estimation*
Sesnie began by discussing the forest growth and volume estimates for ponderosa pine forest type. He explained that his base set of plots came from the Forest Inventory and Analysis (FIA) PIPO type, which equals 327 plots. He also indicated that the plots were measured in the mid 90's, and that he would grow the plots to reflect conditions now and 20 years from now.

Sesnie then presented a set of average forest condition graphs, using a base set of information from FIA, outlining the 2007 and 2027 data from forest vegetation in the southwest United States.
Q: Does this model reflect regeneration? Sesnie indicated that he could add that to these model runs, but added that he didn't think the volume estimates would change that much. Q: Are you going to let us see what that equates to in 2027? Sesnie explained that that would require the team to grow the information forward by pixel; he added that he hasn't thought about how to do that yet.
Q: Can't you put the treatment data into that then? Sesnie affirmed that the team could do that. He explained that they could take an average plot condition and apply the treatment condition to it and see what that area will look like in 20 years. He also added that they would need another model to estimate forest growth pixel by pixel across the entire landscape.
Q: Is the 2007 baseline here our map? Sesnie responded by saying that it will be the date of imagery that was recorded in 2004. One group member commented that the data were based on the FIA plot, which is 1 plot per 6,000 acres, so it's not a very strong representation.

Sesnie also included a graph showing forest growth for 2007 and 2027. He explained that the small diameter volume made up about 30% for 2007 and 24% for 2027; small diameter basal area was 54% for 2007, while it was 36% for 2027. He warned the group that they should be careful about estimating the volume ranges because there is greater error associated with measuring narrower diameter classes. He then confirmed that he would take the FIA data and estimate forest volume across the ponderosa pine forest type, using a regression modeling approach. He presented this as a three-step process:

- FIA plots – reference data by volume class
- Data layers – CC, QMD, BA, TPA, biophysical variables (elevations)
- Error estimation – root mean square difference from observed and imputed variables

Q: What are other biophysical variables? Sesnie answered that these could include precipitation and other climate data.
Q: What about site indexes? Sesnie answered that the data could include site indices to estimate how growth behavior looks in the future.
Q: Have you decided what you will settle on in diameter size class? Sesnie explained that the team considered having a diameter range between 5-12 inches, 12 and above, and 5 and below. He added that he discussed this issue with John Bailey, a professor at Oregon State, who used to be at NAU and has a strong silvicultural background in ponderosa pine forests, who is involved in the project and together they thought that the break-point should be around 5 and 12 inches. Hampton added that they also reviewed the diameter class breaks recommended by the working group at the meeting with Bailey.

Sesnie's final slide looked at tree mortality and disturbance factors affecting volume estimates:

- Forest insect outbreaks
- Fire perimeter (BAER data)
- Fire severity
- Drought killed trees

Sesnie then commented that the first reason he used the growth model was to get the data points up-to-date. He explained that it does help give everyone an estimate of how much volume estimate can be expected at a given time. He added that density and site conditions are really what drive growth, so there is potential to estimate volume in that way.
Q: Is there a limit to the independent variables? Sesnie explained that other IV's could be added to the model, but that they likely wouldn't contribute to the accuracy of what he was doing. Sesnie then added that the team was planning on doing an independent assessment of the volume estimates.

**Jill Rundall:** *Updates on spatial data collection*
Rundall began her segment by reviewing a table summarizing spatial layers that the ForestERA team was almost finished acquiring. She continued with discussing the background information on roads and she referred to Chris Bielecki, ASNF Transportation Engineer, who suggests the group consider using a layer based on distance from arterial roads (i.e., roads already suitable for mechanized equipment). Rundall then presented a slide that represented the distance from system or arterial roads. Hampton reiterated that Bielecki had suggested that the layer might be useful to the working group in lieu of a complete roads layer which does not exist. She added that the information presented was in response to what the group wanted from last meeting. One group member commented that they didn't think the system road layer was useful because there weren't enough roads represented that will be used to harvest small-diameter material. This group member added that there are too few roads that are represented. Why don't we have better roads layer for the Forests when they are going through a Travel Management process? Another group member commented that [from A-S standpoint], there are about 3,000 miles of road that are not in the mapped data system; about 6,000 miles are in the system; only 2,000 of those are knowingly being used. This group member agreed with a previous comment that the distance from system roads layer was not valuable for the group's work. Rundall then showed the group a layer with both system and non-system Forest Service roads – the complete roads data set from the Forest Service. She commented that the layer was missing data for classes 1 and 2. A group member explained that Class 1 are closed roads and Class 2 are maintained roads.
Q: Can you characterize these roads? Rundall responded by saying that they were presenting the current data from the FS road system that is in their database. One group member commented that there are 3,000 miles of roads that are not logged into the system.
Q: Can we get the roads layer from the Coconino NF stemming from the Travel management process? Rundall confirmed that they will ask for this.

Next, Brett Dickson discussed information from treatment alternative worksheet given to working group members. He commented that the table included additional information that was recently developed with professor Bailey, and he then opened the floor for discussion about what was included in the table.
Q: Could you explain the numbers in the categories? Dickson explained that those are the stem reduction values, which were drawn from research and expert opinion.
Q: What is the thinning effort that has gone on around Forest Lakes? One group member commented that that would be the intermediate level – about a 60% reduction in stand density and 40% basal area.
Q: What's a sufficient large-tree component? Dickson iterated that *sufficient* refers to the need for a large tree component for the area to be restored in one entry. One group member

commented that they needed to work on the language to make it more usable for the working group. Dickson confirmed that the team could change the language for the working group.
Q: How do you define where you use these treatments? Can't we just start at existing conditions? Hampton explained that other groups have done that (i.e., in the White Mountain Landscape Assessment). She added that groups have specified ranges of forest structure metrics, such as, place thinning treatments where stem density >200 stems/acre. Hampton then presented several management objectives that previous groups had used:

- Reduce the risk of high intensity crown fires throughout study area
- Prioritize treatments in areas of highest risk for large fires and place higher intensity treatments where fires were predicted to burn more intensely.
- Protect and enhance habitat for endangered species, and minimize treatment impacts
- Treat areas upwind of Mexican spotted owl PAC's and excluded treatments within them
- Restore grasslands
- Select mollisol soil areas as indicators of historic grasslands
- Increase the quality and extent of special habitats, such as aspen stands and pine-oak woodlands
- Remove ponderosa pine from riparian systems and aspen stands

Q: As a group, can we have a discussion about defining a dozen desired conditions and figure out where to apply them? One group member proposed another approach - have a model of fire spread and risk that would define the treatments. Another group member explained that this approach could work from a fire management position, but not from a restoration position.
Q: Do you have information about the total volume that is on the forest floor today? Sesnie explained that the team didn't at this time but they plan hope to by next month.
Q: Can you aggregate areas into 100-acre sections? Sesnie confirmed that they could do this, but that the team needed to think of a size that was manageable.

Romero then asked the working group how they felt about the table. One group member commented that they were uncomfortable with the language. Several other group members claimed that they needed to define desired future conditions (DFC) first. Another group member added that they thought people wanted to see the forest structural attributes written in residual units instead of percent reduction. Hampton responded to this by stating that this could easily be done.

**Haydee Hampton:** *Define management objectives and select treatments (cont.)*
Hampton began the last part of the meeting by recording on screen the working group discussion they requested before the break on desired future conditions. One group member suggested finishing the WUI discussion first. Another responded by saying that the group should choose one of the WUI options. The working group decided to go with the fourth option presented by the WUI small group earlier in the day:

- WUI definition: Place a wind-vector of ½ mile downwind and 1½ miles upwind of private lands within CWPP high priority areas and ¼ mile buffers around private lands outside of CWPP areas.

The group discussed the following objectives that have desired future conditions (one member commented that the group should decide what to do in the WUI at this meeting. What are the desired post-treatment conditions in these areas?):

- Follow goshawk guidelines to reach VSS class targets in terms of % basal area (one member commented that the guidelines specify percentages for area covered, not basal area. Another commented that these are more appropriate to apply at project level)

| VSS 1-2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|
| 20% | 20% | 20% | 20% | 20% |

- Wildlands
  - Objective: Apply heavy thinning to predicted crown fire areas; apply moderate thinning to passive crown fire areas
  - DFCs based on pre-settlement conditions: BA: 40-60 $ft^2$/acre and stem density: 30-70 trees/acre
- WUI
  - Objective: Reduce fire behavior to surface fire based on 500 acre patch size in WUI areas.
  - Several group members recommended that more extreme weather conditions ($97^{th}$ percentile instead of $95^{th}$) be used to predict fire behavior in the WUI to reflect the lower tolerance for fire risk in these areas. One member requested $99^{th}$ percentile in the WUI.
- MSO PACs and restricted habitat
  - Apply 1.5 to 3 miles upwind buffer of packs or blocks of packs where intensive treatment buffer is needed. Discussion ensued that there are better ways to protect MSO habitat that using upwind vectors and the group agreed to explore these.
  - Base on MSO Recovery Plan threshold target habitat.

One group member commented that the goshawk VSS classes apply to fine-scaled project level considerations. Instead, they suggested that the group go back to the management objectives, because looking at desired future conditions would be too difficult. Several group members briefly discussed the issue of current forest structure and what is desired. One member recommended the group could determine a DFC in terms of how many tons could be removed; several group members commented that they would find it difficult to think about desired future conditions in terms of tons (several members concurred). The group then reviewed their draft treatment scenario worksheet on screen. One group member explained that the working group needed some ideas from the team to review next meeting and react to, in order to say that they agree or disagree with those ideas. Specifically, one member of the group commented that we'd like to tease out of the fire behavior models which have inputs of crown bulk density and other attributes, conditions in terms of basal area, tree density and canopy cover. Right now we can define the conditions we'd like and later we can assign forest structure values to them.

Several group members suggested that another group should be established, a "scenario attribute" group. A group member suggested having Shaula, someone from ERI and someone from Forest Service in the group. Hampton commented that the ForestERA team could pull this small group together but recommends they meet earlier than later to allow more time to pull map-based results together before the next meeting. Romero helped the group to select a date for

the fire and scenario attribute groups to meet: Fire group – 9/27 (10-12pm); Scenario attribute group – 9/27 (1-3pm).

**Audience comments**
Bob Maltis commented that today was the first time that he heard that people considered fire only as a restoration treatment. He explained that he could get data from ear, nose and throat doctors related to the effects of smoke billowing through Prescott. He added that he could have that information available. Romero suggested that he provide the working group with that information in the form of a handout. Maltis agreed to get information to Hampton for the next meeting.

**Gary Snider:** *Updates on wood utilization database*
Snider summarized his work to date identifying wood harvesters, mills and manufacturers in the study area and quantifying the number of tons of material processed by each. He told group members that he talked with various contractors in the western Mogollon area at length. He indicated that virtually all of the wood was sent to SW Forest Products in 2006. He also included information about the White Mountains area, which included contractors like Walker Bros., Nutrioso Logging, and Tri Star Logging. He explained that this was wood coming out of National Forest lands, but not off reservation land.

**Logistics**
Romero asked the group if they wanted to meet on October 9th. One group member commented that they were not convinced that working group members could meet in small groups and make progress before Oct 9th. They suggested meeting next on the already scheduled date of October 15th instead. Other group members agreed and added that the Oct 29th meeting was likely to be mandatory, however no final decision was made on this date.
Q: Can we get handouts soon from the small groups? YES – the groups (WUI group and fire group) indicated they would distribute handouts by the end of the week.

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**October 15, 2007**
**9:00 a.m. – 4:15 p.m.**
**Arizona Game and Fish Department Regional Office, Pinetop, AZ**

| | |
|---|---|
| 9:00 – 9:15 a.m. | Welcome – *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:15 – 9:30 a.m. | Review meeting agenda, timetable and various project updates **–** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 10:30 a.m. | **Identify areas appropriate for restoration treatments that recover wood byproducts**<br><br>Review Working Group's efforts to date on identifying areas appropriate for restoration treatments using additive display of map-based scenario components followed by Working Group decision-making session to identify any additional areas, such as areas next to streams, with no road access, or having soils with mechanized equipment limitations **–** *Jill Rundall* (Senior Research Specialist, Environmental Sciences, NAU) *and Haydee Hampton*<br><br>Updates on spatial data collection **–** *Jill Rundall* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | **Define management objectives and select treatments**<br><br>Presentation and group discussion on Scenario Attribute small group efforts by *volunteer from group* (up to 45 minutes) and report back on Fire small group efforts (up to 30 minutes) by *Brett Dickson* (Assistant Research Professor, Environmental Sciences, NAU), with spatial data support by *Jill Rundall and Haydee Hampton* |

| | |
|---|---|
| 12:00 – 1:00 p.m. | Lunch |
| | *** Lunch will be on site. Working group can order sandwiches before 9am for ~$7 (check or cash only) or bring their own. *** |
| 1:00 – 2:30 p.m. | **Define management objectives and select treatments (cont.)** |
| | Landscape-level treatment characterizations **–** *Steve Sesnie* |
| | Working Group decision-making session on the selection of management objectives and treatments of interest to Working Group **–** *facilitated by Rosemary Romero* |
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:30 p.m. | **Define management objectives and select treatments (cont.)** |
| 3:30 – 4:00 p.m. | **Parking lot items and logistics for next meeting** |
| | Discuss parking lot items, if not covered earlier in day: Community Wildfire Protection Plans (CWPPs), Stewardship Contracts, White Mountain Apache reservation-wide volume estimates, salvage logging, and prioritization to sequence potential treatments. |
| | Group discussion on need for Oct. 29 meeting (in Flagstaff). |
| 4:00 – 4:15 p.m. | Public comment period |
| 4:15 p.m. | Adjourn |

**Meeting Summary**
**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**
**October 15, 2007, Arizona Game and Fish Department Regional Office**
**2878 E. White Mtn. Blvd., Pinetop, AZ**

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**Introduction and Agenda Review**
Rosemary Romero (Meeting Facilitator, Romero Consulting) welcomed back the working group members and observers to the fifth group meeting. She opened the meeting by having working group and audience members introduce themselves.

***Working Group members present at meeting*:**
1) Bill Greenwood, City Manager for the Town of Eagar
2) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
3) Herb Hopper, Community-based forest and wood products advocate, Little Colorado Plateau Resource Conservation & Development
4) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forest
5) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
6) Steve Gatewood, Consultant, Wildwood Consulting Inc., representing the Greater Flagstaff Forests Partnership
7) Todd Schulke, Forest Programs Director for the Center of Biological Diversity
8) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
9) Kim Newbauer, Timber Sales Contracting Officer for Coconino National Forest
10) Jerry Drury, Timber Staff Officer for the Kaibab National Forest
11) Sue Sitko, The Nature Conservancy (sitting in for Lisa McNeilly)
12) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
13) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy
14) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest Restoration Products, Inc.
15) Diane Vosick, Associate Director of the Ecological Restoration Institute

***Working Group members not present at meeting*:**
1) Molly Pitts, Executive Director of the Northern Arizona Wood Products Association
2) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization (ECO)/Economic Environmental Counties Organization (EECO)
3) Chuck Peone, Fort Apache Timber Co.
4) Lisa McNeilly, Northern Arizona Program Director of The Nature Conservancy (alternate attended)
5) Paul DeClay, Tribal Forester, Forestry Department, White Mountains Apache Tribe
6) Keith Pajkos, Timber Staff for the Arizona State Lands Department Forestry Division
7) Shaula Hedwall, Ecological Services, U.S. Fish and Wildlife Service

***Meeting observers:***
1) Chris Bielecki, Apache-Sitgreaves National Forest (supplied expert input)
2) Bob Baltes, Baltes Distributed Generation
3) McKinley-Ben Miller, BLM
4) Wally Covington, ERI (supplied expert input)
5) Mike Cooley, Cooley Industries, Inc.
6) Dwayne Walker, Future Forests
7) Jim Pitts, Apache-Sitgreaves National Forest, Springerville Ranger District

Romero then turned the floor over to Haydee Hampton (Research Associate, Forest Ecosystem Restoration Analysis; ForestERA) who is leading this collaborative effort.

**Haydee Hampton:** *Wood Supply Team Introductions and Agenda*
Hampton reviewed the agenda and covered the major points that were to be covered at the meeting. She indicated to group members that they would be reviewing a draft treatment scenario developed by the scenario attribute subcommittee and that she encouraged the group to complete their scenario that day. She also told group members that there would be a brief presentation by Steve Sesnie (Postdoctoral Research Associate, Environmental Sciences, NAU) on landscape-level treatment characterizations.

Hampton then discussed details about the remaining timetable for the working group:
**Oct 15:** Finalize treatment scenario and review draft layers representing various components of scenario. Decide on need for optional meeting on Oct. 29 (or in November).
**Nov 16:** Discuss wood supply results and potential economic or other follow-on analyses.

Hampton gave important project updates such as ForestERA's acquisition of new FIA and satellite imagery and how those will be used to up-date the analysis to the 2006 time period (see meeting slides posted at: http://www.forestera.nau.edu/project_woodsupply_documents.htm. This update will require ForestERA to focus on the analytical effort to have the new data processed with the goal to present scenario results at the Nov. 16th date.

Hampton thanked those who provided comments on the Wood Supply Analysis Progress Report and announced to group members that they should have received an electronic version and that hard copies were available at the meeting. She then reviewed some of the comments received on the progress report:

- Make clear closer to start that focus is on mechanical treatments.
- ASNF has found that 40-50% of acres are not thinned within NEPA project areas (versus lower range of 30-40% found on western Mogollon Plateau).
- To avoid NEPA/FACA issues, change wording to "potential treatments" and don't get too prescriptive.
    - Landscape level treatment characterizations allow the estimation of wood supply, while detailed prescriptions will involve public interaction at a local level.
- Local businesses will have access to materials. Forest Service will not supplant existing contracts (Forsgren letter to Steve Sesnie, 7/19/07. *This document was provided as a handout*).
- How should the White Mountains Stewardship Contracts be accounted for over the next 7 years?

  - Removals should include task orders in next 2-3 years as these acres are committed in contracts
- Include updated scenario worksheet and other materials
  - Decided to keep Sept. 7 timestamp on materials.

Steve Gatewood then discussed stewardship contracts and the timing and scale of these. New contracts will be focused on both large and small-scale contractors. Hampton then reminded the group that at the September working group meeting in Holbrook, she had announced that in order to have time to develop and report back to the group on priority areas (for sequencing treatments), ForestERA would need their input by the end of the today's meeting. She explained that this was not a required part of the Wood Supply Analysis and the Steering Committee recommended completing the treatment scenario first, so there was not likely not time to complete a prioritization analysis as part of this project.

Hampton ended the introductory presentation by providing background information on the goshawk guidelines. She explained that the goshawk guidelines dictate management actions in all forest land outside of Mexican spotted owl or other federally listed species habitat. In 1996, the Southwestern Region of the Forest Service (FS) amended all its forest plans based on the recommendations in GTR-RM-217 (published in 1992), "Management Recommendations for the Northern Goshawk in the Southwestern United States," (the "goshawk guidelines"). Clarifications to the 1992 guidelines were made after the FS observed some inconsistency and confusion associated with the implementation of the standards. Hampton explained that ForestERA is acquiring pre- and post-treatment data on treatments marked or completed using the clarification to the guidelines:

- Demo plots in Pine Hill timber sale, Williams RD (have data in hand)
- Eager South (trying to obtain)
- North Kaibab RD

She explained that at the request of the scenario attribute small group members that she had contacted Jim Youtz, Regional Silviculturist, USDA Forest Service, for a recommendation on how to address the goshawk guidelines in the wood supply analysis. A participant commented that all treatments have been implemented under the guidelines over the past several years. Another that many treatments have sided more on the fuels reduction side in some locations.

Hampton continued by saying that she and Sesnie would be traveling to Whiteriver, AZ, on the White Mountains Apache reservation the following day to talk to a planning board on whether it would be possible to obtain data ForestERA could use to estimate reservation-wide small-diameter wood volumes or direct estimates of wood volumes that the tribe had completed in the past. She then commented that this had been identified by the Steering committee and others as important since there were significant volumes of ponderosa pines on the Mogollon Plateau located on reservation land.

**Jill Rundall and Haydee Hampton:** *Identify areas appropriate for restoration treatments that recover wood byproducts.*

The meeting session on identifying areas appropriate for restoration treatments that recover wood byproducts began with a slide on which Hampton explained that ForestERA had completed checking back with soil scientists on the soil information from four Forests in analysis area on

restrictions placed on using mechanized harvesting equipment based on a number of factors including:

- Erosion hazard
- Shallow soils
- High rock content
- Prone to sheet and rill erosion once ground cover gets thin
- Prone to compaction when wet (secondary factor)

Hampton explained that they had reviewed assumptions used to develop a spatial layer of areas with soils restricted from mechanized equipment with Dr. Steve Hart, Professor, Ecosystem Ecology and Forest Soils, Northern Arizona University and that he had expressed confidence in using the interpretive summaries (e.g., for erosion hazard) in Terrestrial Ecosystem Survey soils data for purposes of Wood Supply Analysis. He has found over time that that TES soil survey is a useful tool for the mid-level scale for which it was designed and there is no other landscape-scale dataset available for the study area. Hart explained that operational factors are also important for protecting soils, such as the condition of soils (e.g., wet) and operator skills and having a good skid trail plan. In addition, Dave Brewer, ERI and former soils scientist on the Kaibab National Forest explained to Hampton that since the 1980s or 90s you had to have a major in soils to qualify (needed a minor in soils) to be a FS Soils Scientist. The working group agreed that the layer should be used in their scenario.

Hampton also explained that ponderosa-pine dominated areas in the study area amounted to 2.4 million acres and included stands of pure ponderosa pine, ponderosa pine and oak (pine-oak), and areas defined in LANDFIRE vegetation layer as riparian which should be classified as ponderosa pine dominated. She summarized that the seven factors considered in the analysis of areas the group had decided were not a source of wood supply in their treatment scenario amounted in 27% of the ponderosa pine dominated areas removed from the analysis area, resulting in 1,750,869 acres remaining.

Hampton and Rundall (Senior Research Specialist, Environmental Sciences, NAU) presented the following table:

| **Factors (in ponderosa only)** | **Acres removed** | **Acres remaining** |
|---|---|---|
| ***Initial ponderosa pine dominated areas*** | n/a | 2,412,833 |
| **MSO** | 181,707 | 2,231,126 |
| MSO, **SDA** | 147,256 | 2,083,870 |
| MSO, SDA, **slope** | 59,155 | 2,024,715 |
| MSO, SDA, slope, **completed treatments** | 64,223 | 1,960,492 |
| MSO, SDA, slope, completed treatments, **Goshawk nest areas** | 52,249 | 1,908,243 |
| MSO, SDA, slope, completed treatments, Goshawk nest areas, **soil restricted from mechanized treatment** | 56,969 | 1,851,274 |
| MSO, SDA, slope, completed treatments, Goshawk nest areas, soil restricted from mechanized treatment, **streamside management zones** | 100,405 | 1,750,869 |

To further explain how ForestERA had accounted for the overlap in removals, they presented the following table:

| | |
|---|---|
| 1. Mexican Spotted Owl PACS | 181,707 |
| 2. Specially Designated Areas | 177,477 |
| 3. Steep slopes (>40%) | 147,067 |
| 4. Marked and completed treatments | 65,030 |
| 5. Goshawk nest areas | 63,019 |
| 6. Soil restricted from mechanized treatment | 126,139 |
| 7. Streamside management zones | 144,762 |
| Total Acres (including overlap) | 905,201 |
| Overlap among all layers | -243,237 |
| Total Acres (excluding overlap) | **661,964** |

Rundall then displayed maps of each layer showing how they progressed to the total removal area. This demonstrated the most up-to-data layers and number of acres that would be removed from wood supply. She described information added since last meeting including new data on treatments. Some additional data will be included from A-S once their layers are ready.

Hampton reviewed material covered in previous meetings concerning the fact that streamside management zones are treated differently by each forest. The working group had asked to see a layer showing a 100ft buffer on either side of streams as a possible removal, which ForestERA displayed explaining that ephemeral, intermittent and perennial streams were all included for all

forests except the ASNF because separate classifications for ephemeral and intermittent were only available for that forest. She mentioned that a layer of perennial streams only was available if the group wanted to limit the zones to those stream types. The working group approved the layer with the 100 foot buffer on all streams for use in their scenario.

Rundall displayed a Forest Service road layer with ¼ and ½ mile buffers as requested at the last meeting by the group. A participant requested the proportion of areas outside of the ¼ mile buffer area to use as a potential removal as it may be inaccessible to harvest. Hampton then explained that with the recommendation of the Steering Committee, ForestERA had invited Chris Bielecki, Transportation Engineer, Apache-Sitgreaves National Forest and two industry representatives with years of experience using Forest Service roads for harvesting (Dwayne Walker and Ed Martin). Although Ed Martin did not attend, ____ and Walker were present. Bielecki expressed that it sounded like the group was going to treat all roads the same. He cautioned the group in using just a blanket road treatment. Some roads were built to accommodate steep area harvesting. Environmental documentation needs to account for this. He explained that arterial roads and ¼ mile from them are basically treated as accessible to harvesting. More primitive roads are potentially in need of improvement adding costs or operational strategies. Road access is presently viewed from a public access perspective and some changes may need to be made if access for wood supply is considered. The ¼ mile buffer shows areas that can be accessed with no additional work. Beyond that there are roads that can potentially be utilized but might need improvements. Lower standard roads have about 60% confidence to be inventoried. How many of total roads vary by forest. In terms of feasibility many roads can be improved depending on economics. [Bielecki provided the following written notes at during the meeting:

1) Every square inch of desired treatment is "feasible," but consider that environmental and economic impacts are proportional to decreases in road standard and increased distance from these routes.
2) There is a different level of environmental and economic impact based on standard of road and distance from roads.

- Generally, treatment areas within ¼ mile of operational maintenance level 3-5 roads are immediately available (no improvements required; access aprons may be required for fed/state highways)
- Treatment areas within ¼ mile of operational maintenance level 2 roads are available w/minimal road improvements and/or maintenance
- Treatment areas within ¼ mile of operations maintenance level 1 roads are available w/ moderate road improvements (ranging from removing closures and blading to full reconstruction).
- Treatment areas beyond ¼ mile of exiting roads are available w/adding temporary or new system road mileage (generally requiring a level of physical impact greater than utilizing existing system routes).]

One participant said in a study he had conducted around the San Francisco Peaks Wilderness Area near Flagstaff that the FS roads layer captured 80-90% of the roads according to their assessment. Another participant mentioned that most roads need some improvements for chip trucks like grading them. Another pointed out that in most of the forest that you can not walk very far without hitting a road.

Q: Is there a way to make a judgment as to whether an economic or environmental limitation is present? We really need to find what is likely to be treated, and the roads layer does not appear to be that useful.
Q: Do we want to use the ¼ or ½ mile buffer? The ¼ mile buffer has significant implications for limitations on wood supply.
Participant response – there are some limitations given the use of chip truck and some of the roads that are adequate. We may need to look at past projects to estimate limitations and new technology and operational equipment may eliminate some limitations. Another suggested that we use some of the information from past contracts and constraints, however constraints likely differ between forests.

The point of the discussion was to determine what distance is realistic to identify an access limitation. One participant commented that ¼ mile is not a realistic distance and that ½ mile buffer is more realistic, we should not be considering ¼ mile buffer. Bielecki – we can look at the categories that have been realistically used in the past. Participant – there is going to be a significant change in the type and quality of the equipment used as contracts forest restoration get under way. Participant – would not like to see roads access on historic economic standards since these are changing. Participant – the group in not tasked with assessing the economic ability to access areas or do this assessment.
Q: Is there are number or distance to use from the operations stand point?
Participant – 2/10$^{th}$ of a mile from a landing is used for developing a logging plan and then road condition and time of year when accessible. Most areas have been accessed at some point in the past to access timber. There are very few acres that have been limited for logging by access. Most of the limitations have been due to other factors. Participant – most access has been limited in the field because there is no available road. Participant – part of this discussion is to come to some zone of agreement to allow restoration to occur on a larger scale than in the past. There are many users concerned with the use and improvement in roads. We should take a very conservative approach to create a very durable recommendation to get political agreement. Participant – the main thing is that the roads layer indicates that the roads are there but may not be the exact location. Over time we see the roads as needing to be different depending on the operational use – it depends on the past system installed and what the current operations require.
Q: Can we possibly rule out the building of any new roads especially near Flagstaff? Bielecki – legally new road construction is defined as extending roads a mile beyond the current system. We should not have said no new roads since road construction can be minor and still be legally considered "new road construction." Participant – there are some project level details that should not be considered here. Participant – there are too many roads already on the map. But regardless we are not going to run a chip van down all of the roads that are shown there. I think that a ¼ mile buffer is good, unless more forwarders are used out there. Participant – we are not defining skid trails are new roads, right? So why not use ¼ mile since there are a lot of other ways to remove chips from the forest than the truck.

Participant – We need to consider roads because of the estimate of the amount of biomass taken out of the wood depends on it. We need a quantitative estimate from using the existing roads to understand biomass that is available for restoration. Participant – we are not necessarily talking about an environmental limitation, but an operational one? Participant – there are many individual out there concerned with roads and road densities so we should be careful with our recommendation. Participant – we should be cautious also to not limit future activities with

information from past logging and the spaghetti of roads out there. Participant – some future harvesting also would afford opportunities to close existing roads and get rid of that spaghetti pattern. Participant - to summarize, our opportunity here is to responsibly estimate the amount of wood volume and the number of acres accessible related to wood volume, that is, a conservative estimate of access and access management. Hampton said that ForestERA would generate the number of acres removed if ¼ and ½ mile buffers were used to estimate accessibility.

**Define management objectives and select treatments – Fire subcommittee report back**
Brett Dickson (Assistant Research Professor, Environmental Sciences, NAU) reported back on Fire small group efforts (up to 30 minutes) since last full group meeting. The purpose of the group is to identify areas where fire could be used as a first management option. The group had concerns over how the fire models were characterizing fire behavior at the 95$^{th}$ percentile weather conditions. Brett worked with Chuck McHugh and Laura Kurth to predict fire behavior at the 97% level and there was little change in the surface fire area extent and conditions. Crown base heights are driving the model predictions and there is a lot of sensitivity in the model for surface to passive and passive to active crown fire. Brett mentioned that we have consulted with the Missoula fire lab to find out what manipulation of inputs may be necessary to get potentially more realistic runs. The recommendations were to make extreme adjustments in crown bulk density and other inputs and would involve making too many assumptions. Dickson presented the following slide summarizing the status of the fire modeling efforts for the Wood Supply Analysis:

- Derived new fire models for 97th percentile weather conditions, however:
    - Surface fire predictions relatively unchanged from 95th
    - Canopy-base height still “too high” in many areas of predicted surface fire = “truth” + “fiction”
    - LANDFIRE inputs require significant adjustment
- USFS Fire Lab cannot recommend a “better” model
    - Large landscape prohibits models of fire dynamics
    - Areas of fire only could be identified using, e.g., current or desired future conditions

Dickson also consulted with Pete Fulé (NAU Associate Professor and ERI employee), regarding how to pin down forest structural conditions that would potentially support or potentially prohibit the transition from surface to a canopy fire.

- Forest structure conditions associated with surface fire behavior (Pete Fulé, ERI)
    - 160 trees/acre (400 +/-100 trees/ha)
    - 109 ft2/acre (25 +/- 10 m2/ha)

Dickson also explained that ForestERA had prepared several spatial layers from their canopy cover layers that could be of use to inform efforts to use fire behavior as an indicator of areas that can potentially support fire as a first management tool.

- Canopy cover thresholds of 10%, 20% and 30%
    - 30% is lower end of canopy cover range in DFCs identified by scenario attribute group.
    - 10 to 30% encompass range reported in manuscripts and unpublished data following restoration treatments and reconstructed pre-settlement conditions.
    - Canopy cover is the highest accuracy layer available for the study area

Q: What is the objective of this discussion? Participant – to identify areas that could be managed right now with fire treatments. Participant – we are developing methods to analyze areas where mechanized treatment may not be appropriate and fire is one available tool that may be used. Participant – is there some kind of value judgment made as to why fire would be used instead of mechanical treatment? Participant –I'm not sure canopy cover is the best structural parameter to use for this. Participant – there are some areas that we are running into critical thresholds with smoke that will play a role in the number of acres that can be burned. Participant – canopy cover is an estimate of the cover of trees, not necessarily a density of trees. Participant – if you can use fire and get the same result as thinning treatments, we should look at those. Participant – if we can use fire and achieve restoration results, we should consider these areas and take that out of the wood supply. Participant – from a restoration point of view, there is no published information that suggests that 160 trees per acre was a historic condition. You might be able to get a surface fire through a 100 tpa stand, but you would not get to a condition that would be considered restoration. Participant – if you still achieve the desired future condition, via fire or mechanical, either method should be considered.

Participant – it is not still clear that we can politically restore fire to these systems, that discussion is not yet mature. Our objective is to come out with a recommendation and agreement that each member can present to their constituencies that is acceptable. I will not be able to find agreement where treatments recommended do not find that middle ground that is reasonably acceptable to all. There is more to this than just this group, but also interested individuals outside the group. Participant – we have almost 30% of the landscape that is already taken out of the supply, does that help provide by-in or agreement? Participant – no, it is not just that 30%. I thought that we would get more and quick acres to take out based on fire behavior models and we did not get that. Participant – we are not here just to look at areas where burning can be applied, but also where mechanized treatments can be applied. We should to swing from one side to the other. We have been looking for a starting point where we might be able to suggest areas where fire might be applied. Participant – it worries me that we are trying to identify prescriptions and where they should occur. I have no problem saying areas should be taking out of wood supply that can be treated with fire, but where there is a resource that can be utilized it will not go over well with others looking at the results of this process. Participant – there are plenty of areas where fire can be used as a treatment right now. This is a compromise perspective. Participant – I have heard Harv Forsgen say that we are trying to get forests back to a restored condition where we can have the use of prescribed or natural fire in the future. There are some criteria that can be used as to where fire can be applied in the future that can be combined with the fire models. Participant – we should use the desired future condition and let the restoration goals suggest what the treatments should be…we should move along and identify those areas where prescribe fire might be used as a first management option. Participant – where we have the opportunity to use fire, we should consider some of the other ecological problems of using mechanized equipment on sites such as exotic or invasive species. We should look at the DFC and move forward with treatments to get us there. Participant – We can put fire into some areas that can right now support fire to get us to the DFC. If you are looking at getting just to the ecological condition, then fire could get to you the restored condition. If economics play a role, then harvesting some of the biomass should be considered. Participant – there are still a lot of area that could be treated with fire if we could do unlimited burning, but smoke management is an issue. We should be capitalizing on the mechanically treated areas to be able to use fire.

Dickson – As we move forward, think about the DFCs and whether these conditions can help suggest sideboards for the type of treatments. Is there additional information that we can give to the sub-groups to help move forward with the scenario?

**Steve Sesnie:** *Wood volume estimation*
Sesnie reviewed the wood volume analysis methodology described at the last full group meeting. He will be using Forest Inventory Analysis vegetation plot data as it covers the entire analysis area in a 4x4 km grid combined with satellite, elevation and other spatial data layers at the 30m pixel scale. He'll use K-nearest neighbor calculations to impute areas for which we don't have volume data.
Q: Will Stewardship contract data be used in your analysis? Sesnie explained that he will be using stand exam forest inventory data and this will be helpful to assess accuracy. I may use some procedures to track down main sources of errors in the prediction.
Q: Will you have results for the next meeting? Sesnie stated that he will have results to show at the Nov. 16 meeting.
Q: Do you anticipate your projection will show the differences between wood supply estimates between forests as described in the progress report? Sesnie stated that if the plot data indicated differing initial conditions between forests that this may lead to different estimates of supply between forests.

**Define management objectives and select treatments – Scenario attribute subcommittee report back**
Diane Vosick summarized the revisions that the Scenario Attribute subcommittee made to the forest treatment scenario worksheet since the last full working group meeting on Sept. 17. She reminded the group that they needed to keep in mind that every acre is under the jurisdiction of the goshawk guidelines. However, there is flexibility in the guidelines that would allow differing treatment activities. Participant – we have guidelines of how goshawk treatments are implemented, but that is an over-arcing guide, not information that can define a treatment level in our scenario. Participant – the set of potential treatments included in the scenario are to be used as a straw man and presented to the group to help quantify the amount of wood volume. You need numbers (DFC) to get numbers (wood volume).

Vosick reviewed the treatment areas and DFC of each area while ForestERA displayed maps representing each area discussed (e.g., Community protection zones, MSO restricted habitat, municipal watersheds, wildlands, etc.). There is a wide basal area range of in the wildlands as the group might be sensitive this large area.

Q: Will there be a volume estimate for each end of the range and the middle, for example? Participant – This was proposed by the scenario attribute group, but we need to discuss where different levels of treatment might be applied in terms of distributions, such as in wildlands, to give ForestERA a location and level of treatment to estimate wood supply. Participant – should we expect to have a number of different scenarios with a range of treatments and is that enough of a recommendation to R3? This will be important as to how we proceed from this point forward, for instance having such a range of treatments and different treatments. Participant – it might be good to have a range of treatments to suggest what is acceptable. Participant – it will be tricky to come to agreement on a particular treatment, as a set of several scenarios. Participant – We don't want to just take of the average of the low to high scenario. The ranges represent a set of ranges within

certain areas (landscape features). Participant – we have to have a final product that is useable and the zone of agreement that everyone is happy with. This suggests some tighter sideboards on treatments in a given area than currently on the scenario worksheet. Participant – is there a way to begin thinking about narrowing down the DFC that is realistic. Participant – we should work systematically through the table and come up with DFC ranges that the group agrees with.

A scenario attribute subcommittee member reviewed the general notes on the scenario worksheet: 1) ForestERA will calculate wood volumes in severely burned areas, falling within fire perimeters, across the full study area, so as not to include them in total volume analysis. There is not sufficient agreement related to available supply from severely burned areas, thus these areas were not identified as sources of available supply in this analysis. 2) Archeological sites and other project level factors can reduce acres thinned and intensity of thinning. Total volumes will be corrected using a reduction factor to account for these sites. Volume estimates stemming from this project will be presented in terms of ranges. 3) Areas once dominated by ponderosa-pine that mixed-conifers have expanded into are not considered in this study. 4) No burning should occur following ponderosa pine thinning in riparian areas.

After discussing the last item the group agreed it was too prescriptive and should be changed to "Burn when appropriate following ponderosa pine thinning in riparian areas." The subcommittee member further explained that salvage logging is a difficult area to reach agreement on, so the group recommends putting this aside and not considering it in this process. Participant – we need to develop some number or range of numbers to reduce wood supply, for example for archaeological sites. Participant – are there areas that we would apply different "project level" factor for wood taken out where there are archeological sites? Participant – yes, different forests have different amounts of these sites.

Q: Can you map old growth? Sesnie explained that he conducted a Forest inventory data analysis on the North Kaibab Ranger District mapping old growth and defining different stages of old growth condition. It involved defining conditions leading to and away from old growth conditions due to fire removing trees. He plugged data into FVS and projected out where old growth conditions would occur. Participant – On CocNF they identify old growth as project level planning. VSS6 are considered almost or old growth. Many stands do not have old growth so they designate stands that are approaching old growth.

Q: Why are we deviating from what is the place of importance or area of importance decided by the community. Member of the WUI subcommittee – community protection area layer was developed based on what we thought were important areas for community protection. For example areas up-wind of the prevailing winds. Participant – the community protection layer has the benefit that all private lands will receive some level of treatment, as not all are included in the CWPP priority areas. Participant – the sub-group found that that definitions and process used to define the WUI in CWPP was applied differently across these communities. Participant – from the state wide strategy, we found that communities perceived themselves and boundaries differently across the state. Participant – the consensus achieved from the CWPP WUI is somewhat undermined by redelineating the boundaries. Q: if the group can articulate why the boundaries have been changed that would be presented in the report, would that be enough for the communities that originally identified them. Participant – no, I think that a member or members of the community might be unhappy with undermining their original decision and WUI boundaries. Participant – We should not undermine what the communities have decided. We could

demonstrate both layers showing the high priority zones identified by the community and other zones that could realistically be protected. Dickson– there are some question about inconsistencies methodological approach used and the data used that were identified as having treatments or not (in the CWPPs). The type of treatments are not specific enough to implement them in the context of estimating wood supply.

Participant – I want to honor what the communities have decided as they have worded hard. Participant – there was too much flexibility allowed communities for identifying priority areas so there is less consistency in the prioritization. Participant – why does if matter that communities came up with different types of priorities? Participant – we need to consider that the policy developed for the CWPP areas and decision making was not necessarily consistent with landscape scale restoration treatments. Participant – we have no option but to consider what the communities have defined. Participant – the Forest Service only has to only consider the CWPP under HFRA. It tells the Forest Service whether the CWPP is consistent with intent of the policy. Participant – we can probably move on from this with the idea that we explain the difference in the volume and areas for CWPP. Participant – use two sets of estimates based on a selected scenario from the ForestERA process and then also one with the CWPP less specific estimate. Hampton – we will clarify in the report what changes were made in what the communities identified as priority and what was captured by the sub-group. In areas where we don't have spatially explicit information or enough treatment information we will not use the CWPP.

Sesnie passed out a handout to provide additional information on the post-treatment conditions that would result following the three thinning levels (low, moderate, and heavy) for three forest structure metrics: BA, CC and stem density. Also shows distributions from FIA data of these stand parameters. Note that 300 t/a is average conditions and that ending condition for heavy, moderate and light thinning potential treatments differ depending on initial conditions. Hampton pointed out that the range of community protection DFCs for basal area approximate those of the post-heavy thinning treatment.

Participant – Using a bell curve as the distribution for the basal area ranges is interesting, but we don't have agreement on this. ForestERA should model high, med, and low treatments across landscape so group can see how they play out. I hope we can reach one common scenario that represents agreement to provide to the FS. Participant – Maybe we can define for a certain area a percentage of the area in each part of DFC range. Participant – It's not prudent to narrow the DFC range too much on some areas of landscape. Participant – We are looking at immediate condition following treatment not DFCs. We're managing for DFCs. In SW US we have good info on reconstructed range 15-35 t/ac on fine texture soils, 55-65t/a on coarser textured soils. We'll have to plant trees to make the DFC in the current scenario. Participant – We're calculating the amount of wood following treatment so we should use PTC, post-treatment condition. Participant – But we don't have Powell Plateau conditions, so we're erring on side of more trees, DPTC. Participant – We could say that anywhere within range is OK. Some have too wide of ranges. Participant – If we have high BA and low densities then it will be on one end of DFC range. We should state which initial conditions lead to what part of DFC/DPTC range. Participant – Could take low, med, and high part of DFC ranges and use predicted effects on MSO, squirrel, etc. then this will be an information based process. This is arbitrary unless we consider these factors. Participant – Why is the range for municipal watersheds so wide if MSO is taken out, such as for Lake Mary watershed?

ForestERA reviewed the data layers used for the scenario. Sesnie summarized how MSO restricted habitat layer was derived. Pine-oak was taken from LANDFIRE and ForestERA vegetation layers. He found target/threshold conditions were met on some areas on the Tonto NF using forest stand data. Hampton explained that infrastructure such as interstate highways and roads were buffered and power lines also (50 ft buffer) at the request of the scenario attribute subcommittee. Participant – the right-a-way is wide depending on the size of the power line. Participant – the Forest Service thins heavily, rather than clear cuts under these. Participant – why do we consider these if they are going to be treated already anyway? Participant – not always treated, lump these infrastructures with priority community areas.

Participant – there are more areas that the Forest Service has identified as level six municipal watershed (Eager South area is already marked for treatment in one).

Haydee – We used data on native fish provided by Shaula Hedwall (from Bureau of Reclamation), TNC (native fish on perennial waters), and the University of Kansas to develop a layer of the 6$^{th}$ level watersheds with native fish. A ForestERA layer of high post-fire sedimentation areas were used to narrow the number of native fish habitat 6$^{th}$ code watersheds to form a second layer. The models predict potential sediment load from a large fire and not from treatments.

Participant – we need an estimate of volume from different tree size classes so that we can tell the model which trees to cut. That is a critical part of this analysis to calculate wood supply – which size class of trees are going to be cut and the volume from that.

Hampton – we have calculated topographic position to identify canyon areas to protect. Treatment areas would be along rim areas Participant – many of the canyon areas will be MSO habitat, so this layer does not provide much useful information (many agreed). Participant – in reality the edge of canyons, if just a small strip surrounded by areas that we would not treat, is not feasible for allocating equipment.

Hampton – does everyone agree that these canyon areas should be placed back into the wildlands? Participant – there is some disagreement, I would like to leave it in. Participant – I'm a lumper and this make management planning more complicated, without buying anything. Participant – we should drop this and move on.

Haydee – For meadows, we have TNC grassland data and TES data on mollisols, an indicator of past grassland and savannah conditions. There are more mollisol areas on the west side of the study area that a FS soils scientist verified is a real condition and not an artifact of the way the soil survey was carried out. Participant – have you looked at the TES potential vegetation data for existing meadows? Hampton – we can look at that, we have the TES data. Participant– the TNC historic grasslands characterization was from a study mainly on BLM land and some of the Apache reservation, not as much information about historic grassland on USFS land.

A participant proposed creating a scenario of PTC, use low, med, high proportion (area) of each PTC for each landscape feature. For example, 20% of the wildlands area would fall in the low basal area range for wildlands following treatments, 60% medium, and 20% high. There was some discussion on this method, but no decision to move forward with it.

**Public comment period**
An observer asked if the group had done anything with the information provided in an email letter from a Prescott ear, nose and throat doctor to the Working Group by ForestERA as his request. The letter contained information about increase in medical cases associated with smoke generated from burning activities. A participant said that this information was more appropriate for the USFS Forest Plan revision process underway and that she had sent it to the appropriate Forest Service staff. Another observer said he had used LANDFIRE FRCC tools as an evaluation tool. How VSS classes can be used to inform outcomes. Gave old-growth example and how much land should be left in that category.

**Parking lot items and logistics for next meeting**
Elaine Zieroth announced that Harv Forsgren, Regional Forest Supervisor would be leaving his post on Nov. 7th, Gilbert Zepeda will become Deputy Forest Supervisor (acting), and Corbin Newman will be the new R3 supervisor. Elaine is retiring on Dec. 21st.

Participant – Stewardship contracts need to be accounted for with FS NEPA polygon information – acres committed to Stewardship contract.

Hampton reiterated that she and Sesnie were going to present at the White Mountain Apache tribal planning board meeting tomorrow to ask them for reservation-wide wood volume estimates. The group decided to include wildlife corridor areas in any project level factor applied to wood supply estimates as no GIS data existed for this landscape factor. Tabled for future discussion were old-growth, roads, burn-only treatments, goshawk guidelines and factors for accounting for project level considerations in reducing thinning levels or acres, such as archeological and historical sites.

**Logistics**
Romero asked the group if they wanted to meet on October 29th or possibly at the end of November after they reviewed how their scenario played out spatially and in terms of wood volumes. The group decided that meeting at the end of November would work better for reaching agreement on their scenario and Thursday November 29th in Flagstaff was chosen as the final meeting date. A proposal was made to have a small group go over the scenario worksheet and use today's discussion to revise the table. The scenario attribute subcommittee agreed to meet to provide ForestERA with recommended assumptions that they needed to complete the analysis to report back to the larger group on November 29th. The following working group members volunteered to serve on the scenario attribute subcommittee: Todd Schulke, Scott Higginson, Shaula Hedwall, Pascal Berlioux, Steve Gatewood, and Diane Vosick. The necessity of keeping the group at a low number of participants representative of the larger group in order to move forward efficiently to develop suggestions to present to the larger group was discussed and agreed upon.

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**November 16, 2007**
**9:00 a.m. – 4:15 p.m.**
**Large Pod Conference room, Applied Research and Development (AR&D) Building**
**Northern Arizona University, Flagstaff, AZ**

| | |
|---|---|
| 9:00 – 9:15 a.m. | Welcome – *Rosemary Romero* (Facilitator, Rosemary Romero Consulting) |
| 9:15 – 9:30 a.m. | Review meeting agenda, timetable and various project updates **–** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:30 – 10:30 a.m. | **Review treatment scenario**<br><br>Review Working Group's efforts to date on identifying areas appropriate for restoration treatments and the desired post-treatment conditions for those areas. ForestERA will build the Wood Supply scenario on screen using an additive display of maps highlighting various components (e.g., steep slopes, community protection areas). **–** *Jill Rundall* (Senior Research Specialist, Environmental Sciences, NAU) *and Haydee Hampton* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | **Review treatment scenario (cont.)**<br><br>Complete review of treatment scenario including using fire as a restoration tool where practicable by *Steve Gatewood* representing the Fire subcommittee, with spatial data support by *Jill Rundall* |
| 12:00 – 1:00 p.m. | Lunch<br><br>*** Lunch will be on site. Working group members may order sandwiches before 9am for $5.00 for a 1/2 sandwich and $7.75 for a whole (check or cash only) or bring their own. *** |

| | |
|---|---|
| 1:00 – 2:30 p.m. | **Report out on major project results** |
| | Presentation on estimates of wood volume by size class for Wood Supply Analysis area and methods for estimating supply based on group's desired post-treatment conditions **–** *Steve Sesnie* (Postdoctoral Research Associate, Environmental Sciences, NAU) |
| | Presentation on results of project level analysis of restoration treatment areas and intensity **–** *Haydee Hampton and Gary Snider* (Forest Economist and Doctoral Candidate, School of Forestry, Northern Arizona University) |
| | Presentation on existing small-diameter wood harvesters, mills and manufactures **–** *Gary Snider* |
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:45 p.m. | **Address miscellaneous issues** |
| | Discuss how "parking lot" or miscellaneous items that are not fully or otherwise included in the group's treatment scenario will be addressed in the final project report, such as Community Wildfire Protection Plans (CWPPs), White Mountain Apache reservation-wide volume estimates, salvage logging, old growth, and use of previous landscape assessments. |
| 3:45 – 4:00 p.m. | **Wrap-up and logistics for next meeting** |
| | *The final Wood Supply Working Group meeting is scheduled for November 29th in Flagstaff.* |
| 4:00 – 4:15 p.m. | Public comment period |
| 4:15 p.m. | Adjourn |

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## Introductions and Agenda Review

Rosemary Romero, meeting facilitator, introduced herself and welcomed Working Group Members to the second to the last official meeting. Group members introduced themselves.

**Working group members present at meeting:**

1) Keith Pajkos, Timber Staff for the Arizona State lands Department Forestry Division
2) Bill Greenwood, City Manager for the Town of Eagar
3) Herb Hopper, Community-based forest and wood products advocate, Little Colorado Plateau Resource Conservation & Development
4) Steve Gatewood, Consultant, Wildwood Consulting Inc., representing the Greater Flagstaff Forests Partnership
5) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest Restoration Products, Inc.
6) Lisa McNeilly, Northern Arizona Program Director of The Nature Conservancy
7) Jerry Drury, Timber Staff Officer for Kaibab National Forest
8) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
9) Todd Shulke, Forest Programs Director for Center of Biological Diversity
10) Diane Vosick, Associate Director of the Ecological Restoration Institute
11) Elaine Zieroth, Forest Supervisor for Apache-Sitgreaves National Forest
12) Shaula Hedwall, representative of the U.S. Fish and Wildlife Service, Ecological Services
13) Molly Pitts, Executive Director of the Northern Arizona Wood Products Association
14) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization
15) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
16) Kim Newbauer, Timber Sales Contracting Officer for Coconino National Forest

**Working group members not present at meeting:**

1) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
2) Scott Higginson, Executive Vice President of NZ Legacy/Snowflake White Mountain Power, Renergy
3) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
4) Mary Steuver, Acting Tribal Forester, Forestry Department, White Mountains Apache Tribe
5) Chuck Peone, Fort Apache Timber Co.

**Project Team Present at Meeting:**

1) Rosemary Romero, Meeting Facilitator, Romero Consulting
2) Jill Rundall, GIS Specialist, ForestERA

3) Tom Sisk, Professor, Center for Environmental Sciences and Education at Northern Arizona University (NAU)
4) Haydee Hampton, Research Associate, Center for Environmental Sciences and Education at NAU; Project Director, ForestERA Wood Supply Analysis
5) Steve Sesnie, Post-Doctoral Research Associate, Center for Environmental Sciences and Education at NAU; Remote Sensing Specialist, ForestERA
6) Gary Snider, Forest Economist and Doctoral student in the School of Forestry at Northern Arizona University
7) Jada Ach, English Instructor, NAU; scribe

**Experts and Observers:**
1) Wally Covington, Director, ERI (supplied expert input)
2) Pete Fulé, Faculty, NAU Forestry and ERI (supplied expert input)
3) Taylor McKinnon, Center for Biological Diversity

**Haydee Hampton: Overview of Agenda**
Hampton presented an overview of the meeting's agenda commented that at this meeting the two major parallel tracks of the project, collaboration and wood volume estimation, will merge. She referred to the first working group meeting which took place in Holbrook, AZ on June 4, 2007, remarking on the progress that the group has thus far made in terms of reviewing and developing a scenario. During this particular meeting, Hampton noted, the focus should be on revising the final scenario, reviewing wood volume estimates, and agreeing on methods for wood supply estimation. The final working group meeting will take place on November 29 in the ARD building on NAU campus in Flagstaff, AZ.

Hampton informed the group of the timeline for finalizing the project report: report will be submitted to working group and Region 3 by Dec. 17, 2007; comments from working group should be submitted to ForestERA by January 18, 2008; and a final report will be ready to distribute by Jan. 31, 2008. Representatives from ForestERA will be presenting analysis results at a meeting hosted by the Association for Fire Ecology in Tucson, AZ Jan. 28-31, 2008.

Hampton then summarized the working group's email discussion two weeks prior regarding the shift in the upper diameter threshold from 12 in. DBH to 16 in. DBH resulting in the following three classes: <5in. DBH, 5-16 in. DBH, and >16 in. DBH. She explained that the main reason given by working group members for requesting this shift was that the classes should be comprehensive enough to encompass as much of the useable material on which there has been a general agreement. She stated that some working group members had commented that a 16 in. threshold is less informative for some types of industry than a 12 in. threshold, and some members requested an 18 in. threshold to match the top end of VSS4, as used in Goshawk Guidelines.

After reviewing the agenda and the shift in diameter class ranges, Hampton provided the members with updated information regarding their restoration treatment scenario. Jill Rundall displayed maps portraying areas with Mexican spotted owl protected activity centers (MSO PACs), Specially Designated Areas such as Wilderness areas, steep slopes, goshawk nesting areas, completed treatments, streamside management zones, soils with limits on mechanized

equipment, and other areas deemed otherwise unavailable as a source of wood supply by the working group in the total 2.4 million acre project area. Once these areas are taken into consideration, the resulting acreage in the analysis area is 1.8 million acres (see details in table below).

## Areas Not Considered Sources of Wood Supply

| | | Acres |
|---|---|---|
| 1. | Mexican Spotted Owl PACs | 182,000 |
| 2. | Specially Designated Areas | 177,000 |
| 3. | Steep slopes (>40%) | 147,000 |
| 4. | Contracted and completed treatments | 113,000 |
| 5. | Goshawk nest areas | 63,000 |
| 6. | Soil restricted from mechanized treatment | 126,000 |
| 7. | Streamside management zones | 52,000 |
| | Total Acres (including overlap) | 860,000 |
| | Overlap among all layers | -222,000 |
| | Total Acres (excluding overlap) | 638,000 |
| | Ponderosa-pine lands in study area | 2,413,000 |
| | Ponderosa-pine lands remaining | 1,775,000 |

Hampton then reviewed information gathered by Gary Snider regarding 8 environmental assessments (EAs) conducted under NEPA in both Coconino National Forest and Apache-Sitgreaves National Forest. She provided draft estimates of the percentage of areas not thinned on the project-level analysis (22% on average for CNF); for ASNF, the average of areas not thinned was 27%. The group had expressed interest in possibly adjusting the number of areas not considered a source of wood supply in their treatment scenario based on the EA assessment as a greater number of factors, such as archeological or historical sites and wildlife movement corridors, are considered at the project level. One participant commented that these project level values validate the amount of area the group has already decided would not significantly contribute to wood supply. Participant: 26% from the landscape level analysis seems on the lower side given that Designated Roadless/Wilderness are not included. Another participant stated that this is an issue the Grand Canyon Trust has been looking at over the last couple of weeks, and agreement on the issue demands a hard look at what's happening realistically across the landscape. We have reviewed 30 EAs – and have found higher percentages of areas have not been thinned. Here are our averages: mean percentage of thinned on ASNF is 51%, on Kaibab the mean is 47%, Coconino is 37%, with a mean of 45% for all projects thinned.

Hampton then stated that the project analyses completed by Snider excluded meadows and to the extent possible focused on ponderosa pine dominated areas to make them comparable with the landscape-scale analysis of the group's treatment scenario and asked if the analyses used by Grand Canyon Trust did the same. In the CocNF, 83% of the areas included by GCT were dominated by PIPO; the remaining areas did include meadows. Another participant noted that the difference of percentages between these two groups might reveal other methodological differences. It might be important, she said, for the two groups to sit down and make sure they

are comparing apples to apples. Hampton agreed and suggested they meet during a break that day and again before the next meeting. One participant recommended that the calculations be based on each project area and not the larger analysis areas. Participant: Urban interface projects are an issue we need to talk about when discussing this percentage as well. We need to consider land classifications, because a lot of the wood supply analysis area is wildlands, not urban interface where thinning has been favored vs. burning; this may be what is reflected in this difference. Group members decided to hold the current conversation until later in the meeting. Hampton then continued with the scenario analysis.

Hampton reviewed the restoration treatment zones included in the final scenario (see table below).

## Restoration Treatment Zones

| | Acres | Full Area | Source Area |
|---|---|---|---|
| 1. Not considered source of wood supply | 638,000 | 26% | |
| 2. Community protection | 355,000 | 15% | 20% |
| 3. Mexican spotted owl restricted habitat | 237,000 | 10% | 13% |
| 4. Municipal watersheds | 60,000 | 2% | 3% |
| 5. Aquatic species watersheds | 313,000 | 13% | 18% |
| 6. Wildlands | 809,000 | 34% | 46% |
| PIPO lands in full study area | 2,413,000 | 100% | |
| PIPO lands available as wood source | 1,775,000 | | 100% |

| | | |
|---|---|---|
| Remaining WM Stewardship Contract Areas* | 416,000 | (in full area) |
| Remaining WM Stewardship Contract Areas | 343,000 | (in source area) |
| PIPO lands available for new contracts | 1,432,000 | |

* Areas remaining to be treated within NEPA Planning Areas between 2008 and 2013

| | | | |
|---|---|---|---|
| Areas over ¼ mi. from exiting roads | 241,000 | 10% | 14% |

The remaining areas available for new contracts comes to 1,432,000 acres. However, the group is still contemplating if more areas should be removed based on the EA study, which is still in progress. White Mountain Stewardship contract NEPA analysis areas amount to 416,000 acres across the full 2.4 million acres ponderosa-pine dominated area. A participant commented that once NEPA has been completed for these areas then the exact project areas within these greater analysis areas will be known. There is no upper limit in the contract. 150,000 acres in the contract is the goal. Participant response: An excess of acreage could go to any contract. Those acres should not be taken out of the wood supply analysis since they are not part of any contract right now. After further discussion the group agreed that the 120,000 acres remaining as part of the initial 150,000 Stewardship contract acres should be used in the report as an estimate of what has already been allocated for the White Mountain Stewardship contracts and thus is not available for new contracts.

Hampton then directed the group members to reconsider the issue of roads as it pertains to the scenario, an issue upon which the members focused much of their attention during the last meeting. After areas of overlap with areas not considered a source of wood supply are not considered, 241,000 acres of land in the project area is further from a quarter mile from existing

roads in ponderosa pines areas (10% of full area, 14% of source area). This might be valuable information for the Forest Service to use since areas greater than that distance (quarter of a mile) are difficult to access with today's chip trucks and other equipment. Hampton inquired what the group's feelings were regarding this proposal from the scenario attributes committee. Participant: My question is this: what would be the best way to present these numbers? The base amount we are confident about? Have an adder, perhaps? Participant response: A quarter mile is the basic skid distance. Participant: This is a conservative number. We have to keep in mind that we are dealing with existing equipment, say nothing of the current condition of the roads. It is probably beyond this group's ability to analyze the accessibility. But the number is there, nonetheless, even if we are unable to get all of these roads in the rest of the area up to the standard for such an endeavor. Another participant mentioned that the group should look 10-20 years from now and consider the machinery that may be available to access zones further than a quarter mile from the roads. He stated that more advanced machinery may then be available, allowing greater access to areas past the quarter-mile mark. Commenting on the language to be used in the report, another participant noted that the roads evaluated in the project area are accessible, and that it is just a question of whether to utilize them or not. They should not be left out of the project because of questions of accessibility; they may just be more expensive to use. Romero paused the discussion, asking the group members to consider the language used to discuss this issue of roads in the report. She questioned how such an issue should be phrased to encompass everything the group had discussed up to this point. Hampton further clarified Romero's question, stating that wood harvesting technology may shift over the next 20 years, allowing people to access more than .25 miles. She asked the group how this issue should be portrayed in the scenario. A participant responded to this question by stating that it is unlikely that there will be mechanical treatment in those harder-to-access areas. The narrative of the report, he stated, should characterize the issue in that way. He suggested that we should give the current available/accessible landscape a value – albeit, a conservative value. In addition, the narrative should discuss the road network; the working group does not have the ability to judge what is and is not usable. The narrative should therefore state that with existing technology, it is unlikely that there will be mechanical treatment in these areas. Participant response: Why are these areas still included in the total number, then, but left out? Mechanical treatment may be unlikely today, but should still be considered when discussing future supply. Some participants stated that different scenarios should be described in the report, one of them discussing the issue of future technology. One participant stated that grants are currently being written for such advancements in technology, making this more of an economic issue than a technological one. The group chose to go with a suggestion by one member on the use of confidence intervals in the report, outlining that supply may be derived in the future from additional acres with moderate or low confidence. When more acres become possible in the future, these items of lower confidence may then be realized.

Hampton then outlined the scenario attribute subcommittee's proposed strategy for defining post-treatment forest structural conditions in each landscape zone using recommended basal area ranges (i.e., in community protection areas the subcommittee recommended a range between 30 and 60 $ft^2$/acre with a mode, or most common value, of 40; in municipal and aquatic species watersheds 40 to 120 with mode of 60; in MSO Target pine-oak habitat 60 to 120 with mode of 100; in MSO other restricted pine-oak habitat 45 to 120 with mode of 70; and in remaining areas or "wildlands" 40 to 160 with a mode of 80 $ft^2$/acre). The subcommittee also provided ranges of

desired post-treatment conditions for canopy cover and tree density as guidelines. She noted that ForestERA has not determined that it is possible to model treatments across the landscape in this way since the methodology differs from what ForestERA has used in the past and given time limits on the project, but they have been working towards getting as close to this as possible and will at a minimum include a description of the group's desired future conditions in the report even if they need to use a more simplified approach. One working group member was concerned that using a mode of 80 $ft^2$/ac in the wildlands would leave the forest too dense to reduce the threat of high severity wildfires. Another member stated that the subcommittee chose a range of basal areas in order to increase the post-treatment heterogeneity of the landscape. He also noted that there were no numbers on the y-axis of the chart as ForestERA has not yet derived curves representing 100% of the basal areas in each zone [i.e., probability density functions] from these curves hand drawn by the scenario attribute committee. They will need to determine the y values for each curve in a subsequent step. Subcommittee participant: The tails of the curves could shift a bit. There is nothing prescribing what those numbers should be. We are trying to push towards a heterogeneous landscape. In the narrative we need to explain why we came up with the numbers for the tails that we did. Hampton asked the group if they agreed to include the distributions in their scenario as they were currently presented; Romero tallied the group and established that consensus had been reached on this issue. Members then discussed what would be an appropriate patch size within which each basal area distribution would apply, however did not come to a conclusion. Hampton commented that this would add greater complexity to the modeling which ForestERA may not be able to include in the analysis given time and resource constraints, but understood that this was of interest to the group even though no specific patch size was decided upon. At any rate, this issue of patch size will be included in the narrative.

**Steve Gatewood: Fire Subgroup**

Gatewood presented information discussed by the fire subgroup since the last full group meeting, stating that the group has focused heavily on where fire-only should be used on the landscape as a restoration treatment. This is relevant to this process as it could impact the quantity of restoration by-products from mechanical treatments (followed by prescribed burning). On the other hand, where is wildfire such a great threat that we need to use mechanical thinning, he asked? Can we define conditions where prescribed burns would be the preferred treatment? Among the factors the group needs to consider when assessing the preferred treatment are weather conditions and structural characteristics. To seek information regarding these questions, the fire group asked, Pete Fulé, Associate Professor of Forestry at NAU and ERI faculty member for his expert opinion. This information was sought to enlighten the working group on issues regarding burn only treatments as they relate to forest restoration and wood supply. In response to a question regarding appropriate treatment strategies under various weather conditions, Fulé responded by saying that under the right conditions, any forest can be burned. In other words, the right weather conditions, when combined with the right fire, will result in a successful treatment. Fulé had been asked whether there was a set of forest structural parameters that one could apply across the landscape to assess where prescribed fire may be the best first-entry tool. Fulé responded that a good rule of thumb would be to consider areas with less than 100sq ft/acre and less than 100 trees per acre, however went on to say that these are complicated questions, and the weather question asked is the only one with a real answer. The forest structure question has more to do with people's interests and opinions. Nothing is set in stone, he then said, and other opinions are valid as well, when discussing these issues.

Gatewood then commented on the percentage of the landscape that falls below 109 ft2/acre BA and 160 trees per acre, which cover between 6 and 10% of the landscape as calculated by ForestERA based on 2006 forest conditions. These are very thick, dense forests. How can we look at those numbers/ranges/percentage sets – where and how much do we want to draw on this analysis? Two parameters affect how the landscape is shown. Hampton then provided maps revealing three different basal area thresholds (below 100 ft2/acre BA, 70BA, and 50BA). Below 50BA (10% of landscape), below 70BA (22% of landscape), below 100BA (40%). Gatewood reiterated that different treatment plans for these three ranges would need to be discussed. Maps revealing trees per acre are not yet available, she said, but will be developed in the next several days. A participant voiced her concern by stating that the fire issue was a NEPA decision, and she was not sure why it should be debated in the context of the working group. NEPA decides what the best tool is and how much smoke we can put into the environment. Proximity to communities is taken into account. This group member said that she does support tagging some acres for group consideration, but while fire might sometimes be suitable for a given area, it may not always be practical. Fulé followed up on the issue of practicality as it relates to prescribed burns. In reference to the checker-boarded zones on the basal area maps displayed, he said that one cannot manage fire in zones this small (say, one or two 90m pixels) – fire managers cannot differentiate between pixels on the land and burn that way, so a using a larger minimum patch size for burn-only treatments would be a better way to model these treatments.

A participant encouraged the group to be soft with language in the narrative in regards to fire treatment issue. For the report to appeal to a broader audience, he proposed a "status quo" approach to the burn-only issue. This approach, according to the participant, would assume that the same proportion of the landscape should be burn-only (~30%) as it has been specified in NEPA documents to burn over the last 10 years. Stay with the current Forest Service burn numbers, he urged. Another participant challenged the assumption that burning was always a restorative treatment. While the Gila NF had been earlier referenced as a good example of a area with many successful burns, the member stated that what he has found in his research is that it doesn't always restore forest structure. Participant response: The issue of using fire as a restorative tool is debated across the political spectrum, and if we want to come to some wood supply numbers, we should go with the interpretation of status quo. Some participants voiced their disagreement with this opinion, stating that current FS policy, as it relates to fire treatment, may not be the best way of arriving at the ultimate goal of forest restoration. Also, just because an area is marked for burn-only in an EA doesn't mean it will be burned. Another member proposed a range of burn-only treatments to include in the report's narrative, using 65% as the high-end percentage. He used the example of fire treatments in the Gila NF as a means of demonstrating to the group that fire is already being used as an effective restorative tool. (Many were concerned with the use of Gila as a model for the rest of the project area, as appropriate treatment depends on individual characteristics of each landscape-unit, proximity to communities, and tree density.) Gatewood stressed the need to agree on structural parameters to include in the report. He stated that the report should be able to inform its readers where, exactly, the fire should go on the landscape and this would allow for a more exact determination of wood supply.

Hampton stated that the reasons lands were designated as burn-only in the NEPA reviewed by Snider were due to steep slopes, road inaccessibility, soils restricted from treatments, and MSO PACs. A participant responded by saying that many of these conditions were noted in previous maps, and those zones (soil, no roads, steep slopes, etc.) were already taken out of the available supply area. We now need to look at risk factors in the remaining areas (smoke, urban interface, etc.), she argued, to make our final decision. A participant added that wildlife movement corridors and old growth were additional reasons "NEPA"ed areas were designated burn only and that the group had already determined that these cannot be accurately portrayed in the landscape analysis. Romero asked the group if there were any alternatives to propose besides the "status quo" proposal. Sisk then reiterated Romero, encouraging those participants who did not agree with the "status quo" proposal to voice an alternative proposal. He stated that the group needed to come to some sort of agreement on one proposal if the process is to move forward. After much debate in regards to appropriate treatment, the outlining of spatial parameters, and the purpose of this project (whether the report should propose directives for the Forest Service or not), the group came up with the following three ways of approaching fire treatment strategies in their scenario:

**General info:**

- NEPA burn-only areas amount to approximately 28% of all ponderosa-pine dominated areas in the analysis area. These burn only areas occur on:
    - Steep slopes, PACs, areas inaccessible from existing roads, old growth areas and wildlife movement corridors
    - Some of these burn-only areas were in PJ
- The Wood Supply scenario's Areas Not Available for Wood Supply (PACs, steep slopes, soils, SDA, streamside mgmt zone, goshawk nests) cover 26% of the study area.
- Burning may not be the best treatment for steep slopes and PACs

Alternatives:

1.) Recent project-level burning levels: Use percent of areas planned via NEPA for burn-only treatments. Most of these areas are included in Areas Not Available, however some are not (e.g., old growth and wildlife movement corridors). The area (acres) of the remaining features will be assumed as the differential between the landscape assessment Areas Not Available and the NEPA burn-only areas and will be indicated in narrative as high confidence as unavailable for wood supply and estimated in terms of average volume per acre. Need to remove Wilderness and Roadless Areas at front end as these are not included in NEPA planning areas. Develop best guess estimate today.

2.) Low risk of wildfire: Use forest structure parameters (basal area and tree density) to define areas where prescribed burning may be the preferred restoration treatment due to low risk of escaped fire or wildfire spread through tree canopies. Develop map showing areas with the following combinations of basal area and tree density: 1) 100 $ft^2$/ac and 100 trees/acre, and 2) 80 $ft^2$/ac and 160 trees/acre.

3.) Wildlands focus: Apply more aggressive burning percentage outside of WUI and possibly municipal watersheds. 65% of area burned to reflect current burning in some wildland settings.

**Below is general discussion of the three approaches to fire-only treatments to include in the scenario:** One participant said that she was uncomfortable with all of the alternatives. She worries about what characteristics would be left were such aggressive strategies to be instituted. There is not enough data, she said, to assess to what degree fire would be a necessary treatment in the project area. We want to say that those areas could be available for treatment and supply in the future, she said, but we have yet to replace the placement habitats of those species. She went on to say that she is not going to recommend the available areas all be burned without additional analysis, as burning may not be the best treatment for many zones in the project area, such as MSO PACs. The member to propose the third alternative recommended that the narrative deal with one of these plans clearly and robustly in the narrative. Unlike stating a specific recommended percentage for fire treatment, he instead wishes the report to offer a range (for example, 10-65%). Such a range should be mentioned in the actual scenario, not lost in a paragraph of the document. A member responded by saying that she worries about the implications of discussing the issue in such a way. The number currently being debated deals with fire treatment, not restoration. How do you get back, she asked, to the best restoration of the landscape's structure and function? The goal of restoration, she reiterated, should be the focus of this discussion. She went on to say that she does not think that 65% of the landscape can safely receive fire. Another participant agreed with this statement, saying that to burn 65% of the forest would be irresponsible. The Apache-Sitgreaves Forest, she said, is a fairly urban forest, ad there would be no way to burn that high of a percentage. Oftentimes fire is the default treatment due to lack of mechanization. We are trying, however, to restore these acres, she said, and if we go through and thin first, then in the future we can get close to burning 65% of the landscape. Today, however, the number will be much lower – close to 10%. We will not be able, she said, to pull off more than that. After a group member asked Hampton what the consequences would be if they did not arrive at a decision during today's meeting, Hampton said that the information would then not be available to present back to the group in their final meeting on Nov. 29. She stressed that ForestERA would need a set of criteria today if the group wanted them to conduct a spatial analysis before the next meeting. Sisk told the group that their ability to shape where they go is now. One participant suggested that due to the high mortality rate that would result in instituting the third alternative at present, the group should highly consider the first alternative. Another member stressed the empirical strength of the second option. He reiterated the need to rethink the basal area and trees per acre, however. If we look at both, he said, we are at 10% of the study area. The group asked if ForestERA could come back with an analyses of 1, 2 and 3 for the next meeting, although alternative #1 received the most support from the group.

The rest of the discussion regarding the issue focused mainly on the range suggested in alternative #3. While some members agreed conceptually on the third alternative, they felt as though 65% was unsafe and unrealistic. Others feared that if wide-scale fire was introduced in wildlands areas, old growth would be at risk. Some members disagreed with option 3 on the grounds of how such wide-scale burning could affect the available wood supply. Some members in support of alternative 3 claimed that as forest conditions change, and depending on various other factors that may change in the future, 65% may not be as unrealistic as it currently seems. Romero asked the group whether these three alternatives should merely be described in the narrative, or if the group should make a specific preference. Hampton said that ForestERA would be able to do a spatial analysis of 2 and 3 fairly easily, although they would have to make some assumptions on patch sizes and other details that the group did not specify. For alternative #1,

she said that ForestERA and the Grand Canyon Trust could meet to bring their project level analyses together. Sisk said that while figures for all three alternatives could be developed, the working group had always tried to resist the temptation to split into multiple scenarios. Including all three alternatives into the report, he said, will not take the group to their final objective. We can look at all three alternatives and present them at the next meeting – all three will come out with a number of supply – but the group should consider coming to an agreement on one (or a combination) of the plans. Rosemary summarized the group's final decision on this item for the current meeting, re-emphasizing Sisk's words of honing in on a zone of agreement. If one alternative cannot be agreed upon, the two options may be possible. Information on all three alternatives will be analyzed by ForestERA and presented to the group at the next meeting for the final alternative to be decided on.

**Wood Volume Estimates (Steve Sesnie)**

Sesnie provided the working group with information on how ForestERA had arrived at their current estimates of wood volume. Information entered into the analyses includes Forest Inventory Analysis ground data and Landsat TM 2006 remote sensing imagery and digital elevation models. After outlining the data used to predict forest structural elements and estimated volume, Sesnie explained the accuracy of such imputations. Between the observed and imputed data, Sesnie stated he had achieved an r-value of 76% for total wood volume. Some of the final data is currently being re-run to ensure the accuracy of the derived amounts. Sesnie stated that the accuracy for smaller basal areas is not as high since it is more difficult to measure differences below the canopy. Also, where there are high density levels of saturation, volume is more difficult to predict.

Sesnie stated that the total wood supply volume in cubic feet in the pine type was 4.6 billion in the 2.4 million acre project area. With 1.3 billion cubic feet (CF) of this volume being set aside in the working group scenario, the total available volume reaches 3.3 billion CF (see table below for additional details):

| Volume category | Total Cu. Ft. (billion) | Vol.% | Acres (million) | Acres % |
|---|---|---|---|---|
| **Total volume** | 4.6 | 100 | 2.4 | 100 |
| **Tot. vol. removed** | 1.3 | 28 | 0.6 | 28 |
| **Tot. vol. remaining** | 3.3 | 72 | 1.8 | 72 |
| | | | | % of available |
| **Community protection** | 0.6 | 20 | 0.36 | 20 |
| **MSO restricted habitat** | 0.5 | 15 | 0.24 | 13 |
| **Municipal watersheds** | 0.1 | 4 | 0.06 | 3 |
| **Aquatic species watersheds** | 0.6 | 19 | 0.31 | 18 |
| **Wildlands** | 1.4 | 42 | 0.81 | 46 |

Sesnie stated that he will be able to calculate the percentage of volume in each diameter class (5 in., 5-16, 16+) after running the grids before the next meeting. To ensure that these estimates

reach the highest level of accuracy possible, Sesnie plans to compare the totals from these categories to total volume.

Hampton then shifted the discussion to wood supply. Hampton reviewed a proposal developed by the Steering Committee and reviewed with the scenario attribute subcommittee for assuming that restoration by-products will largely come from <5 in. DBH and 5-16 in. DBH classes. The report will highlight areas where it is not possible to meet desired post-treatment conditions by removing wood solely from these classes. However, near communities, removals in the > 16 in. DBH class may be realized if necessary. A participant proposed 10% of each of these lower DBH classes should not be removed. The group agreed with this suggested and the plan developed by the Steering Committee. One member suggested including a growth model into the equation as the supply is stretched over the years. Sesnie then stated that growth averages 30 CF/acre a year.

One participant noted that the maps of the project area do not take into consideration the White Mountain Apache Tribe where much wood volume is available on the ground. In past meetings, he said, we mentioned the desire to work with the tribe, and now that we are close to the end of our study we need to act on it. Hampton mentioned that she and Sesnie had traveled to White River on the White Mountain Apache lands on Oct. 18 and met with the Paul DeClay, the Tribal Forester on this issue. A participant announced that sadly, he had passed away several weeks ago and that it would be unlikely for the tribe to provide reservation-wide volume estimates of small-diameter wood for this project. Hampton said she had been in contact with the acting tribal forester, Mary Steuver, who had attended two of the working group meetings, and at the appropriate time, would revisit this issue with her.

In addition to the narrative, Hampton presented a map created by Rundall, that identified treatments recommended in previous CWPPs. Rundall described the types of treatments and intensity of treatments for the areas of Flagstaff, Rim Country, and Apache-Sitgreaves National Forest which are the only CWPPs where specific information on treatments was available. Hampton explained that the idea is to create what we have spatially for CWPPs, not calculated as volume, but just as one scenario. A member questioned how this information would be used, as she was worried that the report may speak against such community-derived treatment plans. Participant response: In the report we plan on discussing why our recommended treatments may or may not match community-approved treatments. We plan on addressing that difference in the report. The member responded by saying the WUIs in her area (Apache-Sitgreaves) were defined by the community, and that the report should not arbitrarily second guess what the community wants. She went on to say that the report has to show why the group is deviating from the CWPP; we may be able to deviate when we prove with science that we need to deviate. Hampton then asked the group if they were ready to decide between the two scenarios for the report: stick with the Wood Supply Analysis community protection zones currently in their scenario, or offer the alternative treatment zones defined by CWPPs. A member stressed that whatever the group decided to do, they must make sure to be consistent in the entire project area. He suggested running it the same everywhere (using the Wood Supply Analysis community protection zones), and then run the CWPP. In other words, he preferred taking a standardized approach, following that standard approach by deviating according to each community's specific wants and needs as outlined in the CWPPs. The group decided to run a consistent application of

treatment zones before consideration of the CWPP. Results would be calculated on a location-by-location basis. In the report he stressed that much care should be taken in deciding how to present this information.

A group member requested that the report should, in some way, address climate issues over the next 20 years in the context of forest restoration and available supply. In the same vein, estimated fire risk, disease, and insect threat should also be placed into consideration. In sum, one member stated that these issues could be handled in a section addressing/estimating future tree mortality. She explained that such an issue should not be handled as a spatial analysis issue, but as a discussion which arrives at a percentage lost in volume. Sisk said that while ForestERA would be able to look at the current trends and project those trends out, such projections always result in there being no forests left. We are left with only uncertainties, he stated, and must therefore rely on adaptive management. The narrative can address these uncertainties, but, it is not possible to provide firm figures on how these risks may affect wood supply or overall forest health. In terms of the final report, several group members have volunteered to supply text for certain sections of the report by Tuesday Nov. 27: Steve Gatewood on CWPPs, Shaula Hedwall on wildlife/restoration treatment issues, Ethan Aumack on burn only treatments, and Lisa McNeilly on impacts of climate change and natural disturbances on future wood supply. Vosick sculpted the narrative for the issue of old growth management and submitted copies to the entire working group during the meeting. Hampton encouraged the group to read through this portion of the narrative carefully and email Vosick comments by Tuesday Nov. 27. These sections will be discussed and finalized at the Nov. 29 meeting.

Gary Snider provided the group with additional information on the 4 EAs from Coconino NF and 4 EAs from Apache-Sitgreaves NF discussed earlier. Taking into account ownership and landscape features, Snider said that, across the board, ~75-80% of these project sites had been set aside for thinning treatments and ~20% had burn-only treatments. The implications of these projects is not yet easy to determine, Snider noted, but he will provide the group with that information once it becomes available. Snider also presented the following updated table for the White Mountain Area (Apache Sitgreaves NF) on Harvesting Contractors for year 2006:

| **Harvesting Contractors** | **Green Tons (old)** | **Green Tons (new)** | **CCF (new)** | **% of Total CCF** |
|---|---|---|---|---|
| | (thousand) | (thousand) | (thousand) | |
| ***Walker Brothers*** | 110.8 | 129.3 | 36.9 | 63.8 |
| ***Tri Star Logging*** | 44.6 | 52.0 | 14.6 | 25.3 |
| ***Nutrioso Logging*** | 12.3 | 14.4 | 4.1 | 7.1 |
| ***Renegy*** | 6.5 | 7.6 | 2.2 | 3.8 |
| **Total** | 174.2 | 203.3 | 57.8 | 100.0 |

The numbers obtained by Snider indicate that green tons have become heavier – 3-3.5 tons. This shift does not affect CCF, however.

The final wood supply working group meeting will be held on Thursday, November 29, 2007, from 9am-4:15pm at the same location as this meeting (Large Pod Conference room, Applied Research and Development Building, Northern Arizona University, Flagstaff).

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**November 29, 2007**
**9:00 a.m. – 4:15 p.m.**
**Large Pod Conference room, Applied Research and Development (AR&D) Building**
**Northern Arizona University, Flagstaff, AZ**

| | |
|---|---|
| 9:00 – 9:15 a.m. | Review meeting agenda and various project updates **–** *Haydee Hampton* (Research Associate, Environmental Sciences, Northern Arizona University) |
| 9:15 – 10:30 a.m. | **Review final treatment scenario**<br><br>Review Working Group's final treatment scenario including areas selected as appropriate for restoration treatments and the desired post-treatment conditions for community protection and other landscape zones defined within these areas. **–** *Haydee Hampton*<br><br>Present final results of NEPA project-level analyses completed by Gary Snider (Forest Economist and Doctoral Candidate, School of Forestry, Northern Arizona University) and Andrew Frost (Assistant, Grand Canyon Trust) **–** *Ethan Aumack* (Director of Restoration Programs, Grand Canyon Trust) and *Haydee Hampton* |
| 10:30 – 10:45 a.m. | Break |
| 10:45 – 12:00 p.m. | **Review final treatment scenario (cont.)**<br><br>Continue any remaining review from earlier session. Present alternatives identified at Nov. 16 meeting for addressing fire as a restoration tool – *Brett Dickson* (Assistant Research Professor, Environmental Sciences, NAU) *and Haydee Hampton* |
| 12:00 – 1:00 p.m. | Lunch<br><br>*** Lunch will be on your own. Working group members are encouraged to bring their own lunch. *** |

| | |
|---|---|
| 1:00 – 2:30 p.m. | **Report out on major project results**<br><br>Presentation on estimates of wood volume by size class across analysis area and estimates of potential wood supply stemming from working group's desired post-treatment conditions **–** *Steve Sesnie* (Postdoctoral Research Associate, Environmental Sciences, NAU) *and Haydee Hampton* |
| 2:30 – 2:45 p.m. | Break |
| 2:45 – 3:15 p.m. | **Discuss project report and potential follow-on economic analyses** |
| 3:15 – 3:45 p.m. | Wrap-up – *Tom Sisk* (Professor, Environmental Sciences, NAU) |
| 3:45 – 4:15 p.m. | Public comment period |
| 4:15 p.m. | Adjourn |

**Wood Supply Working Group Meeting**
**Analysis of Small-Diameter Wood Supply in Northern Arizona**

**November 29, 2007**
**9:00 a.m. – 4:15 p.m.**
**Large Pod Conference room, Applied Research and Development (AR&D) Building**
**Northern Arizona University, Flagstaff, AZ**

## Introductions and Agenda Review

Haydee Hampton welcomed Working Group Members and reminded them that this was the final of seven working group meetings and the purpose was mainly to review the treatment scenario they had developed over the last half year including estimates of wood supply based on their scenario. She introduced Dexter Albert, a meeting facilitator filling in for Rosemary Romero who could not attend. Dexter asked members to introduce themselves.

**Working group members present at meeting:**

1) Keith Pajkos, Timber Staff for the Arizona State lands Department Forestry Division
2) Bill Greenwood, City Manager for the Town of Eagar
3) Herb Hopper, Community-based forest and wood products advocate, Little Colorado Plateau Resource Conservation & Development
4) Steve Gatewood, Consultant, Wildwood Consulting Inc., representing the Greater Flagstaff Forests Partnership
5) Pascal Berlioux, President and Chief Executive Officer of Arizona Forest Restoration Products, Inc.
6) Lisa McNeilly, Northern Arizona Program Director of The Nature Conservancy
7) Jerry Drury, Timber Staff Officer for Kaibab National Forest
8) Rob Davis, President/Owner of Forest Energy Corporation/Future Forests
9) Todd Shulke, Forest Programs Director for Center of Biological Diversity
10) Diane Vosick, Associate Director of the Ecological Restoration Institute
11) Bob Taylor, Supervisory Natural Resource Specialist, Apache-Sitgreaves National Forest (Alternate for Elaine Zieroth, Forest Supervisor, ASNF)
12) Shaula Hedwall, representative of the U.S. Fish and Wildlife Service, Ecological Services
13) Larry Stephenson, Executive Director of the Eastern Arizona Counties Organization
14) Ethan Aumack, Director of Restoration Programs for Grand Canyon Trust
15) Kim Newbauer, Timber Sales Contracting Officer for Coconino National Forest
16) Sarah Lantz, Urban Wildlife Planner for Arizona Game and Fish Department (Region II Flagstaff Office)
17) Scott Higginson, Executive Vice President, Renergy Holdings Inc.

**Working group members not present at meeting:**

1) Robert LaCapa, Forest Manager, DOI BIA Fort Apache Agency Branch of Forestry
2) Mary Steuver, Acting Tribal Forester, Forestry Department, White Mountains Apache Tribe
3) Chuck Peone, Fort Apache Timber Co.
4) Molly Pitts, Executive Director of the Northern Arizona Wood Products Association

**Project support team present at meeting:**

1) Haydee Hampton, Research Associate, Center for Environmental Sciences and Education at NAU; Wood Supply Analysis Project Director and Spatial Analyst, ForestERA
2) Steve Sesnie, Post-Doctoral Research Associate, Center for Environmental Sciences and Education at NAU; Remote Sensing Specialist, ForestERA
3) Brett Dickson, Assistant Research Professor, Center for Environmental Sciences and Education at NAU; Wildlife Ecologist, ForestERA
4) Tom Sisk, Professor, Center for Environmental Sciences and Education at Northern Arizona University (NAU)
5) Gary Snider, Forest Economist and Doctoral student in the School of Forestry at Northern Arizona University
6) Dexter Albert, Meeting Facilitator, Intrinsic

**Observers:**

1) Bob Baltes, Baltes Distributed Generation and Camp Navajo Tribal Development
2) Diane Williamson, Earth Friendly Fuels
3) Sue Sitko, The Nature Conservancy
4) Ed Smith, The Nature Conservancy
5) Stacey Hamburg, Sierra Club

**Overview of Agenda and Group Treatment Scenario**

Haydee Hampton presented an overview of the meeting's agenda including that ForestERA would review the working group treatment scenario and that the group had several final decisions related to the scenario to make that day: 1) how to use the results of the Environmental Assessment review, 2) choosing among the three fire-only alternatives the group developed at the Nov. 16 meeting, and, 3) reaching agreement on several details of how wood supply would be determined, including the post-treatment basal area distributions.

Haydee then summarized the overall goals of the project and the "roadmap" for developing treatment scenario(s) that the working group had developed at their second meeting in Pinetop:

1. Identify areas appropriate for restoration treatments that recover wood byproducts ("what's on the map")
2. Define management objectives ("target conditions") to guide selection of treatments
3. Select appropriate treatments.
    - Calculate supply produced by applying the appropriate treatments across the map
    - Once forest growth recommendations are available, discuss as group if and how to best use them in this study.

Haydee displayed a map portraying areas with Mexican spotted owl protected activity centers (MSO PACs), Specially Designated Areas such as Wilderness areas, steep slopes, northern goshawk nesting areas, completed treatments, streamside management zones, soils with limits on mechanized equipment, and other areas deemed otherwise unavailable as a source of wood supply by the working group within the total 2.4 million acre project area. Once these areas are taken into consideration, the resulting acreage in the analysis area is 1.8 million acres. Haydee noted that tree mortality due to fire, insect outbreaks and other natural disturbances are accounted for in reduced volume estimates. She then reviewed the restoration treatment zones

included in the working group's scenario explaining that at the Nov. 16 meeting the group had decided to include an ASNF estimate of 120,000 acres remaining to be treated as part of the White Mountains Stewardship Contracts even though there is no upper limit to number of acres in the White Mountains Stewardship Contract (at least 150,000 acres is the goal). As there is no spatial information available yet on the location of the project areas within the broader NEPA analysis areas, the contracted acres will be discussed in narrative, but a spatially-derived wood supply estimate will not be possible.

Haydee then outlined the group's strategy for defining post-treatment forest structural conditions in each landscape zone using recommended basal area distributions (i.e., in community protection areas the subcommittee recommended a range between 30 and 60 $ft^2$/acre with a mode, or most common value, of 40; in municipal and aquatic species watersheds 40 to 120 with mode of 60; in MSO Target pine-oak habitat 60 to 120 with mode of 100; in MSO other restricted pine-oak habitat 45 to 120 with mode of 70; and in remaining areas or "wildlands" 40 to 160 with a mode of 80 $ft^2$/acre). A participant recommended removing the MSO Target threshold distribution as basal areas are not supposed to be reduced below 150 f $t^2$/ac in areas where MSO Target Threshold conditions are met. In addition, the locations of these areas are unknown and MSO Target conditions cover only a very small percentage of the landscape. The MSO restricted post-treatment basal area distribution tail should be moved to the right and the MSO Target areas should be assumed to be part of that distribution. The group decided that the US Fish & Wildlife working group member should develop a new MSO restricted curve to provide to ForestERA following the meeting. A member commented that ERI-provided ranges for pre-treatment conditions [in 0.1 to 0.25 acre plots] range widely, from 0 to 337 f $t^2$/ac.

**Review of Past Thinning Projects**

Haydee and Ethan Aumack, Grand Canyon Trust, then reviewed an environmental assessment (EA) analysis of the National Forests in the analysis area gathered by Gary Snider, a PhD student at the NAU School of Forestry contracted by ForestERA for the Wood Supply Analysis, and Andrew Frost an assistant at the Grand Canyon Trust. The group had expressed interest in possibly adjusting the number of areas not considered a source of wood supply in their treatment scenario based on the EA assessment as a greater number of factors, such as archeological or historical sites, old growth areas, and wildlife movement corridors, are considered at the project level than possible at the landscape-scale. Gary reviewed 6 WUI projects and 2 Wildlands projects and these had an average area not thinned of 22% and burn-only treatments of 20%. Gary also interviewed Forest Service staff who guesstimated a range of 40-50% of the area not treated on the ASNF and found an average of 38% not thinned on the Kaibab NF. Andrew found in a review of 25 EAs (including 6 of the same reviewed by Gary) an average area not thinned of 37% and burn-only treatments of 34% (and higher values by approximately 4% if a larger area was considered as the area of possible treatment). One participant commented that about 7 of these were in wildlands (vs. WUI areas). NAU and GCT compared methods before the meeting and determined they were using the same if the smaller total area was used. An average of all 27 EAs reviewed by both groups resulted in 36% not-thinned and 33% burn-only. There was a large range in the values: from 0 to 97% of areas not thinned. Ethan responded to various questions on specific numbers GCT presented for various projects saying that are various types of inaccuracies and imprecisions in the data, but that overall the numbers were valid and that the status quo percent of areas not thinned are in high 30s. One participant noted un-thinned areas include MSO PACs, steep slopes, so there is some overlap with areas already considered not a

source of wood supply in the group's treatment scenario. Another commented that this validates what we already removed from a wood supply source, but we may need another fudge factor, such as an additional 12% (the difference between 26% and 38%), to account for the greater amount of areas not being thinned in project completed over the last decade. Several members thought this would not be scientifically credible and that past performance does not necessarily represent future desired conditions. Does the group want to extrapolate status quo conditions into the future? What do the Forest Service reps think: will high 30s be the percent of land not-thinned in the future? One FS rep responded that we should stick with the 26% to maintain the spatial perspective we have been working with so far as new projects will occur in areas with differing slopes and other conditions that may be better represented at the landscape scale that on the basis of 27 past projects. On ASNF we will be not be burning more that 10% of the landscape both as burn-only and after thinning, however we may let fires burn that we have not set, such as was done on the Chiti Fire. On Kaibab, we have found that areas not treated are 37%. Participant: we could use these values (e.g., 37%) as error bars. Participant: current conditions represent mainly WUI treatment, so higher than 38% should be used such as done on Gila NF. In about 4 or 5 large landscape scale non-WUI projects 58-78% of areas on Gila NF, 40-75% were burned-only, with some areas are not getting any treatment. I would like to see more fire oriented projects, so do not like the status quo. Tom Sisk commented that we've looked at the systematic reasons (slopes, soils, etc.) for areas not-thinned. There is no technical way to anticipate acres not treated due to idiosyncratic and project specific reasons; so we will always underestimate the areas not-thinned with a landscape scale systematic analysis. There is an undeterminable number that won't be treated that should be included in the report. We should discuss in narrative this additional range of nonsystematic factors. Participant: Holding the 26% up as the scientific standard is an over-statement, it's just what we could do with the time and tools available. Participant: I would argue for more thinning on the Mogollon Plateau than in the Gila NF. Participant: Getting into the project level percentages in dangerous because the ranges in the values are so great and prefer going with the landscape scale. Let's quantify what the consensus is on how many acres to treat and then say there may be some more for this and that reason.

Participant: There is not consensus on the lower "status quo" limit (38% not thinned). The broader environmental community position as you extend out from community protection zones to the larger wildlands on how much should be treated is likely about 40% of all ponderosa pine to be thinned (60% not thinned). This value will differ among the zones in our scenario, such as higher in community protections zones and lower in aquatic. We've done a good job of determining where the pine would most likely come from and within that area, there would be a certain proportion, perhaps 40% on average, that we could obtain agreement that could be thinned. This position existed before this process began. This is a process to clarify positions, not to change them. Participant: We should tease out the extent of the range of acres according to various levels of accuracy, uncertainty and consensus. Participant: If the environmental community's offer on the table is 40%, let's start there and see if we have consensus on at least this amount. Participant: We should assign confidence levels. We have total confidence [agreement] on this value and less on higher values. Participant: Most of the lack of agreement is in wildlands and this makes up only 800,000 acres which is less than ½ the supply area. Participant: The 40% seems arbitrary, but given that the environmental community supports this as a maximum level of thinning, it is the zone of agreement we should present to the Forest Service, however the majority of the rest of the group prefers about 60% be available for

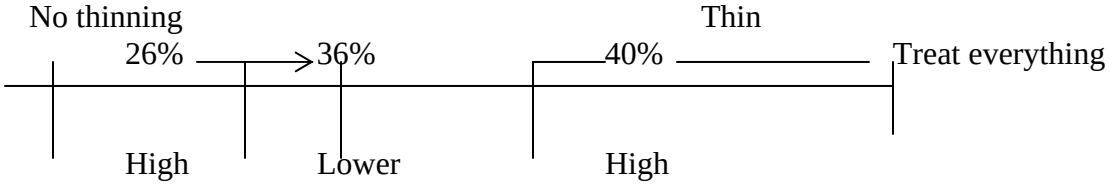
thinning and has a higher level of agreement. The 40% are the highest priority areas to thin mechanically. Participant: I'll throw out these values for consideration: 60% available for thinning in ponderosa pine in communities; 30% in wildlands; 35% aquatic species habitats; 40% municipal watershed, 30% MSO predicted habitat. Participant: Where do these values come from? Answer: The 26% of the area where wood supply is not available that we've come up with here has value. Tom Sisk: It's unreasonable to have expected that the group would all agree. In any problem with a lot of uncertainty, you partition out the where the uncertainty comes from. We have accounted for with great accuracy and high precision, the areas all agree are not a source of wood supply [26%] and have quantified the areas with high uncertainty that we cannot quantify or level of disagreement [between 26% and 60%] due to social and ecological component of the problem that is unknowable. The group has gone as far as it could reasonably be expected to go. Participant: Does the environmental communities' position for an overall 60% of area not thinned (40% to be thinned) include the 26% we already agreed to as a group would not be thinned and if we take out another 6% with no road access, then we're taking out another 28% of the landscape that will not be mechanically thinned? So we do have consensus on the 40% that can be thinned. Answer: yes. Participant: I thought our objective was to reduce the threat of catastrophic wildfire and more acres may need to be thinned in wildlands than 30% to do this. Shouldn't we follow the science? Participant: We're not going through a planning process of what can and should be done. Reality is that 10 years ago many wanted thinning to occur only hundreds of feet from communities. There has been a coming together over time on these issues.

**Burn-Only Treatments**

Haydee and Brett Dickson then presented the three burn-only alternatives that participants requested ForestERA analyze at the Nov. 16, 2007, working group meeting (see p.8 of the Nov. 16 meeting summary for a description of each), so they could choose one. Alternative 1, Recent project-level burning levels: Brett displayed a map showing where burn-only treatments would be if the lowest basal area regions were selected to total 34% of the landscape outside of community protection and municipal watersheds. Participant: The primary value for mapping this alternative is to provide a process for calculating the reduction in wood supply that would occur if 34% of the landscape had burn-only treatments. Participant: The conversation on the environmental community limit of 40% we had earlier supersedes this discussion. Alt#2 Low risk of wildfire: Brett displayed maps showing areas with less than 100 $ft^2$/ac and 100 trees/acre, and areas with 80 $ft^2$/ac and 160 trees/acre; both in terms of 100 acre patches. Alt#3: Wildlands focus with 65% of area with burn-only treatments starting with the lowest basal area regions for all zones except for community protection zones. The basal area threshold ends up being 125 $ft^2$/ac. Participant: Let's not try to make a decision on burn-only treatments and return to the morning discussion. Participant: Let's try to characterize the zone of agreement on this. The group decided to set aside this discussion aside as it's a subset of the earlier discussion.

**Level of Agreement on Percent of Landscape to be Thinned**

Steve Gatewood agreed to present the following scale developed by several working group members for describing the group's level agreement on the percentage of the landscape to be thinned and not-thinned:




**Landscape**
2.4 million acres

**Volume**
4.6 billion cubic feet

Participant: Where is the science behind 40%? Participant: Some of Mark Finney's work at the Missoula Fire lab informs the treatment of some fraction of the landscape. Tom Sisk: Science has informed the discussions so far, such as the volume estimates and landscape analyses. There is no linear set of logical steps that has lead to the 40%. Society does not run on science. Science can inform society so the deliberative process can reach a social outcome that is acceptable for the greatest number. What's important is what the agreement is, given that we have a wide range of core values around the table. Participant: There are constituents who would like to see their homes protected with greater that 40% of the lands treated. I thought consensus was that two numbers are put out and we work towards the middle. Participant: The 40% is an overall landscape average; the environmental community also would like a higher percentage of area treated near communities, perhaps 70% or more. For the majority of the working group members the 40% is a floor, whereas for the environmental community it is the ceiling. The group discussed two options for determining wood supply: 1) assume the area thinned per zone starts at the highest of the basal areas and go down till the percent for each zone (40% on average) of the landscape is reached, 2) multiply the percent of thinning per zone by the overall wood supply in cu. ft volume for each zone. Participant: There are alternate ideas on how much of the landscape you need to treat. The majority view, not just the minority needs to be expressed. Participant: The variability in post-treatment basal areas is what we should focus on in terms of getting agreement for what the majority has expressed for the 74% area not thinned. So for the high values compared to the low of 40% avg, just use what is left in each zone after 26% is removed. The high value should represent the status quo (~65% of the area not thinned), so adjust per zone percentages to get 65% overall.

The group developed the following language for use in the final report describing their level of agreement: "The group reached consensus that 40% of the landscape should be considered a source of wood supply. There is high level, but not total, agreement that an additional 23% to 34% of the landscape might also be available as a source of wood supply. The group reached consensus that 26% should not be considered a source of wood supply."

Proportion of landscape to be treated in each zone:

| | Complete agreement | High level of agreement |
|---|---|---|
| Community | 70% | 63-74% |
| MSO restricted habitat | 30% | 63-74% |
| Municipal Watersheds | 40% | 63-74% |
| Aquatic species Watersheds | 35% | 63-74% |
| Wildlands | 35% | 63-74% |
| Average | 41% | 63-74% |

**Wood Volume Estimation**

Steve Sesnie presented additional wood volume estimates with a discussion of accuracy for year 2006 forest conditions by three diameter size classes as well as the methodology ForestERA is using to calculate wood supply following treatments specified in the working group's scenario.

| **Volume category** | **Total (billion $ft^3$)** | **Vol.%** | **Acres (million)** | **Acres%** |
|---|---|---|---|---|
| Total volume | **4.56** | 100 | 2.4 | 100 |
| Vol. not considered supply | 1.3 | 28 | 0.6 | 26 |
| Vol. considered for supply | 3.3 | 72 | 1.8 | 74 |
| | | | | |
| Landscape feature | | % of total vol. | | % of total ac |
| Community infrastructure | 0.64 | 14 | 0.35 | 15 |
| MSO restricted habitat | 0.50 | 11 | 0.24 | 10 |
| Municipal watersheds | 0.13 | 3 | 0.06 | 3 |
| Aquatic species watersheds | 0.67 | 15 | 0.31 | 13 |
| Wildlands | 1.31 | 30 | 0.79 | 33 |
| Diameter categories | | | | |
| Cf <5" | 0.12 | 3 | | |
| Cf 5 to 16" | 2.45 | 54 | | |
| Cf > 16" | 1.96 | 43 | | |
| Sum | **4.53** | | | |

Steve reminded the group that the volume was a whole stem estimate, which includes tops, as was discussed several meetings prior. It does not include branches and needles, but we understand that these residual materials are of interest to some industries. Steve is exploring ways we could estimate whole tree volumes within the time limits of this project to include in the final report. He then turned back to the methodology for estimating supply explaining that he had developed a regression equation between volume and basal area to relate the post-treatment basal areas to post-treatment volume. ForestERA estimated how much basal area was removed in the under 16 inch diameter categories and mapped these spatially. Based on working group comments and advisement from John Bailey (Associate Professor, Oregon State Univ.) we retained 10% of the BA in <5 in. diameter class and 20% of the BA in 5-16 in. class. Haydee

presented maps depicting before and after basal areas in community and wildlands areas. She clarified that the post-treatment basal area layer had been developed by applying the frequency distributions developed by the working group to the pre-treatment basal area in order of low to high BA values. She also displayed maps showing the surplus of basal area that could not be removed solely in the classes below 16 inch DBH. In other words, to achieve the post-treatment desired BA in some areas, it would require taking trees in the > 16 in. diameter class. These areas are few except for the community protection zones where the post-treatment basal area range is lower. Steve explained that in 54% of the area in community protection zones it was not possible to meet the post-treatment BA conditions in the < 16 in classes. The group asked ForestERA to indicate this in the report for each of the zones. The group asked that the post-treatment basal area mode for wildlands be decreased to 70 $ft^2$/ac and that a sharper decline in values be made.

**Wood Supply Final Report**

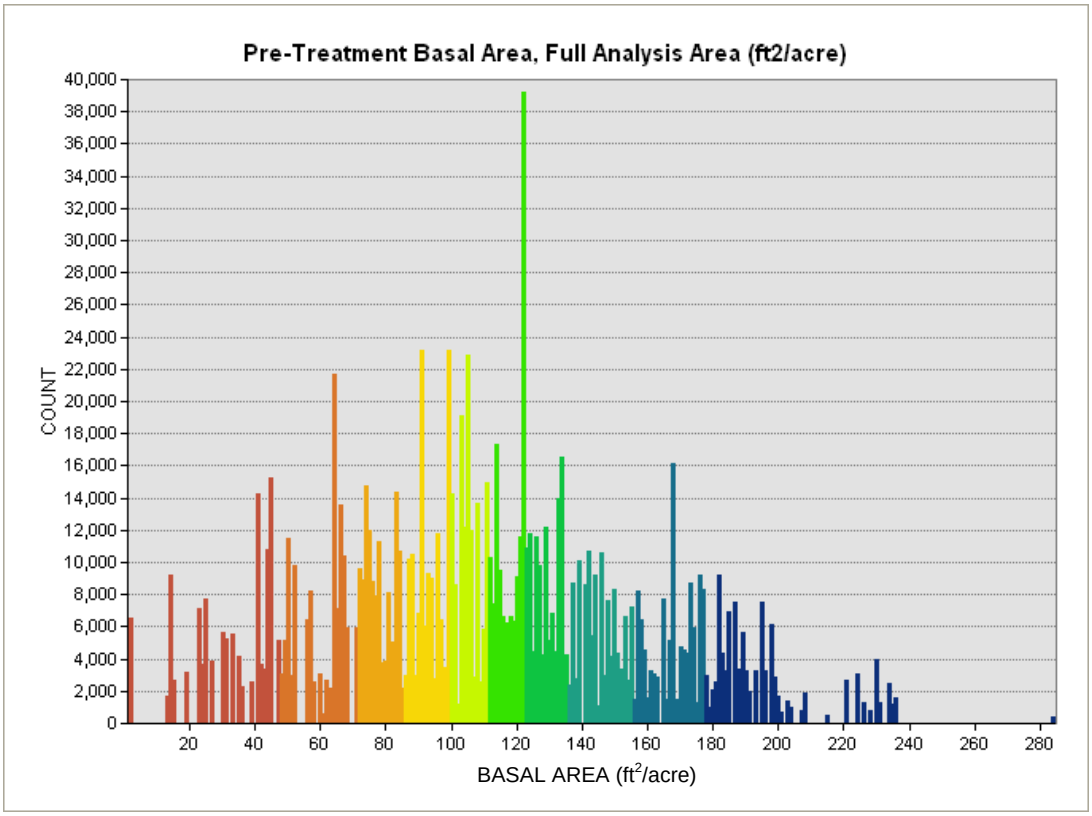
Haydee reminded the group of the timeline for finalizing the project report: ForestERA distributed the report to the working group and Region 3 by Dec. 17, 2007; comments must be provided to ForestERA by January 18, 2008; and a final report will be ready to distribute by late January. The report will include the following major sections:

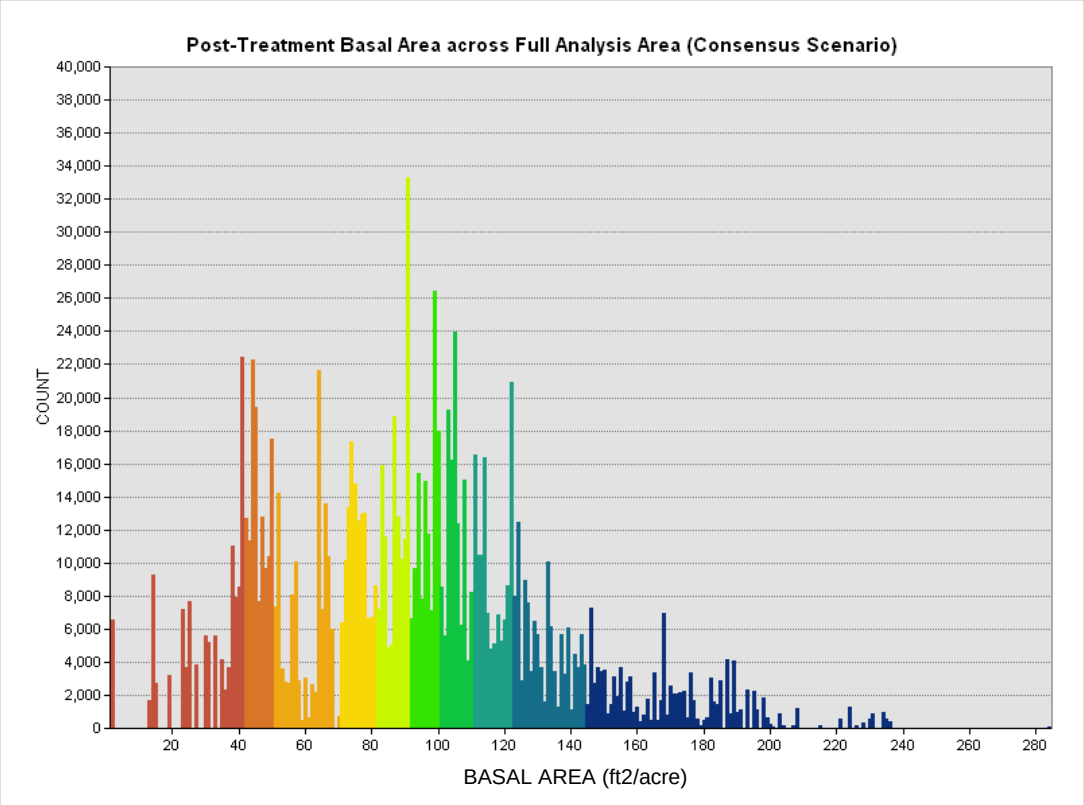
- Background
- Wood Volume Methods and Results
  - Forest growth review and recommendations
- Description of Treatment Scenario
- Wood Supply Methods and Results
  - Project level considerations
  - Existing Harvesters, Mills, Manufacturers
- Other considerations
  - Old growth
  - Climate change and future disturbances
  - Effects of treatments on wildlife
  - CWPPs
  - Burn-only treatments

Haydee reminded the group that she will be presenting wood supply analysis results at a meeting hosted by the Association for Fire Ecology in Tucson, AZ Jan. 28-31, 2008.

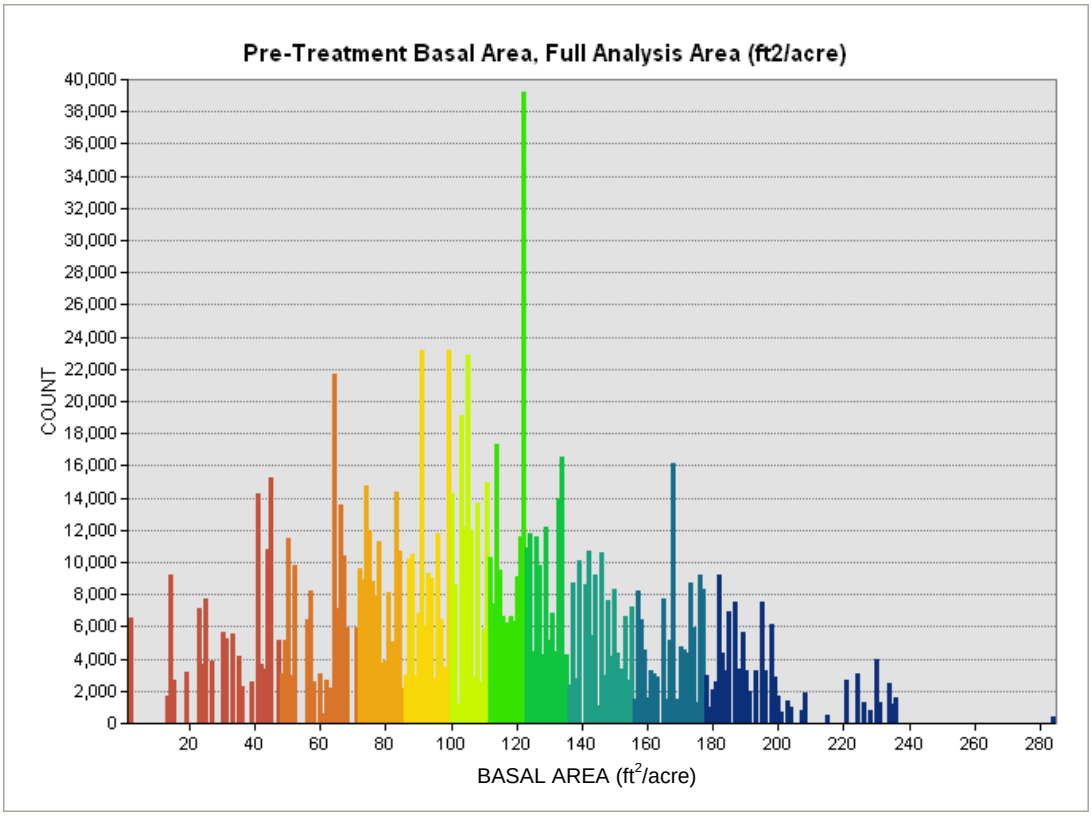
Tom and Haydee thanked the group for their participation over the last half year including recognition of the efforts of the Steering Committee, Region 3 Forest Service, Rosemary Romero, participating experts, scribes, and those who arranged for facilities at the Pinetop AZGFD, Northland Pioneer College, and NAU.

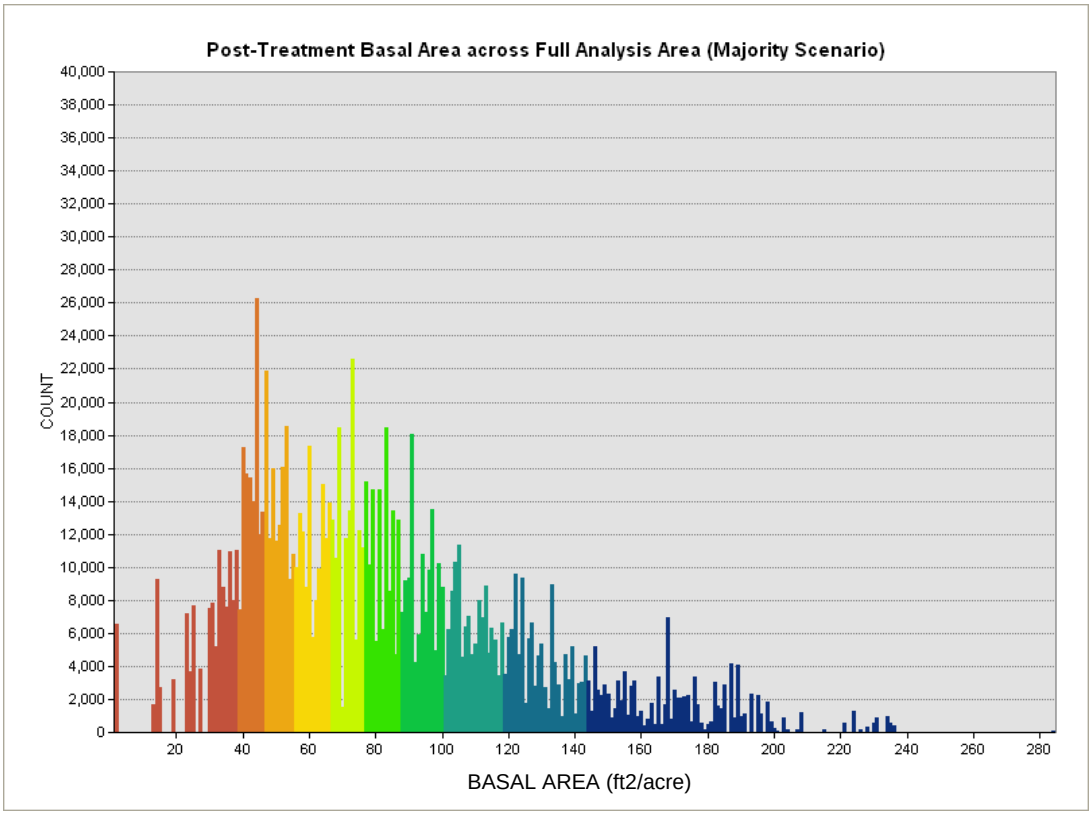
**Appendix C.** Estimated Pre-Treatment and Desired Post-Treatment Basal Area Frequency Distributions

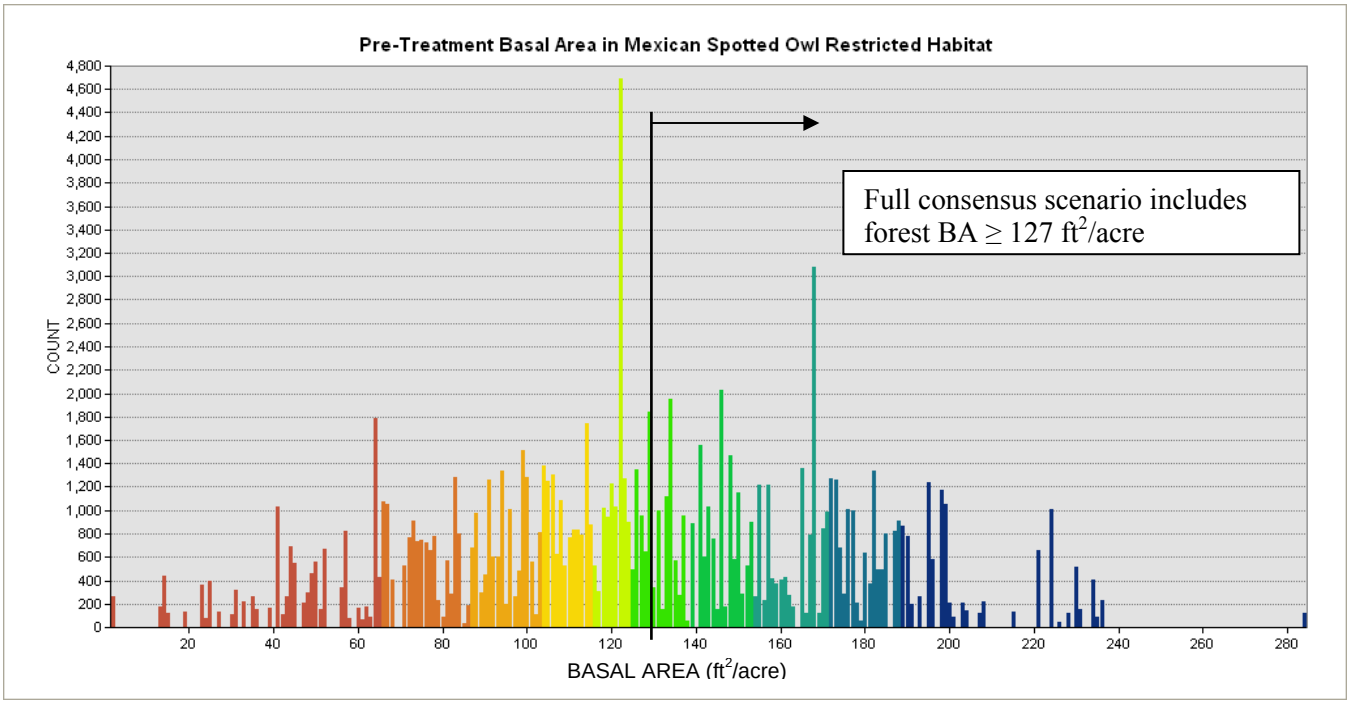


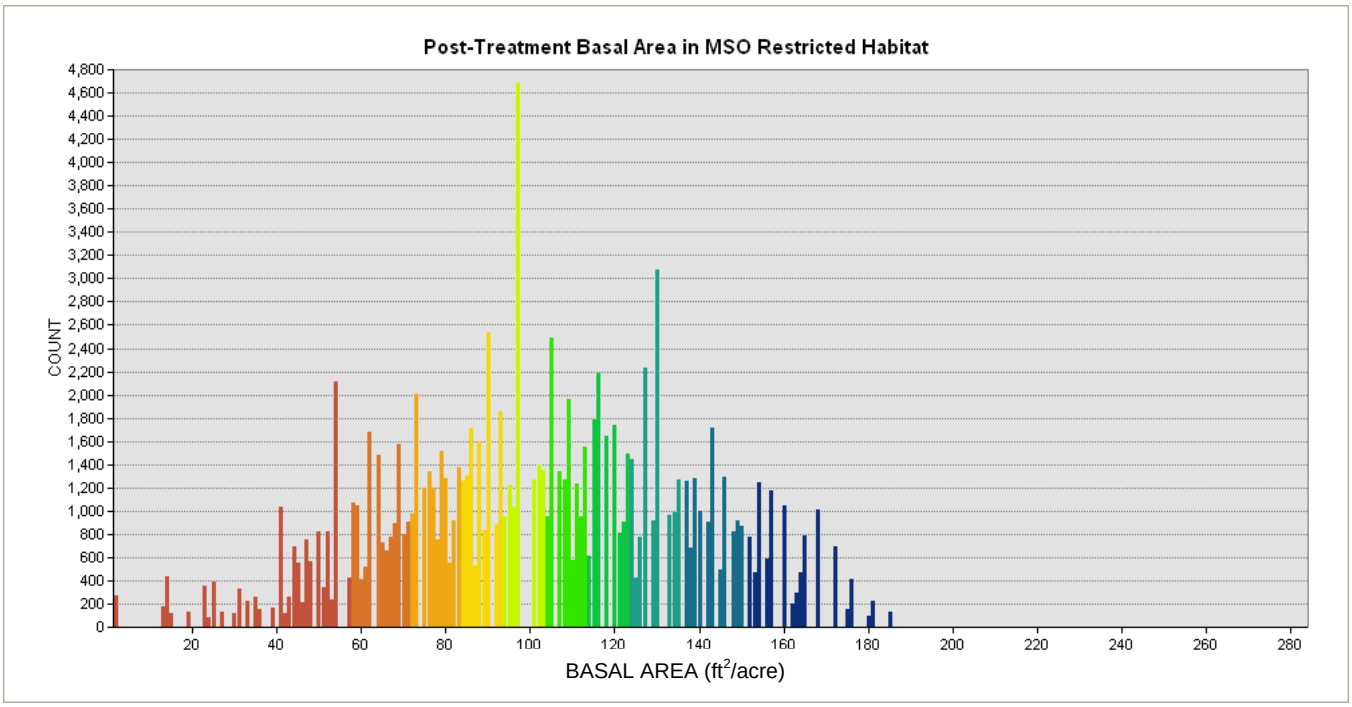



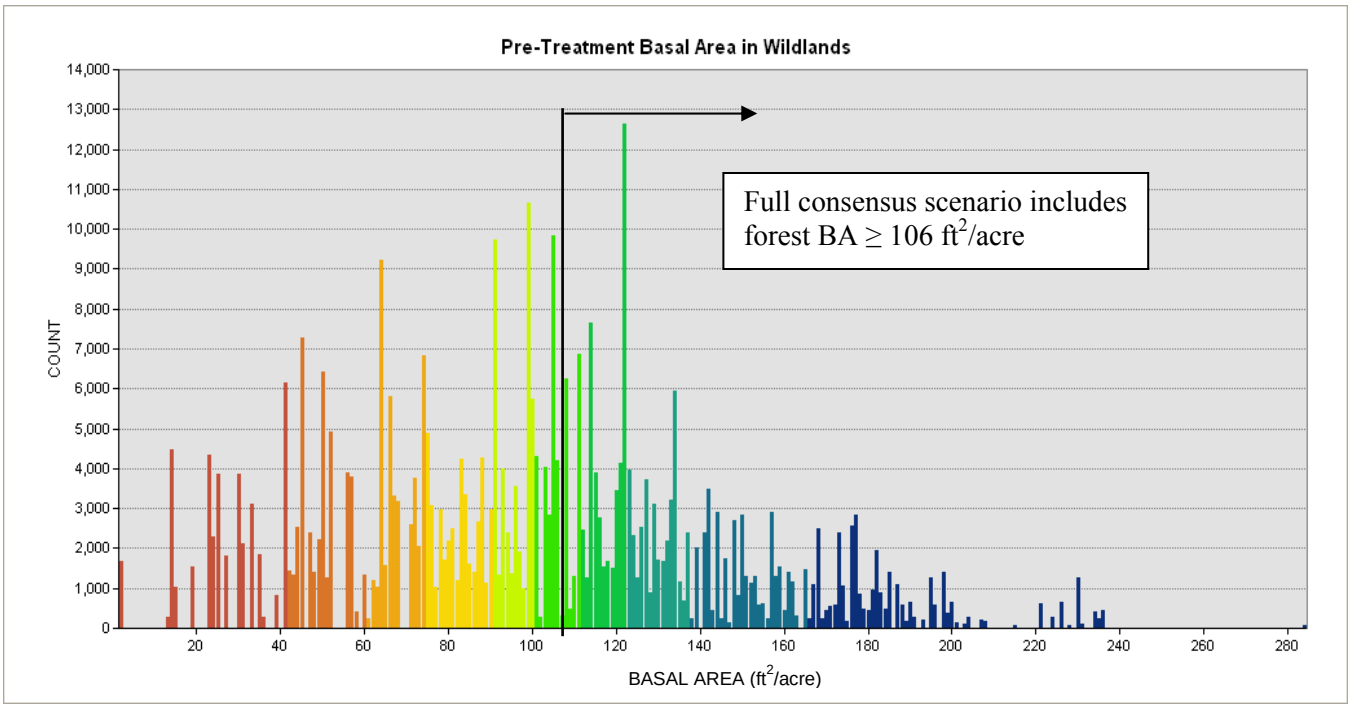

Note: Charts on first 2 pages include areas deemed not a source of wood supply to provide an overall summary for the analysis area. These areas are not included in the distributions on all other pages of this appendix as post-treatment conditions were not assessed in these areas.

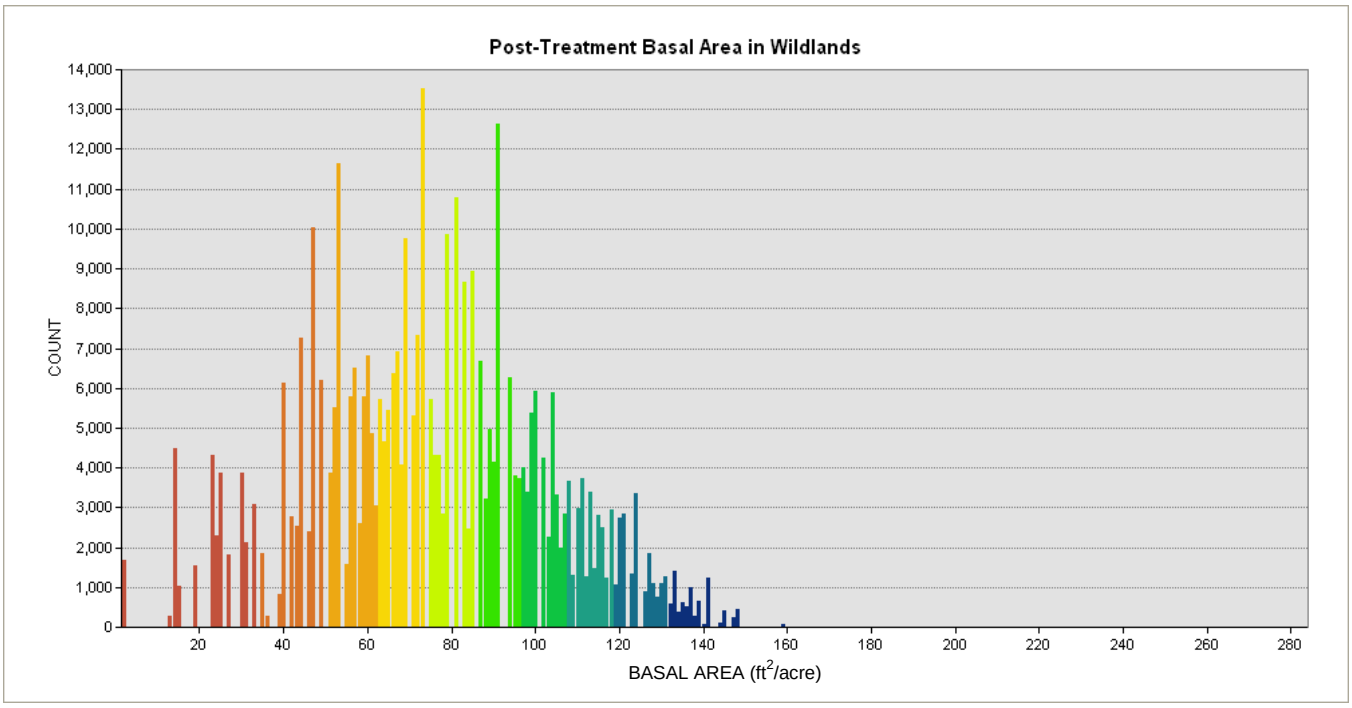

Pre-Treatment Basal Area, Full Analysis Area (ft2/acre)
COUNT
40,000
38,000
36,000
34,000
32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
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20
40
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80
100
120
140
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260
280
BASAL AREA (ft2/acre)

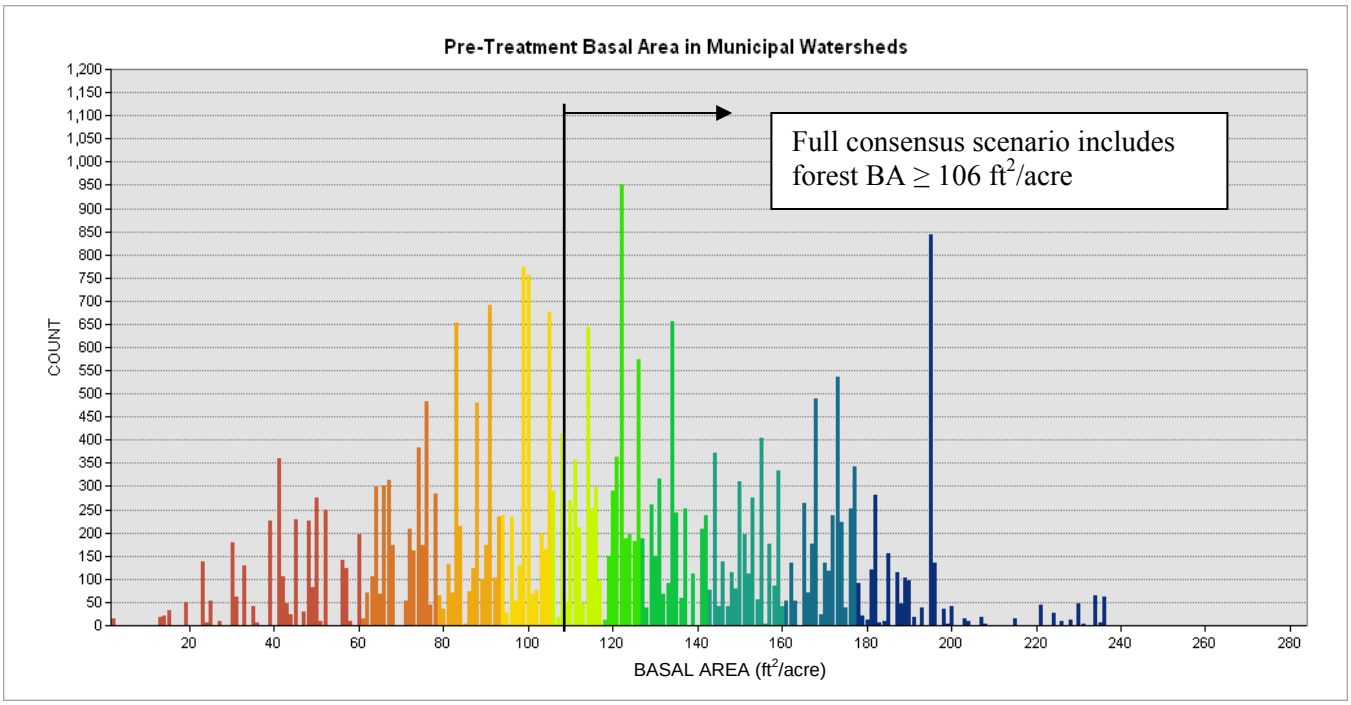

Post-Treatment Basal Area across Full Analysis Area (Majority Scenario)
COUNT
40,000
38,000
36,000
34,000
32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
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BASAL AREA (ft2/acre)

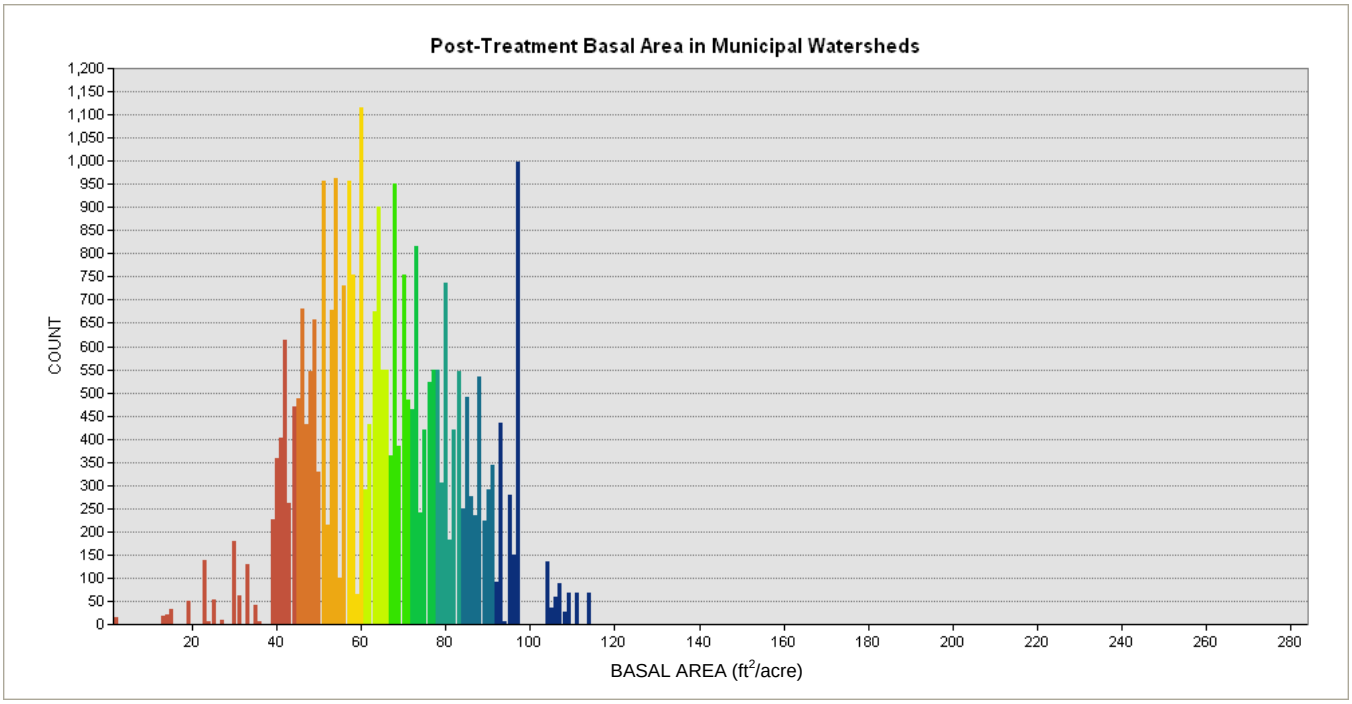

Pre-Treatment Basal Area in Mexican Spotted Owl Restricted Habitat
COUNT
BASAL AREA (ft²/acre)
Full consensus scenario includes forest BA ≥ 127 ft²/acre

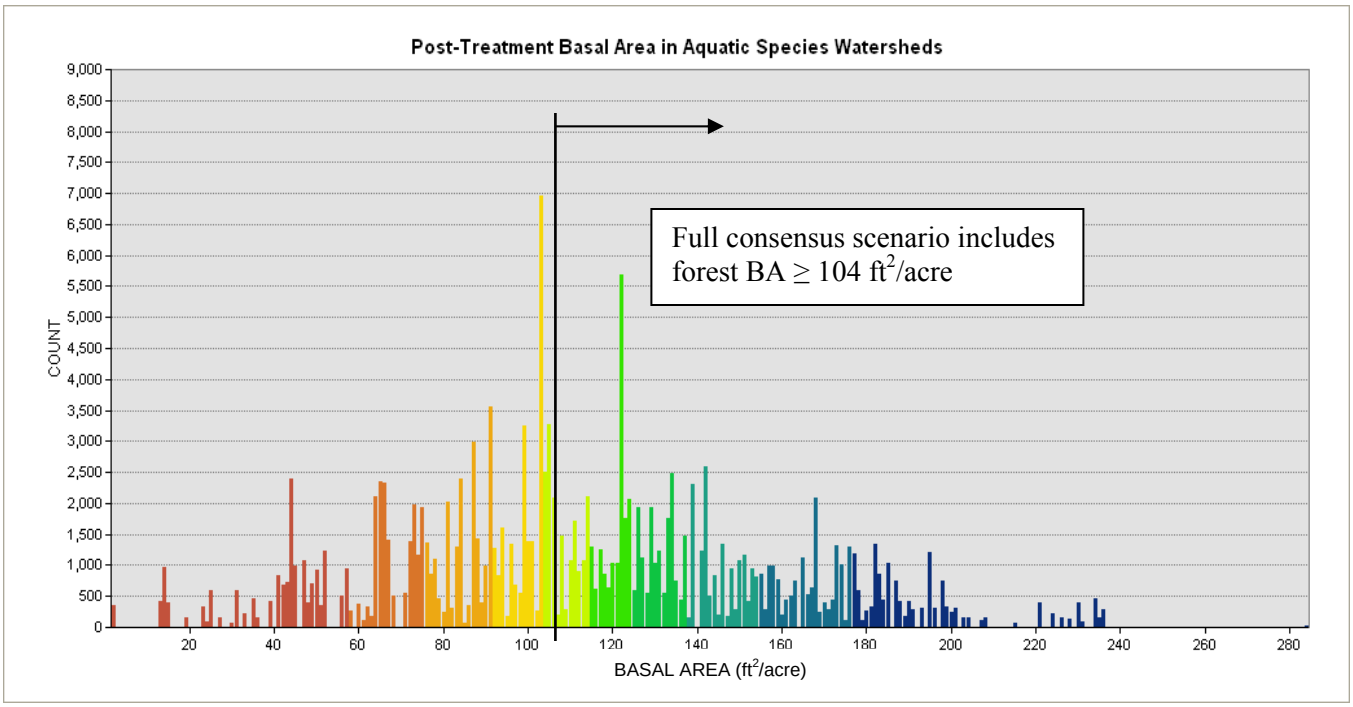

Post-Treatment Basal Area in MSO Restricted Habitat
COUNT
BASAL AREA (ft²/acre)

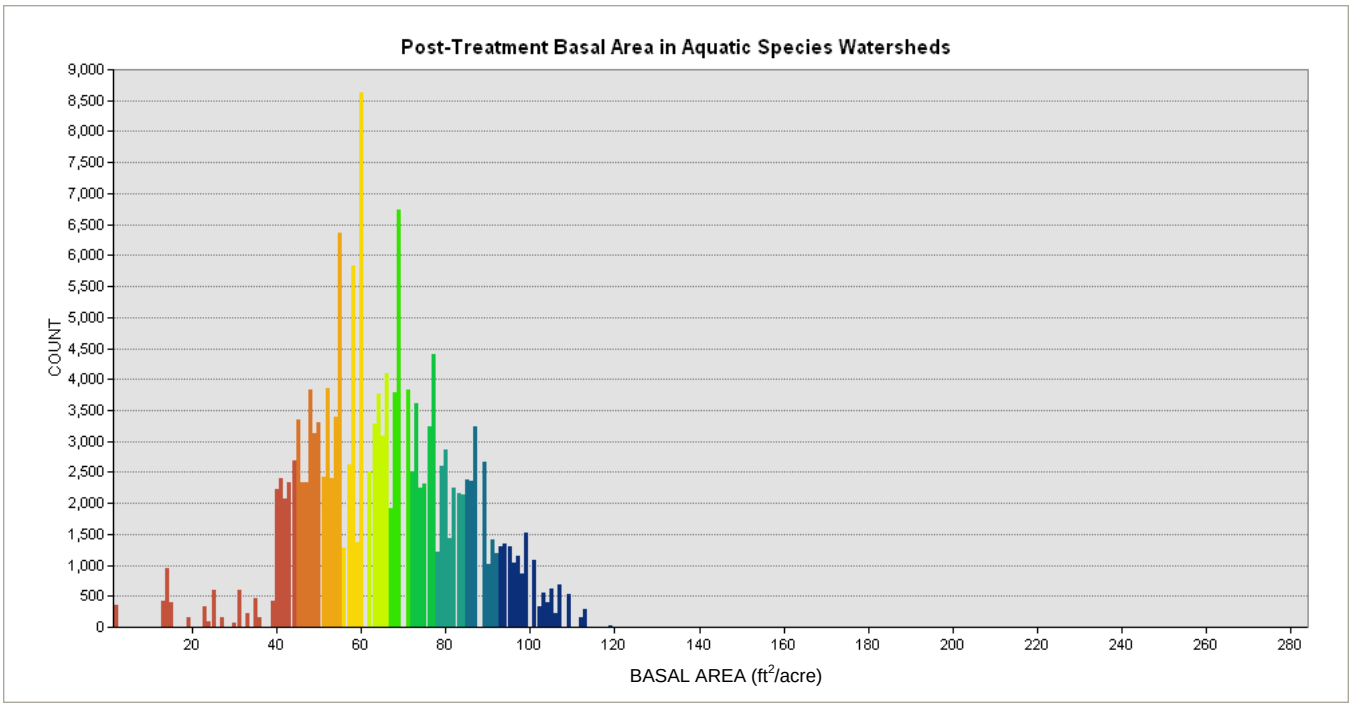

Pre-Treatment Basal Area in Wildlands
Full consensus scenario includes forest BA ≥ 106 ft²/acre
COUNT
BASAL AREA (ft²/acre)

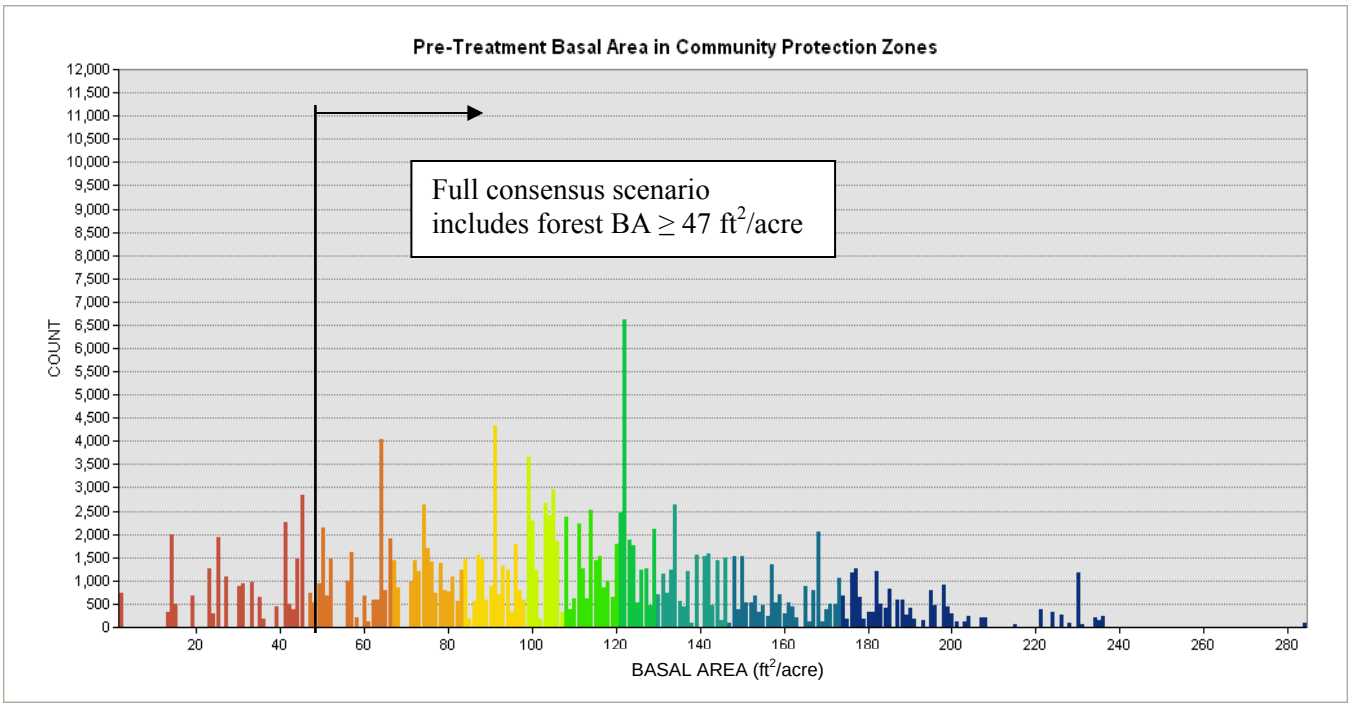

Post-Treatment Basal Area in Wildlands
COUNT
BASAL AREA (ft²/acre)

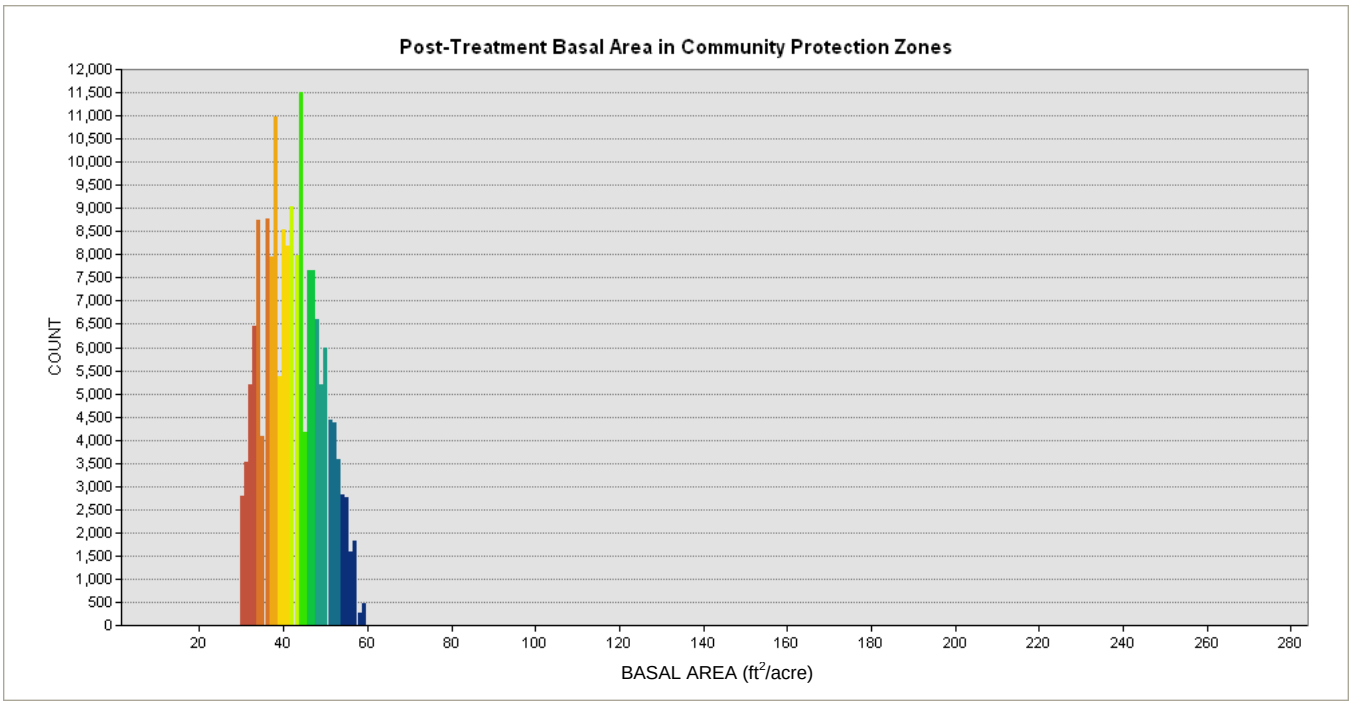

Pre-Treatment Basal Area in Municipal Watersheds
Full consensus scenario includes forest BA ≥ 106 ft²/acre
COUNT
BASAL AREA (ft²/acre)


Post-Treatment Basal Area in Municipal Watersheds
COUNT
BASAL AREA (ft²/acre)


Post-Treatment Basal Area in Aquatic Species Watersheds
COUNT
BASAL AREA (ft²/acre)
Full consensus scenario includes forest BA ≥ 104 ft²/acre


Post-Treatment Basal Area in Aquatic Species Watersheds
COUNT
BASAL AREA (ft²/acre)


Pre-Treatment Basal Area in Community Protection Zones
Full consensus scenario includes forest BA ≥ 47 ft²/acre
COUNT
BASAL AREA (ft²/acre)


Post-Treatment Basal Area in Community Protection Zones
COUNT
BASAL AREA (ft²/acre)

Joe Crouse
10-22-2007
ERI

## Summary of Presettlement Tree Densities in Southwestern Ponderosa Pine

| Site | TPA | TPA-Range | BA/Acre | BA/Acre-Range | Reference |
|---|---|---|---|---|---|
| Bar-M, Coconino N.F., AZ | 23 | | | | 1 |
| Camp Navajo, AZ | 26 | 10-141 | 51 | 0-170 | 2 |
| Carson N.F., NM | 37 | 26-47 | | | 3 |
| Coconino N.F., AZ | 27 | | | | 3 |
| Ft. Valley, Coconino N.F., AZ | 13 | | | | 4 |
| Grandview, GCNP, Kaibab N.F., AZ | 26 | 0-116 | 34 | 0-96 | 5 |
| Gus Pearson Natural Area, Coconino N.F., AZ | 23 | | 18 | 3-37 | 6 |
| Kaibab (Tusayan) N.F., AZ | 35 | | | | 3 |
| Mt. Trumbull, AZ | 15 | 0-51 | 38 | 0-139 | 7 |
| North Kaibab R.D., Kaibab N.F., AZ | 56 | | | | 8 |
| North Kaibab R.D., Kaibab N.F., AZ | 43 | 40-45 | | | 9 |
| Powell Plateau, GCNP, AZ | 62 | 8-262 | 78 | 20-337 | 5 |
| Zion N.P., UT | 14 | 3-25 | | | 10 |
| Swamp Ridge, GCNP, AZ | 53 | 8-106 | 93 | 24-216 | 5 |
| White Mountains, Apache-Sitgreaves N.F., AZ | 40 | 35-45 | | | 11 |
| Woolsey Plots, AZ and NM (average of 15 sites) | 47 | 8-90 | 58 | 1-196 | 12 |

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**Appendix E.** Wood Supply Working Group Meeting Handout on Nov. 29, 2007 with Grand Canyon Trust Environmental Assessment Analysis

| Projects(25) | Project Area | Treatment Area | Acreage PIPO | Acreage burn only | Why | (PIPO) not thinned | %Pipo not thinned | %treatment area not thinned | %project area burned | %treatment area burned |
|---|---|---|---|---|---|---|---|---|---|---|
| Eastside | 22,000 | 19,977 | 16,776 | 12,356 | No reason given | 12,356 | 74% | 62% | 56% | 62% |
| MormonLk. | 2,831 | 2,831 | 2,831 | 313 | MSO | 313 | 11% | 11% | 11% | 11% |
| Kachina | 10,417 | 6,229 | 8,418 | 1,429 | MSO, steep slopes | 1,429 | 17% | 23% | 14% | 23% |
| MundsPark | 2,980 | 2,980 | 2,950 | 1,988 | No reason given | 1,998 | 68% | 67% | 67% | 67% |
| Mountainaire | 16,603 | 13,979 | 12,958 | 1,476 | Steep slope; DFC's | 1,476 | 11% | 11% | 9% | 11% |
| RockyPark | 13,878 | 13,678 | 11,282 | 8,000 | DFC's | 8,000 | 71% | 58% | 58% | 58% |
| WoodyRidge | 31,000 | 11,544 | 26,014 | 2,945 | No reason given | 2,945 | 11% | 26% | 10% | 26% |
| Smith/Schultz | 11,827 | 11,700 | 9,747 | 700 | DFC's, steep slopes | 1,103 | 11% | 9% | 6% | 6% |
| UpperBeaver | 49,123 | 44,694 | 41,922 | 30,414 | Broadcast &maintenance | 27,072 | 65% | 61% | 62% | 68% |
| Victorine | 19,915 | 8,678 | 10,661 | 6,922 | 839prev.treated;DFC's | 6,922 | 65% | 80% | 35% | 80% |
| Huffer | 1,146 | 1,146 | 1,146 | - | NA | - | 0% | 0% | 0% | 0% |
| ElkPark | 6,886 | 6,886 | 6,485 | 1,700 | Steep slope; DFC's | 1,785 | 28% | 26% | 25% | 25% |
| EastClearCreek | 70,000 | 16,228 | 56,116 | - | NA | - | 0% | 0% | 0% | 0% |
| Ft.Valley | 9,100 | 6,960 | 7,281 | 1,800 | Steep slope; DFC's | 2,900 | 40% | 42% | 20% | 26% |
| BlueR.MSO | 16,282 | 16,282 | 14,817 | 2,399 | No reason given | 8,124 | 55% | 50% | 15% | 15% |
| ChittyCreek | 14,000 | 13,076 | 4,972 | 12,600 | Steep slope; DFC's | 11,676 | 89% | 89% | 90% | 96% |
| Greer | 24,092 | 19,629 | 18,636 | - | NA | - | 0% | 0% | 0% | 0% |
| EagerS | 21,779 | 17,543 | 7,946 | 3,233 | Steep slope; DFC's | 3,233 | 41% | 18% | 15% | 18% |
| Nutrioso | 41,768 | 36,166 | 31,964 | 7,590 | Steep slope; DFC's | 7,590 | 24% | 21% | 18% | 21% |
| LongJim | 1,375 | 1,375 | 1,074 | 462 | Steep slope | 662 | 62% | 48% | 34% | 34% |
| Twin | 14,900 | 14,900 | 9,834 | 14,518 | Fuel reduction | 14,518 | 97% | 97% | 97% | 97% |
| JacobRyan | 35,946 | 33,103 | 32,142 | 9,149 | Fuel reduction | 9,149 | 28% | 28% | 25% | 28% |
| EastRim | 17,216 | 9,630 | 4,791 | 1,440 | Fuel reduction | 4,307 | 90% | 45% | 8% | 15% |
| Dogtown | 8,209 | 7,317 | 6,689 | 2,000 | Steep slope | 2,250 | 34% | 31% | 24% | 27% |
| City | 12,403 | 12,359 | 10,369 | 3,263 | Fuel reduction | 3,780 | 36% | 31% | 26% | 26% |
| | | | | | | | 41% | 37% | 29% | 34% |
| Two more from ForestERA | | | | | | | | | | |
| Nagel | | | | | | | | 31% | | 31% |
| LosBurros | | | | | | | | 18% | | 16% |
| | | | | | | | | **36%** | | **33%** |

**Appendix F.** Tree bole and crown biomass estimates in oven dry tons[1] for the consensus and majority scenarios within each landscape management area.

| Landscape zone | Tot. stem tons | Tot. crown tons | Wood supply ($ft^3$) | Total area | Ave stem tons/ac | Ave crown tons/ac |
|---|---|---|---|---|---|---|
| **Consensus scenario** | | | | | | |
| Community protection | 4,867,751 | 1,451,606 | 368,975,519 | 314,017 | 15.5 | 4.62 |
| MSO restricted habitat | 749,769 | 223,829 | 56,832,525 | 113,076 | 6.6 | 1.98 |
| Municipal watersheds | 494,040 | 148,874 | 37,448,212 | 34,471 | 14.3 | 4.32 |
| Aquatic species watersheds | 2,501,664 | 745,835 | 189,626,094 | 187,157 | 13.4 | 3.99 |
| Wildlands | 2,564,987 | 763,374 | 194,426,007 | 338,486 | 7.6 | 2.26 |
| **Sum** | 11,178,211 | 3,333,518 | 847,308,357 | 987,206 | 11.3 | 3.38 |
| **Majority scenario** | | | | | | |
| Community protection | 4,899,755 | 1,461,340 | 371,401,419 | 335,206 | 14.6 | 4.36 |
| MSO restricted habitat | 1,103,524 | 329,499 | 83,647,154 | 225,773 | 4.9 | 1.46 |
| Municipal watersheds | 622,778 | 188,016 | 47,206,561 | 58,031 | 10.7 | 3.24 |
| Aquatic species watersheds | 3,195,876 | 953,205 | 242,247,408 | 323,531 | 9.9 | 2.95 |
| Wildlands | 3,572,698 | 1,063,201 | 270,810,528 | 718,927 | 5.0 | 1.48 |
| **Sum** | 13,394,632 | 3,995,261 | 1,015,313,070 | 1,661,467 | 8.1 | 2.40 |

[1]A factor of 0.0758 was used to convert from oven dry tons to MCF

**Appendix G**. USDA Forest Service timber cruise data from White Mountain Stewardship Project tree thinning contracts on the Apache-Sitgreaves National Forests. Data were provided to us by Bob Taylor from the Apache-Sitgreaves National Forests.

| Steward contract | Acres | Acres thin[1] | Thin residue[2] | ST & RW residue[3] | Total merch.[4] | Ave merch./ac | Residue/ac | Ave merch./ac[5] |
|---|---|---|---|---|---|---|---|---|
| **Year 2004** | ` | | green tons | green tons | green tons | green tons/ac | green tons/ac | $Ft^3$ |
| Alpine WUI 2 | 426 | 426 | 1,077 | 3,940 | 11,466 | 26.9 | 11.8 | 897.2 |
| Little | 635 | 430 | 662 | 1,458 | 3,735 | 5.9 | 3.3 | 196.1 |
| Mineral A | 1,763 | 1,370 | 3,699 | 18,002 | 40,632 | 23.0 | 12.3 | 768.2 |
| Ranch/Iris | 817 | 817 | 4828 | 3,425 | 5,142 | 6.3 | 10.1 | 209.8 |
| Sponseller[6] | 1,244 | 0 | 0 | 4,611 | 9,924 | 8.0 | 3.7 | 265.9 |
| Whipple[6] | 1,397 | 0 | 0 | 9,807 | 24,822 | 17.8 | 7.0 | 592.3 |
| Little Springs | 2,039 | 2,039 | 30,822 | 24,679 | 60,453 | 29.6 | 27.2 | 988.3 |
| Heber/Overgaard | 2,276 | 2,276 | 9,559 | 5,872 | 9,147 | 4.0 | 6.8 | 134.0 |
| | | | | | | | | |
| **Year 2005** | | | | | | | | |
| Mineral B1 | 1,157 | 1,022 | 3,050 | 10,208 | 23,733 | 20.5 | 11.5 | 683.8 |
| Alpine 3,7,9 | 1,030 | 1,030 | 2,104 | 9,545 | 19,665 | 19.1 | 11.3 | 636.4 |
| Woods Canyon[6] | 448 | 0 | 0 | 2,033 | 5,856 | 13.1 | 4.5 | 435.7 |
| Woodland/Camps | 851 | 629 | 2,460 | 4,747 | 9,933 | 11.7 | 8.5 | 389.1 |
| Greer A | 1,377 | 1,377 | 4,311 | 9,010 | 24,294 | 17.6 | 9.7 | 588.1 |
| Brookbank | 1,258 | 936 | 6,867 | 1,872 | 4,119 | 3.3 | 6.9 | 109.1 |
| Blue Ridge 2A | 925 | 45 | 320 | 7,302 | 15,864 | 17.2 | 8.2 | 571.7 |
| | | | | | | | | |
| **Year 2006** | | | | | | | | |
| Country Club | 915 | 795 | 4,000 | 11,257 | 27,615 | 30.2 | 16.7 | 1006.0 |
| Forest Lakes WUI | 946 | 946 | 4,523 | 6,199 | 12,294 | 13.0 | 11.3 | 433.2 |
| Dutch Joe A | 356 | 150 | 573 | 3,578 | 7,881 | 22.1 | 11.7 | 737.9 |
| Greer B | 2,649 | 2,649 | 4,577 | 16,741 | 38,766 | 14.6 | 8.0 | 487.8 |
| Alpine WUI 5,6 | 900 | 654 | 3,468 | 9,571 | 14,211 | 15.8 | 14.5 | 526.3 |
| Dutch Joe B | 810 | 810 | 2,414 | 9,292 | 21,294 | 26.3 | 14.5 | 876.3 |
| Mineral B Hideaway | 226 | 226 | 675 | 1,994 | 4,635 | 20.5 | 11.8 | 683.6 |
| Mineral B2 | 766 | 766 | 2,286 | 6,758 | 15,711 | 20.5 | 11.8 | 683.7 |
| | | | | | | | | |
| **Year 2007** | | | | | | | | |
| Greens Peak[6] | 11 | 0 | 0 | 146 | 423 | 38.5 | 13.3 | 1281.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alpine WUI 4 & 8 | 1,188 | 1,188 | 5,194 | 10,404 | 25,308 | 21.3 | 13.1 | 710.1 |
| Blue Ridge 2B | 1,851 | 255 | 760 | 13,971 | 31,752 | 17.2 | 8.0 | 571.8 |
| Greer D | 1,827 | 1,299 | 1,688 | 12,905 | 32,067 | 17.6 | 8.0 | 585.1 |
| Eagar South | 1,095 | 1,095 | 2,933 | 3,834 | 15,705 | 14.3 | 6.2 | 478.1 |
| Vincent A | 1,170 | 1,170 | 5,346 | 12,239 | 31,338 | 26.8 | 15.0 | 892.8 |
| Vincent B | 813 | 813 | 3,716 | 8,782 | 22,527 | 27.7 | 15.4 | 923.6 |
| **Sum** | 33,166 | 25,213 | | | **Ave** | 17.2 | 10.7 | 611.5 |

[1]Acres of thinning for trees <5” dbh

[2]Green tons of tree residues from thinning trees <5” dbh that included tree boles, tops, limbs, foliage and bark.

[3]Green tons of saw timber (ST) and round wood (RW) tree residues from trees > 5” dbh that included tops, foliage and bark.

[4]Green tons of harvested material from merchantable portions of the tree bole.

[5] Cubic foot volume for ST and RW without residues (trees >5” dbh).

[6]Projects in which only trees > 5” dbh were harvested (i.e., no thinning residues from trees <5” dbh).

Pete Fulé
November 14, 2007

## Fire Information for Wood Supply Analysis Group

A) Based on your experience in the field and with the literature, what would you consider to be the low- and high-end weather conditions (e.g., temperature, RH, windspeed) that would be "typical" or suitable for implementing prescribed fire in ponderosa pine-dominated stands?

A general guideline for southwestern ponderosa forests was presented in a widely used textbook by Pyne et al. (1996:574):

- Relative humidity 20-40%
- Temperature 40-60°F
- 10-hour fuel moisture (sticks between ¼ and 1" diameter) 8-12%
- Winds 5-15 mph in open areas, 2-7 mph in closed stands

Pyne et al. also reproduced a graphic illustration of prescription guidelines that suggested relatively more moist conditions:

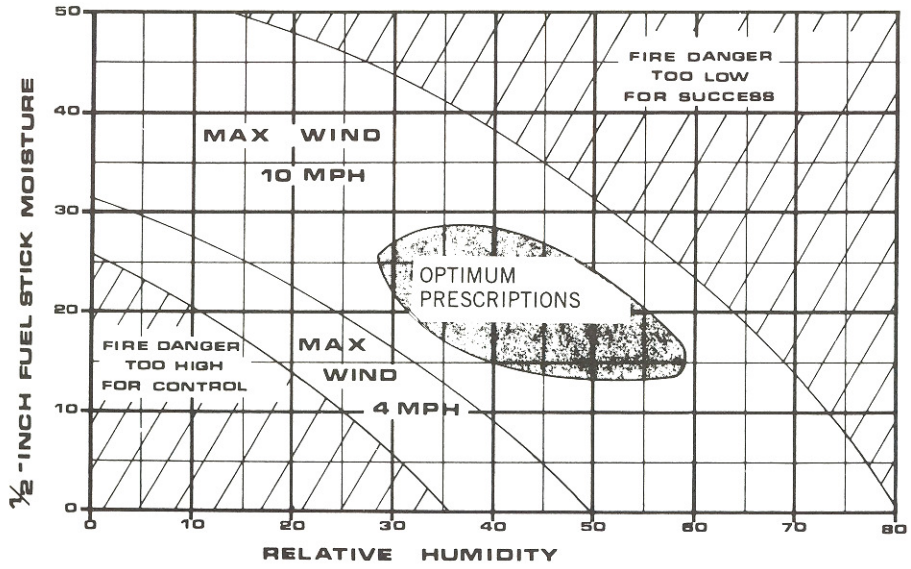



***Figure 10.13.*** *Underburning: southwestern ponderosa pine. The prescription is here represented in unusual but graphic form.* From Southwest Interagency Fire Council (1968).

Managers can alter these parameters based on their experience. An example comes from a City of Flagstaff prescription which includes drier, warmer, and windier values for a very open, low-fuel thinned stand:

- Relative humidity 15-30%
- Temperature 60-75°F
- Winds 10-25 mph at 20´ above ground (equivalent to 4-10 mph at mid-flame height)

Conversely, if burning an area with substantial surface fuel and fuel ladders to a dense canopy, managers might select cooler conditions or forego burning until after tree thinning and/or surface fuel treatment was completed.

B) Under each of these sets of conditions (low and high), what is the range of basal area and tree density values, alone or in combination, which would permit the use of prescribed fire as a primary restoration and/or fuels reduction tool? We recognize that these values may be different in a restoration vs. fuels reduction context, so please provide ranges for each context, if necessary.

This question does not have a simple answer, for several reasons. First, nearly any southwestern ponderosa pine forest *could* be burned with prescribed fire. As an example, even the extraordinarily dense forest at the Chimney Spring interval burning site (up to 4,300 trees/acre) has been successfully burned many times. Second, even a very open, low-hazard forest *could not* be burned if it were adjacent to an area with high hazards or high values at risk. An example is that a manger might refrain from using fire even in low-density stands if they were located at the base of a steep canyon with many dead trees or with spotted owl nest sites, as is the case on north aspects at Walnut Canyon National Monument. Light grassy fuels can also be "flashy" and present hazards of high rate of spread and long flames, thus even open pine savannas can be considered to be hazardous fuels under certain conditions. Third, prescribed fire behavior is regulated not only by weather, fuel moisture, fuel type, and topography, but also by the way in which the fire is ignited. Perhaps the most common ignition method in the Southwest is strip headfires, but different fire behavior would be encountered under otherwise identical conditions if the fire were ignited by aerial ignition, backing fire, or ring burning.

Taking all of the above factors into consideration, it is clear that there can be no single guideline for stand conditions "which would permit the use of prescribed fire as a primary restoration and/or fuels reduction tool." However, it is also logical to suggest that *in many cases* there may be a rational basis for drawing distinctions about the use of prescribed fire. The following is simply my opinion about how to differentiate these conditions based on several criteria:

1. Does the subject stand or forest present a reasonably low risk of escaped fire or wildfire burning into the canopy due to dense canopy fuels or fuel ladders? I would answer this question by looking at the attributes of stands that are vulnerable to crownfire. In a statewide analysis of New Mexico forest data, Fiedler et al. (2002) classified forests with basal areas below 50-80 $ft^2$/acre as low hazard and those up to 90-110 $ft^2$/acre as moderate hazard, as measured by calculating crowning index windspeed values. Studies in northern Arizona indicated that stands averaging basal area of 81 $ft^2$/acre and 71 pines/acre had low crownfire hazard (Fulé et al. 2001a). Even higher values of 97 $ft^2$/acre and 98 pines/acre had acceptably low crownfire hazard—that is, fires were predicted to stay on the surface even under severe burning conditions (Fulé et al. 2001b, Appendix A). This line of reasoning leads to a relatively low-hazard stand condition of approximately $\leq$ 100 $ft^2$/acre and $\leq$ 100 pines/acre. Both attributes are important, because basal area is proportional to total biomass and

canopy fuel loading, while tree density is associated with fuel ladders. However, if it were to be necessary to choose only one attribute, the basal area is probably more important because it relates most closely to the ability of fire to spread through the tree canopies (canopy bulk density).

2. Is the subject stand located in a reasonably safe landscape context? Answering this question requires spatial data about the stand´s location and proximity to hazardous fuels and values at risk.
3. Does management exclusively or primarily with prescribed fire meet all the goals and constraints associated with the desired future condition of the subject stand? Answering this question also requires additional information about goals, social values, and other data.

The question referred to burning for "restoration and/or fuels reduction." There is no question that prescribed fire is an effective fuel reduction tool in ponderosa pine forests. Repeated prescribed burning (intervals ≤ 10 yr) reduces surface fuels (Covington and Sackett 1992) and burning was shown to protect many stands during the most severe fire in southwestern history, the Rodeo-Chediski fire (Finney et al. 2005, Strom 2005). However, there is less evidence indicating that prescribed burning can serve as an effective *ecological restoration* tool in forests that are substantially more dense than historical reference conditions, because established pine trees are resistant to mortality from light surface fires. Repeated fires at Chimney Spring led to negligible thinning of excess young trees, although deliberate use of ring burning fire patterns created higher local mortality (Sackett et al. 1996). Free-burning wildland fire use fires at Grand Canyon National Park in 2003 did exert a substantial thinning effect in ponderosa pine forests invaded by white fir (Fulé and Laughlin 2007). Thus the evidence suggests that effective tree thinning would require relatively intense burning. Such fire behavior would probably not be desirable near communities or other values at risk, though in other places it may be acceptable. It is worth noting that the rough guidelines of ≤ 100 $ft^2$/acre and ≤ 100 pines/acre are still 40-250% higher than estimates of pre-European settlement forests (Appendix B).

C) I would add that we would like to include the same two questions applied to "Fire Use Fire" conditions. That is, Rx fire conditions might be very conservative, whereas if one or more of the forests implement "fire use for resource benefit" programs on a larger landscape, the prescription might be less conservative, allowing for greater variability in acceptable conditions, and hence, more acres in fire management.

The information presented in the preceding sections is also applicable to Wildland Fire Use (WFU), but some additional considerations may be relevant. The premise of the question, that a greater variability in fire behavior might be acceptable in WFU, probably depends on the specific circumstances. Most agencies with approved WFU plans to date have adopted a zoning approach, meaning that certain areas of the wildlands they administer are considered suitable for WFU and others are not. The WFU zones tend to be in the backcountry, where there may be reduced concerns about smoke impacts, aesthetics, and risks of escaped fires damaging developments. Therefore, to the extent that acceptable fire behavior may vary over a wider range, this variability may be more a reflection of the nature of the WFU zone than an inherent characteristic of WFU itself.

Probably the best example of WFU (previously "prescribed natural fire") in the Southwest comes from the Gila Wilderness and adjacent lands, where free-burning fires are permitted to proceed for extended periods and a wide range of fire behavior is considered acceptable. The Gila Wilderness exemplifies the natural role of fire in modern times. However, the Gila also has certain unusual qualities: the lands are mostly designated Wilderness; populations are low, rural, and socially accepting of fire; developed values at risk are minimal; few critical airsheds lie downwind; and the forest itself has had relatively fewer deleterious impacts since European settlement, with little roading or logging and a number of fires in the twentieth century (Rollins et al. 2001). Elsewhere in the Southwest, only the North Kaibab Ranger District and North Rim of Grand Canyon National Park share most of these attributes. Other forests tend to have substantial private inholdings and developments, nearby urban populations with low smoke tolerance, nearby critical airsheds, and substantial forest degradation over the past 100+ years resulting in dense stands of young trees, forest floor fuel buildup, and invasive exotic species. Both the management goals and the methods selected to attain these goals are likely to differ between the Gila Wilderness and the Coconino National Forest, for example.

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# Appendix A: Summary of Pre- and Post-Treatment Forest Structure at Ecological Restoration Experimental Sites

Pete Fulé
September 26, 2007

| Site | Treatment | Pretreatment | | Posttreatment | | Reference | Note |
|---|---|---|---|---|---|---|---|
| | | Trees per Acre | Basal Area ($ft^2$/acre) | Trees per Acre | Basal Area ($ft^2$/acre) | | |
| Mt Trumbull | Full Restoration | 554.4 | 148.5 | 127.5 | 77.1 | 1 | 1 |
| GPNA | Full Restoration | 1253.8 | 150.3 | 61.5 | 46.2 | 2, 3, 4 | 2 |
| Ft Valley | Full Restoration | 386.5 | 151.5 | 56.8 | 67.8 | 5 | 2 |
| Ft Valley | Intermediate Thinning | 603.7 | 167.7 | 68.8 | 77.7 | 5 | 2 |
| Ft Valley | Reduced Thinning | 422.1 | 148.5 | 98.3 | 97.2 | 5 | 2 |
| Tusayan | Full Restoration | 541.3 | 76.2 | 62.2 | 27.0 | 6 | 1 |
| Tusayan | Minimal Thinning | 1187.8 | 98.0 | 276.7 | 58.4 | 6 | 1 |
| **Average** | **Full Restoration** | **684.0** | **131.6** | **77.0** | **43.0** | | |
| **Average** | **All Treatments** | **707.1** | **134.4** | **107.4** | **57.9** | | |

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6. Fulé, P.Z., W.W. Covington, H.B. Smith, J.D. Springer, T.A. Heinlein, K.D. Huisinga, and M.M. Moore. 2002. Comparing ecological restoration alternatives: Grand Canyon, Arizona. Forest Ecology and Management 170:19-41.

**Notes:**

1. Ponderosa dominated, some Gambel oak.
2. Pure ponderosa pine.

## Appendix B: Summary of Presettlement Tree Densities in Southwestern Ponderosa Pine

Joe Crouse
10-17-2007

| Site | Trees per Acre | Reference |
|---|---|---|
| Bar-M, Coconino N.F., AZ | 23 | 1 |
| Camp Navajo, AZ | 26 | 2 |
| Carson N.F., NM | 26-47 | 3 |
| Coconino N.F., AZ | 27 | 3 |
| Ft. Valley, Coconino N.F., AZ | 13 | 4 |
| Grandview, GCNP, Kaibab N.F., AZ | 26 | 5 |
| Gus Pearson Natural Area, Coconino N.F., AZ | 23 | 6 |
| Kaibab (Tusayan) N.F., AZ | 35 | 3 |
| Mt. Trumbull, AZ | 14 | 7 |
| North Kaibab R.D., Kaibab N.F., AZ | 56 | 8 |
| North Kaibab R.D., Kaibab N.F., AZ | 40-45 | 9 |
| Powell Plateau, GCNP, AZ | 62 | 5 |
| Zion N.P., UT | 3-25 | 10 |
| Swamp Ridge, GCNP, AZ | 53 | 5 |
| White Mountains, Apache-Sitgreaves N.F., AZ | 35-45 | 11 |
| Woolsey Plots, AZ and NM (average of 15 sites) | 47 | 12 |

**References:**


1. Covington, W.W. and M.M Moore. 1994. Southwestern ponderosa forest structure: Changes since Euro-American settlement. Journal of Forestry 92(1):39-47.
2. Fulé, P.Z., W.W. Covington and M.M. Moore. 1991. Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. Ecological Applications 7(3):895-908.
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**Appendix I.** Potential Follow-on Studies to Wood Supply Analysis

In the event that follow-up projects emerge as a result of this study, Working Group members and ForestERA recommend the following:

1. Conduct fire spread model analyses (e.g., strategically placed treatments), among other collaborative prioritization analyses, to inform the appropriate spatial and temporal priorities for fuel reduction treatments.
2. Include forest growth in supply estimates based on collaboratively derived priorities.
3. Use fire models to identify thresholds for prescribed burning and wildland fire use as an initial treatment.
4. Evaluate patch quality and habitat connectivity for a suite of wildlife species in a post-treatment scenario. Conduct connectivity analyses for those species to evaluate the potential for distributional shifts of behavioral movements in response to patch treatments.
5. Refine this regional-scale analysis down to a finer scale.
6. Analyze additional Environmental Assessments to more precisely evaluate the reasons why and where certain treatments (e.g., mechanical thinning, fire-only) are planned.
7. Conduct more detailed estimates of biomass (in tons) as was done in the wood supply analysis for wood by-product volumes.
8. Improve Forest Service roads layer.

2011-03-15 - 48

**Paula Cote/R3/USDAFS**
03/15/2011 01:41 PM

To 4FRI Comment Database@FSNOTES
cc
bcc
Subject Fw: Four Forest Restoration Initiative - Comment

Paula Cote'
NEPA Specialist
Coconino National Forest
Four Forest Restoration Initiative (4-FRI)
1824 S. Thompson Street
Flagstaff, Arizona 86001
(928) 226-4686
Fax (928) 527-3620
pcote@fs.fed.us

----- Forwarded by Paula Cote/R3/USDAFS on 03/15/2011 01:40 PM -----



**Frank Welsh**
**<welshfj@yahoo.com>**
03/15/2011 01:01 PM

To pcote@fs.fed.us, hprovencio@fs.fed.us
cc
Subject Four Forest Restoration Initiative - Comment

Paula and Henry: - thanks for the info - hope you'll forward this to the right address. Please ignore first incomplete mes:

general I worked for the Gifford Pinchot in Washington and the Coconino in the 1960s. Through the years I have been involved on your comment sheet. I am a member of the Sierra Club (Grand Canyon Chapter) the Maricopa Audubon Society, Ce Civil Engineers, Republican Party, etc.

general My comments apply to all Arizona National Forests. They coincide with those of Dr. Martin Taylor, Ph.D. ecologist, form and Applied Research and with Center for Biodiversity, as published in a 9/21/2000 commentary in the Tucson Citizen. to fire, cattle grazing and forest management:

general *"By removing grass, the primary carrier for cool understory fires, cattle effectively removed fires from the ponderosa pir fires, saplings of ponderosa pine and other woody species were no longer naturally thinned. Over time, our forests hav spindly trees. Ironically, this fire suppression led top even greater fires of enormous magnitude and damage. Though th suppression and old growth logging also contributed to the problem, fire suppression by cattle has had a primary and w*

general *Ecologists throughout the West, such as Dr. Phil Ogden, have conclusively shown that cattle suppress natural fires. Th absence of fire, ungrazed forests have enough vigorous grasses to prevent tree and shrub thickets from building up. Th Arizona's Tree Ring Lab., has studied these pristine and ungrazed forests and has posted photos online.*

*Restoring our national forests to health after 120 years of abuse is a large and daunting task, one that will thake decad scientific community that addressing livestock grazing impacts on fire and biodiversity must be part of the solution."*

56 Y1

2011-1-0316-49

Janice K. Brewer
**Governor**

Scott Hunt
**State Forester**

# Arizona State Forestry Division

**Office of the State Forester**
**1110 W. Washington St., Suite 100**
**Phoenix, AZ 85007**
**(602) 771-1400**

March 11, 2011

Coconino National Forest
Attn: 4FRI
1824 S. Thompson Street
Flagstaff, AZ 86001

Dear Forest Supervisors Stewart and Williams:

general

The Arizona State Forestry Division welcomes the opportunity to provide comments on the Proposed Action ("PA") and Notice of Intent to Prepare an Environmental Impact Statement for the Coconino and Kaibab National Forests, Four Forest Restoration Initiative (4FRI), as released on January 21, 2011 and published in the *Federal Register* at 76 Fed. Reg. 4279 on January 25, 2011, respectively.

57-1/1

We support the overall approach that the Four National Forests (Apache-Sitgreaves, Coconino, Kaibab, and Tonto) are taking to restore the health and sustainability of forest lands in Arizona. The landscape scale approach will insure that implemented management strategies will not stop at individual forest boundaries and will benefit large scale watersheds, wildlife habitats and scenic landscapes.

1/2

We would encourage that the management strategies being developed consider an all lands approach taking into account adjoining ownerships that have a vested interest in the outcome. To further enhance this effort, we recommend that the recently developed Arizona Statewide Assessment and Strategy be used as a guiding document. This document was developed working closely with our partner organizations and stakeholders statewide.

1/3

The PA does not specifically address the need for forest industry, but we believe it is a critical component to the overall success of the 4FRI. We can offer our assistance and enlist the help of the Governor's Forest Health Council in partnering with the national forests to foster a sustainable forest industry. Our hope is for a forest industry that will encompass a suite of forest products that has the capacity to utilize a variety of tree diameters. We believe the Forest Service will need to develop longer term contracts to cultivate forest industry investment.

1/4

We applaud your goal of reducing the potential for catastrophic wildfires especially where it involves the wildland/urban interface. The landscape approach of 4FRI will be effective

over the long run in reducing fire threat and damage to life, property, infrastructure, and watersheds. This will also benefit federal, state, and local fire and emergency agencies in reducing fire suppression and post fire mitigation costs.

Finally, we ask that as treatment prescriptions are developed, that the emphasis be placed on the health of each stand of trees. Ideally, they should address a broad base of objectives and not focus on any one aspect that may change overtime in a dynamic forest environment.

We appreciate the great effort that your staff has put forth to collaborate with our agency as well as the other stakeholders, and look forward to the success of this project.

Sincerely,

Scott Hunt
State Forester

2011-03-21-58

# THE HOPI TRIBE

#50

**LeRoy N. Shingoitewa**
CHAIRMAN

**Herman G. Honanie**
VICE-CHAIRMAN

March 21, 2011

Michael R. Williams, Forest Supervisor
Kaibab National Forest
800 South Sixth Street
Williams, Arizona 86046-2899

M. Earl Stewart, Forest Supervisor
Coconino National Forest
1824 South Thompson Street
Flagstaff, Arizona 86001-2529

Re: *Four Forest Restoration Initiative-Coconino and Kaibab National Forest Purpose and Need and Proposed Action*

Dear Supervisors Williams and Stewart,

This letter is in response to your correspondence dated January 27, 2011, regarding an enclosed proposal to conduct restoration activities within a 750,000 acres ponderosa pine ecosystem over 10 years, part of the Four Forest Restoration Initiative. The Hopi Tribe claims cultural affiliation to prehistoric cultural groups in Coconino, Kaibab, Apache Sitgreaves and Tonto National Forests. The Hopi Cultural Preservation Office supports the identification and avoidance of prehistoric archaeological sites and we consider the prehistoric archaeological sites of our ancestors to be "footprints" and Traditional Cultural Properties. Therefore, we appreciate the Forest's continuing solicitation of our input and your efforts to address our concerns. 58-1

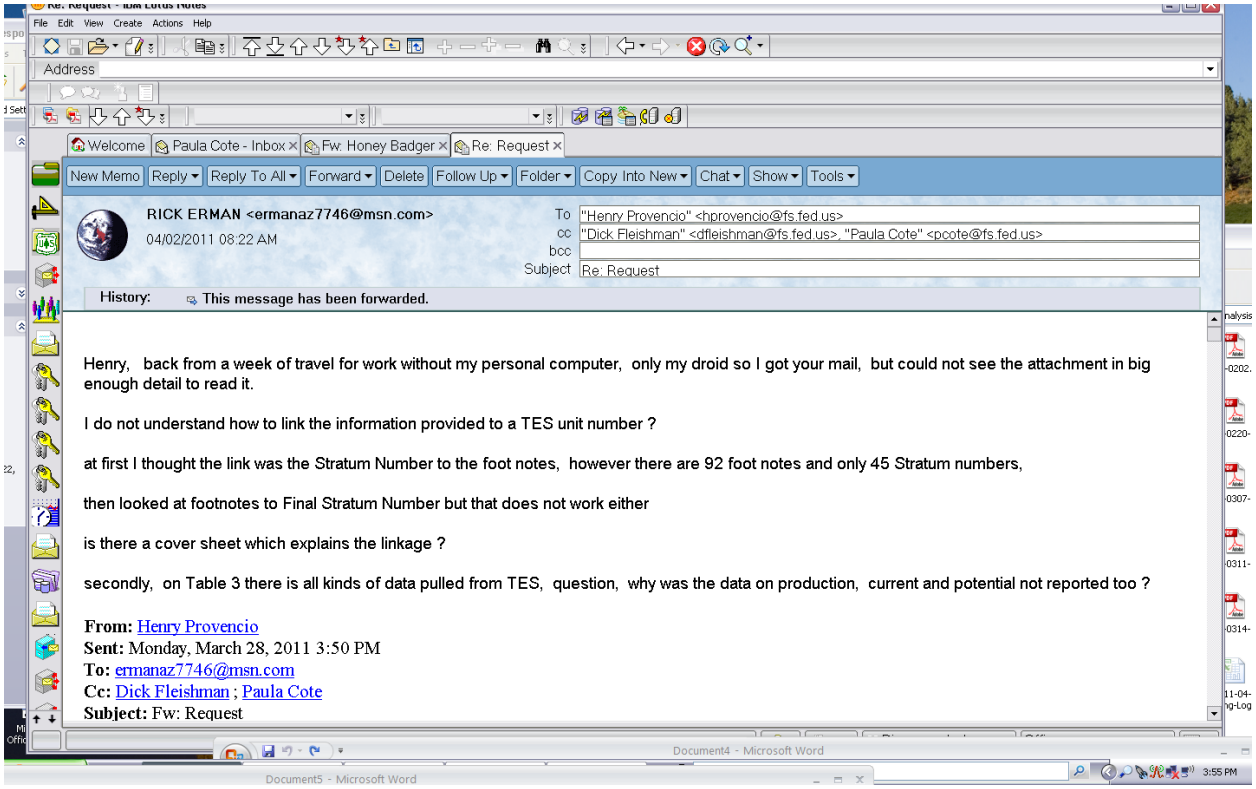
The Hopi Cultural Preservation Office has reviewed the enclosed *Four Forest Restoration Initiative-Coconino and Kaibab National Forest Purpose and Need and Proposed Action.* We routinely consult with Coconino, Kaibab, and Apache-Sitgreaves Forest Managers and Archaeologists during regular scheduled meetings on the Forests' Schedule of Proposed Actions. In initial consultations on the Four Forest Restoration Initiative we have been informed that *Appendix J, Standard Consultation Protocol for Large-Scale Fuels Reduction, Vegetation Treatment, and Habitat Improvement Projects* pursuant to the *First Amended Programmatic Agreement Regarding Historic Property Protection and Responsibilities* will apply to these projects. 58-2

Therefore, we look forward to continuing consultations with the four Forests on the development and implementation of the cultural resources survey plans, and Traditional Cultural Properties and ethnographic studies. If you have any questions or need additional information, please contact Terry Morgart at the Hopi Cultural Preservation Office at 928-734-3619 or tmorgart@hopi.nsn.us. Thank you for your consideration.

Respectfully,

Leigh J. Kuwanwisiwma, Director
Hopi Cultural Preservation Office

xc: Forest Supervisor, Attention: Scott Wood, Tonto National Forest
Forest Supervisor, Attention: Melissa Schroeder, Apache Sitgreaves National Forests
Arizona State Historic Preservation Office
Mike Lyndon, Erin Woodard, Kaibab National Forest
Craig Johnson, Coconino National Forest


File Edit View Create Actions Help
Address
Welcome
Paula Cote - Inbox
Fw: Honey Badger
Re: Request
New Memo
Reply
Reply To All
Forward
Delete
Follow Up
Folder
Copy Into New
Chat
Show
Tools
RICK ERMAN <ermanaz7746@msn.com>
04/02/2011 08:22 AM
To "Henry Provencio" <hprovencio@fs.fed.us>
cc "Dick Fleishman" <dfleishman@fs.fed.us>, "Paula Cote" <pcote@fs.fed.us>
bcc
Subject Re: Request
History: This message has been forwarded.
Henry, back from a week of travel for work without my personal computer, only my droid so I got your mail, but could not see the attachment in big enough detail to read it.
I do not understand how to link the information provided to a TES unit number ?
at first I thought the link was the Stratum Number to the foot notes, however there are 92 foot notes and only 45 Stratum numbers,
then looked at footnotes to Final Stratum Number but that does not work either
is there a cover sheet which explains the linkage ?
secondly, on Table 3 there is all kinds of data pulled from TES, question, why was the data on production, current and potential not reported too ?
From: Henry Provencio
Sent: Monday, March 28, 2011 3:50 PM
To: ermanaz7746@msn.com
Cc: Dick Fleishman ; Paula Cote
Subject: Fw: Request
Document4 - Microsoft Word
Document5 - Microsoft Word
3:55 PM

2011-0403-52

Four Forest Restoration Initative
Coconino and Kaibab National Forest

***Please Tell Us Your Preference for Receiving Documents including the Scoping Letter, DEIS, FEIS/ROD*** *(we would like to keep printing costs down and send documents via e-mail or share by posting to our website):*

✓ I prefer to receive documents by e-mail which is: herk@esedona.net

___I prefer to view documents on the forest web-site

___I would like to receive a CD copy of the DEIS and FEIS/ROD (*Note: Scoping letter will not be available via CD)*

___I would like to receive documents in hard-copy form (***please make sure you have provided your address)***

***Has Your Address Changed? Please provide your new address:***

Marjorie Herkenham
Yes. Now is 35 Kaibab Drive
Sedona, AZ 86336
Note: Norman died Oct 5, 2010

**Please submit all comments no later than March 14, 2010.** This will allow the 4 FRI team sufficient time to consider your comments in order to identify issues, alternatives, mitigation and monitoring options.

**Web Site:** http://www.fs.usda.gov/goto/kaibab/4fri

**Email Address:** 4FRI_comments@fs.fed.us Please note: there is an underscore "_" between the words "4FRI" and "comments" (4FRI_comments)

**US Mail:** Coconino National Forest, 1824 South Thompson St., Flagstaff, AZ 86001, *Attn*: 4FRI

**PLEASE NOTE: General comments will always be accepted and considered in subsequent steps of the 4 FRI NEPA process.**

Thank you for your comments!

More information can be found at http://www.fs.usda.gov/goto/kaibab/4fri

If you have questions, please contact Paula Cote at 928-226-4686.

**Comment Letter #53 – 2011-0420-53**

Stakeholder questions to be addressed in meetings leading up to release of a refined proposed action:

1. Will the refined Proposed Action include a range of mechanical treatment intensities, rather than a focus on high-intensity treatments (as treatment maps currently indicate)?

2. How does the Forest Service plan to measure canopy cover in VSS 4, 5, and 6 stands in accordance with current forest plan direction?

3. What approach does the Forest Service plan to use in order to strategically locate treatments with the goal of changing fire behavior, and what assumptions will be associated with that approach?

4. Is the refined proposed action likely to result in any forest plan amendments?

5. In the goshawk guidelines (which the FS is using to develop treatments for the 4FRI project), the FS states 'implementation of the goshawk guidelines will result in forest landscape restoration (structure, patterns, and species composition within the historic range of variability of natural forest conditions)'. However, I have not seen a description of what the historic range of variability of natural conditions actually is, and more importantly what are the attributes, parameters, and science that are being utilized to develop that historic range of variability as it relates to implementation of the goshawk guidelines? Even if you discount the goshawk guidelines, what is the FS using as HRV and how did it determine the HRV it is using to develop its 4FRI restoration objectives?

6. How will the refined Proposed Action emphasize the objective of safely re-establishing natural fire regimes at landscape scales?

7. How will the refined Proposed Action describe restoration as a corrective step to re-establish self-regulating forests rather than another step in an ongoing system of silvicultural management?

8. Will the refined Proposed Action state and respond to the stakeholder objective of implementing mechanical treatment across 50,000 strategically-located acres per year for 20 years as measured across the entire 2.4 million acre analysis area?

9. Will the refined Proposed Action state that its actions will comply with the MSO recovery plan and not result in new take until and unless re-consultations allowing more take have been completed?

10. How will the refined Proposed Action identify strategically-placed restoration treatments that safely re-establish natural fire regimes at landscape scales, building on the Landscape Strategy and its Treatment Area Portfolios?

11. How will the refined Proposed Action describe Firescapes as a spatial context for designing and deploying strategically-placed restoration treatments to safely manage both planned and unplanned wildland fires?

12. How will the refined Proposed Action incorporate the large tree retention and old growth protection strategy?