United States Department of Agriculture

4FRI Rim Country Project

Draft Environmental Impact Statement

Volume 1

Apache-Sitgreaves, Coconino, and Tonto National Forests
Coconino, Yavapai, Gila, and Navajo Counties, Arizona

Forest Service Southwestern Region MB-R3-04-34 October 2019

4FRI Rim country Project
Draft Environmental Impact Statement

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Coconino, Yavapai, Gila, and Navajo Counties, Arizona

Lead Agency:	**USDA Forest Service**
Cooperating Agencies:	**Arizona Game and Fish Department**
Responsible Official:	**STEPHEN BEST, FOREST SUPERVISOR** Apache-Sitgreaves National Forests 30 S. Chiricahua Dr. Springerville, AZ 85938 **LAURA JO WEST, FOREST SUPERVISOR** Coconino National Forest 1824 South Thompson Street Flagstaff, AZ 86001 **NEIL BOSWORTH, FOREST SUPERVISOR** Tonto National Forest 2324 E. McDowell Rd. Phoenix, AZ 85006
For Information Contact:	**ROBBIN REDMAN, 4FRI PLANNING COORDINATOR** 1824 South Thompson Street Flagstaff, AZ 86001 (928) 527-3635

Abstract: The Four Forest Restoration Initiative (4FRI) is a Collaborative Forest Landscape Restoration Project covering portions of four national forests in Arizona that meets the requirements of the Omnibus Public Lands Management Act of 2009. The first 4FRI Environmental Impact Statement (EIS) was completed and the Record of Decision was signed in 2015. Implementation of the treatments analyzed in the 1st EIS are currently being implemented. The 4FRI Rim Country analysis continues this collaboration effort. Below are specific portions of the Omnibus Public Lands Management Act of 2009 that speak to eligibility of projects under the Collaborative Forest Landscape Restoration Program and also project implementation:

(b) Eligibility Criteria- To be eligible for nomination under subsection (c), a collaborative forest landscape restoration proposal shall--

(1) be based on a landscape restoration strategy that--

(A) is complete or substantially complete;

(B) identifies and prioritizes ecological restoration treatments for a 10-year period within a landscape that is--

(i) at least 50,000 acres;

(ii) comprised primarily of forested National Forest System land, but may also include land under the jurisdiction of the Bureau of Land Management, land under

the jurisdiction of the Bureau of Indian Affairs, or other Federal, State, tribal, or private land;

(iii) in need of active ecosystem restoration; and

(iv) accessible by existing or proposed wood-processing infrastructure at an appropriate scale to use woody biomass and small-diameter wood removed in ecological restoration treatments;

(C) incorporates the best available science and scientific application tools in ecological restoration strategies;

(D) fully maintains, or contributes toward the restoration of, the structure and composition of old growth stands according to the pre-fire suppression old growth conditions characteristic of the forest type, taking into account the contribution of the stand to landscape fire adaptation and watershed health and retaining the large trees contributing to old growth structure;

(E) would carry out any forest restoration treatments that reduce hazardous fuels by--

(i) focusing on small diameter trees, thinning, strategic fuel breaks, and fire use to modify fire behavior, as measured by the projected reduction of uncharacteristically severe wildfire effects for the forest type (such as adverse soil impacts, tree mortality or other impacts); and

(ii) maximizing the retention of large trees, as appropriate for the forest type, to the extent that the trees promote fire-resilient stands; and

(F)(i) does not include the establishment of permanent roads; and

(ii) would commit funding to decommission all temporary roads constructed to carry out the strategy;

(2) be developed and implemented through a collaborative process that—

(A) includes multiple interested persons representing diverse interests; and

(B)(i) is transparent and nonexclusive; or

(ii) meets the requirements for a resource advisory committee under subsections (c) through (f) of section 205 of Public Law 106-393 (16 U.S.C. 500 note)

(g) Program Implementation and Monitoring-

(2) PROJECT IMPLEMENTATION- Amounts transferred to the Secretary from the Fund shall be used to carry out ecological restoration treatments that are—

(A) consistent with the proposal and strategy; and

(B) identified through the collaborative process described in subsection (b)(2).

This draft environmental impact statement (DEIS) documents the analysis of three alternatives, including a "no action" alternative, which were developed for the Rim Country Project on the Apache-Sitgreaves, Coconino, and Tonto National Forests. Alternative 2, the modified proposed action, is the preferred alternative. The project proposes to conduct restoration activities over a 20-year period or until proposed activities are completed. Alternative 1 is the no-action alternative. Alternative 2, the modified proposed action, would mechanically treat vegetation on up to 889,340 acres and would treat up to 953,130 acres with prescribed fire; alternative 3 would mechanically treat up to 483,160 acres and burn up to 529,060 acres. Both of the action alternatives propose significant Forest Plan amendments that would amend the 1985 Tonto National Forest Plan. They are considered significant amendments because they are being considered in an Environmental Impact Statement (EIS).

Reviewers should provide the Forest Service with their comments during the review period of the DEIS. This will enable the Forest Service to analyze and respond to the comments at one time and to use information acquired in the preparation of the final environmental impact statement, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act process so that it is meaningful and alerts the agency to the reviewers' position and contentions. Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement. Comments on the draft environmental impact statement should be specific and should address the adequacy of the statement and the merits of the alternatives discussed (40 CFR 1503.3).

The 90-day public comment period begins on the day after the Environmental Protection Agency publishes a notice of availability for the draft EIS in the Federal Register. Comments, including anonymous comments, will be accepted at any time. However, comments posted after the close of a designated comment period may not be able to be given full consideration. Anonymous comments and comments submitted after the close of the designated comment period will not provide the commenter standing for administrative review. In order to ensure full consideration of your comments, please submit them before the close of business on the last day of the comment period. Comments, including attachments, may be submitted using the web form at https://cara.ecosystem-management.org/Public/CommentInput?project=48210. Comments may also be submitted by email, mail, fax, or in person (8am-4:30pm M-F). E-mail electronic comments, including attachments, in Word (.doc or .docx), portable document format (.pdf), rich text format (.rtf), text (.txt), and hypertext markup language (.html) to 4fri_comments@fs.fed.us. Mail or hand deliver to: 4FRI Rim Country DEIS c/o Coconino National Forest Supervisor's Office, 1824 S. Thompson St., Flagstaff, AZ 86001. Fax to: (928) 527-3620.

List of Acronyms

4FRI	Four Forest Restoration Initiative
ACHP	Advisory Council on Historic Preservation
ADEQ	Arizona Department of Environmental Quality
AGFD	Arizona Game and Fish Department
AUM	Animal Unit Month
BA	Basal area
BAER	Burned Area Emergency Response
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BE	Biological evaluation
BMP	Best management practice
CCF	Hundred cubic feet
CEQ	Council on Environmental Quality
CFLR	Collaborative Forest Landscape Restoration
CFLRP	Collaborative Forest Landscape Restoration Program
CFR	Code of Federal Regulations
CHU	Critical habitat unit
CO	Carbon monoxide
CWD	Coarse woody debris
d.b.h.	Diameter at breast height
DEIS	Draft environmental impact statement
DF	Design feature
dPFA	Dispersal post-fledging area
d.r.c.	diameter at root collar
EIS	Environmental impact statement
EMA	Ecosystem management area
EPA	Environmental Protection Agency
ERU	Ecological response unit
FEIS	Final environmental impact statement
FRCC	Fire regime condition class
FS	Forest Service
FSH	Forest Service Handbook
FSM	Forest Service Manual
FTA	Flexible toolbox approach
FVS	Forest Vegetation Simulator
FWS	United States Fish and Wildlife Service
GIS	Geographic information system
HUC	Hydrologic unit code
IBA	Important bird area
IDT	Interdisciplinary team
IT	Intermediate thin
LANL	Los Alamos National Laboratory
LOPFA	Landscapes outside post-fledging family area
LTIP	Large tree implementation plan
LTRS	Large tree retention strategy
MA	Management area
MAUM	Thousand animal unit month
MIS	Management indicator species

ML	Maintenance level (of a road)
MRNG	Management Recommendations for the Northern Goshawk in the Southwestern United States
MSO	Mexican spotted owl
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NHPA	National Historic Preservation Act
NMED	New Mexico Environment Department
NRV	Natural Range of Variation
PAC	Mexican spotted owl protected activity center
PFA	Northern goshawk post-fledging family area
PJ	Pinyon-juniper
PM	Particulate matter
PNVT	Potential natural vegetation type
ROS	Recreation opportunity spectrum
ROW	Right-of-way
RU	Recovery Unit
SDI	Stand density index
SHG	(4FRI) Stakeholder Group
SHPO	State Historic Preservation Office
SI	Stand improvement
SIO	Scenery integrity objectives
SWCP	Soil and water conservation practice
TAP	Travel analysis process
TCP	Traditional cultural properties
TES	Threatened, endangered and sensitive
TMR	Travel Management Rule
TPA	Trees per acre
UEA	Uneven-aged
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
VMS	Visual Management System
VSS	Vegetation structural stages
WCATT	Watershed Classification and Assessment Tracking Tool
WEPP	Water Erosion Prediction Project
WFLC	Western Forest Leadership Coalition
WUI	Wildland-urban interface

Summary

The Rim Country Project is a project of the Four Forest Restoration Initiative (4FRI). 4FRI is a planning effort designed to restore ponderosa pine forest resilience and function across four national forests in Arizona: the Apache-Sitgreaves, Coconino, Kaibab, and Tonto National Forests (Figure S-1). In 2015, the Record of Decision for the first 4FRI EIS for the northern portion of the Coconino National Forest and the southern portion of Kaibab National Forest was signed.

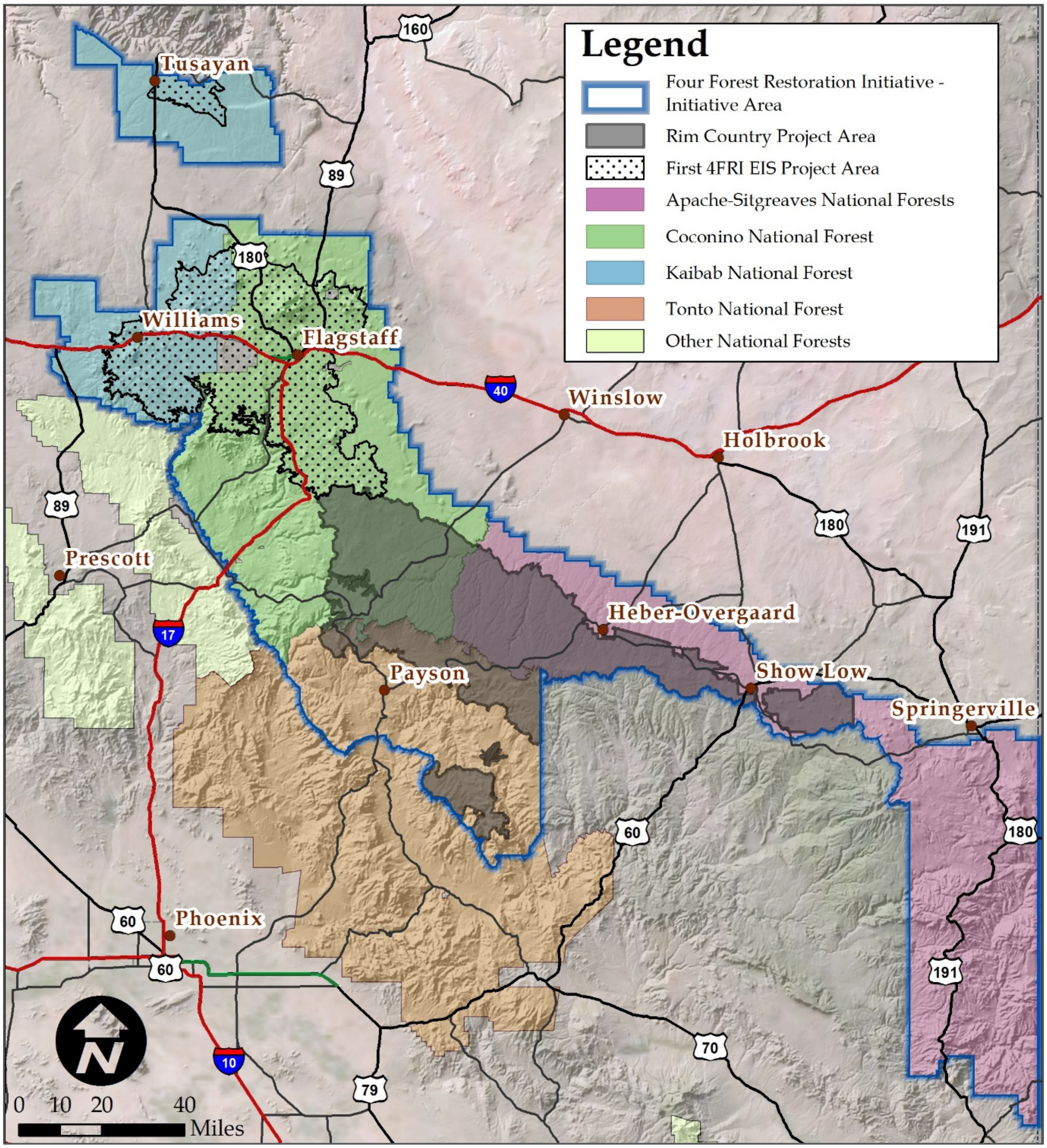

Figure S-1. Four Forest Restoration Initiative

4FRI is a result of many years of planning and collaboration among interested parties, groups and organizations, and federal, state and local government agencies. The focus has been to restore forest landscapes and reduce the potential for severe fire effects in a manner that also benefits the local economy. 4FRI was selected to receive Collaborative Forest Landscape Restoration Act (CFLRA) funding. CFLRA supports landscape restoration on National Forest System lands.

The purpose of the 4FRI Rim Country Project is to restore and maintain the structure, pattern, health, function, and vegetation composition and diversity in ponderosa pine ecosystems, thus moving the project area toward the desired conditions in the respective land and resource management plans. One outcome of restored ecosystems is increased resilience. Resilience is the ability of an ecosystem to survive natural disturbances such as fire, insects and disease, without changing its inherent function (FSH 1909.12,05; SER 2004). This project is needed to:

- Increase forest resilience and sustainability
- Reduce hazard of undesirable fire effects
- Improve terrestrial and aquatic species habitat
- Improve the condition and function of streams, springs and other aquatic and hydrological resources
- Restore riparian vegetation
- Preserve cultural resources
- Support sustainable forest products industries

To meet the purpose and need for action, the Apache-Sitgreaves, Coconino, and Tonto National Forests are proposing a suite of restoration activities on approximately 953,100 acres over a period of 20 years or when activities can be funded or completed. The area affected by the proposal includes approximately 540,020 acres on the Black Mesa and Lakeside Ranger Districts of the Apache-Sitgreaves National Forests, 398,880 acres on the Mogollon Rim and Red Rock Ranger Districts of the Coconino National Forest, and 299,710 acres on the Payson and Pleasant Valley Ranger Districts of the Tonto National Forest.

The 4FRI Rim Country Project has been published in the Apache-Sitgreaves, Coconino, and Tonto National Forests' Schedule of Proposed Actions since January of 2016. The notice of intent to prepare an environmental impact statement was published in the Federal Register on June 27, 2016 (81 FR 41517). A scoping document with the proposed action was sent to parties on the project mailing list (paper copies and electronic mail) and posted on the 4FRI website. Letters were mailed to 676 individuals, local governments, state governments, federal and state agencies, and organizations engaged with the three national forests. Public open houses were held on July 14, 2016 in Showlow, AZ and on July 21, 2016 in Payson, AZ to discuss the proposed action and accept comments. Fifty (50) scoping responses (e-mails letters and public meeting comment forms) were received from this effort.

Issues

Seven issues, including treatments in MSO PACs, treatments in goshawk habitat, large tree retention, dwarf mistletoe mitigation, smoke/air quality, economics, and roads, contributed to alternative and design feature/mitigation measure development and focused the analysis. See Table 17and chapter 1 for information on how these and other public concerns and recommendations were addressed.

Alternatives

Three alternatives were analyzed in detail and four alternatives were considered but eliminated from detailed study. The alternatives analyzed in detail include the no-action alternative (alternative 1), the modified proposed action (alternative 2), which is the preferred alternative, and one additional action alternative (alternative 3). Alternatives 2 and 3 respond to the seven significant issues for the Rim Country Project. See chapter 2 for detailed information on the alternatives considered and analyzed.

Comparison of Alternatives by Activity

Table S-1. Comparison of Alternatives by Activity

Proposed Activity	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred)	Alternative 3 Focused Alternative
Mechanical Treatment Intermediate thinning	No treatments would occur as a result of this alternative being selected	152,270	114,280
Stand improvement	No treatments would occur as a result of this alternative being selected	62,720	32,290
Single tree selection	No treatments would occur as a result of this alternative being selected	12,510	5,630
Uneven-aged group selection	No treatments would occur as a result of this alternative being selected	226,520	113,350
Aspen restoration	No treatments would occur as a result of this alternative being selected	1,230	1,010
Facilitative operations	No treatments would occur as a result of this alternative being selected	123,700	47,880
MSO recovery - replacement nest/roost	No treatments would occur as a result of this alternative being selected	25,290	19,590
MSO PAC - mechanical	No treatments would occur as a result of this alternative being selected	17,460	15,750
Savanna restoration	No treatments would occur as a result of this alternative being selected	18,570	2,470
Severe disturbance area treatment	No treatments would occur as a result of this alternative being selected	132,240	31,760
Wildland Urban Interface (WUI) & Infrastructure Protection	No treatments would occur as a result of this alternative being selected	63,930	46,260
Grassland restoration*	No treatments would occur as a result of this alternative being selected	36,280	36,280

Proposed Activity	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred)	Alternative 3 Focused Alternative
Wet meadow restoration*	No treatments would occur as a result of this alternative being selected	6,400	6,400
Riparian restoration*	No treatments would occur as a result of this alternative being selected	13,060	13,060
Total mechanical treatment (acres)	**No treatments would occur as a result of this alternative being selected**	**889,340**	**483,160**
Prescribed Fire Prescribed fire along with mechanical treatment	No treatments would occur as a result of this alternative being selected	889,340	483,160
Prescribed fire only	No treatments would occur as a result of this alternative being selected	63,790	45,900
Total prescribed fire (acres)	**No treatments would occur as a result of this alternative being selected**	**953,130**	**529,060**
Grassland Restoration Mechanical and Prescribed Fire	No treatments would occur as a result of this alternative being selected	36,280	36,280
Prescribed fire only	No treatments would occur as a result of this alternative being selected	40	40
Total grassland restoration* (acres)	**No treatments would occur as a result of this alternative being selected**	**36,320**	**36,320**
Wet Meadow Restoration Mechanical and Prescribed Fire	No treatments would occur as a result of this alternative being selected	6,410	6,410
Prescribed fire only	No treatments would occur as a result of this alternative being selected	310	310
Total wet meadow restoration* (acres)	**No treatments would occur as a result of this alternative being selected**	**6,720**	**6,720**
Riparian Restoration Mechanical and Prescribed Fire	No treatments would occur as a result of this alternative being selected	13,060	13,060
Prescribed fire only	No treatments would occur as a result of this alternative being selected	1,500	1,500
Springs restored (number)	No treatments would occur as a result of this alternative being selected	184	184

Proposed Activity	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred)	Alternative 3 Focused Alternative
Protective barriers around springs, aspen, native willows and bigtooth maples (miles)	No treatments would occur as a result of this alternative being selected	200	200
Stream restoration (miles)	No treatments would occur as a result of this alternative being selected	777	777
Existing road decommission (miles)	No treatments would occur as a result of this alternative being selected	490	490
Unauthorized route decommission (miles)	No treatments would occur as a result of this alternative being selected	800	800
Temporary road construction and decommission (miles)	No treatments would occur as a result of this alternative being selected	330	170
Road relocation and reconstruction (miles)	No treatments would occur as a result of this alternative being selected	As needed	As needed
Total riparian restoration* (acres)	**No treatments would occur as a result of this alternative being selected**	**14,560**	**14,560**

*Overlap exists between the riparian, grassland and wet meadow restoration categories (approximately 3,120 acres)

Design Features, Best Management Practices, and Conservation/Mitigation Measures

Project design features, best management practices and conservation/mitigation measures (hereafter referred to collectively as design features) that minimize or avoid effects from the proposed activities are included in the analysis in this DEIS (see appendix C).

Implementation Plan

A draft implementation plan (appendix D) was developed in conjunction with the design features found in appendix C. The implementation plan gives guidance that will be used by Forest Service personnel to ensure that treatments and activities are implemented to meet the purpose and need and Forest Plan standards and guidelines.

Monitoring and Adaptive Management

Appendix E includes the monitoring and adaptive management plan. This plan details the framework and process for monitoring restoration activities. The 4FRI Stakeholder Group and the Forest Service collaborated on the design of the monitoring and adaptive management plan.

Forest Plan Consistency

The Rim Country Project was reviewed for consistency with the direction in the Apache-Sitgreaves Revised Forest Plan (USDA Forest Service 2016), the Coconino Revised Forest Plan (USDA Forest Service 2018), and the current Tonto National Forest Plan, as amended (USDA Forest Service 2017).

Consistency evaluations can be found in each specialist report. The design features in appendix C and the implementation plan in appendix D also documents how treatment design meets Apache-Sitgreaves, Coconino, and Tonto National Forests Plan direction and desired conditions.

Apache-Sitgreaves National Forests: The revised Forest Plan for the Apache-Sitgreaves National Forests became effective in July of 2015, with minor changes in 2016. With design features, alternatives 2 and 3 are consistent with Forest Plan desired conditions, objectives, standards, and guidelines, although movement toward desired conditions varies by alternative. Forest Plan consistency evaluations are located in each specialist report, and design features to ensure that activities are consistent with Forest Plans are noted in appendix C.

Treatments to address high severity dwarf mistletoe infections in some stands include high intensity thinning and creation of considerable interspace in order to slow spread of mistletoe and with a purpose of improving forest health. A guideline in the Apache-Sitgreaves National Forest Plan states

> "On single species dominated sites, thinning should not be attempted where more than 80 percent of the host species – or 90 percent of the area - is infected with dwarf mistletoe. Regeneration and/or deferral may be used in these cases."

According to the 2012 Planning rule ((219.7(e)(l)(iii-iv) and 219.15(d)(2-3)), compliance with both standards and guidelines is mandatory, with standards requiring strict adherence to their terms, while guidelines allow for flexibility so long as the purpose for the guideline is achieved.

The approach to severe mistletoe infections in this document attempts modify stand characteristics (i.e. old and large tree retention, basal area, trees per acre, interspace and uneven-aged structure) to within the NRV and is considered a restoration-based treatment with the purpose of improving forest health and resilience. As a result, these treatments are consistent with the Apache-Sitgreaves Forest Plan.

Coconino National Forest: The revised Forest Plan for the Coconino National Forest became effective in June of 2018. With design features, alternatives 2 and 3 are consistent with Forest Plan desired conditions, objectives, standards, and guidelines, although movement toward desired conditions varies by alternative. Forest Plan consistency evaluations are located in each specialist report, and design features to ensure that activities are consistent with Forest Plans are noted in appendix C.

Tonto National Forest: The Tonto National Forest is presently going through the process of revising the Forest Plan. The current plan was developed under the 1982 Planning Rule and went into effect in 1985. Activities proposed in alternatives 2 and 3 are based on the best available scientific information, which includes more than 25 years of advances in forest management science and learning since the current Forest Plan was developed.

To align current Forest Plan standards and guidelines with best available scientific information, thereby making alternatives 2 and 3 consistent with the Forest Plan, three project-specific Forest Plan amendments are proposed (see appendix B). Each amendment is a one-time variance in the current Tonto National Forest Plan direction specifically for the Rim Country Project. The amended, direction would not apply to any other projects or areas outside of the Rim Country Project and it would cease to be in effect upon completion of the project. Analysis of the effects of the proposed amendments is integrated into the analysis of the alternatives presented in Chapter 3.

The purpose of amendment 1 is to bring the Forest Plan into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. The purpose of amendment 2 is to bring the Forest Plan into alignment with the revised

Mexican Spotted Owl Recovery Plan (USDI Fish and Wildlife Service 2012) and defer monitoring to the Fish and Wildlife Service biological opinion that is specific to this project. The purpose of amendment 3 is to update Forest Plan language to account for advances in mechanized thinning technology and capabilities. Amendment 3 would remove language restricting the use of mechanical equipment to slopes less than 40 percent and identifying slopes above 40 percent as inoperable. Proposed language would allow the use of mechanized ground-based equipment to thin on slopes greater than 40 percent where it is not otherwise restricted and where it would not result in adverse effects on soil and water resources. This would allow for restoration treatments to be implemented on steeper slopes to meet the purpose and need of the Rim Project, and to move toward desired conditions in these areas.

With the proposed significant Forest Plan amendments (see appendix B) and the design features in appendix C, alternatives 2 and 3 are consistent with the direction in the 1985 Forest Plan.

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Chapter 1. Purpose of and Need for Action

Document Structure

The Forest Service has prepared this draft environmental impact statement (DEIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. This DEIS discloses the direct, indirect, and cumulative environmental effects that would result from implementation of the modified proposed action (the preferred alternative) and other alternatives presented. The document is organized into two volumes.

Volume 1

Chapter 1. Purpose of and Need for Action: The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for fulfilling that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives, including the Proposed Action: This chapter provides a more detailed description of the agency's proposed action as well as an alternative method for achieving the stated purpose. These alternatives were developed and modified based on significant issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table (Table 18) of the environmental consequences associated with each alternative.

Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.

Volume 2

Continued - Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.

Chapter 4. Preparers and Contributors: This chapter provides a list of those who prepared and contributed to this environmental impact statement.

Chapter 5. Distribution List: This chapter lists all tribes, agencies, organizations, and persons to whom the draft environmental impact statement (DEIS) was provided.

References: This section provides a list of scientific literature used to inform the analysis.

Appendices A through F**:** the appendices provide more detailed information to support the analysis. Appendices include a placeholder for a map packet in appendix A; proposed Forest Plan amendments in appendix B; project design features, best management practices (BMPs), and conservation/mitigation measures in appendix C; an Implementation Plan in appendix D; a Monitoring and Adaptive Management Plan in appendix E; and a glossary of terms in appendix F.

Additional documentation, including the more detailed analysis for each resource in the resource specialist reports, can be found in the project record located at the Coconino National Forest Supervisor's Office, 1824 South Thompson Street, Flagstaff, Arizona. All of the specialist reports are also available on the 4FRI Rim Country webpage at: www.fs.usda.gov/goto/4FRIRimCountry.

Background

The Four Forest Restoration Initiative (4FRI) is a planning effort designed to restore forest resilience and ecosystem function in ponderosa pine forests and associated ecosystems across four national forests in Arizona including the Coconino, Kaibab, Apache-Sitgreaves, and Tonto National Forests (Figure 1).

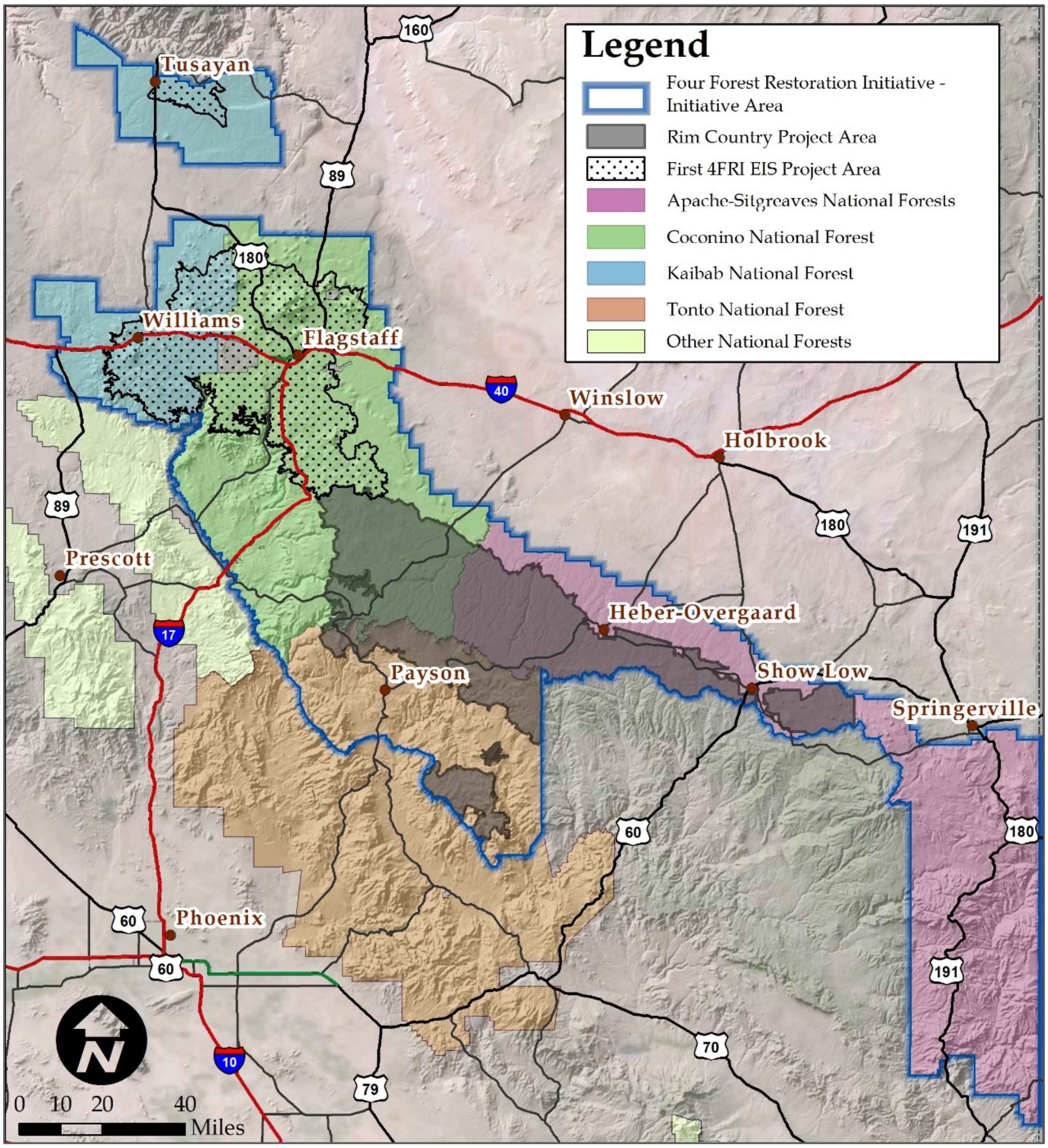

Figure 1. Four Forest Restoration Initiative

In February 2008, based on recommendations within the statewide strategy, the Analysis of Small Diameter Wood Supply in Northern Arizona report (Hampton et al. 2008) was completed. This process demonstrated a level of "social agreement" on how much, where, and under what basic parameters mechanical treatment, as one restoration tool, could be used to accelerate restoration of the 2.4 million-acre initiative area.

To further advance collaborative efforts and secure the necessary assistance, the Forest Service created a task force to work with the Forest Health Council. The purpose of the task force was to identify alternative approaches to accelerating forest restoration in northern Arizona. To move into on-the-ground implementation as quickly as possible, stakeholders consisting of individuals, state and federal agencies, local governments, the four national forests in northern Arizona, and the Forest Service's Southwestern Regional Office moved forward with the Four Forest Restoration Initiative.

In 2009, Title IV of the Omnibus Public Land Management Act (P.L. 111-11) authorized the Collaborative Forest Landscape Restoration (CFLR) Program and Fund to support landscape-scale restoration on National Forest System lands. In 2010, the initiative received funding via the CFLR Program. The CFLR Program objectives include reducing uncharacteristic wildfire and the associated management costs, supporting local and collaborative partnerships, supporting monitoring of restoration efforts, and supporting efforts that utilize forest products that benefit communities and offset treatment costs. In 2015, the Record of Decision was signed for the first 4FRI EIS for the northern portion of the Coconino National Forest and the Kaibab National Forest. The Rim Country Project continues the ecosystem restoration effort on about 1,240,000 acres on the Mogollon Rim and Red Rock Ranger Districts of the Coconino National Forest, the Black Mesa and Lakeside Ranger Districts of the Apache-Sitgreaves National Forests, and the Payson and Pleasant Valley Ranger Districts of the Tonto National Forest (Figure 2). This analysis is independent of any preceding or subsequent environmental analysis that may occur in the national forests across northern Arizona.

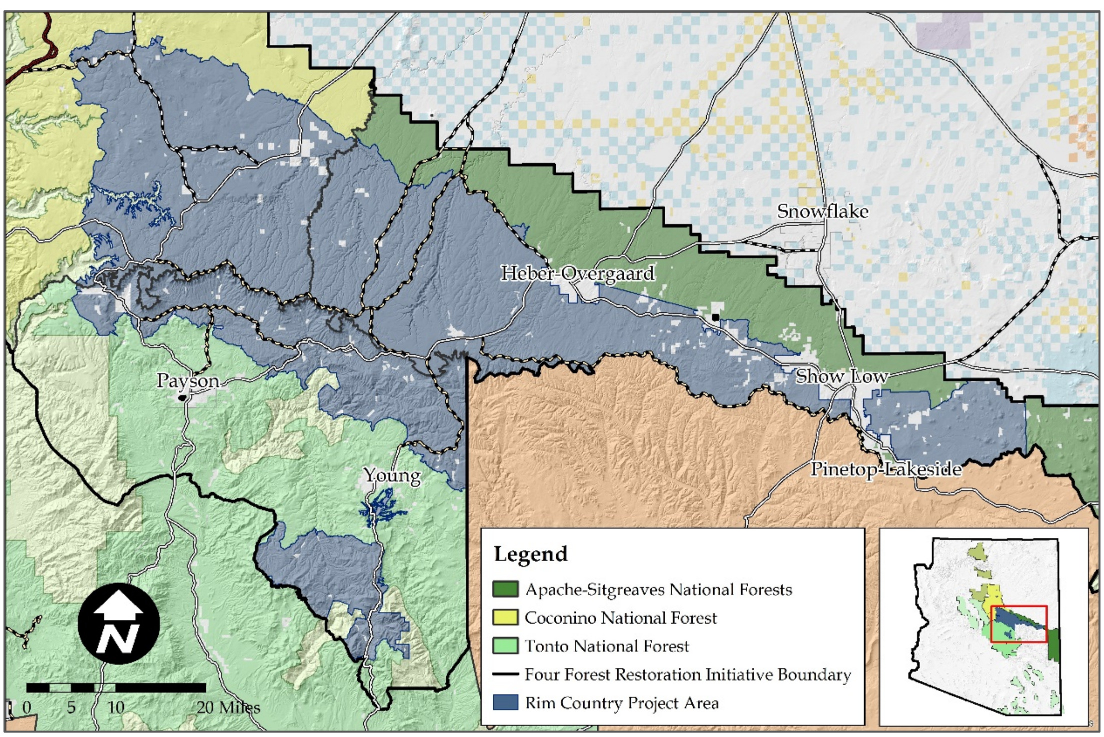

Figure 2. 4FRI Rim Country Project Area

Approximately 192,000 acres already covered by NEPA decisions will be included in the Rim Country analysis in order to incorporate additional restoration activities such as road decommissioning, spring and stream channel restoration, and wildlife habitat restoration. And, of the total project area, about 98,000 acres (Figure 3) have been excluded from analysis because they are not National Forest System lands, or are included in other restoration NEPA projects that already have decisions.

- Approximately 37,000 acres have been excluded from being incorporated into treatment proposals because they are non-Forest Service lands. Past, present, and reasonably foreseeable actions on these lands are addressed under cumulative effects in chapter 3.
- Approximately 61,000 acres have been excluded because they are already covered by NEPA decisions, with treatments designed to meet restoration objectives. These past and ongoing projects will be addressed in cumulative effects.

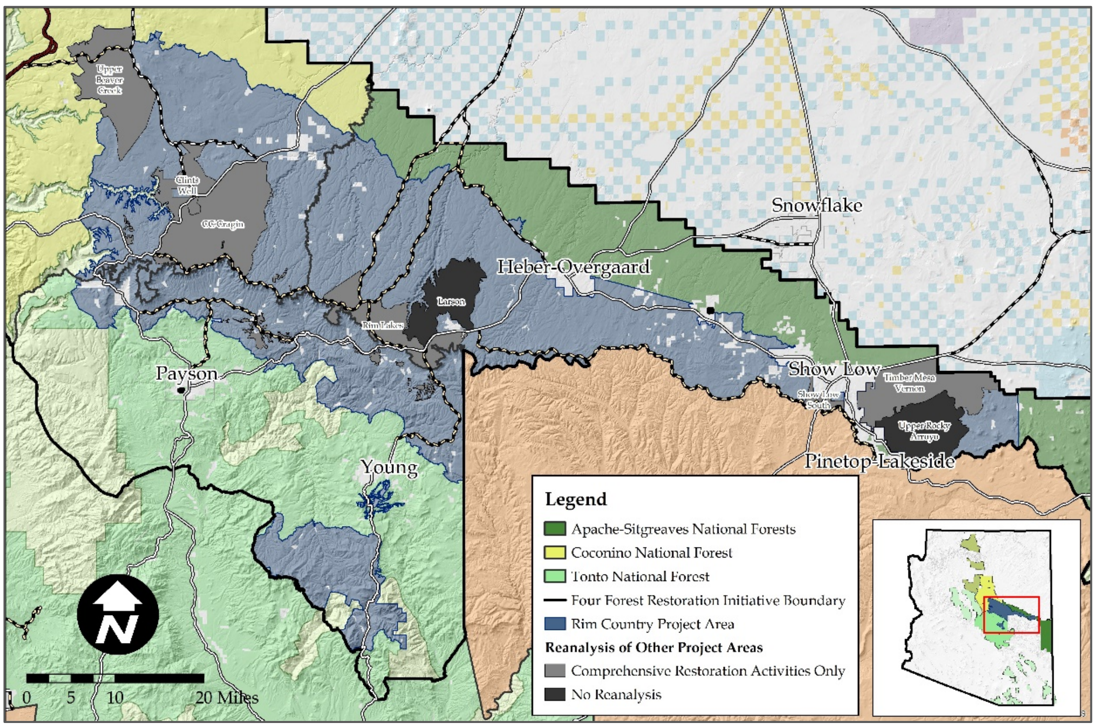

Figure 3. Other Projects within the 4FRI Rim Country Project Area

Current Management Direction

The Rim Country Project was reviewed for consistency with the direction in the Apache-Sitgreaves Revised Forest Plan (USDA Forest Service 2016), the Coconino Revised Forest Plan (USDA Forest Service 2018), and the current Tonto National Forest Plan, as amended (USDA Forest Service 2017). Consistency evaluations can be found in each specialist report. Appendix B provides details on the Forest Plan amendments for the Tonto National Forest Plan proposed in alternatives 2 and 3. The design features in appendix C and the implementation plan in appendix D document how treatment design meets Apache-Sitgreaves, Coconino, and Tonto National Forests Forest Plan direction.

Wild and Scenic Rivers

There are no designated wild and scenic rivers in the Rim Country project area. Unless otherwise specified, references to wild and scenic rivers in this document refer to either river segments that have been evaluated, have been found to be free-flowing, and, in combination with their adjacent land area, possess one or more outstandingly remarkable values (“eligible rivers”), or river segments that a Federal agency has studied and determined to be suitable for inclusion in the National Wild and Scenic Rivers

System but have not been statutorily designated by Congress ("suitable rivers"). A wild and scenic river corridor is the geographic area generally encompassed within one-quarter mile on either side of a river studied for eligibility or suitability that contains the river and its outstandingly remarkable values (FSH 1909.12, 80.5).

Previous eligibility studies identified 12 eligible wild and scenic rivers in the project area. Seven of these occur on the Coconino or Apache-Sitgreaves National Forests or on their shared border (USDA Forest Service 2009, 2013). Five eligible wild and scenic rivers occur on the Tonto National Forest and were identified in a 1993 eligibility report covering all the national forests in Arizona (USDA Forest Service 1993). As part of its ongoing Forest Plan revision process, the Tonto National Forest is completing an updated eligibility report for wild and scenic rivers to replace the existing eligibility report from 1993 (USDA Forest Service 2018). To ensure compliance with current Tonto National Forest Plan direction, the Rim Country DEIS includes both the eligible rivers listed in the 1993 report, as well as those listed in the current draft eligibility report for the Tonto (March 22, 2017). Design features have been included in appendix C specifically for the purpose of adjusting proposed treatments in the future as eligibility and suitability are determined. Any management activities proposed in eligible wild and scenic river corridors in the Rim Country project area would have the purposes of restoring natural geomorphic and ecological processes and protecting or enhancing the specific outstandingly remarkable values (ORVs) of the river (such as fish and wildlife habitat). In addition, classification of an eligible river must be maintained as inventoried in an eligibility study unless a suitability study is completed that recommends management at a less restrictive classification level, such as from wild to scenic, or scenic to recreational (FSH 1909.12, 84.2).

Apache-Sitgreaves National Forests

The revised Forest Plan for the Apache-Sitgreaves National Forests became effective in August 2015, with minor revision in 2016. With design features in appendix C, alternatives 2 and 3 are consistent with Forest Plan objectives, standards, and guidelines. Although movement toward desired conditions varies by alternative.

On the Apache-Sitgreaves National Forest, the Rim Country project area contains the following management or designated areas:

- General Forest (approximately 431,600 acres)
- Community-Forest Intermix (28,480 acres)
- Wildlife Quiet Area (22,400 acres)
- Wild Horse Territory (18,760 acres)
- Natural Landscape (13,230 acres)
- High Use Developed Recreation Area (7,490 acres)
- Energy Corridor (1,510 acres)
- 64 miles of the General Crook National Recreation Trail

Table 1 describes the Apache-Sitgreaves National Forests management areas located in the Rim Country project area and Figure 4 displays the general location of those management areas.

Coconino National Forest

The revised Forest Plan for the Coconino National Forest was signed in March 2018. With design features in appendix C, alternatives 2 and 3 are consistent with Forest Plan objectives, standards, and guidelines. Although movement toward desired conditions varies by alternative.

On the Coconino National Forest, the Rim Country project area contains the following management or designated areas:

- Long Valley (approximately 156,020 acres)
- Pine Belt (102,230 acres)
- East Clear Creek (54,960 acres)
- C.C. Cragin Watersheds (46,000 acres)
- Anderson Mesa (38,016)
- Verde Valley (1,640 acres)
- Long Valley Experimental Forest (1,260 acres)
- Rocky Gulch Research Natural Area (proposed) (930 acres)
- Mogollon Rim Botanical Area (339 acres)
- Scenic Resources, 40 miles of the Arizona National Scenic Trail
- 37 miles of the General Crook National Recreation Trail

Table 2 describes the Coconino National Forest management areas located in the Rim Country project area and Figure 4 displays the general location of those management areas.

Tonto National Forest

The Tonto National Forest is presently going through the process of revising the Forest Plan. The current plan was developed under the 1982 Planning Rule and went into effect in 1985. Activities proposed in alternatives 2 and 3 are based on the best available scientific information, which includes more than 25 years of advances in forest management science and learning since the current Forest Plan was developed.

To align current Forest Plan standards and guidelines with best available scientific information, thereby making alternatives 2 and 3 consistent with the Forest Plan, three project-specific Forest Plan amendments are proposed. Each amendment is a one-time variance in the current Tonto National Forest Plan direction specifically for the Rim Country Project. The amended direction would not apply to any other projects or areas outside of the Rim Country Project and it would cease to be in effect upon completion of the project. Analysis of the effects of the proposed amendments is integrated into the analysis of the alternatives presented in Chapter 3.

These amendments would be required under the current Tonto National Forest Plan if the Rim Country Record of Decision is signed prior to the revised Tonto National Forest Plan going into effect (anticipated in 2020). If this is the case, the Record of Decision will include two separate decisions: a decision on which alternative to implement and a decision on which, if any, Forest Plan amendments to approve. However, if the revised Tonto National Forest Plan goes into effect before the Rim Country Record of Decision is signed, one or more of the three proposed project-specific amendments may not be necessary depending on the content of the revised plan.

The purpose of amendment 1 is to bring the Forest Plan into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. The purpose of amendment 2 is to bring the Forest Plan into alignment with the revised Mexican Spotted Owl Recovery Plan (USDI Fish and Wildlife Service 2012) and defer monitoring to the Fish and Wildlife Service biological opinion that is specific to this project. The purpose of amendment 3 is to update Forest Plan language to account for advances in mechanized thinning technology and capabilities. Amendment 3 would remove language restricting the use of mechanical equipment to slopes less than 40 percent and identifying slopes above 40 percent as inoperable. Proposed language would allow the use of mechanized ground-based equipment to thin on slopes greater than 40 percent where it is not otherwise restricted and where it would not result in adverse effects on soil and water resources. This would allow for restoration treatments to be implemented on steeper slopes to meet the purpose and need of the Rim Project, and to move toward desired conditions in these areas.

Although the current Tonto National Forest Plan was developed under a planning rule enacted in 1982, the 2012 Planning Rule (36 CFR 219) requires the Forest Service to use an updated Forest Plan amendment process for amending plans created under a prior rule (36 CFR 219.17). Section 219.15 (c)(4) of the 2012 Planning Rule provides the language authorizing the proposed project-specific amendments to the Tonto National Forest Plan. These amendments, along with the Rim Country Project, are subject to the predecisional administrative review (objection) process pursuant to 36 CFR 218.

The project-specific amendments included in this project may affect substantive requirements of the 2012 planning rule at 36 CFR 219.9, which requires Forest Plans to provide for maintaining the diversity of plant and animal communities and the persistence of native species in the plan area. Since this project includes two project-specific amendments to modify current Forest Plan direction related to the management of Mexican spotted owl and northern goshawk habitats, it is possible that the plan's inherent capability to meet these attributes would be affected.

The significance of each proposed amendment was evaluated in accordance with Forest Service Manual (FSM) 1926.51 and FSM 1926.52. Proposed amendments would neither significantly alter the long-term relationship between levels of multiple-use goods and services originally projected, nor have an important effect on the entire land management plan or affect land and resources throughout a large portion of the planning area during the planning period. The proposed project-specific amendments would result in minor changes in standards and guidelines that would apply only to activities carried out as part of the Rim Country Project.

With the proposed Forest Plan amendments (see appendix B) and design features in appendix C, alternatives 2 and 3 are consistent with the direction in the 1985 Tonto National Forest Plan as amended.

On the Tonto National Forest, the Rim Country project area contains the following management or designated areas:

- 4D: Mogollon Rim Area (approximately 133,010)
- 5D: Mogollon Rim-Sierra Ancha Area (121,580 acres)
- 5G:General Management Area (29,480 acres)
- 4F:General Management Area (15,570 acres)
- MSO PACs (29,110 acres)

Table 3, describes the Tonto National Forest management areas located in the Rim Country project area and Figure 4 displays the general location of those management areas.

Table 1. Apache-Sitgreaves Forest Plan Management Areas in the Rim Country Project Area

Forest Management/Designated Area	Description	Forest Plan Emphasis	Acres in Rim Country
Community-Forest Intermix	Lands within ½ mile of communities at risk	Complete initial treatments to reduce fire hazard, maintain with prescribed fire and mechanical treatments	28,480
Energy Corridor	Three existing high-voltage energy corridors	Managed to provide a reliable supply of energy	1,510
General Forest	Majority of the Apache-Sitgreaves National Forests, capable of providing a variety of forest products	Restore priority 6th level HUC watersheds, restore fire-adapted ecosystems, reduce the threat of uncharacteristic wildfire, and provide forest products	431,600
High Use Developed Recreation Area	Places with relatively high levels of visitor use	Recreation site plans to provide a wide variety of opportunities to a broad spectrum of visitors	7,490
Natural Landscape	Undeveloped areas that are natural appearing and provide primitive and semi primitive recreation opportunities	Retain natural appearing character	13,230
Wild Horse Territory	The Heber Wild Horse Territory established in 1973	Manage the territory in accordance with the Wild Horse and Burro Act	18,760
Wildlife Quiet Area	Relatively undisturbed habitat where big game and other wildlife aren't disturbed by motorized vehicle use	Manage for nonmotorized access, improve wildlife habitat, and maintain existing wildlife developments	22,400
General Crook National Recreation Trail	Non-motorized scenic trail	Preserve historic route, features, and associated values	64 miles

Table 2. Coconino Forest Plan Management Areas in the Rim Country Project Area

Forest Management/Designated Area	Description	Forest Plan Emphasis	Acres in Rim Country
Anderson Mesa	Grasslands, pinyon juniper, and wetlands on Anderson Mesa	Wildlife-viewing and hunting, supports sustainable population of pronghorn, functioning wetlands	38,020
C.C. Cragin Watersheds	Watersheds for C.C. Cragin Reservoir along the Mogollon Rim	Coordinate with partners to proactively improve the health and resilience of the watersheds, reduce the threat of uncharacteristic wildfires, flooding, and sedimentation, and maintain water quality and quantity	46,000
Long Valley	Ponderosa pine, grassland, riparian, pinyon juniper, mixed conifer, and wetlands in the Long Valley area	Functioning wetlands, low-disturbance wildlife habitat, a mix of dispersed and developed recreation opportunities	156,020
Pine Belt	Dominant ponderosa pine vegetation belt	Functioning wetlands, backcountry recreation, wildlife viewing and hunting	102,230
East Clear Creek	Remote area of East Clear Creek and its tributaries along the Mogollon Rim	Low disturbance wildlife habitat, primitive and semi primitive recreational opportunities	54,960
Verde Valley	The Verde Valley north and west of the Verde River	Reduced risk of uncharacteristic flooding and sedimentation, recreational opportunities, interconnected trail system	1,640
Mogollon Rim Botanical Area	Preserves unique white fir/bigtooth maple community	Interpretation and monitoring	340
Long Valley Experimental Forest		Managed by the Rocky Mountain Research Station	1,260
Rocky Gulch Research Natural Area (proposed)	Area of old-growth ponderosa pine used as a control for research in the Beaver Creek watershed	Prepare establishment report	930
Arizona National Scenic Trail	Non-motorized scenic trail	Minimize visual impacts, keep well maintained, signed, and passable	40 miles
General Crook National Recreation Trail	Non-motorized scenic trail	Preserve historic route, features, and associated values	37 miles

Table 3. Tonto Forest Plan Management Areas in the Rim Country Project Area

Forest Management/Designated Area	Description	Forest Plan Emphasis	Acres in Rim Country
MSO PACs	Mexican spotted owl protected activity centers	Survey all potential habitat, establish PACs,	29,110
4D: Mogollon Rim Area	Ponderosa pine forest below the Mogollon Rim, Payson Ranger District	Intensive sustained yield timber management, timber resource protection, wildlife habitat diversity, recreation opportunity	133,010
4F: General Management Area	General management area on the Payson Ranger District	Wildlife habitat improvement, livestock forage production, dispersed recreation	15,570
5D: Mogollon Rim-Sierra Anchas Area	Ponderosa pine forest below the Mogollon Rim and in the Sierra Anchas Mountains, Pleasant Valley Ranger District	Intensive sustained yield timber management, timber resource protection, wildlife habitat diversity, recreation opportunity	121,580
5G: General Management Area	General management area on the Pleasant Valley Ranger District	Wildlife habitat improvement, livestock forage production, dispersed recreation	29,480

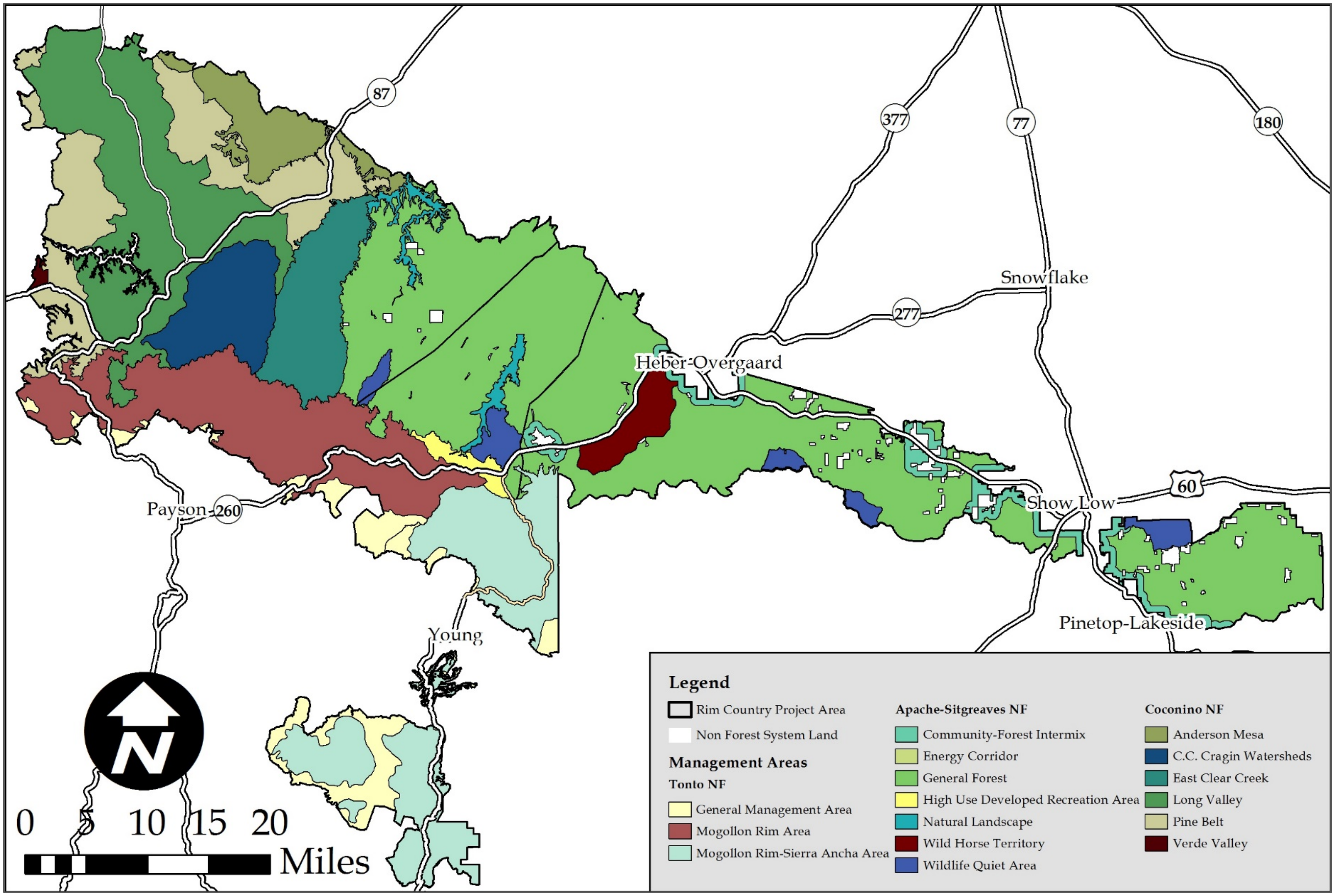

Figure 4. Forest Plan Management or Designated Areas in the Rim Country Project Area

Existing and Desired Conditions

The following description of existing and desired conditions is a summary of those conditions. Full descriptions of existing conditions in the Rim Country project area can be found in chapter 3 of this DEIS by resource area as well as the Rim Country specialist reports. Desired conditions for the Rim Country project area are incorporated by reference from the current Apache-Sitgreaves, Coconino, and Tonto National Forest Plans. Desired conditions pertinent to each resource area are described in each resource specialist report. Movement toward the desired conditions is analyzed in both individual specialist reports and this DEIS.

Existing Conditions

The forested landscapes in the Rim Country project area are highly departed from desired conditions, lacking desired species composition, spatial arrangement, and structure. Stands across the majority of the area where thinning treatments are proposed exhibit extremely high densities as measured by basal area (BA), trees per acre (TPA), stand density index (SDI). Some of these areas are at high risk for disturbance from uncharacteristic fire behavior, insects and disease, density-related mortality, and climate change.

Table 4 shows the cover types that occur on National Forest System land within the Rim Country project area (including areas that are parts of ongoing projects or other analyses) and Table 5 compares the existing conditions to the desired conditions for areas proposed for mechanical thinning.

Table 4. Acres of Cover Type on Forest Service-managed Land within the Project Area

Cover Type	Total Acres
Aspen	1,465
Grassland/Meadow*	20,378
Madrean Encinal Woodland	1,689
Madrean Pinyon-Oak	23,307
Mixed Conifer with Aspen*	19,855
Mixed Conifer/Frequent Fire*	59,860
Pinyon-Juniper Woodland	143,486
Ponderosa Pine*	764,689
Ponderosa Pine/Evergreen Oak*	149,446
Riparian	14,558
Other - Dam/Pit/Road/Water	2,994

*Target cover type: frequent-fire type targeted for restoration treatments

Table 5. Desired Conditions (DC) Compared to Existing Conditions (EC) in Areas Proposed for Mechanical Thinning. *These existing and desired conditions apply to the 953,130 acres analyzed for mechanical thinning and prescribed fire treatments

	Desired Condition	Existing Condition
Structure - Pattern	The majority of stands are in an open condition. Forest arrangement is in individual trees, small clumps, and groups of trees or randomly spaced trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat.	The majority of stands are in a closed condition and lacking groups and clumps of trees or randomly spaced trees. Grasses, forbs and shrubs are underrepresented compared to historic patterns. This is departed from desired conditions consisting of a matrix of groups, clumps and individual randomly spaced trees with interspaces,
Structure - Trees per acre	Trees are distributed across size classes with total number of trees per acre between 10 and 250. An idealized tree distribution across size classes totaling 74 trees per acre and carrying 90 ft^2 of basal area would have 24, 18, 14, 10, and 8 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	Total trees per acre is higher than the desired condition and are overrepresented in the smaller diameter classes and underrepresented in the larger classes. There are currently 813, 114, 35, 9, and 3 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.
Basal Area	Generally less than 90 square feet per acre to meet forest resilience goals while maintaining wildlife habitat desired conditions. For MSO protected and nest/roost replacement habitat 110 to 120 square feet per acre is the minimum.	The current average basal area within the project area is 129 square feet per acre. High densities in terms of basal area make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Stand Density Index	Maintain forest density between 25% and 45% of SDImax to maintain forest health and tree growth. For ponderosa pine this SDI range is between 112.5 and 202.5. For MSO protected and Nest/Roost replacement habitat, desired forest density is between 45% and 60% of SDImax or between 202.5 and 270.	Currently the average stand density index across the project area is 66% of MaxSDI. 21 percent of stands meet the desired condition for SDI. High densities in terms of stand density index make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Forest Insects	Stands in the project area are in the low or moderate hazard for bark beetles	Currently 74% of acreage have a high bark beetle hazard rating. The remaining 26% of stands meet the desired condition for insect hazard.
Forest Disease	Stands in the project area have low to moderate dwarf mistletoe infection severity (Less than 20% of trees infected)	Currently 75% of acreage has a low dwarf mistletoe infection rating, 22% of acres have a moderate rating, and 4% have a severe infection rating. 96% of the project area meets the desired condition for mistletoe infection severity.

Across the project area, fire regimes constitute a spatial and temporal mosaic of landscape patterns. There is a need to reintroduce or maintain fire in ponderosa pine, aspen, mixed conifer, and grasslands in the project area. Currently, across much of the project area, fuel loading in the immediate vicinity of many large and/or old trees is such that mortality would be high in the event of a wildfire burning under undesirable conditions. With a delay of 10 to 20 years between fires or mechanical treatments, areas currently showing potential for passive crown fire are likely to transition to active crown fire, depending on geographic location and site conditions. Table 6 shows the existing crownfire potential in ponderosa pine cover types.

Table 6. Existing Crownfire Potential in Ponderosa Pine Cover Types

Vegetation Cover Type	Acres	All Crown Fire	Active Crown Fire
Ponderosa Pine	556,284	72%	21%
Ponderosa Pine/Evergreen Oak	147,989	82%	29%

Currently, modeling results show that, under conditions similar to those of the Rodeo/Chediski Fire, there is potential for about 75 percent of the dry mixed conifer in the Rim Country project area to burn with crown fire, of which 50 percent would be active crown fire, as shown in Table 7.

Table 7. Existing Crownfire Potential in Dry Mixed Conifer Cover Type

Vegetation Cover Type	Acres	All Crown Fire	Active Crown Fire
Dry Mixed Conifer	49,281	75%	50%

The exclusion of fire has resulted in high canopy cover and high tree density which limits the amount of sunlight and precipitation reaching the ground. Consequently, understory vegetation is less diverse, sparse, and it provides poorer quality food and cover for wildlife than under more open canopies.

The ponderosa pine and mixed conifer cover types support a wide range of wildlife species, including nesting MSO. The Rim Country project area includes about 68,630 acres of MSO PACs and over 128,800 acres of recovery habitat. Protected activity centers currently contain high fuel loadings due to management actions for the last few decades. There are also about 500,940 acres of goshawk post-fledging areas and foraging habitat. The increased tree densities, closed canopies, and loss of habitat heterogeneity have led to the loss of habitat for a wide range of species, including ground and shrub-nesting passerines and small mammals and birds that depend upon the herbaceous understory for food and/or cover. Current stand conditions exhibit declining to stagnant tree growth in areas where late-successional habitat is desired.

Aspen are dying or rapidly declining in the Rim Country project area due to the combined effects of conifer encroachment, browsing, grazing, insects, disease, severe weather events, and lack of fire disturbance.

There are approximately 132,240 acres (severe disturbance areas) where high severity effects from fires, such as the Dude and Rodeo-Chediski fires, insect and disease outbreaks, or harvesting operations have resulted in reduced forest cover and a departure from desired conditions.

Southwestern dwarf mistletoe is a natural component of the forests in the Rim Country project area. Dwarf mistletoe can create or increase forest openings at endemic levels (Conklin 2000), improving wildlife habitat (Parker 2001) by creating unique canopy structure and snags with longevity and conditions that stimulate understory growth (Conklin 2000). At epidemic levels, mistletoe can prevent stands from attaining mature and old-growth conditions (Conklin and Fairweather 2010), preventing trees from attaining nest and roost structure for species like the MSO and northern goshawk. Infections of high severity can increase tree stress, the likelihood of bark beetle infestations during periods of drought, and tree death (Kenaley 2008).

While the overall incidence (distribution and percent of landscape affected) of dwarf mistletoe is thought to have increased only modestly compared to historic conditions, the overall abundance of mistletoe is thought to have increased considerably (Conklin and Fairweather 2010). Stands covering approximately 22 percent of the Rim Country project area exhibit infections at moderate severity levels (20 percent to 80 percent of susceptible trees infected) while stands making up four percent of the area have high severity infection ratings (more than 80 percent of susceptible trees infected) (Moore 2019).

Grasslands, savannas, and meadows provide valuable habitat for many wildlife species including pronghorn antelope (a focal species), raptors such as western burrowing owls, Swainson's hawks, and ferruginous hawks (sensitive species/migratory birds), an abundance of small mammals including Navajo Mogollon voles (sensitive species), and a range of important prey species for both MSOs and northern goshawks. Savannas and meadows are also used by game species such as elk and black bears. In the meadows and grasslands of the Rim Country project area, junipers and other conifers have encroached into these once open grassland habitats, decreasing the size and function of landscapes that were historically grasslands. As tree canopy increases, understory productivity decreases. The grasslands have impaired soil conditions due to inadequate protective ground cover, compacted soil surfaces, and encroaching pines and junipers. In many meadows, vegetative ground cover is low, hydrologic soil function is reduced from compaction, groundwater levels have dropped below root zones due to gully formation, and encroaching upland tree species are competing with desired species.

The Coconino National Forest established its Travel Management Rule (TMR) motor vehicle use designations in 2011; the Tonto National Forest will be publishing its draft Record of Decision for TMR designations this year; and the Apache-Sitgreaves National Forests are currently working on their proposed action for TMR designations.

Most watersheds in the Rim Country project area have been assigned a fair or poor rating for road and trail density, location, distribution, and maintenance. Roads in close proximity to streams have the greatest effects on water quality. High road density increases effective drainage density, which can increase the size of damaging peak flows.

There are approximately 411 known springs in the Rim Country project area. A limited number have been assessed, but these assessments indicate that springs in the project area have been adversely affected by human activities such as flow regulation through installation of spring boxes and piping of discharge to off-site locations, recreation, and urbanization and other construction activities, as well as grazing by wild and domestic herbivores. Approximately 184 springs in the Rim Country project area exhibit declining or degraded conditions where restoration treatments may be applied.

Many riparian streams in the Rim Country project area, particularly within the Rodeo-Chediski Fire area, are currently non-functioning[1] or functioning-at-risk[2], with accelerated erosion and increased peak flows. Table 8 shows the condition classes of riparian areas by national forest within the project area.

Table 8. Condition Classes of Riparian Areas in the Project Area by National Forest

[1] These riparian areas clearly are not providing adequate vegetation, landform, or woody material to dissipate stream energy associated with moderately high flows, and thus are not reducing erosion or improving water quality.

[2] These riparian areas are in limited functioning condition: however, existing hydrologic, vegetative, or geomorphic attributes make them susceptible to impairment.

Forest	Total (miles*)	Properly Functioning (miles*)	Functioning-at-Risk (miles*)	Non-Functioning (miles*)
Apache-Sitgreaves	240	60	113	67
Coconino	196	120	53	23
Tonto	440	77	309	54
Totals	876	257	475	144

*Miles are approximate

Within the Rim Country project area there are approximately 360 miles of streams that are occupied by, or are suitable for, aquatic species such as fish, garter snakes, mollusks, and invertebrates. These streams and associated 6th Hydrologic Unit Code (HUC) watersheds provide habitat for nine federally listed fish and garter snake species and 16 Forest Service Southwestern Region sensitive species, two of which are also federally listed (see Table 9). Fourteen Forest Service Southwestern Region sensitive species, including 12 invertebrates and 2 mollusks, are not shown in the table but were included in the analysis presented in chapter 3 and the aquatics specialist report.

Table 9. Status and Habitat for Federally Listed and Forest Service (FS) Sensitive Fish and Garter snake Species

Species	Status	Occupied/Suitable Habitat (approximate miles/acres)
Gila trout (Oncorhynchus gilae gilae)	Threatened	32.1 miles
Little Colorado spinedace (Lepidomeda vittata)	Threatened with Critical Habitat	186.9 miles
Gila chub (Gila intermedia)**	Endangered with Critical Habitat	21,600 acres
Gila topminnow (Poeciliopsis occidentalis occidentalis)**	Endangered	21,600 acres
Razorback sucker (Xyrauchen texanus)**	Endangered with Critical Habitat	12,300 acres
Loach minnow (Tiaroga cobitis)**	Endangered with Critical Habitat	12,300 acres
Spikedace (Meda fulgida)**	Endangered with Critical Habitat	12,300 acres
Narrow-headed gartersnake (Thamnophis rufipunctatus)*	Threatened with proposed Critical Habitat	3,880 acres
Northern Mexican gartersnake (Thamnophis eques megalops)*	Threatened with proposed Critical Habitat	1,470 acres
Desert sucker (Catostomus clarki)	FS Sensitive	106.1 miles
Sonoran sucker (Catostomus insignis)	FS Sensitive	13.1 miles
Little Colorado sucker (Catostomus sp. 3)	FS Sensitive	147.1 miles
Headwater chub (Gila nigra)	FS Sensitive	47.8 miles
Roundtail chub (Gila robusta)	FS Sensitive	34.4 miles

* USFWS considered all proposed critical habitat as occupied for these species in the Federal Register proposed ruling. These are also Forest Service Southwestern Region sensitive species.
** Species not known to occur within the project area, but known to occur in adjacent/nearby parts of 6th HUC watersheds that intersect the project area. Acres displayed represent the areas of those subwatersheds within the project area.

There are 23 known species of rare plants in the Rim Country project area, including Forest Service Southwestern Region sensitive species and Forest Planning or analysis species. Bebb's willows and bigtooth maples, tree species that provide habitat for songbirds and small mammals, as well as soil and stream bank stability, are declining in health, vigor, and number in the project area.

Desired Conditions

The proposed treatments in the Rim Country Project would restore or move the project area toward desired conditions as described in the Apache-Sitgreaves, Coconino, and Tonto National Forest Plans, and help to re-establish resilient and functioning ecosystems. The proposed mechanical treatments (thinning) are specifically designed to establish interspaces reflecting pre-fire suppression-spatial patterns and uneven-aged stand structure, mitigate adverse effects of dwarf mistletoe, and improve stand structure and health. Table 5 displays the desired conditions related to stand structure, pattern, density, and health. Desired conditions are for no more than 15 percent of the ponderosa pine (under conditions modeled) in the treatment area to be prone to crown fire or high-severity fire, with areas of potential high severity spatially distributed. For the dry mixed conifer cover type, Forest Plan direction is to allow fire to play its natural role, with high frequency (averaging about 12 years) and mostly low severity (less than 20 percent high severity under modeled conditions). Implementing fire and mechanical treatments would decrease surface and canopy fuel loading, as well as ladder fuels in the immediate vicinity of old trees. This would decrease potential fire-caused mortality in large and/or old trees. Use of prescribed burning, particularly when combined with mechanical thinning, would reduce the potential for damage from wildfires, the costs associated with fire suppression and safety concerns for fire managers.

Desired conditions for MSO and northern goshawk habitat include large tree size-classes and higher tree densities for nest areas, activity centers, surrounding nest core areas, and habitat for general foraging and movements. There is a need to restore resilient late-successional forest and increase habitat diversity, particularly within MSO PACs. Improving stands of larger/older trees would improve nesting habitat. Moving towards a forest structure with all age and size classes represented would improve MSO recovery habitat and overall habitat for northern goshawks. Creating rooting zones and returning low-severity fire would maintain a mosaic of grass, forbs, and shrubs, benefiting key prey species for both owls and goshawks.

While many of the understocked forest areas may not be suitable for planting, actions are needed to move them toward their desired forested conditions. Planting, burning, and other management actions will be considered to encourage reforestation.

Grasslands were designated a priority habitat in the Arizona Partners In Flight Bird Conservation Plan, with the objective to permanently protect, enhance, and/or restore over 500,000 acres of grassland in northern Arizona. Grasslands and meadows should have satisfactory soil conditions, with vegetative cover adequate to prevent erosion above tolerance conditions, uncompacted soil surfaces that allow for satisfactory hydrologic function and desirable vegetation, and little to no tree encroachment.

As Travel Management Rule (TMR) plans are completed and implemented for each forest, unneeded and poorly located roads may be improved, removed, or relocated to reduce effects on water quality and natural resources. The Forest Service will reclaim any previously disturbed areas used as temporary access roads on National Forest System lands once activities specified in the decision for the 4FRI Rim Country Project are completed.

Springs exhibiting degraded or declining condition and function need to be improved to sustain these important ecological features. Spring restoration would include reducing tree encroachment and noxious weeds, returning fire to the system (through prescribed fire), placing protective barriers, restoring flow to historic areas of influence, restoring or repairing damaged infrastructure, and removing dilapidated or non-functioning infrastructure where appropriate.

Desired conditions for riparian zones along streams are that they are capable of filtering sediment, capturing and/or transporting bedload (aiding floodplain development, improving flood-water retention, improving or maintaining water quality), and providing ground water recharge within their natural potential. Their necessary physical and biological components provide habitat for a diverse community of plant and wildlife species including cover, forage, available water, microclimate, and nesting/breeding/transport habitat. Stream habitats and aquatic species depend upon perennial streams or reaches and their habitat is maintained by the watershed, soil, and riparian conditions within the ecosystem.

All proposed riparian treatments will also improve or maintain stream habitat by restoring watershed function or resilience. Upland treatments in watersheds may also improve water infiltration rates and increase subsurface flows higher in the stream system that provide cool perennial water to streams which helps to maintain stream temperatures.

Desired conditions for streams and aquatic habitats are to support native fish and other aquatic species, providing the quantity and quality of aquatic habitat within the natural range of variation. This includes increasing habitat complexity such as pools and large woody debris, reducing downcutting and sedimentation, improving riparian areas that provide channel stability and leaf litter, and stream shading to maintain water temperatures.

The habitat for rare plant species will remain suitable and capable to support them. Some habitat may improve as a result of management actions, especially in spring and channel restoration areas and in areas where litter and tree canopy are high. Any negative effects on these species from management actions will be mitigated and plant numbers will remain the same or increase. To stimulate growth, recruit younger age classes, and increase individual recruitment of aspen, protective barriers would be placed around sites to prevent browsing and other disturbance during regeneration. Protective barriers would also be placed around pockets of Bebb's willow and bigtooth maple to reduce browsing and other disturbances, recruit younger age classes, increase populations, and retain this diverse habitat until they are sustainable.

Purpose and Need for Action

The purpose and need for the Rim Country Project was determined by comparing the existing conditions in the project area to the desired conditions in the Forest Plans related to forest and ecosystem function and resilience. In addition, relevant research, the best available science and information, and the landscape restoration criteria found in the Omnibus Public Land Management Act of 2009 (P.L. 111-11, Title IV Forest Landscape Restoration) were used to develop the purpose and need. Among other things, these criteria require that landscape-scale restoration strategies maintain or contribute to the restoration of the structure and composition of old growth stands, maximize the retention of large trees to the extent that they promote fire-resilient stands, focus on small-diameter tree thinning, do not require the establishment of permanent roads, and commit to decommission all temporary roads built for treatment purposes. Below is some of the pertinent language from the Omnibus Public Land Management Act as it relates to the Rim Country project.

The Four Forest Restoration Initiative (4FRI) is a Collaborative Forest Landscape Restoration Project covering portions of four national forests in Arizona that meets the requirements of the Omnibus Public Lands Management Act of 2009. The first 4FRI Environmental Impact Statement (EIS) was completed and the Record of Decision was signed in 2015. Implementation of the treatments analyzed in the 1st EIS are currently being implemented. The 4FRI Rim Country analysis continues this collaboration effort. Below are specific portions of the Omnibus Public Lands Management Act of 2009 that speak to eligibility of projects under the Collaborative Forest Landscape Restoration Program and also project implementation:

> (b) Eligibility Criteria- To be eligible for nomination under subsection (c), a collaborative forest landscape restoration proposal shall--
>
> (1) be based on a landscape restoration strategy that--
>
> (A) is complete or substantially complete;
>
> (B) identifies and prioritizes ecological restoration treatments for a 10-year period within a landscape that is--
>
> (i) at least 50,000 acres;

(ii) comprised primarily of forested National Forest System land, but may also include land under the jurisdiction of the Bureau of Land Management, land under the jurisdiction of the Bureau of Indian Affairs, or other Federal, State, tribal, or private land;

(iii) in need of active ecosystem restoration; and

(iv) accessible by existing or proposed wood-processing infrastructure at an appropriate scale to use woody biomass and small-diameter wood removed in ecological restoration treatments;

(C) incorporates the best available science and scientific application tools in ecological restoration strategies;

(D) fully maintains, or contributes toward the restoration of, the structure and composition of old growth stands according to the pre-fire suppression old growth conditions characteristic of the forest type, taking into account the contribution of the stand to landscape fire adaptation and watershed health and retaining the large trees contributing to old growth structure;

(E) would carry out any forest restoration treatments that reduce hazardous fuels by--

(i) focusing on small diameter trees, thinning, strategic fuel breaks, and fire use to modify fire behavior, as measured by the projected reduction of uncharacteristically severe wildfire effects for the forest type (such as adverse soil impacts, tree mortality or other impacts); and

(ii) maximizing the retention of large trees, as appropriate for the forest type, to the extent that the trees promote fire-resilient stands; and

(F)(i) does not include the establishment of permanent roads; and

(ii) would commit funding to decommission all temporary roads constructed to carry out the strategy;

(2) be developed and implemented through a collaborative process that—

(A) includes multiple interested persons representing diverse interests; and

(B)(i) is transparent and nonexclusive; or

(ii) meets the requirements for a resource advisory committee under subsections (c) through (f) of section 205 of Public Law 106-393 (16 U.S.C. 500 note)

(g) Program Implementation and Monitoring-

(2) PROJECT IMPLEMENTATION- Amounts transferred to the Secretary from the Fund shall be used to carry out ecological restoration treatments that are—

(A) consistent with the proposal and strategy; and

(B) identified through the collaborative process described in subsection (b)(2).

The purpose of the 4FRI Rim Country Project is to restore and maintain the structure, pattern, health, function, and vegetation composition and diversity in ponderosa pine ecosystems to conditions within the natural range of variation, thus moving the project area toward the desired conditions in the Forest Plans. One outcome of restored ecosystems is increased resilience. Resilience is the ability of an ecosystem to survive natural disturbances such as fire, insects and disease, and climate change without changing its inherent function (FSH 1909.12, 05; SER 2004). This project is needed to:

- Increase forest and grassland resilience and sustainability
- Reduce hazards associated with undesirable fire effects
- Improve terrestrial and aquatic species habitat
- Improve the condition and function of streams and springs
- Restore woody riparian vegetation
- Preserve cultural resources
- Support sustainable forest products industries
- Improve the motorized transportation system and provide for a more sustainable road system where poorly located roads are relocated or obliterated.

Forest Resilience and Sustainability. There is a need to restore the frequent low-severity fire regimes in which the forest in the Rim Country project area evolved. Resilience increases the ability of the ponderosa pine and mixed conifer-frequent fire forest types (target cover types) to survive natural disturbances and stressors such as fire, insect and disease outbreaks, and climate change (FSM 2020.5).

There is a need to move tree group pattern, interspaces, and stand density toward the natural range of variation. There is a need to manage forest density, structure, and composition to improve forest health and reduce adverse effects from bark beetles and dwarf mistletoe, while also providing a diversity of habitat types and features. In the oak woodland and shrubland cover types, there is a need to stimulate new growth, maintain vigor in large-diameter trees, encourage faster growth in young smaller oaks, and provide for a variety of shapes and sizes of trees across the forest cover types.

Where aspen is found in the frequent fire forest cover types, there is a need to stimulate growth, reduce conifer encroachment, and increase individual tree recruitment.

In grassland cover types, there is a need to reduce or remove trees and other woody species that have encroached, which has decreased the size and function of these systems that were historically grasslands and functionally connected montane meadows.

There is a need to improve the condition of native plant communities and the resilience of rare species. There is also a need to improve the abundance, diversity, distribution, and vigor of native understory vegetation to provide food and cover for wildlife where it is absent under dense forest stands where fire has been excluded.

Tonto Forest Plan Amendments - There is also a purpose and need to amend the 1985 Tonto Forest Plan in three different areas. They are discussed below.

Amendment #1, Ponderosa pine vegetation/forest cover types- The Tonto Forest Plan (1985) does not reflect a change in conditions since the 1980's including acknowledgement that vegetation conditions (structure, composition, and function) are divergent from reference conditions and forest conditions indicate a substantial departure from the naturel fire regime. The revised forest plans of the Apache-Sitgreaves and the Coconino National Forest's use the best available science and information so therefore do acknowledge changing conditions. This amendment is needed to replace forest plan standards and guidelines for ponderosa pine/bunchgrass, ponderosa pine/Gambel oak, and ponderosa pine/evergreen oak, dry mixed conifer and old growth with desired conditions and guidelines, to add a desired condition for the percentage of interspaces within uneven-aged stands to facilitate restoration, add the desired interspaces distance between tree groups, add a definition to the Tonto FP glossary for the terms interspaces and openings.

Amendment #2, the Mexican Spotted Owl (MSO) component- The Tonto Forest Plan (1985) is inconsistent with the 2012 Mexican Spotted Owl Recovery Plan. This amendment is needed to update definitions, language and treatment opportunities within MSO habitat. The Apache-Sitgreaves and Coconino Forest Plans are more recent and are consistent with the MSO recovery plan.

Amendment #3, Mechanical treatments on steep slopes- The Tonto Forest Plan (1985) currently restricts the use of mechanical equipment to slopes less than 40 percent. Since the 1985 plan began being implemented the design of mechanized ground-based equipment has progressed to allow operations on steep slopes more effectively and without adverse effects on soil resources. It is necessary to allow for use of specialized mechanical equipment to cut and remove threes and also to mechanically treat other vegetation on steep slopes, in order to carry out restoration treatments in portions of the Rim Country project area on the Tonto National Forest and to meet the projects purpose and need.

Undesirable Fire Effects. There is a need to reduce the risk of undesirable fire behavior and effects, which currently pose a threat to ecosystem function and services, and human safety, lives, and values. Restoring fire regimes in forests and grasslands would decrease the risks of post-fire flooding and debris flows that cause loss of soil productivity, water quality, and watershed function. Reducing the potential for undesirable fire effects and reducing excessive fuel loadings would help protect terrestrial and aquatic species habitat as they increase resilience to fires, including areas within and adjacent to Mexican spotted owl habitat.

Terrestrial and Aquatic Species Habitat. There is a need to move the project area toward desired conditions for snags, coarse woody debris, forest structural stages, and stream habitat complexity. There is a need to retain as many old and large trees as possible, while moving toward restoration-based desired conditions and recognizing the ecological and socio-political importance of these trees. Where restoration activities occur in the ponderosa pine and dry mixed conifer cover types, there is a need to maintain and promote the development of old growth characteristics and components. There is a need to maintain or improve aquatic habitats to meet needs for fish, frogs, and garter snakes, recognizing the ecological and socio-political importance of these streams and associated riparian areas.

Streams and Springs. There is a need to improve the condition and function of riparian areas, wet meadows, streams, and springs in the Rim Country project area in order to sustain these features for terrestrial and aquatic habitat, as well as for human use.

Riparian Vegetation. There is a need to restore native riparian vegetation, including large conifers and willows in some cover types, to reduce sedimentation to stream habitat, provide stream shading, maintain cool-water conditions, and provide large wood recruitment to streams to improve habitat complexity.

Cultural Resources. There is a need to reduce threats to cultural resources caused by overly dense vegetation and soil erosion. Though most archaeological sites can tolerate low-severity fire, all are very vulnerable to the effects of high severity fire in unnaturally high fuel loads and to the soil loss that occurs in post-fire flooding. In particular, there is a need to reduce fuels accumulation around cultural resources to reduce threats to these non-renewable resources.

Forest Products Industries. There is a need to support appropriately-scaled, sustainable, forest products industries that strengthen local economies, while conserving natural resources and aesthetic values. Appropriately-scaled businesses would play a key role in accelerated forest restoration, by harvesting, processing, and selling wood products, thereby reducing treatment costs and providing economic opportunities. Engaging industry would offer the opportunity to cover all, or nearly all, of the cost of removal of forest restoration byproducts by the value of the products removed.

Improved Motorized Transportation System. There is a need to have adequate access for project implementation, and decommission temporary roads after use to restore these areas once project activities are completed. In addition, there is a need to decommission unneeded routes identified during the forest Travel Management Rule planning processes as part of the restoration of the landscape in the project area.

Public Involvement

Collaboration

Collaboration has been integral to the 4FRI, and in 2010, stakeholders began refining their vision for ponderosa pine forest restoration across 2.4 million acres on four national forests in Arizona including the Apache-Sitgreaves, Coconino, Kaibab, and Tonto.

The 4FRI stakeholders developed a comprehensive restoration strategy for the first analysis area on the Coconino and Kaibab National Forests (4FRI Stakeholders 2010). The landscape strategy documented existing conditions, identified potential treatment areas, and desired post-treatment conditions. The Forest Service used the stakeholder's landscape strategy to inform the purpose and need and proposed action for both the 1st 4FRI EIS and this Rim Country Project DEIS.

Cooperating Agencies

On July 15, 2015, the Arizona Game and Fish Department (AZGD) became a cooperating agency. AZGD specialists attended interdisciplinary team meetings, held workshops to gather aquatics and terrestrial wildlife data, and provided existing condition and location information (tabular and spatial) for priority species. AZGD specialists served on the interdisciplinary team for the Rim Country Project, helped develop the proposed action and other action alternatives, provided existing conditions for species and their habitat, and reviewed, edited, and augmented species analysis.

Tribal Consultation

Each forest consulted with specific tribes to reduce redundancy of information sharing. Comments gathered by each forest liaison is continuously shared with the other forests. Tribes who received invitations to consult on the project include: the Hopi Tribe, Havasupai Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, San Juan Southern Paiute Tribe, Fort McDowell Yavapai Nation, Yavapai-Apache Nation, Yavapai-Prescott Indian Tribe, Mescalero Apache Tribe, San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Pueblo of Acoma, Pueblo of Zuni, Gila River Indian Community, Salt River Pima–Maricopa Indian Community, Navajo Nation, and Navajo chapters in proximity to the project area: the Alamo, Bodaway/Gap, Cameron, Coalmine Canyon, Dilkon, Lechee, Leupp, Ramah, Tolani Lake, and To'Nanees'Dizi Chapters.

On July 1, 2016 the Rim Country Project proposal was sent to each Tribe along with an invitation to formally consult with the Forest Service. This resulted in various phone calls, emails, and consultation meetings. One written scoping response was received from the Hopi Tribe in which the Tribe requested continued consultation on implementation and review of cultural resource surveys, Traditional Cultural Properties, and ethnographic studies. On April 6, 2017 the Archaeological Site Treatment strategy was distributed to tribes for comment.

The tribal relations section in chapter 3 of this DEIS and tribal relations specialist report provide more information and complete documentation of consultation.

Stakeholder and Public Involvement

The Rim Country Project has been published in the Coconino, Apache-Sitgreaves, and Tonto National Forests' Schedule of Proposed Actions (SOPA) since January of 2016. As the Rim Country project area was developed, the Forest Service worked with stakeholders to define the project boundary as well as the extent of the analysis in different portions of the project including multiple meetings, presentation, and field visits. The notice of intent to prepare an environmental impact statement was published in the Federal Register on June 27, 2016 (81 FR 41517). A scoping document was posted on the project website (www.fs.usda.gov/goto/4FRIRimCountry) and mailed to all known potentially interested parties, inviting public comment on the proposed action for the Rim Country Project. Letters and scoping documents were mailed to 676 individuals, local governments, state governments, federal and state agencies, and organizations that engage with all three national forests. Public workshops were held on July 14 in Show Low and on July 21 in Payson, to discuss the proposed action and accept comments.

Fifty (50) scoping responses (e-mails, letters, and public meeting comment forms) were received from this scoping effort.

Development of Action Alternatives

The preliminary alternatives being considered for Rim Country were first posted to the 4FRI website and shared with the SHG in March of 2017. The preliminary alternatives were then defined and shared at public workshops cohosted by the SHG in April 2017. The IDT reviewed feedback received at these workshops on the preliminary alternatives.

Additional presentations on the Rim Country alternatives were given to the SHG in July and November 2017, discussing the progression of the action alternatives that would be analyzed in the draft environmental impact statement (DEIS). The decision was made by the 4FRI Board of Supervisors to drop one of the preliminary alternatives from consideration in the Rim Country DEIS.

Collaboration on the Mechanical Treatments and Aquatics Flexible Toolbox Approaches with the SHG, Arizona Game and Fish Department and Trout Unlimited took place throughout 2017 with meetings, presentations and field visits.

Issues

Issues are statements of cause and effect, linking environmental effects to proposed activities. Comments from the public, the 4FRI Stakeholder Group, other agencies, tribes, and Forest Service personnel were used to formulate issues concerning the proposed action. All comments received were reviewed and analyzed by the interdisciplinary team to "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review…" (Council on Environmental Quality, Sec. 1506.3; 40 CFR 1501.7(a) (3)).Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. Significant issues were identified as those directly or indirectly caused by implementing the proposed action. Significant issues were grouped by issues that can be responded to through mitigation measures and those that were responded to in alternatives to the modified proposed action.

The public comments received during the scoping period from June 27 to August 11, 2016 presented seven issues that are within the scope of the proposed action, and relevant to the decision to be made for the project These key issues were used to modify the proposed action and formulate a new action alternative for the analysis.

Significant Issues Responded to through Mitigation Measures, Analysis, and Modifications to the Proposed Action

Issue 1 – Treatments in MSO PACs

The proposed action may have negative effects on Mexican spotted owl (MSO) by cutting trees up to 17.9 inches in diameter in MSO protected activity centers (PACs). The Forest Service should act conservatively to protect MSO habitat and consider all cautions identified in the revised Recovery Plan for MSO (USDI Fish and Wildlife Service 2012). There is a concern about how MSO will respond to the removal of trees up to 17.9 inches in diameter, given a lack of monitoring data.

How Issue 1 is addressed

This issue is addressed in the effects analysis for all alternatives using the best available science and with design features and conservation measures as outlined in the 2012 revised MSO Recovery Plan to apply to treatments in MSO PACs. The wildlife analysis will reference all available monitoring information from the 1st 4FRI EIS and from other sources across the region.

Indicators/Measures

Indicators will include changes in the amount and quality of MSO nest/roost habitat within PACs. Specific measures include:

- Stand density as measured by stand density index (SDI), trees per acre (TPA), quadratic mean diameter (QMD), Canopy Cover, Basal Area Average, reduction of average basal area (BA) of large young trees;
- Fuel loading, fire hazard index, and risk of crown fire;
- Prey habitat as measured by number of snags/acre ≥ 12 inches in diameter, coarse woody debris (CWD), and shrub and herbaceous cover.

Issue 2 – Treatments in Northern Goshawk Habitat

The proposed action may have negative effects on northern goshawk and canopy-dependent prey species by reducing late seral, dense understory, and old growth habitat. Specifically, there is a concern that treatments will reduce the mix of densities and cover types, including later seral stages.

How Issue 2 is addressed

This issue will be addressed in the effects analysis for all alternatives, and with design features and conservation measures as outlined in the most current management recommendations to apply to treatments in northern goshawk habitat.

Indicators/Measures

Indicators will include changes in the amount and quality of goshawk nesting and foraging habitat. Specific measures include:

- Stand density as measured by stand density index (SDI), trees per acre (TPA), quadratic mean diameter (QMD), Canopy Cover, Basal Area Average, reduction of average basal area (BA) of large young trees;
- Fuel loading, fire hazard index, and risk of crown fire;
- Prey habitat as measured by number of snags/acre ≥ 12 inches in diameter, downed logs, coarse woody debris (CWD), and shrub and herbaceous cover.

Issue 3 – Large Tree Retention

The proposed action may cause the loss of large trees which may significantly affect old growth recruitment. Proposed management actions in old growth, future old trees (large young trees), and high-canopy patches should be very explicit, and no old trees be cut.

How Issue 3 is addressed

This issue will be addressed in the effects analysis for all alternatives. Large tree retention will be addressed with treatment design and location, design features, mitigation measures, and BMPs to retain old growth and groups of large trees in all action alternatives. The Old Growth Protection and Large Tree Retention Strategy (OGP/LTRS) as developed by the 4FRI Stakeholder Group will be evaluated and considered as fully as possible in all action alternatives.

Indicators/Measures:

- Number of acres of stands meeting collaboratively established Stands with a Preponderance of Large Young Trees (SPLYT) criteria.

Issue 4 – Dwarf Mistletoe Mitigation

The proposed action includes dwarf mistletoe treatments that may remove the largest trees in some stands. The scale and intensity of mistletoe mitigation should be more clearly defined as far as scale, that where it occurs at natural levels it be allowed to remain to provide essential food and occupancy needs to wildlife, and that the mitigation treatments not focus on removing the largest trees.

How Issue 4 is addressed

This issue is addressed in the effects analysis for all alternatives. Dwarf mistletoe mitigation will be addressed with treatment design and location and collaboratively developed guidance in the implementation plan (appendix D). Some dwarf mistletoe will be retained as a natural component for wildlife, and limits will be placed on removal of large infected trees. The alternatives will propose a range of mitigation treatments depending on the severity and extent of infection.

Indicators/Measures

- Acres of intermediate thinning proposed in stands with severe dwarf mistletoe infection
- Anticipated percent change in dwarf mistletoe infection severity ratings on acres proposed for mechanical thinning treatments.

Issue 5 – Economics

The proposed action does not include measures to make it economically viable. A wide range of options should be considered in the action alternatives that would allow for biomass removal where economically feasible but would also allow other options to dispose of uneconomically feasible biomass.

How Issue 5 is addressed

To improve the economic viability, analysis of the development and use of 12 in-woods processing sites to increase the utilization of forest products and transportation efficiencies is included in both action alternatives. Alternative 2 provides for treating the most acres in the project area as identified by the Mechanical Treatments Flexible Toolbox Approach and determined during implementation. Alternative 3 focuses on those areas most highly departed from the natural range of variation (NRV) of ecological conditions and/or that put communities at risk from undesirable fire behavior and effects. This issue will be included in the analysis in this DEIS, the Implementation Plan (appendix D), and will also be addressed during implementation as opportunities for biomass removal are developed.

Indicators/Measures for the Analysis:

- Volume of wood products (ccfs and biomass dry tons) available for removal by restoration activities.
- Unit and overall project net treatment costs.
- Mill delivered value of wood products from restoration activities.
- Economic efficiency (project benefits/value less project costs).
- Changes in employment (annual jobs created) and labor income.

Significant Issues Responded to in Alternatives to the Proposed Action

Issue 6 – Smoke/Air Quality

<u>The proposed prescribed burning may have negative effects on air quality and human health</u>. Some commenters are concerned that the smoke from prescribed burns will degrade air quality and the health of northern Arizona residents.

How Issue 6 is addressed:

Alternative 3 was partially developed to respond to this issue. It includes fewer acres of prescribed burning than the other action alternatives. This issue will be also be addressed in a considered-but-eliminated-from-detailed-study alternative that proposes even less prescribed fire (see chapter 2). This issue will be addressed in the effects analysis for all alternatives. Design features and/or mitigation measures will be included to minimize effects on air quality from prescribed fires.

Indicators/Measures:

The potential for emissions from proposed prescribed fire to affected communities will be evaluated qualitatively. The pollutants to be modeled include the six listed in the Clean Air Act for which there are

National Ambient Air Quality Standards: carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone (O_2), and sulfur dioxide (SO_2). There will be a discussion on the ecological effects of smoke, and the socioeconomic analysis will evaluate the effects of smoke on the quality of life and tourism.

Issue 7 – Roads

The miles of temporary roads in the proposed action may negatively affect watershed and stream conditions, and wildlife habitat and connectivity. Commenters asked that the Forest Service limit road networks to those roads needed for access and management. Commenters requested an alternative that dramatically reduces temporary road mileage.

How Issue 7 is addressed:

Alternative 3 was partially developed to respond to this issue. It includes the least number of miles of temporary roads. Design features and/or mitigation measures will be developed to reduce effects on watersheds, streams, and wildlife habitat. This issue will be addressed in the effects analysis for all alternatives.

Indicators/Measures:

Indicators will include the range of temporary roads that may be needed in each of the alternatives, measured by the approximate number of miles of temporary roads proposed in each alternative.

Decision to be Made

The Apache-Sitgreaves, Coconino, and Tonto National Forest Supervisors are the Forest Service officials responsible for the decision about the Rim Country Project. Based on the purpose and need for action, the findings in the Environmental Impact Statement and supporting project record, and consideration of the best available science, the responsible officials' will decision will include:

- Selecting one of the alternatives analyzed, or selecting an alternative that combines activities proposed in the different alternatives analyzed. This "blending" of alternatives must be a mix of proposed activities for which the Rim Country analysis discloses the effects.
- Determining which, if any of the proposed Forest Plan amendments to approve and whether one or more amendments would affect the plan's inherent capability of meeting the substantive requirements in the 2012 Planning Rule.
- Determining the design features, best management practices, and conservation and mitigation measures to be used in implementation.
- Establishing the Implementation Plan, and the Monitoring and Adaptive Management Plan prepared with the Multi-party Monitoring Board.

Chapter 2. Alternatives, Including the Proposed Action

This chapter describes and compares the alternatives considered for the Rim Country Project. It includes a description of each alternative considered. Maps for the alternatives can be found in appendix A. This section also presents the alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public. Some of the information used to compare the alternatives is based upon the design of the alternative and some of the information is based upon the environmental, social, and economic effects of implementing each alternative.

Alternative Development Process

As a result of scoping, and extensive collaboration and public involvement since June 2016, the proposed action was modified as allowed by 36 CFR 220.7(b)(2)(iii). Modifications to the Proposed Action include dropping the even-aged shelterwood treatments originally proposed and replacing them with regular restoration treatments, modifying to propose treatments with a broader range of openness in some stands, defining the proposed treatments and terms in more detail, and detailing the acreages and miles of proposed treatments.

Those concerns that could not be addressed through modifications and additions to the Proposed Action were considered significant issues (see the Issues section in Chapter 1). Three of these issues drove the development of an additional action alternative in this DEIS.

Alternatives Considered in Detail

This DEIS documents the analysis of three alternatives, including the no action (Alternative 1), the Modified Proposed Action (Alternative 2), which is the preferred alternative, and one additional alternative (Alternative 3). Alternatives 2 (as modified) and 3 respond to issues by the public during the scoping period. The alternatives are described below.

Alternative 1 – No Action

Alternative 1 is the no action alternative as required by 40 CFR 1502.14(c).[3] It represents no changes to current management, and current forest plans would continue to be implemented. Ongoing vegetation treatments and fire management activities, as well as road maintenance, recreation, firewood gathering, authorized livestock grazing, and other activities already authorized in separate NEPA decisions would continue. There would be no other restoration activities approved with the Rim Country Project. The potential direct, indirect, and cumulative effects from no action will be analyzed. The no action alternative is the baseline for assessing the action alternatives (Alternatives 2 and 3).

Alternative 2 – The Modified Proposed Action

Alternative 2, the preferred alternative, is the Proposed Action as presented for scoping, with additional detail, clarifications, corrections, and modifications in response to public comments received. Changes made to the Proposed Action in response to public comment include:

1. Modifications to acreages and mileage of treatments based on additional modeling.
2. Additional clarity, details, and definitions of key terms used.

[3] http://ww.nepa.gov/nepa/regs/ceq/1502.htm#1502.14

3. Elimination of even-aged shelterwood silvicultural prescriptions to address dwarf mistletoe infections, replaced with regular restoration treatments.

In addition, the proposal to mechanically thin trees and implement prescribed fire on approximately 1,260 acres in the Long Valley Experimental Forest was dropped from this alternative, as well as from the Rim Country Project. In discussions with researchers with the Rocky Mountain Research Station, it was decided that experimental treatments for the experimental forest would be analyzed in a separate NEPA analysis.

This alternative, as modified, responds to the Dwarf Mistletoe Mitigation issue through the use of intermediate thinning (IT) treatments and/or the application of prescribed fire to address moderate and high levels of mistletoe infection. The presence of dwarf mistletoe will not be used to prioritize areas for treatment, but it will be addressed where it exists. Considerations for implementing IT treatments and prescribed fire will be included in the implementation plan as they continue to be developed with the 4FRI Stakeholder Group. Other restoration activities in Alternative 2 include vegetation treatments (mechanical thinning and burning) using the Flexible Toolbox Approach for Mechanical Treatments (see appendix D of the DEIS), as well as comprehensive restoration treatments for meadows, springs, streams, and riparian habitat using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D of the DEIS). Alternative 2 also includes treatments to restore habitat for wildlife and rare species (Table 10, Table 11, Figure 5, Figure 6, and Figure 7). Proposed activities include:

Mechanically thin trees and/or implement prescribed fire on up to 953,130 acres.

- Implement mechanical thinning and prescribed fire on approximately 454,020 acres including:
  - ♦ Approximately 152,270 acres of intermediate thinning
  - ♦ Approximately 62,720 acres of stand improvement
  - ♦ Approximately 12,510 acres of single tree selection
  - ♦ Approximately 226,520 acres of uneven-aged group selection
- Implement prescribed fire alone on approximately 54,070 acres in target vegetation cover types
- Mechanically thin and/or implement prescribed fire on approximately 82,280 acres (in target and non-target vegetation cover types) of Mexican spotted owl (MSO) protected activity centers (PACs) including --
  - ♦ Approximately 23,550 acres of mechanical thinning and/or prescribed fire
  - ♦ Approximately 58,730 acres of prescribed fire only
- Mechanically thin and/or implement prescribed fire on approximately 25,290 acres of MSO replacement nest/roost recovery habitat.
- Conduct facilitative operations in non-target cover types to support treatments in target cover types, including –
  - ♦ Approximately 123,400 acres of facilitative thinning and prescribed fire outside of PACs
  - ♦ Approximately 1,260 acres of facilitative prescribed fire only outside of PACs
  - ♦ Approximately 6,880 acres of facilitative prescribed fire only in PACs
  - ♦ Approximately 300 acres of facilitative thinning and prescribed fire in PACs

- Restore aspen on approximately 1,230 acres, including about 30 acres in PACs.
- Restore approximately 132,240 acres that have experienced severe disturbance, including about 3,610 acres in PACs.
- Restore approximately 18,570 acres of savanna.
- Protect private property and critical infrastructure on approximately 63,930 acres within a ½ mile of non-Forest System lands with structures and critical infrastructure
- Restore approximately 36,320 acres of grassland, including –
  - ♦ Maintaining or restoring montane meadow connectivity in pronghorn corridors.
- Restore hydrologic function and vegetation on approximately 6,720 acres of meadows.
- Restore approximately 14,560 acres of riparian areas for aquatic stream habitat

The additional actions below are in both Alternative 2 and 3.

- Restore approximately 184 springs.
- Restore function and habitat in up to 777 miles of streams, including stream reaches with habitat for threatened, endangered, and sensitive aquatic species.
- Decommission up to 200 miles of existing system roads on the Coconino and Apache-Sitgreaves National Forests, and up to 290 miles on the Tonto National Forest.
- Decommission up to 800 miles of unauthorized roads on the Apache-Sitgreaves, Coconino, and Tonto National Forests.
- Construct or improve approximately 330 miles of temporary roads (new and/or occurring on existing unauthorized roads) to facilitate mechanical treatments; decommission all temporary roads when restoration treatments are completed.
- Relocate and reconstruct existing open roads adversely affecting water quality and natural resources, or of concern to human safety.

Construct up to 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration.

Table 10. Alternatives 2 (Preferred Alternative) and 3 Mechanical and Fire Treatment Descriptions and Objectives

Treatment Type	Treatment Description/Objective
Intermediate Thin (IT)	Mechanical and fire treatments that thin stands with up to moderate infection levels of dwarf mistletoe, thins tree groups to an average of 70 to 90 square feet of basal area (BA) in pine cover types and 40-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of dwarf mistletoe and as many old and/or large trees as possible.
Single Tree Selection (ST)	Mechanical and fire treatments that leaves fewer tree groups and more randomly spaced trees. Designed to increase or maintain age class diversity and reduce understory brush and shrub response, creating small openings less than or equal to ¼-acre in size where seedlings and saplings are underrepresented and brush cover is greater than 40%. Maintains higher basal area where brush competition is expected to be strong to suppress woody understory response.
Stand Improvement (SI)	Mechanical and fire treatments that thin young, even-aged stands dominated by trees less than 8.5 inches in diameter. Establishes tree groups and interspace adjacent to tree groups. Manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group and as many old and/or large trees as possible, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Begins conversion to uneven-aged structure.
Uneven-aged (UEA)	Mechanical and fire treatments designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Thins tree groups to an average of 20-80 BA in pine cover types and 30-100 BA in dry mixed conifer cover type, and establishes non-forested grass/forb interspace/openings between residual tree groups or individual randomly-spaced trees. Manages to enhance growing space for younger trees, while retaining as many old or large trees as possible. Establishes regeneration openings where seedlings and saplings are underrepresented. Locates interspace in currently non-forested areas and lacking pre-settlement evidence.
Prescribed Fire Only (in and outside of PACs)	Prescribed burning to improve structure, maintain and develop large trees, and reduce risk of high-severity. Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire. Reduce conifer litter/duff at ground level to promote increased herbaceous species cover and species richness. Restore/regulate vegetation mosaics, including woody and herbaceous species

Treatment Type	Treatment Description/Objective
Aspen Restoration (in and outside of PACs)	Mechanical treatments that removes post-settlement conifers within 66 feet (one chain) of the aspen clone. Managed to stimulate suckering by removing aspen, disturbing the ground, and/or applying fire as needed.
Facilitative Operations (FO) – Mechanical (in and outside of PACs)	Mechanical and fire treatments in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes mastication/chipping; lop and scatter; thinning/limbing; and moving, rearranging, or removal of jackpots or excessive surface fuels. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction.
Facilitative Operations (FO) – Prescribed Fire Only (in and outside of PACs)	Fire treatment in non-target cover types to support the use of prescribed fire in cover types targeted for restoration. Includes broadcast burning, jackpotting, pile burning, and blacklining. Designed to improve safety, improve treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction.
MSO Recovery – Replacement Nest/Roost	Mechanical and fire treatments designed to develop uneven-aged structure, irregular tree spacing, and a mosaic of interspace and tree groups of varying size. Intent is to continue to develop replacement Nest/Roost where possible, and to develop a diverse mix of heterogeneous stand structures and densities to provide for owl dispersal and foraging.
MSO PAC Mechanical	Mechanical and fire treatments outside core areas that thins to improve structure, maintain and develop large trees, and reduce hazard of high-severity fire in PACs. Designed to increase tree vigor and health, to promote irregular tree spacing, and to create canopy gaps more conducive to fire treatment (reduce fire risk). Retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-treatment.
Savanna Restoration (70 to 90% interspace)	Mechanical and fire treatments that restore pre-settlement tree density and pattern by removing encroaching post-settlement conifers. Manages for a range of 70 to 90 percent interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Retains all pre-settlement trees and the largest post-settlement trees as replacement trees adjacent to pre-settlement tree evidence (stumps, dead and down).
Severe Disturbance Area Treatment (in and outside of PACs)	Combination of restoration treatments: reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods. Objective is to identify treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted.

Treatment Type	Treatment Description/Objective
Wildland-Urban Interface (WUI) and Infrastructure Protection	Mechanical treatments that allow maintenance of a more open structure and/or lower fuel load than elsewhere in the project area, up to but not exceeding 70 percent interspace within a ½-mile buffer surrounding critical infrastructure (transmission lines and communication sites) and high value Forest Service infrastructure (buildings and recreation sites), and around non-Forest System lands where structures are present. Treatments are designed to: reduce fire transmission to and from communities, improve firefighter safety and effectiveness, increase evacuation time in emergencies, reduce ember production, increase decision space for fire managers, and allow for more frequent prescribed fires.
Grassland and Wet Meadow Restoration	Mechanical and fire treatments to reduce or eliminate woody species encroachment (pines, junipers and various shrubs). Remove trees established since interruption of the historic fire regime. Promote and re-establish the historic meadow edge. Retain all pre-settlement trees and leave replacement trees where evidence of historical large trees exist.
Riparian Restoration	Combination of restoration treatments, including mechanical and fire treatments to maintain riparian vegetation and habitat. Remove encroaching upland tree and shrub species. Remove noxious or invasive plants. Promote, protect, or plant native aquatic or riparian species. Prescribed fire to regenerate riparian species and reduce fuels accumulation.

Table 11. Alternative 2 (Preferred Alternative) Mechanical and Fire Treatment Categories and Acres

Treatment Type	Acres
Intermediate Thin (IT) 10-25 (10 to 25% interspace)	30,210
IT 25-40 (25 to 40% interspace)	60,000
IT 40-55 (40 to 55% interspace)	62,060
Single Tree Selection (ST)	12,510
Stand Improvement (SI) 10-25 (10 to 25% interspace)	13,660
SI 25-40 (25 to 40% interspace)	34,590
SI 40-55 (40 to 55% interspace)	14,460
Uneven-aged (UEA) 10-25 (10 to 25% interspace)	77,820
UEA 25-40 (25 to 40% interspace)	109,210
UEA 40-55 (40 to 55% interspace)	39,490
Prescribed Fire Only	3,240
Prescribed Fire Only in PACs	50,830
Aspen Restoration	1,200
Aspen Restoration in PACs	30
Facilitative Operations (FO) Mechanical	123,400
FO Mechanical in PACs	300
FO Prescribed Fire Only	1,260
FO Prescribed Fire Only in PACs	6,880
MSO Recovery – Replacement Nest/Roost	25,290
MSO PAC Mechanical	17,460
Savanna Restoration (70 to 90% interspace)	18,570
Severe Disturbance Area Treatment	128,630
Severe Disturbance Area – in PACs	3,610
Wildland-Urban Interface (WUI) and Infrastructure Protection	63,930
Grassland Restoration	36,320
Wet Meadow Restoration	6,720
Riparian Restoration	14,560

Spring Restoration

Specific treatments to restore springs would be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D). Treatments could include: removing tree canopy close to the spring, applying fire, re-plumbing the spring improvements to conserve water, protecting the spring with fencing, and removing or relocating adjacent roads or trails.

Stream Restoration

Specific treatments to restore riparian streams and stream channels and their function would likely be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for

Aquatic and Watershed Restoration Activities (see appendix D). Treatments could include: reestablishing former drainage patterns, stabilizing slopes, restoring vegetation, protecting sites from grazing ungulates, removal of upland species that compete with riparian species, returning fire to the system (prescribed fire), and/or removing stock tanks. The emphasis will be on non-structural rather than structural methods.

Riparian Habitat Restoration

Proposed stream habitat treatments may be needed within all or some portion of the fish-bearing streams. Specific treatments to restore riparian streams and stream channels and their function would likely be identified prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D). Restoration treatments may include channel restoration (one rock dams, grade control or induced meandering) and channel structural improvements (felling or girdling trees to provide large woody debris for cover and habitat complexity).

Road and Trail Relocation/Reconstruction

Specific treatments for roads, trails, and unauthorized routes that are affecting water resources would be evaluated prior to mechanical and fire treatments in the vicinity, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D). Generally, routes crossing and those within 300 feet of streams and waterbodies are the highest priority for evaluation and treatment. Treatments could include: adding gravel to the road surface of existing authorized routes, stabilizing slopes, and restoring vegetation; closing roads, trails, or unauthorized routes by blocking the entrance or installing water bars; removing culverts, reestablishing drainages, removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed; and obliterating the roadbed by restoring natural contours and slopes.

Specific treatments for improving stream crossings that are affecting water resources would be evaluated prior to mechanical and fire treatments in the vicinity. Treatments could include: armoring downstream outlets of culverts, upsizing existing culverts, installing culverts or additional culverts, installing culvert arrays to mimic existing channel width, installing low water crossings, installing bridges, restoring downstream channels created from crossings, using sediment reduction methods on connected disturbed areas upstream from roads that connect to the drainage, paving crossings, and relocating the segment of the road that has the crossing issue out of the stream.

Figure 6 and Figure 7 display the locations of Grassland, Meadow, and Riparian and Stream Restoration activities for both Alternative 2 and Alternative 3.

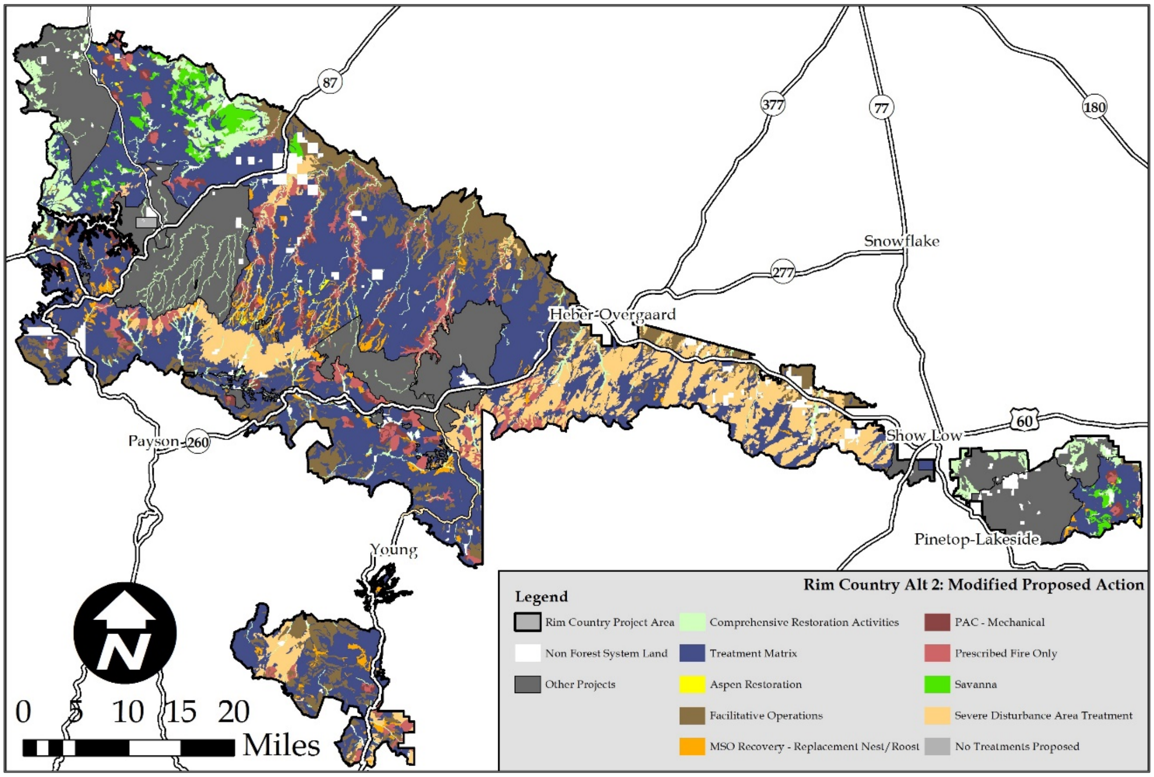

Figure 5. Alternative 2 proposed mechanical and fire treatments

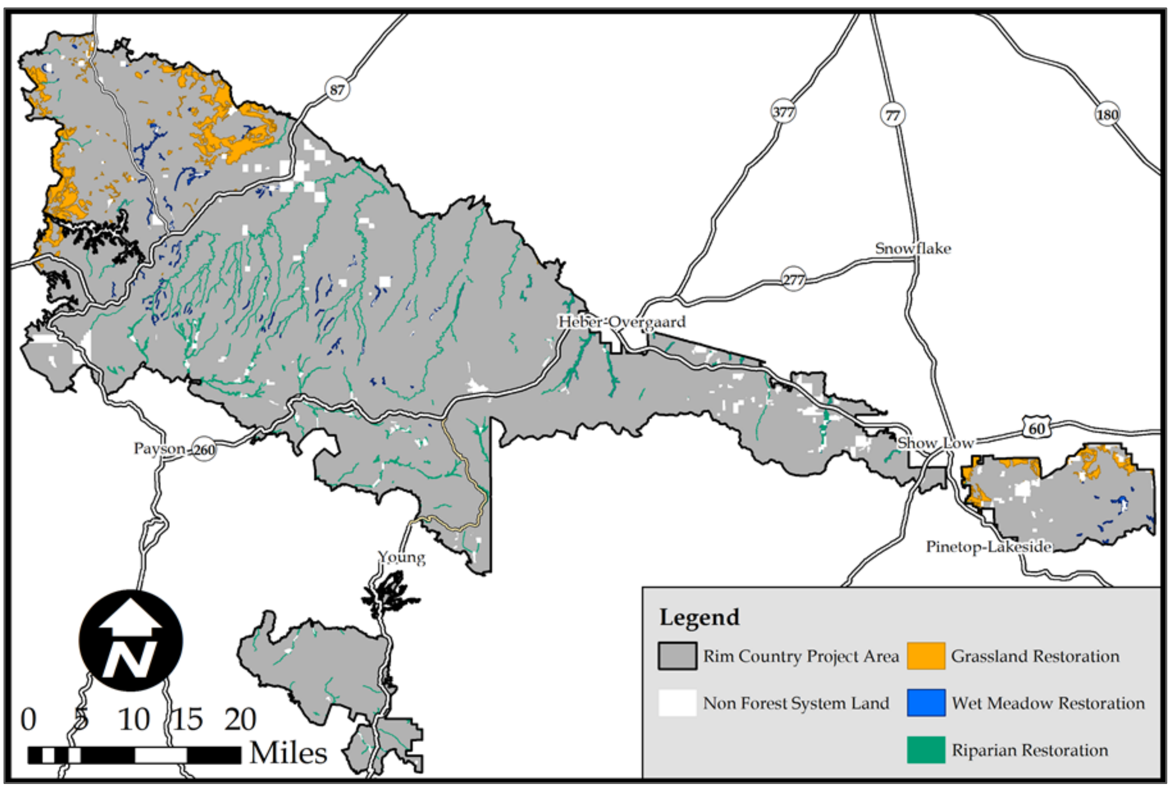

Figure 6. Alternatives 2 and 3 grassland, meadow, and riparian restoration activities

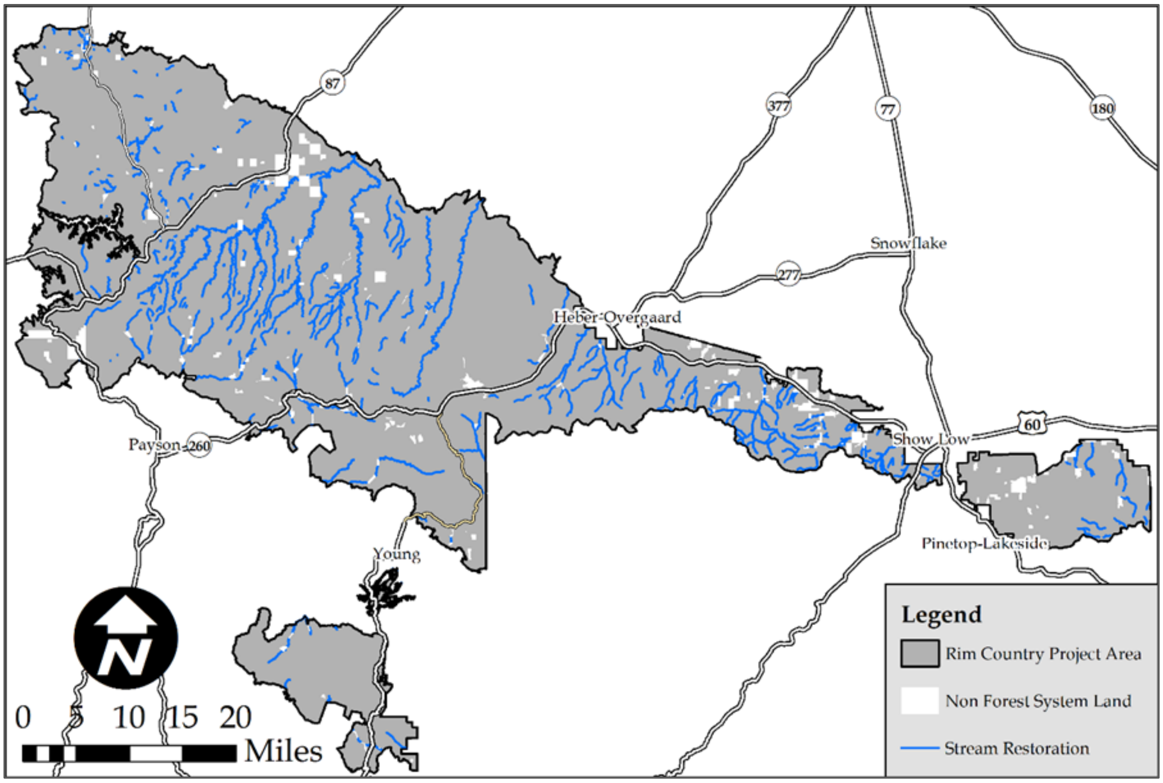

Figure 7. Alternatives 2 and 3 stream restoration activities

Alternative 3 – Focused Restoration

This alternative is designed to focus restoration treatments in areas that are the most highly departed from the natural range of variation (NRV) of ecological conditions, and/or that put communities at risk from undesirable fire behavior and effects. High value assets will be better protected and burn boundaries will be designed to create conditions safe for personnel and to ensure fire can meet objectives. Treatment areas would be chosen to optimize ecological restoration, those areas that are most important to treat and can be moved the furthest toward desired conditions. Focusing on the higher priority ecological restoration will result in fewer acres being treated.

The intermediate thinning (IT) treatments and/or the application of prescribed fire proposed in Alternative 3 will be used to address moderate and high levels of mistletoe infection, similar to Alternative 2, but to a lesser extent on the fewer acres proposed for mechanical treatment and fire. The presence of dwarf mistletoe will not be used to prioritize areas for treatment, but it will be addressed where it exists, using the same types of treatments as Alternative 2. Considerations for implementing IT treatments and prescribed fire will be included in the implementation plan as they continue to be developed with the 4FRI Stakeholder Group.

Alternative 3 responds to the Smoke/Air Quality, Economics, Roads, and Dwarf Mistletoe Mitigation issues. The restoration activities listed for Alternative 3 include vegetation treatments (mechanical thinning and burning) (Figure 8), using the Flexible Toolbox Approach for Mechanical Treatments (see appendix D); as well as the same comprehensive restoration treatments as proposed in Alternative 2 for grassland and meadows, springs, streams, riparian habitat, using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D), wildlife habitat, and rare species restoration (Table 10, Table 12, Figure 6, and Figure 7). Proposed activities include:

Mechanically thin trees and/or implement prescribed fire on up to 529,060 acres.

- Implement mechanical thinning and prescribed fire on up to 265,540 acres.
  - ♦ Approximately 114,280 acres of intermediate
  - ♦ Approximately 32,290 acres of stand improvement
  - ♦ Approximately 5,630 acres of single tree selection
  - ♦ Approximately 113,350 acres of uneven-aged group selection
- Implement prescribed fire alone on approximately 40,630 acres in target vegetation cover types
- Mechanically thin and/or implement prescribed fire on approximately 61,700 acres (in target and non-target vegetation cover types) of Mexican spotted owl (MSO) protected activity centers (PACs) including:
  - ♦ Approximately 19,650 acres of mechanical thinning and/or prescribed fire
  - ♦ Approximately 42,050 acres of prescribed fire only
- Mechanically thin and/or implement prescribed fire on approximately 19,590 acres of MSO replacement nest/roost recovery habitat.
- Conduct facilitative operations in non-target cover types to support treatments in target cover types, including:
  - ♦ Approximately 47,580 acres of facilitative thinning and prescribed fire outside of PACs
  - ♦ Approximately 630 acres of facilitative prescribed fire only outside of PACs
  - ♦ Approximately 3,070 acres of facilitative prescribed fire only in PACs
  - ♦ Approximately 300 acres of facilitative thinning and prescribed fire in PACs
- Restore aspen on approximately 1,010 acres, including about 30 acres in PACs.
- Restore approximately 31,750 acres that have experienced severe disturbance, including about 1,420 acres in PACs.
- Restore approximately 2,470 acres of savanna.
  - ♦ Protect private property and critical infrastructure on approximately 46,260 acres within a ½ mile of non-Forest System lands with structures and critical infrastructure
- Restore approximately 36,320 acres of grassland, including:
  - ♦ Maintaining or restoring montane meadow connectivity in pronghorn corridors.
- Restore hydrologic function and vegetation on approximately 6,720 acres of meadows.
- Restore approximately 14,560 acres of riparian areas for aquatic stream habitat.

The additional actions below are in both Alternative 2 and 3.

- Restore approximately 184 springs.
- Restore function and habitat in approximately 777 miles of streams, including stream reaches with habitat for threatened, endangered, and sensitive aquatic species.

- Decommission approximately 200 miles of existing system roads on the Coconino and Apache-Sitgreaves National Forests, and approximately 290 miles on the Tonto National Forest.
- Decommission approximately 800 miles of unauthorized roads on the Apache-Sitgreaves, Coconino, and Tonto National Forests.
- Construct or improve approximately 170 miles of temporary roads (new and/or occurring on existing unauthorized roads) to facilitate mechanical treatments; decommission all temporary roads when restoration treatments are completed.
- Relocate and reconstruct existing open roads adversely affecting water quality and natural resources, or of concern to human safety.
- Construct approximately 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration.

Table 12. Alternative 3 Mechanical and Fire Treatments

Treatment Type	Acres
Intermediate Thin (IT) 10-25 (10 to 25% interspace)	24,260
IT 25-40 (25 to 40% interspace)	40,290
IT 40-55 (40 to 55% interspace)	49,730
Single Tree Selection (ST)	5,630
Stand Improvement (SI) 10-25 (10 to 25% interspace)	7,480
SI 25-40 (25 to 40% interspace)	17,120
SI 40-55 (40 to 55% interspace)	7,690
Uneven-aged (UEA) 10-25 (10 to 25% interspace)	48,500
UEA 25-40 (25 to 40% interspace)	53,740
UEA 40-55 (40 to 55% interspace)	11,110
Prescribed Fire Only	2,670
Prescribed Fire Only in PACs	37,960
Aspen Restoration	980
Aspen Restoration in PACs	30
Facilitative Operations (FO) Mechanical	47,580
FO Mechanical in PACs	300
FO Prescribed Fire Only	630
FO Prescribed Fire Only in PACs	3,070
MSO Recovery – Replacement Nest/Roost	19,590
MSO PAC Mechanical	15,750
Savanna Restoration (70 to 90% interspace)	2,470

Treatment Type	Acres
Severe Disturbance Area Treatment	30,340
Severe Disturbance Area – in PACs	1,420
Wildland-Urban Interface (WUI) and Infrastructure Protection	46,260
Grassland Restoration	36,320
Wet Meadow Restoration	6,720
Riparian Restoration	14,560

The same amount of comprehensive restoration activities: spring restoration, stream restoration, riparian habitat restoration, and road and trail relocation/reconstruction, are proposed in Alternatives 2 and 3. These activities are described above for Alternative 2 and will be implemented using the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities (see appendix D of the DEIS).

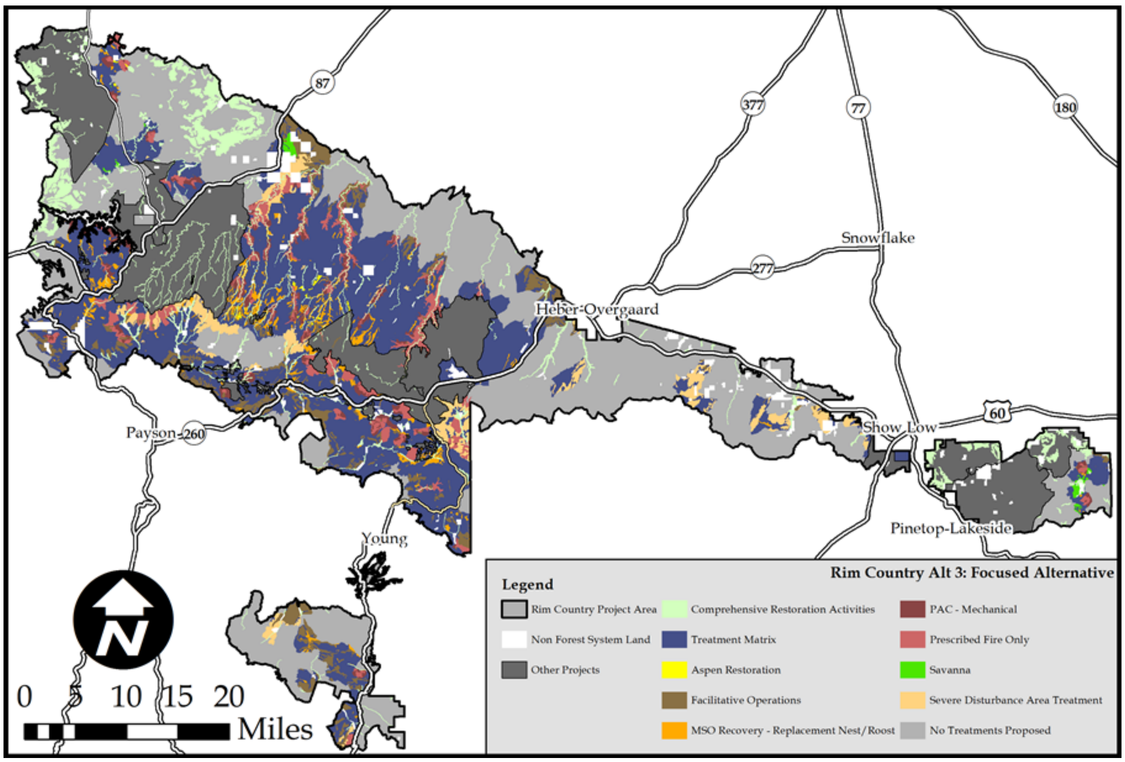

Figure 8 Alternative 3 proposed mechanical and fire treatments

Elements Common to Alternatives 2 and 3

Forest Plan Amendments

Three project-specific plan amendments for the Tonto National Forest are proposed for both action alternatives. The purpose of Amendment 1 is to bring Alternatives 2 and 3 into alignment with the revised Mexican Spotted Owl Recovery Plan and defer monitoring to the FWS biological opinion that is specific to this project. Amendment 2 clarifies existing direction related to managing canopy cover and interspace in the Forest Plan. The purpose of Amendment 2 is to bring the project into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. Amendment 3 removes the restrictive language related to 40 percent slopes and the language identifying slopes above 40 percent as inoperable, to allow mechanical treatments with new methods and equipment on slopes greater than 40 percent without adverse environmental effects (see appendix B for the full amendment text).

A project-specific plan amendment is a one-time variance in current Forest Plan direction for a project; Forest Plan direction reverts back to its original language/direction upon completion of the specified project. The language proposed does not apply to any other project.

Comprehensive Restoration

The overall goal of 4FRI is landscape-scale restoration that provides for fuels reduction, forest health, and wildlife and plant diversity. All kinds of restoration work, in addition to thinning and prescribed burning, are proposed in the Rim Country Project. Comprehensive restoration is the term used for these other types of restoration activities. The two action alternatives include the same amount of comprehensive restoration activities throughout the project area: grassland restoration, meadow restoration, spring restoration, stream restoration, and aquatics habitat restoration.

The Flexible Toolbox Approach

The flexible toolbox approach is a condition-based management strategy that allows predetermined treatments to be aligned, prior to implementation, with current conditions on the ground. A combination of selection criteria and vegetation conditions are used to determine habitat and forest cover filters and modifiers, as well as the appropriate treatments for each. Using existing stand data, these conditions and criteria are quantified to estimate the acreages of specific treatments to propose in a project area. These estimates are used to analyze the effects from those treatments. Site-specific field reviews are conducted before implementation to verify that ground conditions match those predicted. If they do not, the same selection criteria are applied again based on the actual ground conditions to be sure that the right treatment occurs on the right acre.

The flexible toolbox approach:

- Gives the ability to obtain more detailed site-specific information.
- Adapts to changes in environmental conditions.
- Uses expected conditions to make an informed decision about what types of treatments would work best in those conditions.
- Encourages application of the appropriate tool based on site conditions at time of implementation.
- Uses site-specific landscape features and current site conditions during implementation to guide selection of specific treatments or tools to move areas toward desired conditions and put the right treatment in the right place.
- Gives resource specialists flexibility to increase heterogeneity across the landscape by varying the extent, type, or intensity of treatments within the extent of the treatment.

The flexible toolbox approach is used to:

- Identify forest cover and habitat types that warrant special consideration and require additional management constraints before prescribing treatments are “filtered” out of the decision matrix treatment considerations. These include MSO PACs, MSO Nest/Recovery Habitat, Aspen Restoration, Grassland, Savanna, Severe Disturbance Areas, and Non-target Cover Types. (The Aquatics FTA allows specialists to choose from a variety of tools designed for specific site conditions.)

- Develop decision matrices to display the different site conditions that would lead to different treatments in areas outside of filters. While treatments in some cover and habitat types will not be determined by the decision matrices, others will make use of the decision matrices with added design features or "modifiers" to ensure resource protection. These include: MSO Recovery Habitat, NOGO Nest Stands, NOGO PFAs, SPLYT, and Sensitive Soils.
- Estimate the number of acres of each type of treatment proposed in each of the action alternatives. Proposed treatments, each with a defined range of openness, are analyzed at the higher end of openness or intensity, in order to analyze the maximum potential effects from these treatments.
- Prescribe appropriate treatments during implementation. Pre-implementation surveys will determine site-specific cover and habitat types and current conditions. Selection criteria for these types as spelled out in the FTA will be used to prescribe the appropriate treatments.

Two flexible toolbox approaches (FTAs) are being used in the Rim Country Project: one for mechanical treatments (and fire), and one for aquatics and watershed restoration activities. The two FTAs use different types of decision matrices. The mechanical treatments FTA uses decision matrices based on vegetation or stand conditions to determine the appropriate mechanical and/or fire treatments to prescribe. The aquatics FTA uses a different type of decision matrix for implementation of and prioritizing restoration projects. These two FTAs are included in appendix D of this EIS, the Implementation Plan, in their entirety.

Figure 9 diagrams the process used in the Flexible Toolbox Approach for Mechanical Treatments for assigning mechanical and fire treatments. Table 13 lists the considerations used in the Flexible Toolbox Approach for Aquatics and Watershed Restoration Activities to prioritize these activities.

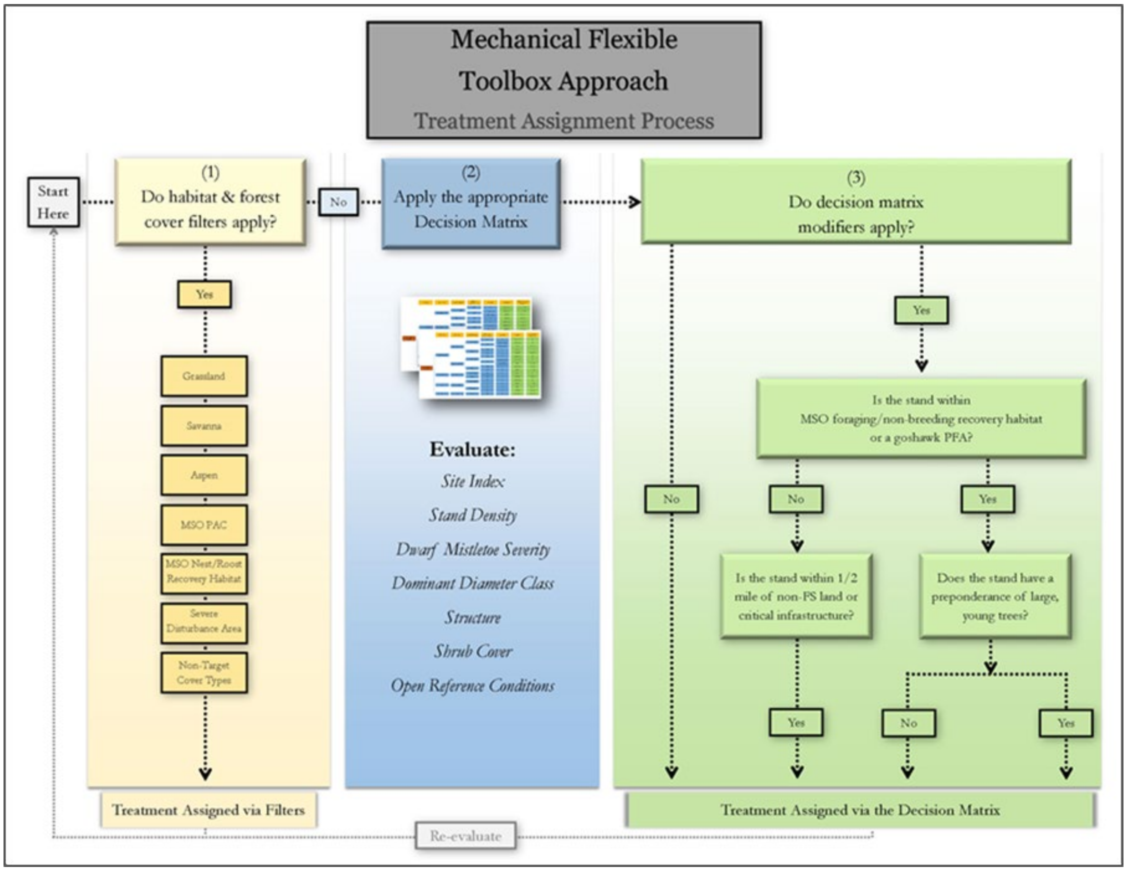

Figure 9. Mechanical flexible toolbox approach treatment assignment process

Table 13. Considerations for Prioritizing Aquatics and Watershed Restoration Activities

Consideration	Description
Watershed Condition Framework and priority watersheds.	Areas or activities within existing Watershed Restoration Action Plans can increase opportunities to move watersheds into a higher condition class. Maintaining or improving watershed condition where feasible should be taken into consideration. Projects in priority watersheds should be considered.
Projects that improved impaired waters	Projects that improve water quality in ADEQ TMDL (water quality improvement plan) or 303b listed streams,
Vegetation restoration activities within the area.	Incorporating aquatic and watershed restoration activities in an area with other restoration treatments whenever possible is one way to create efficiencies with heavy equipment and personnel.
Partner Interest	Projects that already have partners or interested partners, particularly if funding is available, should be considered.
Presence of federally listed or candidate species	The presence of these species and improving their habitat could increase the prioritization of a project over a site that had none present.
Wet meadows, cienegas, and other similar habitats.	These habitat types store water in upper watersheds and maintain baseflow to other aquatic habitats. They also cool water and can provide for lower stream water temperatures. Maintaining and improving these areas can have great downstream beneficial impacts.
Upper watershed vs. lower	Restoration in upper portions of watersheds can have beneficial impacts downstream such as reduced sedimentation, maintaining baseflow, and cooling stream temperatures. They will have a larger range of beneficial impacts than projects lower in a watershed.
Issues that are new, easily treated, or could quickly spread.	Newer issues have not yet caused that much damage; restoration treatments of these are more cost and time effective as well as preventing more degradation. Projects such as these are 'low-hanging fruit' when compared to larger or more widespread issues. In addition, new infestations of noxious weeds or aquatic invasive plants are easier to treat early rather than after they spread.
Federal employee, contracted, and partner implementation	All three categories have merit, but may have differing financial or oversight costs. These should be considered differently amongst options and assessed. Prioritization may depend upon which category a project occurs in when weighed against work load, capacity, and financial considerations.
Process versus form-based projects	Projects that enhance site conditions, but do not restore the processes that create habitat or site conditions are considered form-based. These types of projects can require more maintenance than projects that restore the processes that create and maintain habitat. Projects that restore processes may be more of a priority than those that address a specific issue rather than the larger problem.

Facilitative Operations

Facilitative operations (FO) are vegetation treatments proposed in non-target cover types in the Rim Country project area to support the use of prescribed fire in target cover types (those targeted for restoration). FO would be used in non-target cover types that are adjacent to or between target cover types, or where existing features can be used as prescribed fire unit boundaries. FO treatments would either move these non-target cover types toward Forest Plan desired conditions or maintain their current condition.

FO treatments would not have to be implemented to meet Rim Country objectives, but would be available as needed to facilitate the use of prescribed fire. The use of FO would:

1. <u>Improve safety</u> by expanding burn units to existing natural or man-made features that could serve as effective firelines (roads, cliffs, ridges, powerlines, etc.) This would reduce firefighter exposure to risks encountered during fireline construction. These existing barriers are usually

more effective than a fire line made by firefighters and heavy machinery, or can be made so with less risk, less time, less effort, and lower costs.

a. Improve treatment effectiveness and the timeframes for which prescribed fire treatments can be applied

b. Under some conditions, heavy fuel loading in chaparral or dense pinyon/juniper (particularly with a significant dead component) has the potential to produce extreme fire behavior, spotting, or other undesirable fire behavior. Where these kinds of fuels exist between target cover types and logical fuel breaks, undesirable fire behavior and effects could be decreased by manipulating fuel loading and structure. This would allow prescribed fire to be implemented under a broader range of conditions, while producing the desired fire effects.

c. Minimize the disturbance associated with fireline construction, such as soil disturbance, branch breakage, or bole damage caused by bulldozers, ATV draglines, handlines, and other means. Using existing features would result in less disturbance than other methods of creating a functional burn unit.

Types of FO Treatments

The expectation is that most FO treatments would be only prescribed fire with no mechanical treatments. Mechanical FO treatments would be the exception.

Fire

All areas proposed for FO would be available for prescribed fire, including:

- Broadcast burning
- Jackpotting (process of adding to and igniting small accumulations of woody debris)
- Pile burning
- Blacklining

Mechanical

Where mechanical FO treatments are needed, they would be site-specific and consider the requirements for all resources. Mechanical treatments could be combined with prescribed fire include:

- Mastication/chipping
- Lop and scatter
- Thinning/limbing
- Moving, rearranging, or removal of jackpots or excessive surface fuels
- Any combination of the above

Figure 10 shows an idealized landscape in which the existing features that would make a good fireline are some cliffs, two Forest Service roads, a highway, and a trail. In this case, all of the burn units that could be outlined with these features would include pinyon/juniper. Excluding pinyon/juniper from a burn unit would require a fireline. If the pinyon/juniper was included in the burn units, the need for ground disturbing activities would be minimized, and decrease the risk of injury for fire managers building firelines.

In this case, the use of FO would allow the inclusion of the pinyon/juniper area between the ponderosa pine and the road to be included in the prescribed burn unit, as shown in Figure 11. Fire managers would identify areas where there would be a potential need for mechanical treatments, and work with other resource specialists to identify the appropriate mechanical treatments.

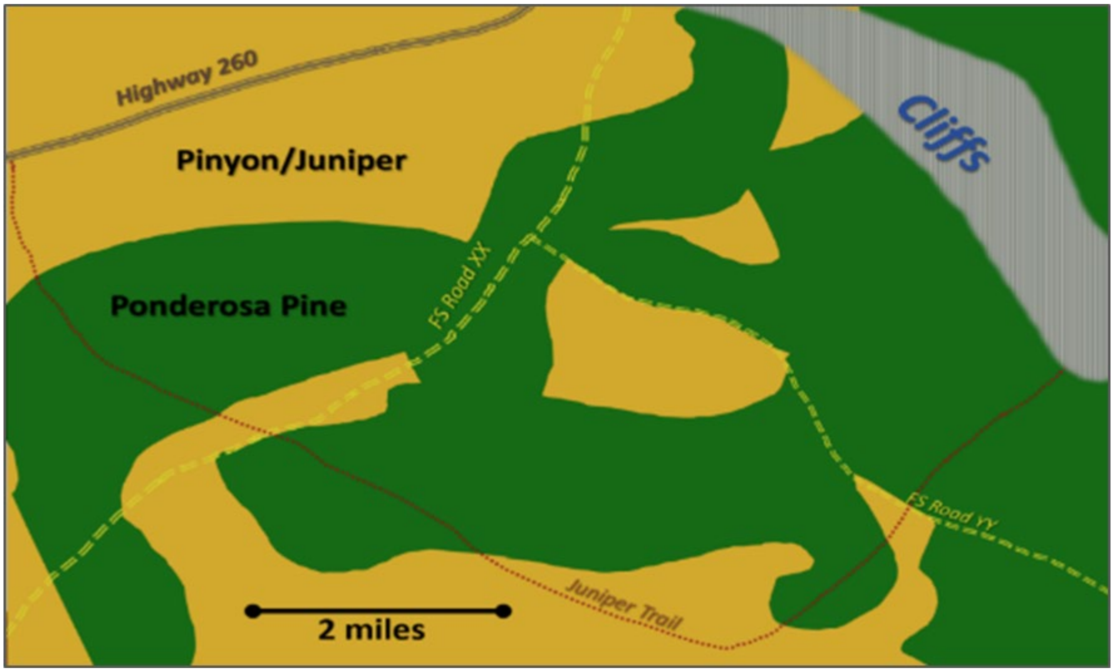

Figure 10. Idealized landscape of target and non-target cover types and fireline features

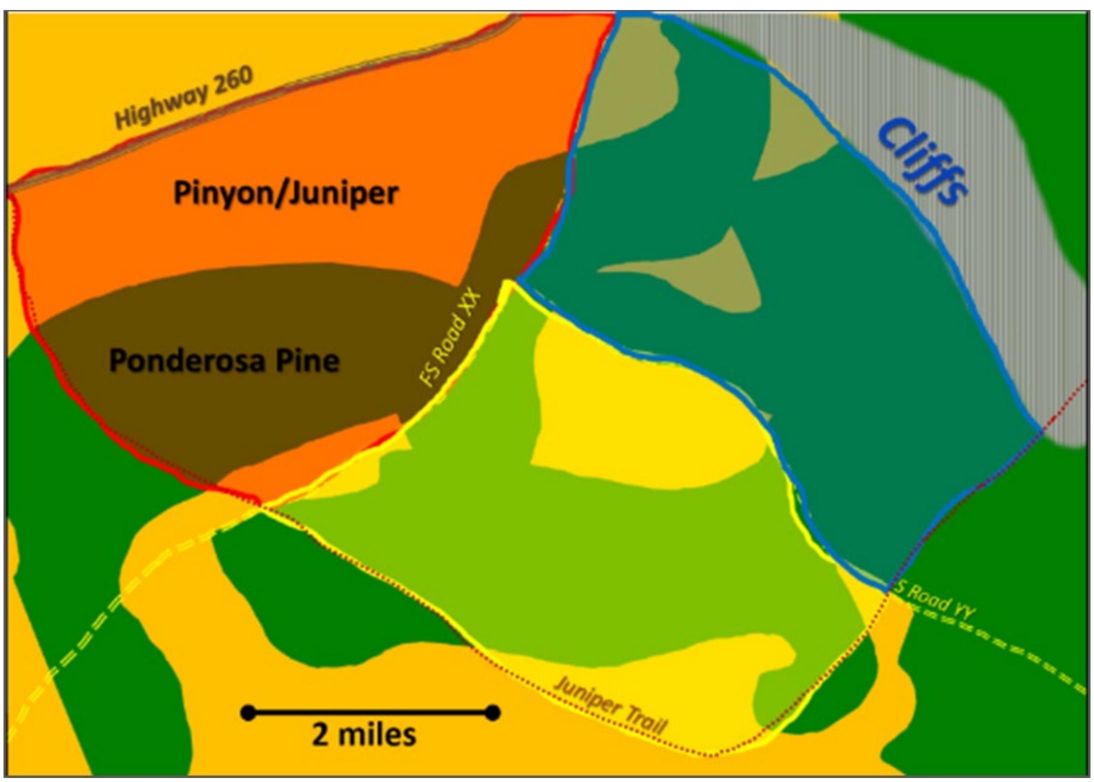

Figure 11. Same landscape with three burn units

Severe Disturbance Area Treatments

Severe disturbance areas (approximately 125,800 acres) are those where the spatial extent or the pattern of high severity fire effects is not within NRV. In some places this has resulted in aggressively sprouting species, such as alligator juniper and various species of oak dominating the vegetative response, making it difficult or impossible for ponderosa pine to establish or thrive. In other areas, extensive, overly dense patches of ponderosa pine regeneration have put stands on a trajectory toward stagnation, density-related mortality, or additional severe disturbance. Those severe disturbance areas known and included in this acreage for Rim Country are:

- Bray Fire (Coconino, Tonto)
- Breed Fire (Apache-Sitgreaves)
- Coon Fire (Tonto)
- Crossing Fire (Apache-Sitgreaves)
- Dude Fire (Apache-Sitgreaves, Coconino, Tonto)
- Durfee Fire (Apache-Sitgreaves)
- February Fire (Tonto)
- Five Mile Fire (Coconino, Tonto)
- Juniper Fire (Tonto)
- Mistake Peak Fire (Tonto)
- Packrat Fire (Coconino, Tonto)
- Picture Fire (Tonto)
- Pot Fire (Coconino)
- Potato Fire (Apache-Sitgreaves)
- Promontory Fire (Tonto)
- Rodeo-Chediski Fire (Apache-Sitgreaves, Tonto)
- Rim Fire (Tonto)
- Slim Fire (Apache-Sitgreaves)
- Tanner Fire (Tonto)
- Webber Fire (Tonto)
- Tinder Fire (Coconino)
- Pivot Rock Fire (Coconino)

Restoration treatments in severe disturbance areas will include combinations of reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods with the objective of identifying treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted. In areas of extensive, pure ponderosa pine regeneration, the decision matrix in the flexible toolbox approach for mechanical treatments will be applied.

In-woods Processing and Storage Sites (Processing Sites)

The distance of the western part of the Rim Country project area from businesses that can process wood products from mechanical thinning prompted the identification of potential processing sites for use as needed by contractors during implementation. If primary processing can be accomplished in the project area, it would facilitate more utilization of forest resources, increase transportation efficiencies, reduce implementation costs, and generally make it easier to complete implementation.

The identification of potential processing sites was initially done using spatial analysis techniques and followed up with on-the-ground validation and input from subject matter experts. Variables such as current road system, slopes and landforms, economics of transportation, recreation sites, visual aesthetics, and wildlife and hydrological concerns were factored into the analysis process.

The closest mill to Rim Country is the Lumberjack Mill, approximately 13 miles from Heber, Arizona, just north of the eastern edge of the project area. The Lumberjack Mill is operated by Good Earth Power. The mill underwent an extensive upgrade in 2017 and is currently processing dry kilned and finished lumber.

On the western side of Rim Country, the closest wood processing facility is Canyon Wood Supply, approximately 25 miles from the western boundary of the project area in Camp Verde, Arizona. Canyon Wood Supply processes ponderosa pine into bundled fuelwood for retail consumption.

A fully loaded log truck at a gross weight of 80,000 pounds can typically transport 5,000 board feet of raw logs. In comparison, a tractor trailer with a 45-foot trailer can typically transport 40,000 board feet of green logs and be within the 80,000-pound threshold. Drying ponderosa pine wood for 60 days results in a weight reduction of 23 percent, which results in considerable haul cost savings. These figures put into perspective the underlying economics of transporting forest products in Arizona.

Processing sites serve many purposes. Some log sorting would be done on all processing sites, for various reasons such as increased log value and decreased hauling cost, taking advantage of available log markets, and providing a better log mix to consuming mills. Concentration log yards would provide a central point for accumulating logs for drying, debarking, and processing, and later shipment to mill yards. Small diameter timber or residue from log processing may be chipped and hauled to mills or other businesses. The advantage of having strategically-located processing sites over sorting logs at a landing is that logs can be more easily moved, bucked, and sorted by quality characteristics (species, size, and grade) for allocation to their highest values use (Dramm et al. 2002).

Tasks done by equipment at processing sites would include drying, debarking, chipping stems and bark, cutting logs, manufacturing and sorting logs to size, producing wood cants4, scaling and weighing logs, and creating poles from suitable sized logs. Equipment commonly used at processing sites would include circular or band saws, various sizes and types of front-end loaders, log loaders, and several types of chippers. Equipment may include timber processors, planers and mechanized cut to length systems, associated conveyers, and log sorting bunks for accumulation and storage of logs. Electric motors and gas or diesel generators would also be used to provide power. Large processing sites, 10 or more acres in size, would allow for more flexibility in their design and allow for more area to process, grade, scale and sort logs, and manufacture cants, poles, and chip and haul products. Larger sites would handle surges in incoming logs and would protect workers better by providing better separation between processing and transport functions. Medium-sized processing sites, five to 10 acres in size, would allow log processing

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4 A **cant** is a piece of **wood** usually over 2" thick and sawn flat on one to three sides. Most pallet shops want cants to re-saw into pallet parts because they have more options on what sizes they can cut from them.

equipment use with more limited storage (Dramm et al. 2002). Landings for mechanical thinning contracts would be considerably smaller than log sort yards, typically about 1/3 of an acre.

Eight processing sites were proposed and analyzed for environmental effects in the Cragin Watershed Protection Project (CWPP) (Table 14). These sites are carried forward for potential use in implementing the Rim Country Project. In addition, 12 in-woods processing sites are being proposed and the environmental effects from their use analyzed in the Rim Country EIS (Table 15). For both projects, processing site location and siting considerations include: flat uplands less than 5 percent slope; more than 200 feet from perennial, intermittent, and ephemeral stream channels/ more than 300 feet from meadows, springs, and karst features; more than ¼ mile from MSO PACs and outside of NOGO PFAs; more than ¼ mile from system hiking trails, campgrounds, and group event recreation sites; more than ¼ mile from private lands, residences, or offices; and adjacent to roads that are open year-round for product removal. Processing sites were located to provide a buffer of 100 to 300 feet from forest roads and state highways to provide for visual screening from Concern Level 1 and 2 travel ways. Figure 12 displays the processing sites already analyzed in the CWPP Environmental Analysis (EA) and the additional sites being analyzed in this EIS.

Table 14. Processing Sites Analyzed in CWPP

Site Name	Acres
FR 141, 9398	5
FR 147, 6096/6097	5
211 Revised	15
613F	15
9033H	15
FR 95, North 9032C	10
FR 95F/396	9
9729A	5
Total (8)	79

Table 15. Processing Sites Analyzed in 4FRI Rim Country

Site Name	Acres
FR 117, 1321	4
FR 139, 9729D	14
FR 145A, 9615X	7
FR 288, 2781	4
FR 294, 294D	18
3238, 512	20
FR 582, Hwy 87	5
FR 609, 1938	7
FR 74, 64	8
FR 81, 81E	7
9364L, FH 3	21
9731G, Hwy 87	9
Total (12)	128

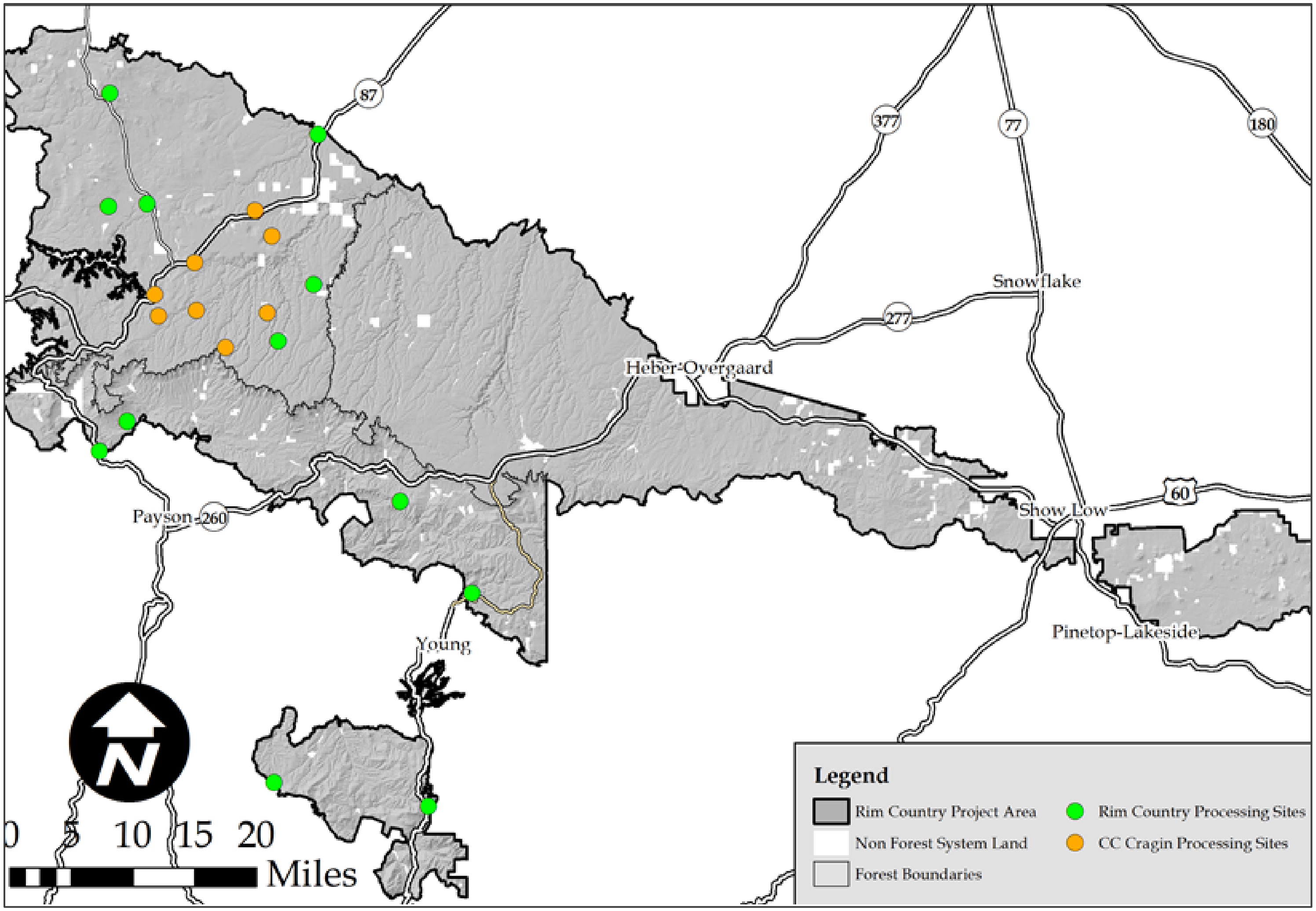


Figure 12. Proposed in-woods processing sites

These 20 in-woods processing and storage sites may be used for implementation of the Rim Country Project over its implementation period for 20 years, or until implementation is completed. Continuous-use processing sites are those where use is expected to be continuous on a regular basis for 10-20 years. These sites are typically the larger 10 to 21-acre areas located close to major highways. Sites originally developed and operated for continuous use will frequently change to intermittent use or occasional use following initial harvest activities in the area. Intermittent use processing sites are those where use is expected to be shorter term and used for one or multiple contract periods, lasting from 3-10 years.

The design features for in-woods processing sites are listed in appendix C of this DEIS.

Rock Pit Use

The Rim Country Project will analyze the effects from the use of several rock pits in the project area. On the Coconino National Forest, the development, expansion, and use of nine rock pits in the Rim Country project area were analyzed in the Rock Pits Environmental Assessment for the Coconino and Kaibab National Forests (June 2016). One additional rock pit, Park Knoll, is currently being developed by Coconino County under permit. The Forest Service will have a reserve of approximately 20,000 cubic yards of material in this pit, so the potential effects from the use of this rock pit will be analyzed in the Rim Country EIS.

On the Apache-Sitgreaves National Forest, two ranger districts are in the Rim Country project area, the Lakeside and Black Mesa Ranger Districts. Surfacing material needs on the Lakeside Ranger District are met by a large county-operated rock pit under special use permit, as well as other commercial sources. On the Black Mesa Ranger District, 11 existing rock pits in the Rim Country project area are proposed for expansion to provide future material for implementation of Rim Country. Each of these rock pits are considered for 30 percent expansion of their current footprint. The potential environmental effects from the anticipated expansion of these rock pits, as well as those from their use, will be analyzed in the Rim Country EIS.

On the Tonto National Forest, all road surface material needs would be met by local commercial sources. Therefore, no effects from rock pit use on the Tonto would be analyzed in the Rim Country EIS. Figure 13 displays the locations of these rock pits in the Rim Country project area.

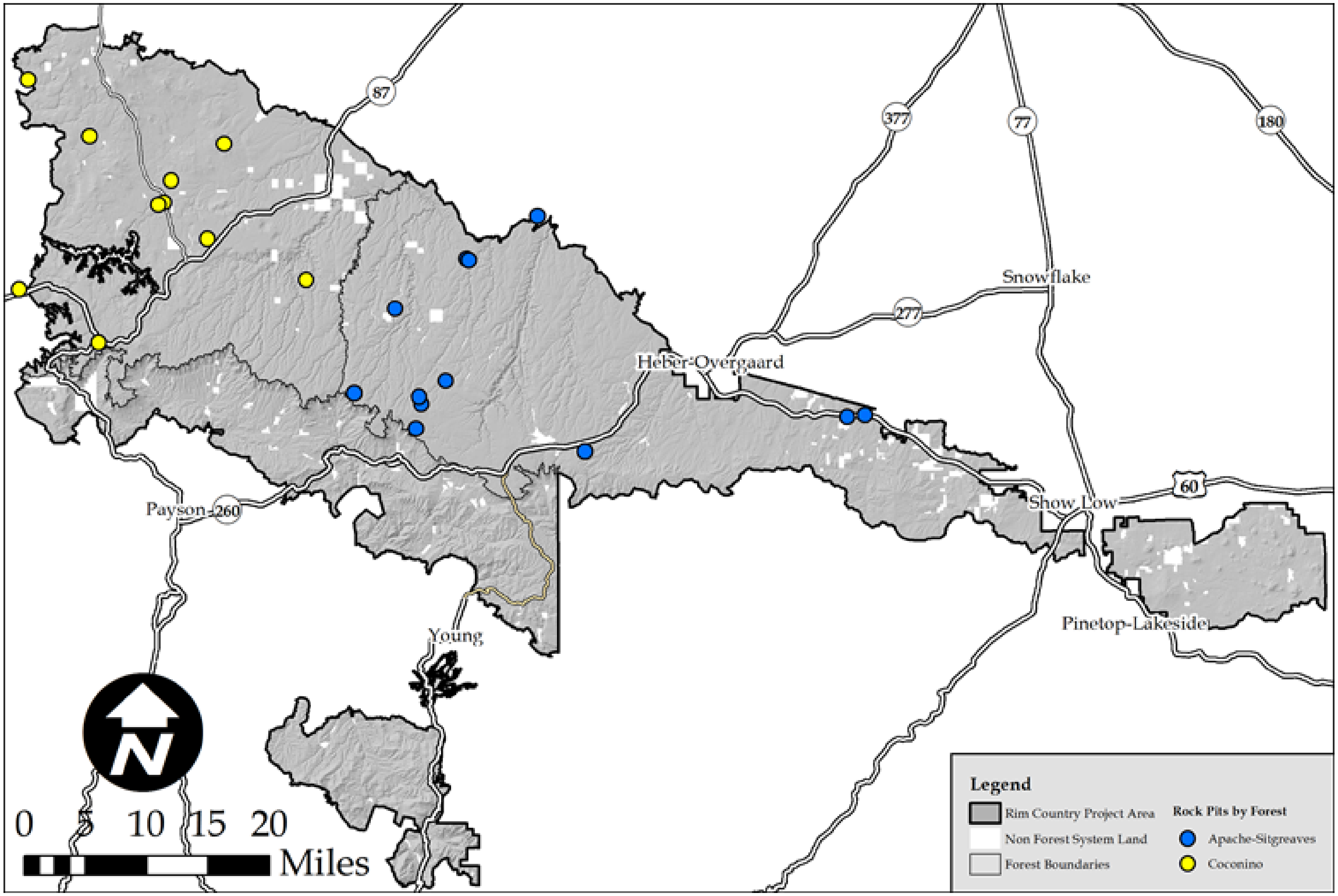


Figure 13. Coconino and Apache-Sitgreaves National Forests rock pits

Alternatives Considered but Eliminated from Detailed Study

This DEIS documents four (4) alternatives recommended in public comments that have been considered and eliminated from detailed study. Public comments suggested four alternative methods to meet the purpose and need, including alternatives that would: (1) eliminate the use of prescribed fire, (2) use the original Large Tree Retention Strategy, (3) return the forest to historic reference conditions, and (4) prioritize strategic treatments for fire use.

Each alternative was evaluated to determine how well the proposal would meet the purpose and needs for the Rim Country Project. The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity in ponderosa pine ecosystems to conditions within the natural range of variation, thus moving the project area toward the desired conditions established in the Apache-Sitgreaves, Coconino, and Forest Plan Tonto National Forest Plans. The needs are to increase forest resiliency and sustainability, reduce the risk of undesirable fire effects, improve terrestrial and aquatic species habitat, improve the condition and function of streams and springs, restore woody riparian vegetation, preserve cultural resources, and support sustainable forest products industries. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, and climate change (FSM 2020.5).

Eliminate the Use of Prescribed Fire

Some public comments suggested eliminating all prescribed fire (broadcast burns, pile burns, jackpot burning) to reduce hazards from particulate matter and other substances released during burning, to protect the health of the public, to provide cleaner air, and to reduce carbon emissions. Recommendations for alternatives to prescribed fire include logging for fire breaks, chipping, thinning, and goat or cattle grazing.

After an initial review, it was determined that it would not meet various elements of the purpose and need for the Rim Country Project or move toward the desired conditions in the Forest Plans, such as:

Eliminating the use of prescribed fire would negatively affect forest structure in terms of moving toward age and size class diversity and desired conditions for forest health. Without the thinning effects of fire on canopy fuels, seedlings, and young saplings, denser conditions could slow stand development and growth (Waring et al 2016). This would result in more of the landscape continuing in the young forest stage. Contrary to the restoration purpose and need, development of the mature and old forest stages would be impeded.

Mechanical treatments would address the majority of conditions associated with density-related mortality, bark beetle hazard, and dwarf mistletoe infections (Conklin and Geils 2008). However, the pruning effect of fire that would potentially reduce dwarf mistletoe infection severity (Wasserman and Waltz 2018) and reduce tree densities (due to the thinning effect of fire) would not occur. This could lead to slight increases in bark beetle infestation (Kenaley 2008) and density-related mortality, and would move the project area away from the desired conditions for resiliency and sustainability.

Without the use of prescribed fire, patterns of surface vegetation would further depart from the natural range of variation as fire-adapted shrubs and herbaceous species decline (Huffman and Moore 2008, Moir 1988). Eliminating fire would also have an effect on Gambel oak growth forms and densities. Currently, the Gambel oak population throughout the project area is dominated by seedlings and saplings. Without fire as a regulator of these smaller size classes, both the variety of oak growth forms and densities of seedlings and saplings would continue to be outside of the natural range of variation (Waring et al 2016).

This would move the project area away from the desired conditions for forest structure, pattern, and vegetation composition and diversity.

Mechanical treatments in the project area would be effective initially at restructuring most of the canopy bulk density, canopy base heights, tree density, and the arrangement of trees in the short term (immediately after treatment). Additionally, mechanical treatments have only a minimal effect on seedlings, and provide mineral soil that can increase seedling germination. In order to avoid seedling re-growth that would support undesirable fire behavior and effects, much of the forested areas of the Rim country project area would need some kind of treatment every 10 years, roughly 90,000 acres annually.

Mechanical treatments alone would not be sufficient to produce effects that simulate regeneration and growth of native herbaceous understory vegetation (move toward desired conditions for vegetation composition and diversity) or reduce the natural surface fuels that have accumulated since the interruption of fire on the landscape (Puhlick et al 2013). Mosaics created by patterns of litter/duff and other surface vegetation could not be recreated by mechanical means, and species that benefit from the heat or smoke of fire, such as Beardtongue Penstomon, Fendler's Ceanothus, several species of Grama grass, and various species of legumes (Abella et al. 2007, Huffman and Moore 2008, Lata 2015). The negative effects of the head and smoke of fire on species such as Pineland Dwarf Mistletoe or non-native crabgrasses are beneficial for the native ecosystems they inhabit.

Accumulations of litter, duff, dead and down woody debris, seedlings, and small saplings would not be reduced. These accumulations, in addition to the debris from mechanical treatments, could result in surface fires that burn at high intensities and lethally scorch tree crowns. It could also result in mortality of large and old trees in the project area.

High severity fires have the potential to cause second-order fire effects (such as flooding, debris flows, and erosion). This would be contrary to the need to reduce the risk of undesirable fire behavior and effects and move toward forest ecosystems with increased resiliency to wildfires.

Nutrients would increasingly become locked up in litter layers, and soil productivity would decline, affecting species composition and patterns (Moir 1988; Laughlin et al. 2011; Abella et al. 2007).

Depending primarily on mechanical means for project implementation, whether it was grazing or machines, this alternative would not meet the purpose and need of the Rim Country Project. The Guidance for Implementation of Federal Wildland Fire Management Policy states:

Fire, as a critical natural process, is 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.

Fire is a critical natural process, and not including prescribed fire in the Rim Country Project would not meet the purpose and need of the project. The effectiveness of using prescribed fire as a tool, alone or combined with mechanical treatments, to restore ponderosa pine to healthier, more sustainable and resilient conditions is well documented (Fulé et al. 2012).

Grazing was suggested as a method to reduce fuel loading. Grazers would remove the herbaceous vegetation that helps carry a fire across the majority of the project area.

To replace the use of prescribed fire, livestock (cattle and goats) would be authorized to graze on up to 899,340 acres (Alternative 2). This type of increased use would exceed what is currently permitted in the existing allotment management plans in the Rim Country project area. There would likely be a decline in herbaceous species production and diversity, and possibly an increase in soil compaction across the project area. This is contrary to the purpose and need to improve the abundance, diversity, distribution, and vigor of native understory vegetation to provide food and cover for wildlife, as well as move toward the desired conditions of improved condition and function of streams and springs, grasslands and connected montane meadows, watersheds, and forest ecosystems.

This alternative would respond to Issue 6—Smoke/Air Quality. It would be possible to use mechanical treatments to move biomass offsite and reduce surface fuels that would have been burned and produced smoke The costs to implement this would be significant and there would be a large increase in truck traffic that would increase emissions, dust, and degradation to roads however, mechanical treatment would not replace the role fire has in improving vegetation composition and diversity.

It is estimated that the project area would move away from the desired conditions for forest structure and pattern and resiliency within 10 years of mechanical treatments without the ability use prescribed fire to: (1) stimulate understory vegetation growth; (2) reduce excessive fuel loadings (accumulated since the interruption of fire on the landscape); (3) maintain desired canopy base heights; (4) reduce ladder fuels (attained through mechanical treatment); (5) thin seedlings and small saplings to maintain a mosaic of age classes; and (6) reduce threats to cultural resources and terrestrial and aquatic species habitat.

The use of alternative fuel reduction methods in lieu of prescribed fire could reduce some surface fuels, but would not meet the ecological need for a fire-adapted landscape and would add significantly to the cost of restoration. Fire that did occur on the landscape would be wildfire, and the effects and behavior would be more severe than on a landscape which prescribed fire had been part of the restoration treatments.

Use the Original Large Tree Retention Strategy (LTRS)

Scoping comments recommended incorporating the LTRS as written by the 4FRI stakeholders. In the 1st 4FRI EIS analysis, it was determined that incorporating and implementing the original LTRS would not meet various elements of the purpose and need. The Forest Service modified the original strategy, developing the Large Tree Implementation Plan (LTIP), which was included in that EIS and is brought forward with modifications into this EIS and is part of the Implementation Plan

Return the forest to historic reference conditions (an aggressive strategy to achieve comprehensive landscape restoration)

An alternative that analyzes the effects of "returning the forest to a state closely approximating historic reference conditions, and which incorporates an aggressive strategy to achieve the stated goal of comprehensive landscape restoration while complying with requirements such as the Endangered Species Act was recommended during scoping.

The comments suggested a full restoration alternative is needed to consider treating the landscape to the fullest extent that mimics historic conditions that based on studies were projected to have had far less trees per acre on the landscape. Historic conditions are also considered to have a larger number of large trees due to estimated historic fire return intervals.

This type of alternative was considered similar to the evidence-based full restoration alternative considered and evaluated in the 1st 4FRI EIS, except that it provided additional provisions to meet current direction for retention and improvements to certain habitat types (such as in the Endangered Species Act). Also included would have been the flexible tool box approach, including the Old Tree/Large Tree (OT/LT) retention strategies

This alternative would meet the purpose of and need to increase ecosystem resiliency and sustainability. It would be compliant with Forest Plans, ESA, and other direction for species preservation.

Having an industry that is sustainable over time helps the Forest Service gain and retain desired forest conditions, provides jobs, and provides products to the American people. The best model for industry sustainability is to provide flow of wood. There is concern this alternative would demand treatment of a large amount near term then there would be a small amount longer term (boom-bust model). This does not provide for long-term sustainability which is needed to maintain the forest over time.

It was found when all the conditions were applied to meet ESA, habitat and species preservation, OT/LT retention strategy, the projection for treatments did not vary by a lot to warrant detailed study. In addition there was concern by some that while the numbers didn't vary by much, that the stands that would be available for this type of treatment would warrant more open conditions than desired, and may lead to removal of larger trees to meet the prescription. Therefore the alternative was dropped from detailed study.

Strategic Treatments for Fire Use Alternative

This alternative was recommended after public scoping and initial development of the alternatives. This suggested alternative proposes "expanded use of prescribed and resource benefit fire, coupled with strategic placement of mechanical treatments...," and a "spatially-explicit means to prioritize the Rim Country landscape and identify optimal treatment actions." The project area would be divided into three types of management areas:

2. Community Protection (1/2 mile around homes and critical infrastructure, highest priority for mechanical treatment)
   - d. Strategic Thinning Treatment (approximately 20% of operable landscape outside of community protection areas, next priority, consensus-based treatments including fire-only)
   - e. Fire Use (rest of project area not prioritized for mechanical treatment, prescribed and resource benefit fire only with increased resources and dedicated fire implementation team)

This alternative would meet the purpose of Rim Country to increase ecosystem resiliency and sustainability, and would move the project area toward desired conditions. However, this alternative was not analyzed in detail as the major elements suggested have been considered and included in the existing action alternatives, the Modified Proposed Action and the focused restoration alternative. The Modified Proposed Action proposes fire across the project area and would incorporate the use of any naturally-occurring fire for resource benefits. The focused restoration alternative prioritizes and limits where mechanical treatments are proposed, based on spatial analysis of the values-at-risk to protect from undesirable fire effects, and where resources should be deployed to "yield the greatest restoration benefit." Although the three management areas recommended are not used, both action alternatives prioritize treatments around non-Forest Service land with structures and critical infrastructure. The focused restoration alternative also prioritizes areas with the highest probability of active crown fire. Both action alternatives propose "consensus-based treatments" as developed with stakeholders through the collaboration process.

Design Features, Best Management Practices, Conservation and Mitigation Measures

The Forest Service employs several measures in the planning and implementation of management activities to reduce or prevent negative effects on the environment. The application of these measures begins in the planning and design phase of a project. Forest Plan standards and guidelines and the direction contained in the Watershed Conservation Practices Handbook (FSH 2509.25) are protection measures applied to any project. Both of these sources are incorporated by reference and are not reiterated here.

Project design features, best management practices (BMPs), and conservation and mitigation measures that are designed to minimize or avoid effects from the proposed activities have been included in the analysis of this DEIS (see appendix C). All design features apply to both action alternatives.

Implementation Plan

The implementation plan (appendix D) is designed to be integral to the selected alternative and record of decision. It must be considered in conjunction with appendix C, which provides the design criteria, best management practices, and conservation and mitigation measures. The implementation plan provides direction to be used by Forest Service personnel to ensure that management activities are implemented to meet the purpose and need for Rim Country and to follow Forest Plan standards and guidelines. The implementation Plan includes the Large Tree Implementation Plan (LTIP) and Old Tree Implementation Plan (OTIP) as well as permits and other law, regulations and policy requirements the project would follow.

Monitoring

Appendix E includes the biophysical and socioeconomic monitoring plan. This plan is designed to be integral to the selected alternative and record of decision. The monitoring plan details the framework and process for monitoring selected activities. The 4FRI stakeholders and the Forest Service coordinated on the design of the monitoring plan.

Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Information in the table is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Table 16. Comparison of Alternatives by Proposed Treatment

Proposed Activity	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Mechanical Treatments		
Intermediate thinning	152,270	114,280
10% to 25% interspace	30,210	24,260
25% to 40% interspace	60,000	40,290
40% to 55% interspace	62,060	49,730
Stand improvement	71,270	37,300
10% to 25% interspace	13,660	7,480
25% to 40% interspace	34,590	17,120
40% to 55% interspace	14,460	7,690
Single tree selection	12,510	5,630
Uneven-aged group selection	226,520	113,350
10% to 25% interspace	77,820	48,500
25% to 40% interspace	109,210	53,740
40% to 55% interspace	39,490	11,110
Aspen restoration	1,230	1,010
Facilitative operations	123,700	47,880
MSO recovery - replacement nest/roost	25,290	19,590
MSO PAC - mechanical	17,460	15,750
Savanna restoration	18,570	2,470
Severe disturbance area treatment	132,240	31,760
Wildland Urban Interface & Infrastructure Protection	63,930	46,260
Grassland restoration*	36,280	36,280
Wet meadow restoration*	6,400	6,400
Riparian restoration*	13,060	13,060
Total mechanical treatment (acres)	**889,340**	**483,160**
Prescribed Fire		
Prescribed fire along with mechanical treatment	889,340	483,160
Prescribed fire only	63,790	45,900
Total prescribed fire (acres)	**953,130**	**529,060**
Grassland Restoration	36,280	36,280
Mechanical and Prescribed Fire		

Proposed Activity	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Prescribed fire only	40	40
Total grassland restoration* (acres)	**36,320**	**36,320**
Wet Meadow Restoration Mechanical and Prescribed Fire	6,410	6,410
Prescribed fire only	310	310
Total wet meadow restoration* (acres)	**6,720**	**6,720**
Riparian restoration Mechanical and Prescribed Fire	13,060	13,060
Prescribed fire only	1,500	1,500
Total riparian restoration* (acres)	**14,560**	**14,560**
Springs restored (number)	**184**	**184**
Protective barriers around springs, aspen, native willows and bigtooth maples (miles)	**200**	**200**
Stream restoration (miles)	**777**	**777**
Existing road decommission (miles)	**490**	**490**
Unauthorized route decommission (miles)	**800**	**800**
Temporary road construction and decommission (miles)	**330**	**170**
Road relocation and reconstruction (miles)	**As needed**	**As needed**

*Overlap exists betw een the riparian, grassland and w et meadow restoration categories (approximately 3,120 acres)

Comparison of Alternatives by Issue

Table 17. Comparison of Alternatives by Issue

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Issue 1 – Treatment in MSO PAC Stand density as measured by SDI, TPA, QMD, Canopy Cover and Basal Area (BA). Metrics are calculated for Mixed Conifer (MC) and Pine-Oak (PO) Cover Types.	SDI MC: from 398 (existing condition) to 414 in 2029 and 425 in 2039 SDI PO: from 339 (existing condition) to 353 in 2029 and 362 in 2039 TPA MC: from 1,291 (existing condition) to 1,170 in 2029 and 1,057 in 2039 TPA PO: from 1,276 (existing condition) to 1,130 in 2029 and 990 in 2039 QMD MC: from 6 to 7" over 20 years QMD PO: from 6 to 7" over 20 years Canopy Cover MC: from 74% (existing condition) to 76% in 2029 and 78% in 2039 Canopy Cover PO: from 69% (existing condition) to 71% in 2029 and 73% in 2039 BA MC: from 173 inches in the existing condition to 185 in 2029 and 196 in 2039 BA PO: from 144 inches in the existing condition to 155 in 2029 and 163 in 2039	SDI MC: from 398 (existing condition) to 253 in 2029 and 218 in 2039 SDI PO: from 339 (existing condition) to 215in 2029 and 191 in 2039 TPA MC: from1,291 (existing condition) to 392 in 2029 and 227 in 2039 TPA PO: from1,276 (existing condition) to 369 in 2029 and 232 in 2039 QMD MC: from 6" (existing condition) to 9" in 2029 and 12" in 2039 QMD PO: from 6" (existing condition) to 9" in 2029 and 11" in 2039 Canopy Cover MC: from 74% (existing condition) to 67% in 2029 and 66% in 2039 Canopy Cover PO: from 69% (existing condition) to 62% in 2029 and 61% in 2039 BA MC: from 173 inches in the existing condition to 131 in 2029 and 127 in 2039 BA PO: from 144 inches in the existing condition to 110 in 2029 and 106 in 2039	SDI MC: from 398 (existing condition) to 262 in 2029 and 235in 2039 SDIPO: SDI PO: from 339 (existing condition) to 237 in 2029 and 223 in 2039 TPA MC: from 1,291 (existing condition) (existing condition) to 531 in 2029 and 379 in 2039 TPA PO: from1,276 (existing condition) to 496 in 2029 and 368 in 2039 QMD MC: from 6" (existing condition) to 9" in 2029 and 12" in 2039 QMD PO: from 6" (existing condition) to 9" in 2029 and 10" in 2039 Canopy Cover MC: from 74% (existing condition) to 67% in 2029 and 67% in 2039 Canopy Cover PO: from 69% (existing condition) to 64% in 2029 and 64% in 2039 BA MC: from 173 inches in the existing condition to 131 in 2029 and 130in 2039 BA PO: from 144 inches in the existing condition to 117 in 2029 and 117 in 2039

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Fuel loading in Mixed Conifer (MC and Pine-Oak Cover Types, fire hazard index, and risk of crown fire	Fuel loading MC:29 tons per acre (existing condition) to 29 tons/acre in 2029 and 33 tons/acre in 2039 Fuel Loading PO: 20 tons/acre (existing condition to 23 tons/acre in 2029 and 25 tons/acre in 2039 Fire hazard index: from 49,889 acres (41 % of all PACs in the project area) in the existing condition to 57,191 (47 %) are at risk of high severity wildfire Active and Passive Crown fire assessment: from 58,253 acres (48% of all PACs in the project area) in the existing condition to 61,608 acres (50%) that are at risk of active fire	Fuel loading MC: 29 tons/acre (existing condition) to 28 tons/acre in 2029 and 27 tons/acre in 2039 Fuel Loading PO: 20 tons/acre (existing condition to 18 tons/acre in 2029 and 19 tons/acre in 2039 Fire hazard index: from 49,889 acres (41 % of all PACs in the project area) in the existing condition to 34,410 (28 %) are at risk of high severity wildfire Active and Passive Crown fire assessment: from 58,253 acres (48% of all PACs in the project area) in the existing condition to 34,068 acres (28%) that are at risk of active fire	Fuel loading MC: 29 tons/acre (existing condition) to 27 tons/acre 2029 and 27 tons/acre in 2039 Fuel Loading PO: 20 tons/acre (existing condition to 19 tons/acre in 2029 and 20 tons/acre in 2039 Fire hazard index: from 49,889 acres (41 % of all PACs in the project area) in the existing condition to 33,105 (30 %) are at risk of high severity wildfire Active and Passive Crown fire assessment: from 58,253 acres (48% of all PACs in the project area) in the existing condition to 33,044 acres (30%) that are at risk of active fire

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Prey habitat as measured by number of snags/acre ≥ 12 inches in diameter, CWD, and shrub and herbaceous cover. Metrics are calculated for Mixed Conifer (MC) and Pine-Oak (PO) Cover Types.	Snags/acre ≥ 12"MC: from 7/acre (existing condition) to 5/acre in 2029 and 2039 Snags/acre ≥ 12"PO: from 3/acre (existing condition) to 4/acre in 2029 and 2039 CWD MC: from 10 tons/acre (existing condition) to 12 tons/acre in 2029 and 14 tons/acre in 2039 CWD PO: from 8 tons/acre (existing condition) to 9 tons/acre in 2029 and 10 tons/acre in 2039 Shrub cover MC: from 0.4 tons/acre (existing condition) to 0.34 tons/acre in 2039. Shrub cover decreased Shrub cover PO: from 0.23 (existing) with no change through 2039 Herbaceous cover MC and PO: from 0.21 tons/acre (existing condition) with no change through 2039.	Snags/acre ≥ 12" MC: from 7/acre (existing condition) to 12/acre in 2029 and 8/acre in 2039 Snags/acre ≥ 12" PO: from 3/acre (existing condition) to 7/acre in 2029 and 2039 CWD MC: from 10 tons/acre (existing condition) to 12/tons/acre in 2029 and 13 tons/acre in 2039 CWD PO: from 8 tons/acre (existing condition) to 9 tons/acre in 2039 Shrub cover MC: from 0.4 tons/acre (existing condition) to 0.63 tons/acre in 2029 and 0.73 tons/acre in 2039 Shrub cover PO: from 0.23 (existing) to 0.24 in 2039 Herbaceous cover MC: from 0.21 tons/acre (existing condition) to 0.24 tons/acre in 2039 Herbaceous cover PO: from 0.21 tons per acre (existing condition) to 0.23 tons/acre in 2039	Snags/acre ≥ 12" MC: from 7/acre (existing condition) to 10/acre in 2029 and 8/acre in 2039 Snags/acre ≥ 12" PO: from 3/acre (existing condition) to 7/acre in 2029 and 6/acre in 2039 CWD MC: from 10tons/acre (existing condition) to 12 tons/acre in 2029 and 12 tons/acre in 2039 CWD PO: from 8 tons/acre (existing condition) to 9 tons/acre in 2039 Shrub cover MC: from 0.4 tons/acre (existing condition) to 0.55 tons/acre in 2029 and 0.65 tons/acre in 2039. Shrub cover PO: from 0.23 (existing) to 0.25 in 2039 Herbaceous cover MC: from 0.21 tons/acre (existing condition) to 0.24 tons/acre in 2039. Herbaceous cover PO: from 0.21 tons per acre (existing condition) to 0.22 tons/acre in 2039
Issue 2 – Treatments in Goshawk Habit Stand density as measured by SDI, TPA, QMD, reduction of average BA of large young trees Size Classes 3 (5-12") and 4 12-18"	SDI: from 312 (existing condition) to 326 in 2029 and 336 in 2039. TPA: 872 (existing condition) to 793 in 2029 and 721 in 2039. QMD: from 6 to 7" over 30 years. BA of Tree Size Classes: 3 (5-12") 47 trees/acre (existing condition) to 48 trees/acre in 2039 4 (12-18") 41 trees/acre (existing condition) to 47 trees/acre in 2039	SDI: from 312 (existing condition) to 129in 2029 and 118 in 2039. TPA: 872 (existing condition) to 136 in 2029 and 88 in 2039. QMD: from 6 to 14" over 30 years BA of Tree Size Classes: 3 (5-12") 47 trees/acre (existing condition) to 9 trees/acre in 2039 4 (12-18") 41 trees/acre (existing condition) to 20 trees/acre in 2039	SDI: from 312 (existing condition) to 168in 2029 and 165 in 2039 TPA: 872 (existing condition) to 271 in 2029 and 224 in 2039. QMD: from 6 to 12" over 30 years BA of Tree Size Classes: 3 (5-12") 47 trees/acre (existing condition) to 18 trees/acre in 2039 4 (12-18") 41 trees/acre (existing condition) to 25 trees/acre in 2039

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Fuel loading, fire hazard index, and risk of crown fire	Fuel loading: from 17 tons/acre (existing condition) to 22 tons/acre in 20439 Fire hazard index: from 16,211 acres (28 % of all PFAs in the project area) in the existing condition to 19,472 (33 %) are at risk of high severity wildfire Crown fire assessment: Risk of crown fire in PFAs goes from 23,270 acres (39% of all PFAs in the project area in the existing condition to 24,653 acres (41%) in 2039	Fuel loading: from 17 tons/acre (existing condition) to 12 tons/acre in 2039 Fire hazard index: from 16,211 acres (28 % of all PFAs in the project area) in the existing condition to 8,281 (14 %) are at risk of high severity wildfire Crown fire assessment: Risk of crown fire in PFAs goes from 23,270 acres (39% of all PFAs in the project area in the existing condition to 11,170 acres (19%) in 2039	Fuel loading: from 14 tons/acre (existing condition) to 13 tons/acre in 2039 Fire hazard index: from 16,211 acres (28 % of all PFAs in the project area) in the existing condition to 9,621 (17 %) are at risk of high severity wildfire Crown fire assessment: Risk of crown fire in PFAs goes from 23,270 acres (39% of all PFAs in the project area in the existing condition to 11,421 acres (20%) in 2039
Prey habitat as measured by number of snags/acre ≥ 12 inches in diameter, CWD, and shrub and herbaceous cover	Snags/acre ≥ 12 inches: from 4/acre (existing condition) to 3/acre in 2039. CWD: from 7 tons/acre (existing condition) to 9 tons/acre in 2039 Shrub cover: from 0.28 tons/ acre (existing condition) to 0.26 tons/acre in 2039 (no change). Herbaceous cover: from 0.20 tons/acre (existing condition) with no change through 2039	Snags/acre ≥ 12 inches: from 4/acre (existing condition) to 6/acre in 2039. CWD: from 7 tons/acre (existing condition) to 6 tons/acre in 2039 Shrub cover: from 0.28 tons/acre (existing condition) to 0.38 tons/acre in 2039 Herbaceous cover: from 0.20tons/acre (existing condition) to 0.24 tons/acre in 2039	Snags/acre ≥ 12 inches: from 4/acre (existing condition) to 5/acre in 2039. CWD: from 7 tons/acre (existing condition) to 7tons/acre in 2039 Shrub cover: from 0.28 tons/acre (existing condition) to 0.38 tons/acre in 2039 Herbaceous cover: from 0.20 tons/acre (existing condition) to 0.23 tons/acre in 2039
Issue 3 – Large Tree Retention Acres meeting SPLYT criteria (2019 / 2039)	36,270 / 80,140	36,270 / 64,770	36,270 / 72,420
Issue 4 – Dwarf Mistletoe (DM) Mitigation Acres of intermediate thinning proposed in severe DM stands	0	18,456	16,236

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
% of acres in DM severity rating classes	The proportion of acreage with a severe dwarf mistletoe rating would increase from 4 percent in 2019 to 6 percent in 2029, reaching 9 percent in 2039. The proportion of acreage that meets the desired condition decreases from 96 percent in 2019 to 91 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating would decrease from 4 percent in 2019 to 2 percent in 2029, reaching 3 percent in 2039. The proportion of acreage that meets the desired condition would increase from 96 percent in 2019 to 97 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating remains essentially unchanged from 4 percent in 2019 to 2 percent in 2029, returning to 4 percent in 2039. The proportion of acreage that meets the desired condition is also the same in 2019 and in 2039.
Issue 5 – Economics Volume of wood products available	Ongoing projects will continue to provide some amount with no contribution from the Rim Country Project	5.3 MMCCF	3.6 MMCCF
Economic efficiency (project benefits/value less costs)	No direct project benefits or costs; no economics of scale in forest restoration activities	Avoided costs from forest restoration and reduced risk of high intensity wildfire	Avoided costs from forest restoration and reduced risk of high intensity wildfire; more concentrated treatments (compared to alternative 2) would lower operating costs
Changes in employment (jobs created) and labor income	Three national forests would continue to support local employment and labor income associated with harvesting, grazing and recreation at levels similar to current conditions	1,890 jobs and 78 million dollars in labor income	1283 jobs and 53 million dollars in labor income
Issue 6 – Smoke/Air Quality Potential for Rx fire emissions	Smoke and associated emission impacts on air quality would come solely from wildfire events. These events would be unpredictable in both magnitude and timing, with the potential for large pulse impacts to air quality metrics. Wildfire related emissions would be expected infrequently (a few times a year). Overall, smoke impacts would be less predictable, less frequent, and more concentrated than impacts from the prescribed fires proposed for alternatives 2 and 3.	Smoke and associated impacts on air quality would come primarily from prescribed fire. Wildfire would continue to occur, but per acre emissions for wildfires occurring post treatment would be reduced up to 40% compared with existing conditions. Variability from year to year in total smoke related emissions would be high, but overall, smoke impacts would be more predictable, less concentrated, though potentially more frequent than wildfire related emissions associated with alternative 1. All prescribed fire treatments would comply with National Ambient Air Quality Standards.	In treated areas, smoke and associated impacts on air quality would come primarily from prescribed fire, while smoke from untreated areas would be generated from wildfires. On average, approximately 45% less acreage would be burned with prescribed fire in this alternative compared with alternative 2. Areas burned with prescribed fire would produce lower emissions per acre than untreated acers burned by wildfires. All prescribed fire treatments would comply with National Ambient Air Quality Standards.

Issue Indicator/Measure	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Level of modelled pollutants	Modeled wildfire emissions: PM2.5- 359 lbs/acre PM10- 304 lbs/acre Carbon monoxide- 3,384 lbs/acre Sulfur dioxide- 35 lbs/acre	Modeled wildfire emissions: PM2.5- 164-227 lbs/acre PM10- 139-193 lbs/acre Carbon monoxide- 1,790-2,447 lbs/acre Sulfur dioxide- 8-12 lbs/acre	Modeled wildfire emissions: PM2.5- 164-359 lbs/acre PM10- 139-304 lbs/acre Carbon monoxide- 1,790-3,384 lbs/acre Sulfur dioxide- 8-35 lbs/acre
Effects of smoke on quality of life and tourism	This alternative would not result in smoke emissions from prescribed fire in the project area. Smoke from wildfires, though unpredictable in frequency and duration, would be likely to adversely affect quality of life and tourism over both the short and long terms. Because this alternative would not reduce fuel loading, wildfires in the project area would likely produce more smoke and particulate matter compared with wildfires in treated areas or prescribed fires. Because wildfires are unplanned there is little potential to work with fire managers to reduce smoke impacts in areas when fires occur. High-severity fires in untreated areas are likely to result in substantial tree mortality and post-fire effects that have the potential to negatively affect quality of life and tourism for forest users.	Prescribed burns would have short-term and minimal negative effects to quality of life and tourism during implementation, and long-term benefits from reduced risk of severity of wildfire. Mechanical treatments would reduce fuel loading so that prescribed fires and wildfires in treated areas would be likely to emit less smoke and particulate matter. Wildfires in treated areas would be less likely to kill entire stands, thus protecting resources and forest characteristics that contribute to quality of life and tourism in the area.	Prescribed burns would have short-term and minimal negative effects to quality of life and tourism during implementation, and long-term benefits from reduced hazard and severity of wildfire. Mechanical treatments would reduce fuel loading so prescribed fires and wildfires in treated areas would emit less smoke and particulate matter. Compared to alternative 2, benefits of reduced fire hazard and potential negative, short-term effects would occur across a smaller area. Wildfires in treated areas would be less likely to kill entire stands, protecting resources and forest characteristics that contribute to quality of life and tourism in the area.
Issue 7 – Roads # of miles temporary roads needed	0 miles	330 miles	170 miles

Comparison of Alternatives by Effects

Table 18. Comparison of Alternatives by Effects

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Water Quality	Upland and riparian vegetation, soil productivity, and w etland function would not be restored to desired conditions. Degrading contributors to w ater quality would continue to persist.	Localized, short-term changes in w ater quality due to sediment concentrations are possible in w ater bodies adjacent to project activity areas. Risk to long-term surface water quality is expected to decrease more rapidly and over a larger extent w hen compared to alternative 3 by bringing upland and riparian vegetation, soil productivity, and w etland function to desired conditions.	Same as Alternative 2 w ith the exception of substantially fewer upland acres treated w ith mechanical vegetation and prescribed burning treatments in forested conditions 48% less) and grasslands and savannahs (28%) less and prescribed burning treatments. Prescribed burning only acres are 26% less. Therefore, potentially fewer short-term effects and long-term benefits to w ater quality.
Water Quantity	Water yield including persistence of flow and stability of hydrologic flow regimes w ould likely continue to decline as a result of continued departure from desired conditions.	Water yield may increase depending on vegetation type and climate variables. More stable hydrologic regimes are expected as a result of moving resources towards desired conditions.	Due to few er acres being treated through mechanical vegetation treatments and prescribed burning overall w ater yield and stability may be low er than in Alternative 2 but greater than in Alternative 1.
Riparian Zones	Degradation of riparian systems would continue unabated, w ith reduced function and stability of riparian areas, w etlands, and springs.	Vegetation treatments, including mechanical thinning and prescribed burning along w ith other aquatic and w atershed treatments, w ould increase water availability and stability to riparian areas, w etlands, and springs. Riparian vegetation and stream habitats w ould be restored and maintained.	Few er acres would receive mechanical vegetation and prescribed burning treatments than Alternative 2, resulting in potentially less w ater availability for supporting riparian areas, w etlands, and springs and restoration of fewer areas of riparian vegetation and stream habitat.
Watershed Condition	There w ould be no discernable change in w atershed condition. Current rates of w atershed restoration are insufficient to fully restore w atershed functionality at the landscape scale.	Watershed condition w ould be improved throughout the project area w ith implementation of the suite of proposed restoration actions.	Watershed condition w ould improve throughout the Rim Country analysis area, just not to the extent provided by Alternative 2.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Soil Condition	With no activities resulting from the Rim Country Project, no additional soil disturbance or displacement w ould occur beyond existing projects for w hich NEPA analysis has been completed. By not decommissioning or relocating roads as part of the Rim Country Project, soil conditions on those roads w ill not be improved.	Greatest soil disturbance and displacement w ould occur with short-term negative effects throughout much of the Rim Country analysis area. As a result of proposed restoration treatments, Alternative 2 w ould achieve desired condition for soils and w atershed over the long term by removing sufficient canopy cover to allow sunlight to penetrate to the forest floor, increasing grow th response of grasses, forbs and shrubs. In the long term, increased fine roots and vegetative ground cover w ould protect soils from erosion by w ind and w ater better than forest litter alone, providing the greatest long term soil condition improvement. Road decommissioning w ould improve soil condition on former road beds.	Less soil disturbance and displacement than Alternative 2, resulting in less short-term adverse effects to soils. Would not achieve desired conditions at the landscape scale for soils over the long-term since it w ould result in treatment of only the highest priority areas. Soil nutrient cycling w ould progress tow ard the desired condition in treated areas, w hich are substantially less than Alternative 2. Untreated areas w ould continue to have less understory vegetative cover. The litter layer, or duff would continue to provide soil nutrients and contribute to soil profile development, but not to the extent provided by grasses, forbs, and shrubs in Alternative 2. Road decommissioning w ould improve soil condition on former road beds.
Forest Structure - General	Stand structure would continue to not meet the desired conditions as smaller trees are overrepresented. This trend w ould be expected to continue, leading to increased density dependent mortality, w hile basal area and stand density index (SDI) w ould continue to increase. The number of trees per acre and basal area and SDI w ould move further aw ay from the natural range of variation (NRV) and the desired conditions. This trend w ould be expected to continue. Insect hazard rating and severity of dw arf mistletoe infections w ould continue to increase.	Stand structure would move tow ard desired conditions as trees w ould be w ell distributed across size classes. The number of trees per acre, basal area, and SDI w ould decrease considerably, trending tow ard desired conditions w ithin NRV as a result of thinning and prescribed fire activities. Insect hazard rating and dw arf mistletoe severity would be reduced in treated areas, thus moving tow ard the desired conditions.	In general, the effects would be similar to the effects of Alternative 2, w ith a muted effect due to the fewer number of acres treated, and w ould only be observed in the stands treated. The number of trees per acre, basal area, and SDI w ould decrease considerably, trending tow ard desired conditions w ithin NRV as a result of thinning and prescribed fire activities. Insect hazard rating and dw arf mistletoe severity would be reduced in treated areas, thus moving tow ard the desired conditions.
Forest Structure - Pattern	Stands w ould continue to remain in a closed condition, lacking groups and clumps of trees or randomly spaced trees. Grasses forbs and shrubs w ould continue to be underrepresented. Forest structure would continue to be departed from historic conditions.	This alternative w ould generally meet the desired condition. The majority of stands w ould be in an open condition. Forest arrangement w ould be in individual trees, small clumps, and groups of trees or randomly spaced trees that are similar to historic patterns and are as a result of the proposed action Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals w hile maintaining w ildlife habitat.	This alternative w ould generally meet the desired condition on the acres that w ere treated, how ever the acres that w ere not treated w ould resemble the conditions described in the no action alternative. Forest arrangement w ould resemble historic forest structure in some places, w hile many other areas w ould not meet the desired condition for forest pattern and structure.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Forest Structure – Trees per Acre	Total trees per acre continues to remain above the desired condition. The percentage of acreage in the project within desired condition moves up from 13 percent in 2019 to 15 percent in 2039 as a result of density-dependent mortality. Tree distribution does not approximate the idealized distribution with too many trees in the smaller size classes. By 2039 there would be 621, 121, 39, 12, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	The percentage of acreage within desired condition for trees per acre increases dramatically from 13 percent in 2019 to 84 percent in 2049. The distribution of trees across size classes approximates the idealized distribution by 2039 better than any of the other alternatives. By 2039 there would be 48, 18, 14, 8, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	Trees per acre: The percentage of acreage within desired condition for trees per acre increases from 13 percent in 2019 to 55 percent in 2039. Tree distribution does not approximate the idealized distribution with too many trees in the smaller size classes. By 2039 there would be 222, 50, 21, 9, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.
Forest Structure – Basal Area	Average basal area would continue to increase across the project area from 129 square feet per acre in 2019 to 150 square feet per acre in 2039. The percentage of acres that would meet desired condition decreases from 19 percent in 2019 to 12 percent by 2039.	Average basal area would decrease across the project area from 129 in 2019 to 65 in 2029 and 62 in 2039. The percentage of acres that meet desired condition would increase from 19 percent in 2019 to 58 percent in 2029 and then to 56 percent in 2039.	Average basal area would decrease across the project area from 129 in 2019 to 87 in 2029 and 89 in 2039. The percentage of acres that meet desired condition for basal area would increase from 19 percent in 2019 to 42 percent in 2029 and then to 40 percent in 2039.
Forest Structure – Stand Density Index	Average stand density index would continue to increase across the project area from 296 in 2019 to 324 in 2039. The percentage of acres that would meet desired condition decreases from 15 percent in 2019 to 11% in 2039.	Average stand density index would decrease across the project area from 296 in 2019 to 116 in 2029 and 103 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then 21 percent in 2039.	Average stand density index would decrease across the project area from 296 in 2019 to 172 in 2029 and 170 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then to 21 percent in 2039.
Forest Insects	The proportion of acreage that would meet the desired condition for bark beetle hazard decreases from 26 percent in 2019 to 19 percent in 2039 as a result of increased stocking and lack of disturbance over time.	The proportion of acreage that would meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 92 percent in 2039.	The proportion of acreage that meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 60 percent in 2039.
Forest Disease	The proportion of acreage with a severe dwarf mistletoe rating would increase from 4 percent in 2019 to 9 percent in 2039. The proportion of acreage that meets the desired condition decreases from 96 percent in 2019 to 91 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating would decrease from 4 percent in 2019 to 3 percent in 2039. The proportion of acreage that meets the desired condition would increase from 96 percent in 2019 to 97 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating remains essentially unchanged from 4 percent in 2019 to 4 percent in 2039. The proportion of acreage that meets the desired condition also remains unchanged from 96 percent in 2019 and 2039.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Fire Ecology	Fire Type: Wildfires would continue to impact the project area, though no prescribed burning would occur. Existing conditions, which are currently prone to high severity crownfire would only worsen. Conditions across 80% of the project area would be capable of supporting active or passive crown fire under extreme fire weather conditions. This includes approximately 33% of the project area with potential for active crown fire. Fire Hazard Index: 40% of the project area would have moderate to extreme Fire Hazard Index ratings, representing difficult and dangerous conditions for fire suppression during wildfire events and elevated potential for adverse post fire effects to soils and surface water quality. Surface Fuel Loading: Total surface fuel loading would continue to accumulate. Approximately 123,000 acres of the Ponderosa Pine cover type and nearly 26,000 acres of the Dry Mixed Conifer cover type would exceed desired conditions for fuel loading after 20 years of additional accumulation.	Fire Type: Wildfires occurring within the project area would generally be less likely to burn with high severity. Existing susceptibility to crown fire would be reduced. Conditions across 69% of the project area would be capable of supporting active or passive crown fire under extreme fire weather conditions. This would include 12% of the project area with the potential for active crown fire under these extreme fire weather conditions. Prescribed fire would be predominantly surface fire. Fire Hazard Index: There would be an overall decrease in the Fire Hazard Index, with only 15% of the project area in moderate to high ratings. This would decrease the overall area where difficult and dangerous conditions for fire suppression during wildfire. Surface Fuel Loading: Total surface fuel loading would fluctuate during implementation, but overall would decrease in most portions of the project area with the exception of areas proposed for MSO treatments. Approximately 40,000 acres of the Ponderosa Pine cover type and 15,500 acres of the Dry Mixed Conifer cover type would exceed desired conditions for fuel loading.	Fire Type: In treated areas, wildfires would generally be less likely to burn with high severity, though untreated areas would continue to have elevated potential for high severity fire. Conditions across 74% of the project area would be capable of supporting active or passive crown fire under extreme fire weather conditions. This would include 18% of the project area with the potential for active crown fire under these extreme wildfire conditions. Fire Hazard Index: Treated areas would lead to an overall decrease in Fire Hazard Index ratings, though untreated areas would continue to contribute to elevated FHI ratings. 22% of the project area is expected to have moderate to high Fire Hazard Index ratings. Surface Fuel Loading: In treated areas, total surface fuel loading would fluctuate during implementation, and decrease overall, with the exception of areas proposed for MSO treatments. Untreated areas would see continued accumulations of surface fuels. Approximately 64,300 acres of the Ponderosa Pine cover type and 16,500 acres of the Dry Mixed Conifer vegetation type would exceed desired conditions for fuel loading.
Air Quality	Smoke and associated emission impacts on air quality would come solely from wildfire events. These events would be unpredictable in both magnitude and timing, with the potential for large pulse impacts to air quality metrics. Wildfire related emissions would be expected infrequently (a few times a year). Overall, smoke impacts would be less predictable, less frequent, and more concentrated than impacts from the prescribed fires proposed for alternatives 2 and 3.	Smoke and associated impacts on air quality would come primarily from prescribed fire. Wildfire would continue to occur, but per acre emissions for wildfires occurring post treatment would be reduced up to 40% compared with existing conditions. Variability from year to year in total smoke related emissions would be high, but overall, smoke impacts would be more predictable, less concentrated, though potentially more frequent than wildfire related emissions associated with alternative 1. All prescribed fire treatments would comply with National Ambient Air Quality Standards.	In treated areas, smoke and associated impacts on air quality would come primarily from prescribed fire, while smoke from untreated areas would be generated from wildfires. On average, approximately 45% less acreage would be burned with prescribed fire in this alternative compared with alternative 2. Areas burned with prescribed fire would produce lower emissions per acre than untreated acers burned by wildfires. All prescribed fire treatments would comply with National Ambient Air Quality Standards.

Wildlife	Under the no-action alternative, most w ildlife habitat w ould move tow ard desired conditions more slow ly than w ith the action alternatives, w hile some habitat may not move tow ard desired conditions at all. No acres are proposed for mechanical treatment or prescribed fire, so the project area w ould have less tree age class-diversity than w ith the action alternatives. Specifically, alternative 1 w ould result in the low est proportion in grass-forb-shrubs, seedlings, and saplings; the highest proportion in mid-aged forest; and the low est proportion in older tree age classes. Alternative 1 w ould result in the slow est progress of all alternatives tow ard desired conditions of higher proportions of older age classes within uneven-aged forest conditions.	Northern goshaw k: Within post-fledging family habitat (PFA), in ponderosa pine habitat the average trees per acre (TPA) w ould decrease under alternative 2, from the existing 872 TPA to 136 TPA in 2029 and 88 TPA in 2039. Average basal area and canopy cover would also decrease, along w ith stand density index (SDI), w hich would decrease from 312 to 118 in 30 years. Low er competition for resources w ould increase the quadratic mean diameter (QMD), from 6 inches to nearly 14 inches after 20 years. Mid-aged forest in age class 3 (5-12" in diameter), and age class 4 (12-18") w ould be greatly reduced, meeting desired conditions for these age classes in 30 years. MSO: There could be increased disturbance to individual MSO from noise or smoke in the short term. Given restoration project objectives, the scale of the cumulative effects area, the distribution of MSO habitat across the project area, and the length of time over w hich treatments would be implemented alternative 2 is not expected to negatively affect MSO population in the long term. Treatments in MSO habitat should move forest conditions tow ard desired conditions and decrease the risk of habitat loss to large-scale high-severity fire. Snags of all size classes important to w ildlife species w ould increase. Coarse woody debris and dow ned logs important to prey and w ildlife species w ould increase over the 20 years modeled. Herbaceous and shrub layers, also important to prey and w ildlife species, would increase or be maintained. Various other restoration activities (grassland and meadow restoration, spring restoration, riparian stream and stream channel restoration, stream habitat restoration, and aspen restoration) w ould occur under alternative 2 to benefit w ildlife.	Alternative 3 treats goshaw k habitat w ith slightly less restoration to bring about desired conditions. Northern goshaw k: Within PFA habitat, in ponderosa pine habitat the average trees per acre w ould decrease under alternative 3, from the existing 872 to 271 in 2029 and 224 in 2039. The average of all basal area and canopy cover w ould also decrease, but the stand density index w ould be reduced from 312 to 165 after 20 years. Low er competition for resources in treated areas w ould increase the quadratic mean diameter, from 6 inches to nearly 12 inches after 20 years. Mid-aged forest (BA3, 5-12 inches, and BA4, 12-18 inches) w ould be greatly reduced under Alternative 3, bringing these age classes closer to desired conditions after 20 years. MSO: MSO habitat not assigned treatments using the decision matrix w ould include 218,670 fewer acres in Alternative 3 than in Alternative 2. In PACs, 14,640 few er acres w ould be thinned and burned in alternative 3. In Recovery Nest/Roost habitat, 5,820 few er acres would be treated in Alternative 3. Savannah treatments in Alternative 3 w ould be reduced by 15,190 acres, providing less restoration to benefit the MSO prey base. While short-term effects from disturbance w ould be reduced in Alternative 3, the long-term effects and risk of habitat degradation from stand-altering w ildfire or insect infestations would be greater than under alternative 2. Snags of all size classes important to w ildlife species w ould increase in the treated acres and in the untreated acres. Coarse w oody debris and dow ned logs important to prey and w ildlife species would increase over the 30 years modeled. Herbaceous and shrub layers, also important to prey and w ildlife species, w ould increase or be maintained in the acres treated. The higher number of untreated acres, relative to alternative 2, leaves habitat at a greater risk of high severity wildfire that could result in more severe effects on ecosystem components than those w hich would occur as part of a natural fire regime.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
			Fewer acres of habitat would be restored and conserved for wildlife in alternative 3 than in alternative 2. Other restoration activities beneficial to wildlife species are the same as in alternative 2.
Aquatic Species	By not moving vegetation toward desired conditions and a more natural fire regime, riparian and watershed condition would remain the same or degrade over time. The hazard of undesirable fire behavior and negative fire effects to aquatic resources would remain. Riparian condition and instream aquatic habitat would remain in the current state or degrade further over time. There would be no decrease in road density or improvement of riparian condition from decommissioning or relocating roads.	Vegetation treatments (fire and mechanical) will have short- to mid-term negative impacts to aquatic species and habitats, but will have the most long-term benefits by promoting or improving riparian and watershed condition by increasing forest resiliency and reducing road density. The risk of undesirable fire behavior and effects wildfire would be reduced across all treated acres. Long-term beneficial impacts of improved riparian condition and instream aquatic habitat from stream restoration would occur.	There would be fewer short- and mid-term impacts to aquatic species and habitats from fewer acres of vegetation treatments and temporary roads. Decreased acres of vegetation treatments would equate to less long-term improvement in riparian and watershed condition. The same amount of aquatic restoration and road decommissioning and associated long-term benefits would occur.
Southwestern Region Sensitive Plants	There would be no effects to sensitive plants from management activities because no activities would occur. There would be no restoration activities to address overly dense stands, allowing conditions to move further out of the natural range of variation (NRV) and away from the desired conditions identified for forested areas across the project area. There would be no opportunities to improve the habitat of understory plants including sensitive plants in the project area. There would be no reduction of the risk of uncharacteristic wildfires in the habitats of sensitive plants. Riparian vegetation and habitat would remain in the current state or degrade further over time. There would be no decrease in road density or improvement of riparian condition from decommissioning or relocating roads, precluding opportunities to improve habitat for species such as Bebb's willow or Arizona sneezeweed.	Would move treated areas in the project area closer to NRV and the desired conditions, providing more open stands in some areas which would improve habitat for understory plants including sensitive plants. Would reduce the risk of uncharacteristic wildfire and therefore the risk of habitat damage and potential loss of sensitive plants. Would improve riparian conditions and aquatic habitats and reduce road densities in certain areas of the project, thereby improving the habitat for species such as Bebb's willow and Arizona sneezeweed.	Would reduce the risk of uncharacteristic wildfire, the risk of damage to habitat, and the potential of loss of sensitive plants on fewer acres in the project area than under alternative 2. Would improve riparian conditions and aquatic habitats and reduce road densities in certain areas of the project, thereby improving the habitat for species such as Bebb's willow and Arizona sneezeweed.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Noxious and Invasive Weeds	Weed infestations that would have been detected by surveys would not occur. Weed treatments would not occur except as part of other projects within the Rim Country project area, or if treated by a cooperating agency.	Vegetation and prescribed burning treatments would limit the establishment and spread of invasive species within and adjacent to the project area over the next several decades by decreasing risk of undesirable fire behavior and effects.	Vegetation and prescribed burning treatments would limit the establishment and spread of invasive species within and adjacent to treated areas over the next several decades by decreasing risk of undesirable fire behavior and effects. With fewer acres being treated, the benefits of limiting the establishment and spread of weeds would be diminished compared to alternative 2.
Heritage Resources	Fuels would continue to accumulate across the project area, including in and around archeological sites. This may result in more frequent and intense wildfires which could cause site and artifact damage such as spalling of rock art and cracking of artifacts. Fire suppression actions, particularly bulldozer operations, may damage or completely destroy surface and subsurface (pit houses/kivas) archaeological sites resulting in the loss of the pit houses and associated resources.	Mechanical thinning on up to 889,000 acres would result in improved protection to cultural resources from the effects of high intensity fires. Ground disturbing treatments have potential to adversely affect cultural resources. Effects could include rutting, erosion, dislocation or breakage of artifacts and features, and destruction of sites and site stratigraphy. Traditional uses of areas or resources by Native American tribes may be affected. These concerns can be addressed through on-going consultation. Rock pit use and expansion have the potential to affect cultural sites adjacent to the pits. These effects would be avoided through coordinated pit expansion design and avoidance measures. Possible unauthorized collection of artifacts may increase near pits but would be mitigated by requiring that sites identified near the pit operation areas are recorded in detail, and monitored. Use of in-woods processing and storage sites would have mitigations in place to limit impacts to cultural resources.	Mechanically thinning on up to 483,000 acres will result in improved protection to cultural resources from the effects of high intensity fires, but less so than in alternative 2. Ground disturbance treatments have potential to adversely affect cultural resources. Effects could include rutting, erosion, dislocation or breakage of artifacts and features and destruction of sites and site stratigraphy. Traditional uses of areas or resources by Native American tribes may be affected. These concerns can be addressed through on-going consultation. Rock Pit use and expansion have the potential to affect cultural sites adjacent to the Pits. These effects would be avoided through coordinated pit expansion design and avoidance measures. Possible unauthorized collection of artifacts may increase near pits but would be mitigated by requiring that sites identified near the pit operation areas are recorded in detail, and monitored. Use of in-woods processing and storage sites would have mitigations in place to limit impacts to cultural resources.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Socioeconomics	Ongoing projects will continue to provide some amount of socioeconomic benefits with no contribution from the Rim Country Project. There would be no direct project benefits or costs and no economics of scale in forest restoration activities. The three national forests would continue to support local employment and labor income associated with thinning, grazing and recreation at	Up to 5.3 million cubic feet (MMCCF) of products would be produced. There would be avoided costs from reducing the risk of high intensity wildfire and post-fire effects such as flooding and sedimentation. Up to 1,890 jobs and $78 million in labor income would be expected.	Up to 3.6 MMCCF of products would be produced. There would be avoided costs from reducing the risk of high intensity wildfire and post-fire effects such as flooding and sedimentation. Compared to alternative 2, alternative 3 would treat fewer acres. Focusing treatments on a smaller area could lower the operating costs associated with treatments. Fixed costs associated with site preparation would be lower, site infrastructure needs (e.g., processing, roads) would be reduced, and costs associated with transporting forest products would be lower than under alternative 2. Up to 1,280 jobs and $53 million in labor income would be expected.
Recreation	Current management would continue. However, the risk of undesirable fire behavior and effects would not be reduced. This could have negative consequences for recreation values and experiences in affected areas. Developed recreation sites could be adversely affected. Fire-affected areas could be closed to camping. Trails could be closed until repaired. Long-term recreation user displacement and activity substitution behavior could result from negative effects on areas affected by severe wildfires.	Dispersed recreation would not be significantly affected, as there would be many places to camp and recreate. Treatments around the perimeters of campgrounds and other developed sites would protect these areas from the risk of undesirable fire behavior and effects. Trails may be temporarily closed during prescribed burning treatments. After mechanical treatments, trail crossings would be restored to pre-treatment conditions.	Effects would be similar to, but less than those from alternative 2, because fewer acres are proposed for treatment in alternative 3. The acres not treated would retain the same level of wildfire risk as in alternative 1. There would be less short-term recreation user displacement and activity substitution behavior compared to alternative 2 since fewer acres would be treated.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Scenery	In the short term, scenic integrity would remain unchanged. In the long term, if dense stands foster insect outbreaks, increased dwarf mistletoe spread, or other forest health concerns, there is the potential for a reduction in scenic integrity. If stand-replacing wildfire occurs, this would also result in the loss of valued scenic character, as views of a fire-altered landscape may begin to dominate the project area.	In the short term, the scenic integrity would be reduced while project activities (e.g. temporary road construction and reconstruction, rock pits, landings and in-woods processing sites) take place. Scenic integrity should increase once the appearance of slash and ground disturbing activities diminish, roads are rehabilitated, and plant communities respond to the decreased resource competition. In the long term, this alternative would improve the stability of scenic resources by reducing fuel loads and move the project area toward the desired landscape character.	Would have similar effects as those described in alternative 2 except the short-term impacts are expected to be fewer than in alternative 2 due to fewer acres being treated. The acres not proposed for treatment in this alternative would retain the same degree of potential for long-term effects to scenic integrity if insect and mistletoe outbreak and undesirable fire behavior occurs as expected for alternative 1. Since high severity fire is a risk factor for most scenery attributes, the smaller area of proposed mechanical and prescribed fire treatments would result in fewer improvements to scenic quality in the long term compared to alternative 2.
Lands and Minerals	Fuel loading would continue to increase across the project area, increasing the risk of undesirable fire behavior and effects, and leaving the area less resilient to disturbance. Severe wildfire could affect lands special uses by threatening structures and infrastructure they authorize in both the short term (10 years) and long term (beyond 20 years). Infrastructure associated with active minerals sites would also be similarly threatened.	Implementation would result in lower risk of undesirable fire behavior across the treated area, which would reduce the threat to the infrastructure and structures whose use are authorized under lands special use, and mineral permits. Short-term impacts to lands special uses and mineral projects could occur as restoration activities are implemented. Potential negative effects would be minimized through notifications of and coordination with permit holders.	Implementation would result in lower risk of undesirable fire behavior across the treated area, which would reduce the threat to the infrastructure and structures whose use are authorized under lands special use, and mineral permits. Permitted uses and infrastructure outside of treated areas would continue to be at risk from severe wildfire. Short-term impacts to lands special uses and mineral projects could occur as restoration activities are implemented, although potential disruptions would occur across fewer acres relative to alternative 2. Potential negative effects would be minimized through notifications of and coordination with permit holder.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Tribal Relations	The risk of undesirable fire behavior and effects would not be reduced. Severe wildfire in untreated areas could result in impacts to Traditional Cultural Properties (TCPs) including loss of traditionally important native plant species and continued loss of culturally important springs due to decreased ground water recharge and availability.	Within treated areas, ground disturbing activities that could impact traditional collecting, gathering and ceremonial uses areas and TCPs would increase in the short term. Protection measures such as the use of tribal monitors other mitigation measures will help minimize potential negative effects during treatment implementation. In the long term, thinning and burning treatments would lead to increases in understory vegetation, including traditionally important native plant species. Water yield from springs may increase depending on vegetation type and climate variables.	Within treated areas, ground disturbing activities that could impact traditional collecting, gathering and ceremonial uses areas and TCPs would increase in the short term. Potential effects would occur across fewer acres than in alternative 2. Protection measures such as the use of tribal monitors other mitigation measures will help minimize potential negative effects during treatment implementation. In the long term, thinning and burning treatments would lead to increases in understory vegetation, including traditionally important native plant species. Water yield from springs may increase depending on vegetation type and climate variables. Potential benefits would occur across fewer acres compared to alternative 2.
Range	With no additional treatments, high tree densities would continue to suppress understory vegetation. In the short-term, no changes to livestock management would be needed but, over time, as forage production continues to decline, reductions in grazing capacity would occur.	Proposed thinning and prescribed fire would reduce tree densities, allowing for the greatest amount of understory vegetation production of all the alternatives. Short-term adjustments to pasture rotations may be needed but, in the long term, this alternative would result in the greatest increase the forage production.	Proposed thinning and prescribed fire would reduce tree densities, allowing for understory vegetation production, but on fewer acres than in alternative 2. Short-term adjustments to pasture rotations may be needed, but fewer than in alternative 2. The long-term forage production and grazing capacity would increase, but there would be less improvement than in alternative 2.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Transportation	No new restoration activities would take place and no additional use of existing roads would occur. Current rates of public and administrative use would continue. Maintenance to provide public and administrative access would continue, contingent upon funding. No increase in road maintenance to accommodate restoration activities would occur. No road decommissioning would occur within the project area unless it is analyzed under separate NEPA analysis. No new temporary roads would be constructed, unless under separate NEPA analysis. No effects from in-woods processing and storage sites.	Nearly all, if not all system roads within the project area could be utilized at some point in implementation Roads that would be used would likely see pre-haul maintenance if needed and continued maintenance during implementation. This maintenance would be in addition to regularly scheduled maintenance Up to 200 miles of system roads would be decommissioned on the Coconino National Forest and the A-S National Forest. Approximately 290 miles of system roads on the Tonto National Forest would be decommissioned, and approximately 800 miles of unauthorized roads on all three forests may be decommissioned. Up to 330 miles of temporary road would be constructed and decommissioned after use Construction of temporary roads would expand the existing transportation system within the project area to provide adequate access to all stands in need of mechanical treatment. Construction of temporary roads would allow nearly all stands to be harvested with a maximum skidding distances of 1,250' or less". Temporary roads can also be used for access for prescribe fire and other restoration activities. In-woods processing and storage sites could require a limited amount of temporary road. This mileage is included in the overall estimated temporary road mileage for the alternative.	Nearly all, if not all system roads within the project area could be utilized at some point in implementation Roads that would be used would likely see pre-haul maintenance if needed and continued maintenance during implementation. This maintenance would be in addition regularly scheduled maintenance Up to 200 miles of system roads would be decommissioned on the Coconino National Forest and the A-S National Forest. Approximately 290 miles of system roads on the Tonto National Forest would be decommissioned, and approximately 800 miles of unauthorized roads on all three forests may be decommissioned. Up to 170 miles of temporary road would be constructed and decommissioned after use. Construction of temporary roads would expand the existing transportation system within the project area to provide adequate access to all stands in need of mechanical treatment. Construction of temporary roads would allow nearly all stands to be harvested with a maximum skidding distances of 1,250' or less". Temporary roads can also be used for access for prescribe fire and other restoration activities. In-woods processing and storage sites could require a limited amount of temporary road. This mileage is included in the overall estimated temporary road mileage road mileage for the alternative.

Chapter 3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It presents the assumptions and methodologies used to analyze the effects of the alternatives, which is the scientific and analytical basis for comparing the alternatives. Only summaries are provided here for each resource area. All specialist reports in their entirety are incorporated by reference and are available on the 4FRI Rim Country webpage at: www.fs.usda.gov/goto/4FRIRimCountry.

Law, Regulation, and Policy

Applicable laws, regulations, policies, and executive orders, as well as Forest Service manual and handbook guidance, memoranda of understanding, conservation strategies, and programmatic agreements, are listed here by resource area. For more information on these, forest plan direction, and other guidance, see the individual resource specialist reports. The relevant documents are available on the Forest Service website (http://www.fs.fed.us/publications/) and from Forest Service offices.

All

- Organic Administration Act of 1897 (at 16 U.S.C. 475, 551)
- Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531)
- National Environmental Policy Act of 1969 (16 U.S.C. 4321 et seq.)
- Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended by the National Forest Management Act (NFMA) of 1976 (16 U.S.C. 1600-1614, 472a)
- 40 CFR 1500 Council on Environmental Quality

Watershed and Soils

- Organic Administration Act of 1897
- Weeks Law of 1911
- Knutson-Vandenberg Act of 1930
- Bankhead-Jones Farm Tenant Act of July 22, 1937
- Federal-State Cooperation for Soil Conservation Act of December 22, 1944
- Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act of 1949
- Granger-Thye Act of 1950
- Watershed Protection and Flood Prevention Act of August 4, 1954
- Sikes Act (Fish and Wildlife Conservation) of September 15, 1960
- Joint Surveys of Watershed Areas Act of September 5, 1962
- Land and Water Conservation Fund Act of September 3, 1964
- Federal Water Project Recreation Act of July 9, 1965

- Water Resources Planning Act of July 22, 1965
- Water Quality Improvement Act of April 3, 1970
- Clean Water Act of 1948 (as amended in 1972 (Federal Water Pollution Control Act) and 1987)
- Federal Land Policy and Management Act of October 21, 1976
- Surface Mining Control and Reclamation Act of August 3, 1977
- Soil and Water Resources Conservation Act of November 18, 1977
- Safe Drinking Water Amendments of November 18, 1977
- Emergency Flood Prevention (Agricultural Credit Act) Act of August 4, 1978
- North American Wetland Conservation Act of 1989
- 33 CFR 323 Permits for Discharges of Dredged or Fill Material into Waters of the United States
- 40 CFR 121-135 Water Programs
- EO 11988 Floodplain Management, 1977
- EO 11990 Protection of Wetlands, 1977
- FSM 2500 – Watershed and Air Management
- FSH 2500 – Watershed and Air Management

Vegetation

- Weeks Law of 1911, as amended (at 16 U.S.C. 515, 552)
- Knutson-Vandenberg Act of 1930 (16 U.S.C. at 576b)
- Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act of 1949 (at 16 U.S.C. 581j and 581 j(note))
- Granger-Thye Act of 1950 (16 U.S.C. at 580g-h)
- Surface Resources Act of 1955 (30 U.S.C. 611-614)
- Healthy Forests Restoration Act (HFRA) of 2003 (16 U.S.C. at 1611-6591)
- Stewardship End Result Contracting Projects (16 U.S.C. 2104 (note))
- Tribal Forest Protection Act of 2004 (P.L. 108-278, 118 Stat. 868; 25 U.S.C. 3115a)
- Omnibus Public Land Management Act of 2009 (Title IV – Forest Landscape Restoration of PL 111-11)
- Collaborative Forest Landscape Restoration Act (CFLRA) of 2009
- National Forest Resource Management: Forest Service Manual (FSM) 2000—Chapter 2020—Ecological Restoration and Resilience
- Silvicultural Practices Handbook (FSH 2409.17), Silvicultural Examination and Prescription Handbook (FSH 2409.26d)

Fire Ecology

- Federal Wildland Fire Policy of 1995 (Updated in 2001)

- Guidance for Implementation of Federal Wildland Fire Management Policy, February 2009
- Federal Land Assistance, Management and Enhancement (FLAME) Act of 2009
- FSM 5100

Air Quality

- Clean Air Act (CAA), as amended 1977 and 1990
- 40 CFR 51 300-308 Federal Regional Haze Rule
- National Ambient Air Quality Standards (NAAQS)

Terrestrial Wildlife and Plants

- Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), as amended
- Bald and Golden Eagle Protection Act of 1940, as amended
- Migratory Bird Treaty Act of 1918 (as amended)
- Executive Order 13186 (migratory birds)
- FSM and FSH, Chapters 2620 and 2670
- FSM Chapter 2070, Regional Native Plant Policies

Aquatic Species and Habitat

- Endangered Species Act of 1973
- Clean Water Act of 1948 (as amended in 1972 (Federal Water Pollution Control Act) and 1987)
- FSM 2600 re: fish and wildlife management
- FSH 2600 re: fish and wildlife management
- Executive Order 12898 Environmental Justice, February 11, 1994
- Executive Order 13112 Invasive Species, February 3, 1999

Noxious or Invasive Weeds

- Environmental Justice, EO 12898 of February 11, 1994
- Invasive Species, EO 13112 of February 3, 1999 and amendment EO 13751 of December 2016, Safe guarding the Nation from the Impacts of Invasive Species.
- FSM 2370 (Special Recreation Designations), Part 2672 (Areas Designated Administratively) (RNAs and Botanical Areas) and Forest Service Manual, FSM 2372, 2372. 01, 2372. 02 and 2372. 05
- FSM 2620, 2630, 2670, 2672 re: sensitive species
- FSMs 2900 and 2150 and Regional Supplement No. 2100-98-1, re: noxious weed control
- FSMs 2080 and 2150 and Regional Supplement No. 2100-98-1 re: noxious weed management

Heritage Resources/Tribal Interests

- National Historic Preservation Act of 1966 (NHPA), as amended (16 U.S.C. 470), and its implementing regulation 36 CFR 800
- Indian Financing Act of 1974
- Cooperative Funds and Deposits Act of 1975
- Forest and Rangeland Renewable Resources Research Act of 1978
- Archaeological Resources Protection Act of 1979 (ARPA), as amended (16 U.S.C. 47Oaa et seq.), as implemented by 36 CFR part 296
- American Indian Religious Freedom Act (AIRFA)
- Federal Technology Transfer Act of 1986
- Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), as amended (25 U.S.C. 3001), as implemented by 43 CFR Part 10, Subpart B—Human Remains, Funerary Objects, Sacred Objects, or Objects of Cultural Patrimony From Federal or Tribal Lands
- Department of Interior, Environment, and Related Agencies Appropriations Act of 1992
- The Religious Freedom Restoration Act of 1993 (RFRA)
- Tribal Forest Protection Act of 2004 (TFPA)
- Culture and Heritage Cooperative Authority of 2008 (CHCA)
- Wyden Amendment (Public Law 109-54, Section 434)
- Executive Orders 11593 (Protection of the Cultural Environment), 13007 (Indian Sacred Sites), 13175 (Tribal Consultations), and 13287 (Preserve America).
- Programmatic Agreement (PA) between the Southwestern Region of the Forest Service; the Arizona, New Mexico, Texas, and Oklahoma State Historic Preservation Offices; and the Advisory Council on Historic Preservation (USDA 2003)
- FSM 2300, Chapter 2360, Heritage Program Management

Recreation and Scenery

- National Forest Roads and Trails Act of 1964
- Wilderness Act of 1964
- Wild and Scenic Rivers Act of 1968
- National Trails System Act of 1968 (16 USC 1241)
- Environmental Quality Act of 1970
- The Forest and Rangeland Renewable Resources Planning Act of 1974
- Federal Cave Resources Protection Act of 1988 (16 U.S.C. 4301–4309)
- FSH 1909.13.13a, Chapter 10 re: the Scenery Management System (SMS)
- FSH 1909.13.2.3; FSM 2380.61 re: landscape aesthetics guidance
- FSM 2310 re: use of Recreation Opportunity Spectrum

- FSM 2350 re: trail, river, and similar recreation opportunities
- FSM 2370 re: special recreation designations
- FSM 2380 re: managing landscape aesthetics and scenery

Socioeconomics

- Civil Rights Act of 1964
- Environmental Justice, EO 12898 of February 11, 1994

Lands and Minerals

- Act of 1866, General Mining Law
- An Act to Repeal Timber-Culture Laws, 1891
- Occupancy Permits Act (March 4, 1915)
- The Act of March 4, 1915, as amended July 28, 1956, (16 U.S.C. 497) authorizes term permits for structures or facilities on National Forest System land
- Bankhead-Jones Farm Tenant Act of 1937, Section 31-33
- Highway Act of August 27, 1958, (23 U.S.C. 317), supplemented by the Act of October 15, 1966 (49 U.S.C. 1651)
- Land and Water Conservation Fund Act of September 3, 1964
- National Forest Roads & Trails Act 1964
- Telecommunications Act of 1996 (Public Law 104-104)
- The Act of November 16, 1973, (30 U.S.C. 185) authorizes the Forest Service to issue authorizations for oil and gas pipelines and related facilities
- Mineral Leasing Act of 1920, as amended on November 16, 1973, (30 U.S.C. 185(1))
- Oil and Gas Pipeline amendment to the Mineral Leasing Act, Section 28
- Term Permit Act of March 4, 1915, amended July 28, 1956
- Federal Land Policy and Management Act of 1976
- National Forest Townsite Act of July 31, 1958 (72 Stat. 483; 7 U.S.C. 1012a; 16 U.S.C. 478a) as amended by Section 213 of the Federal Land Policy and Management Act of 1976 (90 Stat. 2760)
- Alaska National Interest Lands Conservation Act, 1980
- Small Tracts Act of January 12, 1983 (96 Stat. 2535; 16 U.S.C. 521c-i)
- Water Conveyance Act of 1986
- Colorado Ditch Act of 1986 (FLPMA amendment)
- Telecommunications Act of 1996 (Public Law 104-104)
- Forest Service Facilities Realignment Act of 2005 (119 Stat 559-563; 16 U.S.C. 580d, as amended).
- Energy Policy Act of 2005

- Executive Order 11990 (Wetlands) and Executive Order 11988 (Floodplains)
- Forest Service Handbook 2709.11 Special Uses Management
- Forest Service Manual 2700 Special Uses Management

Range

- Forest and Rangeland Renewable Resources Planning Act of 1974
- Federal Land Policy and Management Act of 1976
- National Forest Management Act of 1976
- 36 CFR 222: Subpart A – Graving and Livestock Use on the National Forest System, Subpart B – Management of Wild Free-roaming Horses and Burros, and Subpart C – Grazing Fees
- Forest Service Manual (FSM) 2200 – Range Management
- Forest Service Handbook (FSH) 2209.13 – Grazing Permit Administration Handbook

Transportation

- National Forest Roads and Trails Act of October 13, 1964, as amended (16 U.S.C. 532-538)
- Highway Safety Act of 1966 (23 U.S.C. 402)
- Organic Administration Act of 1897 (16 U.S.C. 551)
- Revegetation – Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. 1601, Pub. L. 93-378) as amended by the national Forest Management Act of 1976 (16 U.S.C. 1608, Pub. L. 94-588).
- Title 36, Code of Federal Regulations, Part 212 (36 CFR 212) re: administration of the forest transportation system
- Travel Management (36 CFR Part 212, Subpart A)
- Prohibitions (36 CFR Part 261, Subpart A) re: prohibitions on forest transportation system roads
- Sale and Disposal of National Forest System Timber (36 CFR Part 223 Subpart B) re: revegetation of temporary roads
- Forest Service Manual (FSM) 7700- Transportation System

Forest Plan Amendment Substantive Requirements

The proposed project-specific amendments discussed in detail in chapters one and two include several modifications to the current Tonto National Forest Plan standards and guidelines so new controls and technologies can be utilized where appropriate. The 2012 Planning Rule requires consideration of the applicable substantive requirements as described in 36 CFR 219.8 through 219.11 that are directly related to the plan direction being added, modified, or removed by the amendments (36 CFR 219.13). The responsible officials have determined the proposed amendments are directly related to the following substantive requirements:

§219.8 Sustainability

(a)(1)(vi) Ecological Sustainability, Ecosystem Integrity, Opportunities for Landscape Scale Restoration;

(a)(2)(i) Air, Soil, and Water, Air Quality;

(a)(2)(iii) Air, Soil, and Water, Water Quality;

(b)(2) Social and Economic Sustainability, Sustainable recreation; including…scenic character;

(b)(3) Social and Economic Sustainability, Multiple uses that contribute to local, regional, and national economies in a sustainable manner.

§219.9 Diversity of Plant and Animal Communities

(a)(1) Ecosystem Plan Components, Ecosystem Integrity;

(b)(1) Additional Species-Specific Plan Components, Provide the ecological conditions to contribute to the recovery of federally listed threatened and endangered species.

Evaluation of Substantive Requirements

The effects of the proposed amendments disclosed in this chapter, are the same as the effects analysis for the respective resources and substantive requirements related to the amendments, and were informed using the best available scientific information, scoping, effects analysis, monitoring data, or other rationale.

36 CFR 219.8 Sustainability (Ecological and Social/Economic)

Per 36 CFR 219.8, "a plan developed or revised under this part must provide for social, economic, and ecological sustainability within Forest Service authority and consistent with the inherent capability of the plan area…" Specifically, the activities that would be authorized by the amendments could potentially influence protections for:

a. ecological sustainability including ecosystem integrity to include structure, function, composition, and connectivity of terrestrial and aquatic ecosystems and watersheds; air quality; and water quality and resources.

The proposed modifications to the Tonto Forest Plan would not result in substantial adverse effects associated with the sustainability requirement nor would the proposed amendments substantially lessen protection for a specific resource or use associated with social, economic, or ecological sustainability. As a result, these plan amendments are consistent with the sustainability requirements at 36 CFR 219.8.

36 CFR 219.9 Diversity of Plant and Animal Communities

Per 36 CFR 219.9, "a plan developed or revised under this part must provide for the diversity of plant and animal communities, within Forest Service authority and consistent with the inherent capability of the plan area…" Additionally, the plan must support the persistence of most native species in the plan area. Specifically, the activities that would be authorized by the amendments could potentially influence protections for:

a. ecosystem plan components including ecosystem integrity of terrestrial and aquatic ecosystems and watersheds; and
b. species-specific plan components including providing for ecological conditions that contribute to the recovery of federally listed, proposed, and candidate species, and that contribute to the viability of species of conservation concern.

The project analysis includes consideration of substantial adverse impacts to, or substantially lessened protections for, federally listed, sensitive, management indicator, and other plant and animal species that may occur as a result of the amendments in accordance with 36 CFR 219.13(b)(6).

The proposed modifications to the Tonto Forest Plan would not result in substantial adverse impacts to plant and animal communities within the Rim Country Project area, including to those species of conservation concern. Nor would the proposed amendments substantially lessen protection for any plant and animal species. The proposed modifications to the Forest Plan support the persistence of native species in the Rim Country Project area. As a result, these plan amendments are consistent with the diversity of plant and animal communities as required by 36 CFR 219.9.

Watershed conditions, wildlife habitat, and timber are all resources as well as multiple uses that would be improved by the proposed modifications to the Tonto Forest Plan. Beneficial impacts to these resources would also improve the associated multiple uses. For example, by improving the watershed conditions and wildlife habitat, there would be increased opportunities for wildlife viewing, improved recreational uses, and sustainable ecosystems. Thinning treatments allowed as part of the proposed modifications to the Tonto Forest Plan could also contribute to traditional cultural uses, forest product industries, rangeland uses because access to such forest products or opening up stands would be desirable.

The proposed modifications to the Tonto Forest Plan to allow for mechanical treatments on steep slopes could alter recreation experience, particularly scenery, as a result of surface disturbance, smoke and charred vegetation from unplanned and prescribed fires, and long-term changes in vegetation structure and composition. The impacts to scenery and recreational settings would be localized and visible in both the short and long term. Impacts from smoke would be short term; these impacts would dissipate when fire activities cease. Resulting charred vegetation from fires would be visible in the long term. Scenic quality would be further impacted by the presence of activity slash and temporary roads and skid trails in the short term. These impacts would be reduced by natural vegetation regeneration and site rehabilitation in the long term. Changes to vegetation structure would have long-term, positive effects on scenic quality because improving forest health and resiliency also improves the recreation setting.

The proposed amendments would aid forest restoration efforts by allowing implementation of needed vegetation treatments across the project area, as opposed to treating smaller portions of the project area. While there would be short-term adverse impacts from the project, the resulting long-term benefits would be a sustainable, resilient forest ecosystem capable of supporting diverse plant and animal communities and multiple uses valued by local communities and visitors.

Assumptions and Methodology

To facilitate landscape analysis and strategic planning in the Southwest, the Forest Service has developed a framework of ecosystem types referred to as Ecological Response Units (ERUs). In the Southwestern Region of the Forest Service, these ERUs provide the foundational unit for analysis of vegetative attributes and associated ecosystem services at the landscape and strategic planning scales (USDAFS 2017). Reference conditions and desired conditions are described for each ERU. The desired conditions correspond with the final regional vegetation desired conditions that are carried forward in forest plans revised after this framework was developed. Of the three forest plans tiered to in the Rim Country EIS, only the 2018 Coconino Revised Forest Plan used ERUs. The 2015 Apache-Sitgreaves Revised Forest Plan used Potential Natural Vegetation Types (PNVTs) in its analysis, and the 1996 amended Tonto Forest Plan incorporated the earlier Terrestrial Ecological Unit Inventory (TEUI).

The forest cover types used for the Rim Country analysis are based on the Ecological Response Units (ERUs) identified in the project area. Ecological Response Units represent an ecosystem stratification based on vegetation characteristics that would occur when natural disturbance regimes and biological processes prevail (TNC 2006), and combine potential vegetation and historic fire regimes to form ecosystem classes useful for landscape assessment (USDA Forest Service 2014). Ecological Response Units are the next derivation based on the concepts developed for PNVTs. Ecological Response Units incorporate more information concerning fire and its role in the ecosystem. For the purposes of the Rim Country Project EIS analysis PNVTs and ERUs are considered equivalent and the term ERUs will be used throughout.

For some resource areas or at certain scales, the analysis presented may include classifications of forest cover types other than ERUs. For example, analysis of the effects of proposed treatments on vegetation at the fine- to mid-scale may discuss the existing vegetation type or existing condition (EC) in terms of cover types (e.g., ponderosa pine/Gambel cover type) that were derived from data collected as part of Common Stand Exams performed within the project area. Each resource area's section of Chapter 3 discusses the resource-specific assumptions and methodologies used for analysis, including cover types where relevant.

Each resource specialist determined what ecological units and subunits would be best to use for their effects analysis. Most specialists use watersheds as their landscape-scale analysis units, while the finer-scale analysis units differ by resource area. The analysis units used for each resource area are described in the Assumptions and Methodology section of each specialist report and summarized here for each individual resource area. Due to differences in specialists' approaches to rounding when displaying numerical data, sums of table columns may differ slightly from the totals displayed.

Effects Analysis

The Rim Country DEIS includes analysis of the potential direct, indirect, and cumulative effects from treating the number of acres proposed for each specific treatment toward its highest level of openness for that treatment (IT, SI, and UEA 10-25 at 25 percent; WUI and Infrastructure treatment at 7 percent. This level of examination is done to ensure that the maximum potential effects from the activities proposed in each action alternative are analyzed, even though it will give the appearance of more effects than expected. A stand treatment adjusted to a lower intensity during implementation, per the flexible toolbox approach used for this project, may have fewer effects on the environment, depending on the affected resource, than the more open treatments originally proposed for that stand, resulting in slightly different effects than those analyzed in the DEIS.

Cumulative Effects

A summary of past, present, and reasonably foreseeable projects with management activities proposed and completed (see Table 19), as well as past wildfires (see Table 20), in the Rim Country project area and in the 6th HUC watersheds is presented here. This summary is intended to provide a snapshot of those projects and events that have influenced the existing conditions of the project area (in terms of vegetation structure, composition, diversity and function). It also includes a summary of ongoing and reasonably foreseeable projects that may cumulatively affect project area resources. This summary represents the best available information made available to each resource specialist to determine relevancy to their specific resource. Each resource specialist identified the cumulative effects analysis boundary and past, present and reasonable foreseeable projects relevant to their specific resource and used this information, along with the potential direct and indirect effects, to analyze the cumulative effects on their resource area. Cumulative effects analyses are discussed in this chapter by resource area.

Table 19. Past, Current, and Reasonably Foreseeable Projects

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Vegetation Management Projects (Mechanical Thinning and Prescribed Fire)								
Mullen Saw timber and Whitcom Multiproduct Offerings	1990	Group selection, intermediate thin, pre-commercial thin, shelterwood seed cut	Mullen: 1,798/0/0 Whitcom: 1,440/0/0	0 /130/685 wildlife habitat improvement	Apache-Sitgreaves	YES	NO	NO
Jersey Horse Timber Sale	1991	Species habitat improvements, timber sales, forest vegetation improvements, fuel treatments	N/A	1,452/351/0	Apache-Sitgreaves	YES	NO	NO
Amended Elk Timber Sale	1993	Commercial and pre-commercial mechanical thinning	2,589/0/0	834/466/0	Apache-Sitgreaves	YES	NO	NO
Brookbank Multi-Product Timber Sale	1994	Mechanical thinning and prescribed fire	6,177/6,465/0	5,624/4,981/0	Apache-Sitgreaves	YES	NO	NO
Cottonwood Wash Ecosystem Management Area	1995	Mechanical thinning, fuelwood sales, prescribed fire	3,493/10,896/0	516/2,447/0	Apache-Sitgreaves	YES	NO	NO
Blue Ridge-Morgan	1997	Commercial mechanical thinning, fuelwood sales, broadcast burning	8,280/7,618/0	14,471/14,552/0	Apache-Sitgreaves	YES	NO	NO
Gentry	1997	Thinning, fire	7,718	451/191/0	Apache-Sitgreaves	YES	NO	NO

[5] Acres of implementation may be counted more than once for multiple activities on the same acres.

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Sundown Ecosystem Management Area	1997	Salvage cut intermediate treatment, regen, fire	7,607	2,075/24/170 range vegetation control, 1,830 range veg manipulation and type conversion, 3,463 tree encroachment control, 1,560 tree release and weed	Apache-Sitgreaves	YES	NO	NO
Wiggins Analysis Area	1998	Group selection, intermediate thinning, pre-commercial thinning, broadcast burning	5,935/3,385	0/4,224/0	Apache-Sitgreaves	YES	NO	NO
Show Low South (#22297)	1999	Prescribed fire, construction/ maintenance of defensible space	N/A	0/2,696/0	Apache-Sitgreaves	YES	NO	NO
Larson Rx Burn	2001	Prescribed fire	0/2,500/0	0/3,015/0	Apache-Sitgreaves	YES	NO	NO
Treatment of Dead Trees in the Rodeo-Chediski Fire (#20740)	2002	Treat dead trees for trail management, facility and road maintenance, utility line safety	N/A	5,730/1,880/15 fuels compaction	Apache-Sitgreaves	YES	NO	NO
Heber-Overgaard WUI	2003	Mechanical thinning, prescribed fire	3,593/489/0	5,089/686/571 fuels chipping, 541 range forage improvement, 96 special products removal	Apache-Sitgreaves	YES	NO	NO
Hidden Lake Rx Burn	2003	Prescribed fire	0/2,000/0	0/2,828/0	Apache-Sitgreaves	YES	NO	NO
Camp Tatiyee / Camp Grace Fuel Reduction	2004	Pile Burning	340/340/0	0/172/0	Apache-Sitgreaves	YES	NO	NO
Country Club Escape Route	2004	Commercial thinning, fire	0/975/0	524/1,848 burning/915 range cover manipulation	Apache-Sitgreaves	YES	NO	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
High Value Ponderosa Pine Tree Protection	2004	Mechanical thinning, insecticide treatment	698/0/698	985/826/203 insect control and prevention	Apache-Sitgreaves	YES	NO	NO
Rodeo-Chediski Fire Salvage	2004	Mechanical thinning, fuel treatments	47,467/0/0	25,913/626/1,256 fuel breaks, 411 planting/ regeneration site prep	Apache-Sitgreaves	YES	NO	NO
Forest Lakes WUI Treatment	2005	Mechanical thinning, hand thinning, piling, pile burning	N/A	1,691/1,645/0	Apache-Sitgreaves	YES	NO	NO
Rim Top Rx Burn (formerly Woods Canyon Fuel Treatment)	2005	Prescribed fire	0/665/0	0/665/0	Apache-Sitgreaves	YES	NO	NO
Show Low South (#4456)	2005	Thinning, fuels treatments	N/A	10/585/0	Apache-Sitgreaves	YES	NO	NO
Dye Thinning	2006	Mechanical thinning	250/250/0	247/0/0	Apache-Sitgreaves	YES	NO	NO
Hilltop WUI	2006	Mechanical thinning, mastication, prescribed fire	1,544/1,544/0	1,534/45/616 range forage improvement	Apache-Sitgreaves	YES	NO	NO
Bruno Thinning and Slash	2009	Hand thinning, piling, pile burning	0/86/0	0/70/0	Apache-Sitgreaves	YES	NO	NO
Whitcom WUI	2009	Commercial thinning, fire	0	925/0/0	Apache-Sitgreaves	YES	NO	NO
Hilltop II Fuels Reduction	2011	Mechanical thinning, prescribed fire	190/1,544/0	0/799/616 cultural site protection	Apache-Sitgreaves	YES	NO	NO
Little Springs WUI	2003	Group selection, improvement cut, commercial thin	7,991/0/0	4,376/4,227/ 2,500 range cover manipulation	Apache-Sitgreaves	NO	YES	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Nagel	2005	Commercial thin, salvage cut, fire	116,618	19,611/18,231/ 889 range cover manipulation, 1,592 range forage improvement, 321 scarify and seed landings	Apache-Sitgreaves	NO	YES	NO
Los Burros	2006	WUI thinning, hazardous fuels treatments, woodland stand thinning, thin from below, aspen regeneration treatments	22,224/3,560/0	30,237/13,059/ 29 range cover manipulation	Apache-Sitgreaves	NO	YES	NO
Nutrioso WUI	2006	Commercial thin, salvage cut, fire	28,576/39,356/0	19,476/9,870/ 827 tree planting, 394 control range vegetation, 33 control tree encroachment	Apache-Sitgreaves	NO	YES	NO
Show Low South (#29987)	2011	Commercial thin, group selection, fire	3,739/4,637/0	3,372/0/0	Apache-Sitgreaves	NO	YES	NO
Rodeo-Chediski Fire Rx Burn	2012	Fire, pruning, limbing	0/148,222/0	0/9,506/9,670 range cover manipulation, 5,162 weed & tree release	Apache-Sitgreaves	NO	YES	NO
Timber Mesa/Vernon WUI	2012	Single tree and group selection, commercial thinning, fire	27,000/as needed/0	18,781/39,760/ 9,911 range cover manipulation, 3,979 control tree encroachment, 6,551 weed & tree release	Apache-Sitgreaves	NO	YES	NO
Rim Lakes Forest Restoration	2013	Selection cut, broadcast burn	23,671/32,954/0	12,483/1,335/ 116 pruning, 6,251 range cover manipulation, 80 weed & tree release	Apache-Sitgreaves	NO	YES	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Larson Forest Restoration	2015	Group selection, intermediate thinning, pre-commercial thin, shelterwood seed cut, broadcast burn	25,726/4,906/0	1,867/0/2,513 range cover manipulation, 3 weed & tree release	Apache-Sitgreaves	NO	YES	NO
Upper Rocky Arroyo Restoration	2016	Mechanical thinning, hand thinning, fire	30,400/as needed/0	696/5,411/ 3,960 wildlife habitat improvement	Apache-Sitgreaves	NO	YES	NO
Section 31 Fuels Reduction	2017	Mechanical thinning	230/0/0	44/0/0	Apache-Sitgreaves	NO	YES	NO
Rodeo-Chediski Mastication (Heber-Overgaard and Ricochet/ Williams Ranch Fuels Reduction)	2018	Mastication, removal of small trees, piling & burning	285/285/0	0/0/0	Apache-Sitgreaves	NO	NO	YES
Pocket Baker	2000	Mechanical treatment, prescribed fire	5,200/17,000/0	0/5,450/0	Coconino	YES	NO	NO
Blue Ridge Urban Interface	2001	Pre-commercial thinning, prescribed fire	8,158/10,549/0	416/6,225/ 2325 control range vegetation	Coconino	YES	NO	NO
IMAX	2002		N/A	0/6,008/0	Coconino	YES	NO	NO
Pack Rat Salvage	2004	Salvage, thinning, pile burning	550/550/0		Coconino	YES	NO	NO
Bald Mesa Fuels Reduction	2005	Mechanical treatment, prescribed fire, fuels reduction	N/A	2,485/5,150/0	Coconino	YES	NO	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
APS Blue Ridge 69kV Transmission Line	2005	Mechanical treatment, prescribed fire	N/A	0/1,600/0	Coconino	YES	NO	NO
Good/Tule	2006	Thinning, prescribed fire	4,337/8,361/0	1,389/2,025/0	Coconino	YES	NO	NO
Post-Tornado Resource Protection and Recovery	2011	Removing downed wood, thinning	14,776/3,990/0	765/0/0	Coconino	YES	NO	NO
Lake Mary Road ROW Clearing (ADOT)	2016		N/A	788/0/0	Coconino	YES	NO	NO
Lake Mary Meadows Two Fuel Reduction	2005		N/A	117/10,223/ 803 control range vegetation	Coconino	NO	YES	NO
East Clear Creek Watershed Health Improvement	2006	Mechanical treatment, prescribed fire	10,407/10,497/0	40,020/38,470/ 30,000 weed & tree release, 10,000 control tree encroachment	Coconino	NO	YES	NO
Victorine 10K Area Analysis	2006	Mechanical thinning, prescribed fire	1,293/8,407/0	9,015/29,585/0	Coconino	NO	YES	NO
Upper Beaver Creek Watershed Fuel Reduction	2010	Mechanical thinning, prescribed fire	15,807/75,068/0	20,608/64,000/0	Coconino	NO	YES	NO
Blue Ridge Community Fire Risk Reduction	2012	Mechanical, pile burning	50-75/5/0	0/45,000/0	Coconino	NO	YES	NO
Clints Well Forest Restoration	2013	Mechanical thinning, prescribed fire	12,899/16,444/ 25 rock pit expansion	11/6,639/0	Coconino	NO	YES	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Hutch Mountain Communication Site	2017	Clearing for communication site and solar array, thinning	2.5/0/0	0.5/0/0	Coconino	NO	YES	NO
Cragin WPP	2018	Mechanical thinning, prescribed fire	41,046/63,656/0	0/0/0	Coconino	NO	NO	YES
Ridge Analysis Area	1994	Commercial thinning, salvage, vegetation improvements, hazardous fuels reduction	N/A	33,311/0/1,094 control range vegetation	Tonto	YES	NO	NO
Lion Analysis Area	2001	Intermediate thinning, prep cutting, uneven-aged management, wildlife forage areas, prescribed burning	2,455/9,000-10,000/0	5,664/6,900/ 664 weed & tree release	Tonto	YES	NO	NO
Verde WUI	2004	Thinning, PJ savanna restoration, fuel break construction, prescribed burning	15,471/28,438/1,401 PJ savanna restoration	10,648/48,500/ 5,000 range cover manipulation	Tonto	YES	NO	NO
Parallel Prescribed Burn	2014	Prescribed fire	0/24,089/0	0/4,759/0	Tonto	YES	NO	NO
Pine-Strawberry WUI	2006	Thinning, grassland restoration, fuel break construction, prescribed fire	9,709/40,928/ 7,525 grassland restoration	41,086/19,868/ 200 range cover manipulation	Tonto	NO	YES	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Chamberlain Analysis Area	2008	Mechanical thinning, prescribed burning, shaded fuel breaks	8,072/20,050/0	9,044/19,000/ 1,675 control range vegetation	Tonto	NO	YES	NO
Christopher/Hunter WUI	2009	Thinning, fuel break construction, prescribed burning	32,358/20,550/0	10,763/19,000/ 450 weed & tree release, 489 control range vegetation	Tonto	NO	YES	NO
Cherry Prescribed Burn	2012	Prescribed burning	0/14,700 – 21,000/0	0/6,582/0	Tonto	NO	YES	NO
Myrtle WUI	2012	Fuel breaks, thinning, prescribed fire	16,702/27,131/0	103,891/75,800/1,091 weed & tree release, 744 control range vegetation	Tonto	NO	YES	NO
Flying V&H Prescribed Fire	Decision expected 2018	Prescribed burning, shaded fuel breaks	1,798/59,124/0	0/0/0	Tonto	NO	NO	YES
Haigler Fuels Analysis	?	Prescribed burning, shaded fuel breaks	43,435/43,435/0	0/0/0	Tonto	NO	NO	YES
Right-of-Way (ROW) Projects with Herbicide Use								
Management of Noxious Weeds and Hazardous Vegetation on State Highway ROWs	2004	Herbicide treatment of noxious weeds and hazardous vegetation	N/A	25/0/ 11,005 pesticide control of noxious or invasive weeds and hazardous vegetation	Tonto	YES	NO	NO
APS-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	Decision expected 2019	Herbicide treatment	0/0/ 2,136 herbicide application	0/0/0	Apache-Sitgreaves Coconino Tonto	NO	NO	YES

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
WAPA Glen Canyon-Rogers 230/345kV Integrated Vegetation Management	Decision expected 2019	Hazard tree removal, herbicide treatment, road repair	13,338/0/0	0/0/0	Coconino Tonto	NO	NO	YES
SRP-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	Decision expected 2018 or 2019	Herbicide treatment	0/0/ 7,469 herbicide application	0/0/0	Apache-Sitgreaves Tonto	NO	NO	YES
Wildlife Habitat Improvement, Grassland Restoration Projects/Allotment Projects								
Park Day Allotment	1994	Mechanical and hand thinning, fuelwood sales, broadcast burning	14,665/250/0	2,193/0/ 701 control range vegetation	Apache-Sitgreaves	YES	NO	NO
Clear Creek Allotment	2000	Species habitat improvement, rangeland vegetation improvement	108	2,397/0/ 949 control tree encroachment, 2,288 range cover manipulation	Apache-Sitgreaves	YES	NO	NO
Wallace Allotment	Unknown			0/0/ 1,586 control tree encroachment, 161 control understory vegetation	Apache-Sitgreaves	YES	NO	NO
Railroad Allotment (Formerly Carlisle Complex Vegetation Treatments)	2007	Mechanical juniper removal	10,000/0/0	2,873/0/ 561 control tree encroachment	Apache-Sitgreaves	NO	YES	NO
Heber Allotment		Mechanical thinning, prescribed fire	0/0/ 39,000 grassland restoration	0/0/0	Apache-Sitgreaves	NO	NO	YES

Project Name	NEPA Decision Year	Treatment Types	Acres <u>Planned</u> Mechanical/ Prescribed Fire/Other	Acres <u>Implemented</u> Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Apache Maid Grassland Restoration	2004			54,528/6,770/0	Coconino	YES	NO	NO
Bar T Bar/Anderson Springs Allotment	2005	Meadow, grassland, wildlife corridor restoration treatment; prescribed fire	32,677/32,677/0	1,304/132,938/ 1,519 control range vegetation, 39,180 control tree encroachment, 652 wildlife habitat improvement	Coconino	NO	YES	NO
Flying V and Flying H Allotment		Juniper removal, seeding native grass, fence construction	10,875/0/ 112 fence construction	0/0/0	Tonto	NO	NO	YES
Hardscrabble Allotment Juniper Clearing		Cut juniper trees	100/0/0	0/0/0	Tonto	NO	NO	YES
New Delph Tank & Bear Tank Maintenance		Construct earthen stock tank, maintain existing tank	0/0/ 0.15 acres dredging and berm construction	0/0/0	Tonto	NO	NO	YES
Pleasant Valley Northwest Grazing Allotments		Fence construction, juniper removal	N/A	0/0/0	Tonto	NO	NO	YES
Red Lake Tanks		Tank construction, shrub removal	0/0/0.8 acres dredging, berm construction, ditch excavation	0/0/0	Tonto	NO	NO	YES
Reforestation/Planting Projects								
Bison Reforestation	2003	Site prep, planting	0/0/500	356/312/ 308 tree planting, 275 animal damage control	Apache-Sitgreaves	YES	NO	NO
Clay Springs Reforestation	2004	Site prep, planting	0/0/710	0/0/ 169 tree planting, 169 animal damage control	Apache-Sitgreaves	YES	NO	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Jacques Marsh Elk Proof Fence & Riparian Planting	2006	Exclosure, planting	0/0/10	0/73/0	Apache-Sitgreaves	YES	NO	NO
Pierce Reforestation	2009	Site prep, planting	0/0/1,375	0/0/ 203 tree planting, 203 animal damage control	Apache-Sitgreaves	YES	NO	NO
Rodeo-Chediski Riparian Planting	2010	Planting	0/0/ 1 tree planting	0/0/ 0.6 tree planting	Apache-Sitgreaves	YES	NO	NO
Rodeo-Chediski Reforestation (#18675)	2007	Planting, shade installation, fencing	0/0/3,071	0/150/ 551 tree planting, 303 animal damage control, 202 weed & tree release	Apache-Sitgreaves	NO	YES	NO
AGFD Fairchild Draw Elk Exclosure	2018	Maintain fence	0/0/ 16 fence maintenance	0/0/0	Apache-Sitgreaves	NO	NO	YES
Conifer Weeding for Aspen Enclosure	Unknown	N/A	N/A	65/0/0	Coconino	YES	NO	NO
Spring and Meadow Restoration Projects								
Bill Dick, Foster, and Jones Springs Enhancement	2013	Pond and trough installation, fence installation and maintenance, willow pole planting	0/0/9.3	Unknown	Coconino	YES	NO	NO
Long Valley Work Center Meadow Restoration	2018	Channel reconstruction, tree removal, pond removal, install erosion control matting		0/0/ 16 tree encroachment control	Coconino	NO	YES	NO
Mogollon Rim Spring Restoration Project	2018	Invasive weed removal, planting, install fencing, tree thinning	Unk/Unk/ 5 spring restoration		Coconino	NO	NO	YES

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
Other Projects								
ASNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	Tree planting and replanting, site prep, animal damage control, invasives control, control range vegetation, range cover manipulation, seeding and plating, tree encroachment control, weed & release, habitat improvement.	N/A	42,763/74,202/ 2,158 tree planting, 350 replant trees, 1,720 site prep, 59 animal damage control, 82 invasives control, 497 control range vegetation; 4,297 range cover manipulation, 438 seeding and planting, 5,563 control tree encroachment, 27 weed & tree release, 1,465 habitat improvement	Apache-Sitgreaves	NO	YES	NO
Four Springs Trail Realignment	Decision expected 2018	Trail reroute and rehabilitation	0/0/4.5 miles	0/0/0	Apache-Sitgreaves	NO	NO	YES
Heber-Overgaard Non-motorized Trail System		Creation of trail system		0/0/0	Apache-Sitgreaves	NO	NO	YES
Navopache Electric Cooperative Trunk Line Addition		Add new trunk line		0/0/0	Apache-Sitgreaves	NO	NO	YES
Grapevine Interconnect (Grapevine Canyon Wind Project)	2012	Installation of powerline and switchyard	24/0/0		Coconino	YES	NO	NO
APS Line Maintenance	Unknown			87/0/0	Coconino	YES	NO	NO

Project Name	NEPA Decision Year	Treatment Types	Acres Planned Mechanical/ Prescribed Fire/Other	Acres Implemented Mechanical/ Prescribed Fire /Other[5]	Forest	Past	Current	Reasonably Foreseeable
COF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	N/A	N/A	16,049/15,175/ 15 biocontrol of invasives, 20 pesticide control of invasives, 3,921 control range vegetation, 739 weed & tree release	Coconino	YES	NO	NO
Sixteen Rock Pits and Additional Reclamation	2017	Expansion and reclamation of rock pits	66/0/ 66 excavation, 5 re-contouring, 5 planting	0/0/0	Coconino	NO	YES	NO
Glen Canyon-Pinnacle Peak 345kV Transmission Line Vegetation Management (WAPA)	2014	Mechanical vegetation removal	4,580/0/0		Coconino	NO	YES	NO
TNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	N/A	N/A	15,565/26,386/ 260 tree planting, 198 tree re-planting, 4,018 pesticide control of invasives, 21,000 biocontrol of invasives, 6,890 range cover manipulation, 11,345 weed and tree release	Tonto	YES	NO	NO
Noxious Weed Treatment Projects	2005	Noxious weed treatment		61,015/1,008/ 2,021 pesticide control of invasives, 11 biocontrol of invasives	Tonto	NO	YES	NO
Cragin-Payson Water Pipeline and Treatment Plant	2012	Construct, operate, and maintain water transmission pipeline right-of-way	≤ 352/0/ ≤ 352 excavation, construction, and pipeline burial	0/0/0	Tonto	NO	NO	YES

Table 20. Wildfire History

Year	Acres
1943-1989	40,994
1990-1999	37,369
2000-2009	262,531
2010-2017	168,583
Total	**509,477**

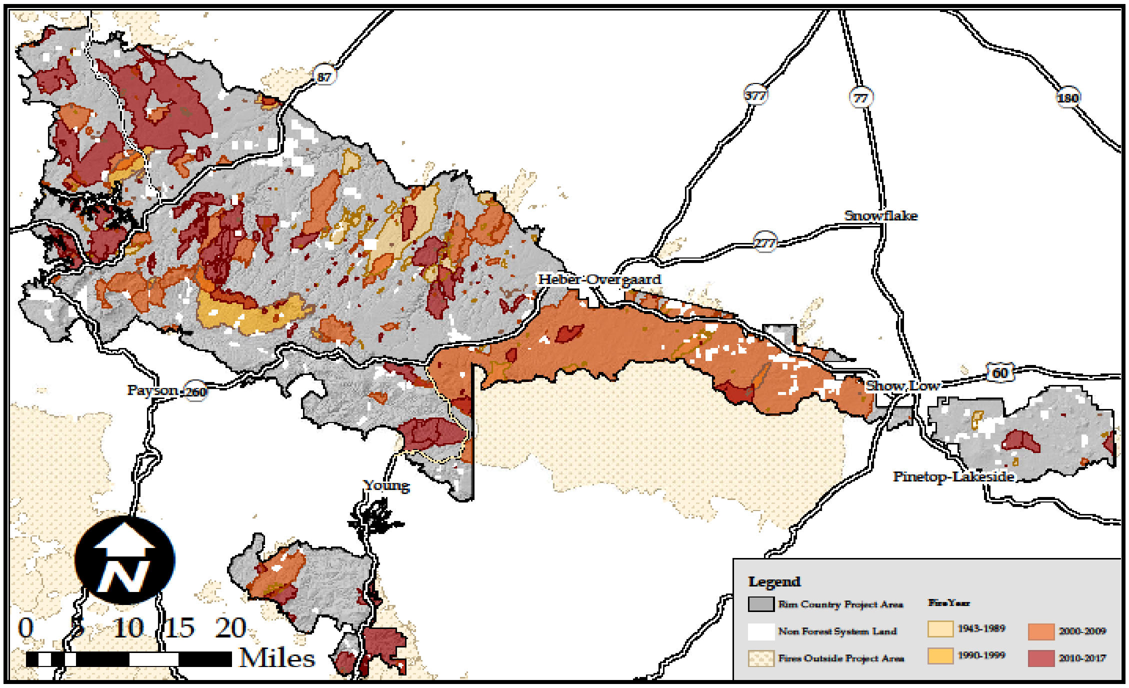


Figure 14. Wildfire history

Water and Riparian

The Water and Riparian Resource Report (Brown 2019) is incorporated by reference. See the specialist report for detailed information.

Affected Environment

Water Quality

Water quality of surface waters has been assessed on 113 miles of streams within the Tonto National Forest portion of the Rim Country project area, primarily within the Salt River and Verde River watersheds. Approximately 161 miles of surface waters have been assessed on the Apache-Sitgreaves and Coconino National Forest's portion of the project primarily within the Little Colorado watershed. In addition, 9 lakes totaling 739 acres were assessed within the Rim Country footprint. The specific water quality status of specific streams, rivers, and lakes that have been assessed by the Arizona Department of Environmental Quality (ADEQ, 2016) is available in the water and riparian resources report.

Within the Salt River and Verde River Basins, primarily on the Tonto National Forest, water quality is attaining all uses in 13.8 miles (12 percent), attaining some uses in 48 miles (42 percent), is inconclusive in 32.8 miles (29 percent) streams and is not attaining/impaired in 18.2 miles (16 percent) of assessed streams. Within the Little Colorado Basin, primarily on the Apache-Sitgreaves and Coconino National Forests, water quality is attaining some uses on 108 miles (67 percent) and inconclusive on 53.3 miles (33 percent) of assessed streams. In addition, nine lakes within the project area were assessed with two (totaling 149 acres) attaining some uses, four (totaling 387 acres) were inconclusive, one (111 acres) was not attaining some uses, and two (totaling 91 acres) were impaired.

The impaired lakes (Bear Canyon and Black Canyon) have a moderate priority for additional sampling that may indicate the need for initiating a total maximum daily load (TMDL) analysis to determine causative factors and to develop appropriate pollutant mitigation strategies. Some streams have had samples that exceed state water quality standards, however, most of the water bodies lack sufficient data to either remove or recommend impairment as there are state statutes dictating minimum data quality and quantity levels. The completion of a total maximum daily load assessment on impaired water bodies may result in developing additional water quality improvement strategies and mitigation of effects within associated watersheds.

The Upper Tonto Creek watershed includes stream reaches that are impaired for Nitrogen, Phosphorous, Low Dissolved Oxygen (D.O.), and E. coli. TMDL assessments were completed for Nitrogen and E. coli bacteria in 2006. Sources of contamination were identified as inadequate septic systems and recreational sources. ADEQ has approved Water Quality Improvement Grants (grants that allocate funds from the US EPA for implementing nonpoint source pollution control projects) for improving septic systems at R-Bar-C Boy Scout Camp (2007), Tonto Baptist Camp (2008), and to Gila County (2006). The Forest Service has constructed new bathrooms, restricted vehicle access to maintain a buffer for the creek, and converted portions of the area from overnight camping to day-use only. A TMDL for Phosphorous has not yet been scheduled and is identified as a low priority for development by ADEQ.

The Upper Tonto Creek watershed is identified as one of Arizona's Targeted Watersheds. These watersheds are a priority in the state for Clean Water Act (CWA) Section 319 Water Quality Improvement Grants and other strategies to restore and/or protect water quality conditions. Development of a TMDL for Low Dissolved Oxygen impairment in the Headwaters of Tonto Creek is identified as a low priority by ADEQ. (http://www.azdeq.gov/environ/water/assessment/download/Appendix_G_Priority_Ranking.pdf)

Implementation of site-specific Best Management Practices (BMPs) have been shown to be effective in mitigating impacts to water quality, and the development, implementation and monitoring of BMPs are Forest Service responsibility as described within the Memorandum of Understanding between the State of Arizona, Department of Environmental Quality and USFS Southwestern Region (USFS, 2013). The completion of a total maximum daily load assessment on impaired water bodies may result in developing additional water quality improvement strategies and mitigation of effects within associated watersheds.

Stream Courses

Stream courses within the project area are generally low-gradient ephemeral and intermittent streams with dendritic drainage patterns, except in areas with very steep terrain such as mountains (i.e., extinct volcanoes) and cinder cones, which typically have radial drainage patterns with high-gradient ephemeral and intermittent drainages flowing in all directions from upper slopes. Approximately 4,047 miles of occur within the analysis area, of which approximately 385 (10.5 percent) miles exhibit perennial flow.

Riparian and Stream Condition

In the Southwest, the Forest Service uses a system of ecosystem types, "ecological response units" (ERUs), to facilitate landscape analysis and strategic planning. ERUs have been built from plant associations and ecosystem units that have been identified through Terrestrial Ecological Unit Inventory (Wahlberg et. al. 2013). Within the project area, there are approximately 21,330 acres identified as riparian by the Region 3 ecological response unit ERU map (Treipke 2014a and b). Table 21 shows the percentages of each ERU within the project area. Of this total, the largest proportion consists of Narrowleaf Cottonwood/ Shrub with 35.6 percent, follow by Ponderosa Pine / Willow and Herbaceous (wetland) with 26.3 and 20.0 percent, respectively. Willow –Thinleaf Alder contributed 7.6 percent and each remaining unit comprised less than 5 percent of the total.

Table 21. Acres and Percent of Riparian ERUs

ERU	Acres	Proportion
Arizona Alder - Willow	228	1.1%
Arizona Walnut	68	0.3%
Fremont Cottonwood - Conifer	169	0.8%
Fremont Cottonwood / Shrub	539	2.5%
Herbaceous (wetland)	4270	20.0%
Historic Riparian - Residential/Urban	298	1.4%
Narrowleaf Cottonwood / Shrub	7584	35.6%
Ponderosa Pine / Willow	5607	26.3%
Sycamore - Fremont Cottonwood	946	4.4%
Willow - Thinleaf Alder	1617	7.6%
Total	**21,326**	**100%**

ERU – Ecological response units

The three forests surveyed riparian condition using different assessment methods. Therefore, for necessity of this analysis all the forest data was cross-walked into a single protocol for display and reporting. The protocol selected is the Proper Functioning Condition (PFC) (Dichard et al. 2015). Reaches meeting Proper Functioning Condition criteria are also in satisfactory riparian condition in terms of Forest Plan standards. Channel morphology (drainage configuration) is typically too variable in ephemeral reaches to allow applying any sort of standard or expectation.

Riparian condition was either documented or estimated on a total of 876 miles of intermittent and perennial streams since the late 1990's. A compilation of condition information across the three forest three forests within the project area is presented in the water and riparian resource report. A total of 257 miles (29 percent) were to be at PFC, with 475 miles (54 percent) at Functional at Risk and 145 miles (17 percent) rated nonfunctional.

The PFC summary data for the Tonto National Forest displays estimated riparian conditions developed during the Watershed Condition classification analysis completed in March 2011. Twenty four miles of riparian areas had been inventoried. The remaining stream channel condition classes were derived from gathering all existing riparian and stream information within each HUC12 watershed using the guidance found in the National Watershed Classification Technical Guide, Indicator #5 for Riparian/Wetland Vegetation Condition.

Wetlands and Springs

There are approximately 1,000 natural lakes, reservoirs, and natural wetland depressions within the project boundary that impound water for a sufficient duration to exhibit some wetland characteristics and are therefore listed in the U.S. Fish and Wildlife Service National Wetlands Inventory database.

Approximately 360 springs have been inventoried by the Spring Stewardship Institute within the Rim Country Project analysis area. Of these 360 springs, 214 have survey information, 138 are unverified, and 8 were verified. Information regarding historic flow or water quality from these springs is minimal. Most springs within the project area are either rheocrene- meaning they flow directly from the ground resulting in a small stream, helocrene- they emerge from low gradient wetlands, or hillslope – they emerge from confined or unconfined aquifers on a hillslope (typically 30 to 60 degrees); often with indistinct or multiple sources.

Several springs within the project area are currently being assessed using the Spring Ecosystem Assessment Protocol (SEAP) (Stevens et al. 2011) with at least one objective being that to see document effects of thinning treatments, such as those proposed by landscape- level restoration efforts like the Rim Country Project, on spring discharge. Eighty springs have been assessed using the SEAP protocol within the Rim Country project boundary. All these assessed springs are located on the Coconino National Forest. Eight percent of the springs were identified to be at moderate or greater risk. Many springs within the project area have been adversely affected by human activities including flow regulation through installation of spring boxes and piping of discharge to off-site locations, recreational impacts, urbanization and other construction activities, and grazing by domestic livestock and wildlife herbivores.

Watersheds and Watershed Condition

The Rim Country Project lies within 141 sixth-level, or 12-digit, hydrologic units (i.e., sub-watersheds), 28 10-digit (watersheds) and 11 eight-digit (sub-basins).

A watershed condition assessment was initially completed in 2011 for all sub-watersheds in the project area as part of an agency-level assessment of watershed conditions for each forest Watershed condition information is also included in the Soil and Watershed Specialist’s Report. Some of the sub-watersheds have very limited areal extent within the project and will not be analyzed further in detail.

The result of the analysis of all watersheds in the project area indicate 20 (15 percent) were rated as Functioning Properly, 111 (83 percent) were rated as Functioning at Risk, and 2 (2 percent) were rated as Impaired. This information is presented in appendix B of the Water and Riparian Specialist Report (Brown 2019).

Watersheds that are identified as Class 2 or 3 (Functioning-at-risk or Impaired rating) are a result of, in large part, overly dense forests with fire regime condition classes of 2 or 3 (moderately or highly departed from reference conditions), a high-density road network that can alter hydrology with many in close proximity to stream courses, a riparian condition rating (PFC) of Functioning-at-risk and Non-functioning condition, and lack of native fisheries or aquatic species in watersheds with perennial streams. Current conditions are dominated by overly dense forests that lead to high fuel loads with the potential of uncharacteristic wildfires. Uncharacteristic wildfires in many cases result in soils with high burn severities that pose risk to watershed function, soil productivity, and water quality following storm events. High burn severity results in water-repellent soils, loss of protective vegetative ground cover and, following storm events, accelerated erosion and sediment delivery to connected stream courses that may degrade water quality. Consequently, accelerated erosion and sediment delivery into connected stream courses leads to loss of soil productivity and watershed function.

The distribution of ratings for these indicators related to water and riparian resources in the Rim Country project area are displayed in Table 22. Overall, ratings indicate that water quality was the highest of the three indicators, with 70 percent of watershed at a good rating. This is followed by 48 percent of the water quality ratings as Good. Riparian/Wetland condition was the lowest with most ratings at 'Fair' condition and a greater percentage of 'Poor' ratings than 'Good'. This suggests that the Riparian /Wetland indicator is most departed from desired conditions and is critical to address for restoration.

Table 22. Distribution of ratings for water quality, water quantity, and riparian/wetland condition indicators within Rim Country

Indicator	Poor	Fair	Good
Riparian/Wetland Condition	27%	58%	15%
Water Quality Condition	6%	23%	70%
Water Quantity Condition	15%	37%	48%

Environmental Consequences

Water Quality

The indicators for water quality includes acres of vegetation (forest, woodland, grassland, riparian) restored by mechanical and prescribed burning, the number of miles of stream channel and number of springs proposed for restoration, the changes in road miles and unauthorized routes, and overall projected changes to water quality, most importantly potential changes with compliance with the Clean Water Act.

Water quality in Arizona is reassessed and reported every 2 to 3 years by the State of Arizona. The latest assessment was documented in the Department of Environmental Quality in 2016 Clean Water Act Assessment (July 1, 2010 to June 30th, 2015) (ADEQ 2016). The findings and recommendations of the report are summarized in the affected environment section.

Most adverse effects on these resources can be minimized or mitigated through appropriate use of resource protection measures such as Soil and Water Conservation Practices (SWCPs) and Best Management Practices (BMPs) as outlined in the Soil and Watershed Conservation Practices Handbook (Forest Service Handbook 2509.22) (USDA 1990). These resource protection measures for the Rim Country Project are included as design features in appendix C. This project will incorporate BMPs, both general and site specific, designed to protect water quality. A memorandum of understanding with the State of Arizona and USDA Forest Service, Region 3 (USDAFS/ADEQ 2013) states 'Ensure that all project work schedules for project implementation on the ground contain site-specific BMPs, developed through the LRMP implementation process and consider technical, economical, and institutional feasibility and water quality impacts from the proposed activity in selection of the BMP. Monitor BMPs on selective activities to ensure they are implemented and are effective, adjust as necessary.' An important BMP feature is the Aquatic Management Zone (AMZ), which is an area adjacent to a waterbody where activity is restricted or limited to project aquatic and riparian values at risk. The proposed AMZ widths are outlined in the Rim Country design features.

Water Quantity

Water quantity is discussed in terms of stable hydrologic regime, persistence of flow, peak flows, and discharge to waterbodies and springs. Surrogates to analyzing these indicators are similar to those for water quality and include: acres of vegetation treated by mechanical treatments and prescribed burning, miles of roads opened and temporary constructed roads, decommissioned roads and unauthorized routes, and acres of rock pits and in-woods processing areas.

Riparian Resources

The indicators used to assess riparian include the miles of stream restoration, the number of springs proposed for restoration, and the number of acres proposed for vegetation treatments such as mechanical treatments and prescribed burning, including most importantly riparian and wetland areas. Other indicators include the miles of temporary roads constructed and Forest Service system roads reopened, the miles of Forest Service roads and unauthorized routes decommissioned. These are surrogates for assessing potential changes to resource conditions.

The Spring Stewardship Institute provided a spring inventory geodatabase for the project area, including Spring Ecosystem Assessment (SEAP) results for many springs.

Cumulative Effects and the Watershed Condition Framework

As mentioned previously, although all Watershed Condition Framework indicators are interrelated to some degree. Specific indicators such as Water Quality, Water Quantity, and Riparian/Wetland Vegetation condition were used to evaluate watershed-scale cumulative effects for water and riparian resources. Other Watershed Condition Framework indicators are addressed in the Soils and Watershed specialist report (MacDonald 2019).

Alternative 1

There would be no direct effects on water and riparian resources as a result of the no action alternative, however there would be indirect effects by not be moving these resources towards desired conditions. Overstocked and dense stands within the project area would not be treated, leaving a less healthy, less vigorous, and under productive forest. Risk of uncharacteristic wildfire would not be reduced. No improvement would be realized in woodlands, savanna, and grassland vegetation types where ground cover conditions are departed from desired conditions. No road decommissioning, rehabilitation of unauthorized routes or stream crossings would occur improving water quality. Stream, wetland, riparian, and spring restoration would not be completed at the scale intended for this project. The project area would not move toward desired conditions, as outlined in the Apache-Sitgreaves, Coconino, and Tonto Forest Plans.

Water Quality and Quantity

Absence of Mechanical Treatments and Prescribed Fire

It is likely that under any conditions, a wildfire entering these untreated watersheds under the no action alternative would have considerably greater impacts to water quality and channel stability than wildfire occurring after implementation of the action alternatives. Increased water turbidity, and downstream flooding would be more widespread in an uncontrolled wildfire situation than under prescribed fire conditions where the size and intensity of the fire can be controlled. Increased sediment loads are the primary physical impacts to surface waters following fire. The bulking effect of sediment and ash in runoff increases the risk to surface water impoundments, infiltration basins, and public water treatment systems. Sediment and debris flows can damage water supply infrastructure. Sedimentation of impoundments can decrease their effective life, resulting in a need for dredging and other mitigation measures.

Soils with erosion rates that are exceeding tolerance thresholds would likely continue to erode at current rates. Sediment delivery to streamcourses and waterbodies could continue at current rates or gradually increase from poor upland conditions. In areas where overstory densities are high, little long-term improvement in hydrologic flow regime will occur without mechanical treatment and/or prescribed fire. The soils in these areas have reduced moisture storage and infiltration capacity and are frequently overwhelmed by high intensity summer precipitation events, producing runoff events with relatively large peak flows of short duration. In areas that are overstocked with trees and encroached, water quantity would continue to decline as less water would be available for stream flows due to the closing of the overstory.

Absence of Riparian, Stream, and Upland Improvements

Riparian vegetation provides many water quality maintenance functions such as reducing surface water temperatures, which promotes high dissolved-oxygen concentrations, by blocking solar radiation. Stabilizing roots reduce the amount of bank cutting and erosion. Uptake by riparian vegetation can effectively remove excess nutrients and pollutants from water. Several stream reaches within the Rim Country Project area are experiencing increased water flows and sediment delivery from the effects of poor upland conditions, some of which are the result of several fires which have occurred over the past 20 years, most notably the Rodeo-Chediski Fire of 2002. These increased flows are causing stream instabilities both vertically and laterally. Stabilizing riparian vegetation has been scoured away causing detachment and movement of channel and bank material impacting sediment concentrations in water bodies. Without active stabilization activities water quality will likely not improve as quickly as with the action alternatives.

Absence of Roads Activities

This alternative is not anticipated to produce any changes to existing water quality trends in the streams, springs and surface water bodies in or downstream of the project area. Open roads and unauthorized routes being used for motorized travel will continue to discharge runoff and sediment to project area streams, especially where the roads are poorly located in stream bottoms, have inadequate drainage structure, and are hydrologically connected to the stream network (USDA 2010, Orndorff 2017, Berg 1988, Lousier 1990).

The short-term inputs of sediment into waterbodies caused by disturbance associated with the action alternatives would not occur.

Absence of Rock Pits and In-woods Processing Sites

The no action alternative would have slightly more potential of increased sediment yield to downstream perennial waters than the action alternatives because of the use and improvements of Forest Service system roads associated with the rock pits. Increased sediment yield by itself does not constitute an impact on water quality because the sediments leaving the road would have to enter a water body in large enough quantities to cause a change in beneficial uses. Maintaining roads to appropriate standards would be more difficult in this alternative due to the higher haul costs of bringing in rock from elsewhere. Fewer miles of roads surfaced combined with an increase in miles driven compared to the other alternatives would result in continued water quality impacts.

Riparian and Wetland Resources

Absence of Mechanical Treatments and Prescribed Fire

Under the no action alternative and assuming the absence of wildfire, current trends in condition of riparian areas within the project area would be expected to continue. Riparian condition would not benefit from improving upland watershed conditions to desired conditions with mechanical and prescribed fire treatments. There would be no potential benefit from improvement of the hydrologic flow and altered sediment regime by restoring herbaceous ground cover. Fuel loading would remain high, thus there would be greater risk of high burn severity and subsequent flooding effects, which could negatively affect riparian condition. Tree density and canopy closure within the riparian areas would increase. Current levels of large woody debris would be available to the stream channel both from the riparian and adjacent upland zones. Areas where deciduous woody riparian vegetation is being shaded out by invading conifers would remain in that condition.

This alternative would result in riparian condition improvement at a slower rate than either of the action alternatives as there would be no direct reduction of conifer encroachment via mechanical and prescribed fire to increase the potential for expansion and vigor of riparian vegetation.

Absence of Riparian, Stream, and Upland Improvements

Many of the stream reaches accessed are not currently at desired conditions and are in less than proper functioning condition. Headcuts and other instabilities can adversely affect riparian vegetation by scouring away soils and stabilizing plants leading to channel entrenchment and subsequent lowering the water table. It is expected that riparian condition of these reaches would continue to decline or, if recovering, recover at a slower rate with the no action alternative than the action alternatives.

Absence of Roads Activities

Potential effects from construction of temporary roads and opening of closed Forest Service roads, such as increased runoff on disturbed soils and potential increased delivery of sediment to water bodies, would not occur with the no action alternative. Forest service roads and unauthorized roads will not be decommissioned or relocated, therefore resource degradation from these roads will continue, and the improvement to riparian condition will not occur.

Absence of Rock Pits and In-woods Processing Sites

The absence of rock pits and in woods processing sites would have no impact on riparian or wetland resources because of the location of these away from these resources. The no action alternative would result in no additional acres of ground disturbance from rock pits and in little to no potential of sediment generation distribution from in-woods processing sites.

Effects Common to Both Action Alternatives

Water Quality and Quantity

Upland Mechanical Vegetation and Prescribed Burning Treatments

Water Quality

Fire, including prescribed burning, can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire some of the soil and organic matter nutrients such as calcium, magnesium, and potassium are converted into oxides and accumulated in ash (DeBano et al. 1998). During precipitation events these compounds can be delivered to nearby waterbodies. However, the primary short-term risk to water quality from prescribed fire and mechanical vegetation treatments is from increased sediment input to water bodies from where ground cover has been reduced or eliminated. This risk of is greatest where treatment activities result in soil disturbance or complete removal of vegetative ground cover in close proximity to drainages. Such areas would include designated stream crossings, skid trails, log landings, installed firelines, and areas with higher soil burn severity.

As reported in the Soils and Watershed specialist report (MacDonald 2018), erosion potential is expected to increase on 10 to 15 percent of areas treated mechanically due to removal or displacement of ground cover. However, this erosion would be short term (1 to 5 years) and localized. In the long-term, these treatments will likely increase vegetative ground cover and decrease the potential for high severity fire and substantially more drastic effects from heavy fuel loading. As shown in erosion modeling results, sediment delivery following high to moderate soil burn severity areas is about twice that of low severity areas, which is the predominant severity class resulting from prescribed burning. Where uncharacteristic, or high-severity wildfires have occurred, 36 percent of the TES (Terrestrial Ecosystem Survey) strata exhibited erosion and sediment delivery rates above soil loss tolerance thresholds. Bringing these areas towards desired conditions will promote stability in hydrologic and sediment regimes.

Thinning of forest cover on soils currently characterized as unsatisfactory would improve those soils over the long-term by improving soil moisture and allowing greater sunlight penetration to the forest floor, resulting in an increase in forest understory of desired herbaceous species. Vegetative recovery following fuel reduction treatments is generally rapid, with erosion rates typically returning to pre-treatment levels within 1 to 2 years (Elliot 2000). The increased herbaceous vegetation would likely reduce soil erosion and associated sediment delivery rates by providing vegetative and litter ground cover. This cover would intercept rain before it can reach soil surfaces, and detach and entrain soil particles in runoff water, promoting long-term improvement in water quality.

Resource protection measures including BMPs (see design features) are included with this project to protect water quality are effective in preventing long-term degradation of water quality from sediment and point sources of contamination. The use of streamside buffer zones, referred to as aquatic management zones (AMZs) in this project, to increase filtration capacity, have been shown to be capable of reducing sediment entering waterways to non-significant levels (Rashin 2006).

Water Quantity

Departures from historical ranges of variability (HRVs) in vegetation and fire regimes have the potential for alteration of hydrologic regimes. Excessive overland flows can increase channel flow volume and velocity, causing channel erosion and increased deposition downstream. The proposed mechanical treatments and prescribed fire would move portions of the uplands toward desired conditions. The increase in vegetative grass component would improve the ability of the watershed to intercept and retain water inputs (precipitation and snow melt). Herbaceous ground cover, residual plant material, and plant vigor would increase surface roughness, reducing runoff velocities. Soil compaction would start to break up and additional organic material incorporate into the soil, allowing for reduced surface runoff, increased water infiltration, and moisture retention. Overall, these conditions could promote more stable hydrologic flow regimes.

Fuel reduction treatments in forested watersheds, including mechanical treatments and prescribed burning, can result in long-term increases in water yields either on-site or downstream (Brewer 2008; Bosch and Hewlet 1982; Troendle et al. 2003, 2007). Treatment prescriptions that cover most of the project area and remove greater than 20 percent of tree basal area would be needed to generate a detectable change in surface flows. Treatments prescribed in the action alternatives would include leaving groups of trees, which would allow more snow collection in openings and result in greater potential for on-site water storage and yield. This could provide longer periods of flow in intermittent streams within and downstream of the project area (Zou et al. 2009).

In drier ponderosa pine stands, increased yields of one-quarter to one inch would be realistic. In cases where there is a detectable hydrologic response to vegetative treatments, the observed response would be greatest in wet years and smallest or non-detectable in dry years.

Prescribed fires, when designed and used as a fuel reduction tool alone, are probably less likely to influence water yield than mechanical treatments or a combination of burning with mechanical treatments, because of the smaller reduction in basal area and lack of ground disturbance by heavy machinery.

Riparian, Wet Meadow, Spring, and Stream Restoration

Restoration activities described in the Aquatic and Watershed Flexible Toolbox Approach (AWFTA) could promote conditions for desirable water quality and quantity characteristics. Reducing trees encroachment on riparian areas would allow for decreased precipitation interception, improved infiltration and water storage. Riparian vegetation often acts as a mitigating influence on flooding. Riparian vegetation provides instream roughness via large woody debris as well as live vegetation along stream banks. This roughness can reduce stream velocities and dissipate stream energy, resulting in an increased stream stage. The spreading of water out onto a floodplain promotes water entering into storage, further dampens peak flows. Improving conditions in these areas would also promote resiliency during uncharacteristic wildfires, by reducing the potential for high severity burning. High severity burning in riparian areas can reduce shading causing increasing stream temperatures, and destroy stabilizing vegetation resulting in excessive erosion and sediment production.

Long-term water quality would benefit from promotion of soil and channel stability and establishment of riparian vegetation, with improved dissipation of stream energy, water storage, and more stable flow regimes. Riparian vegetation can also maintain cooler temperatures within water bodies by reducing the amount of solar radiation impinging on the water surface. Water quality improvements can also occur from nutrient uptake and storage by riparian vegetation.

Short-term effects to water quality and quantity would be mitigated from riparian, wet meadow, spring, and stream restoration activities, but not eliminated entirely with implementation of design features. BMPs related to riparian restoration that are protective measures for water quality and quantity include those associated with AMZs and spill prevention and remediation (see water quality and quantity BMPs for general mechanical and prescribed burning).

Roads Activities

Road management-related activities include: road improvements, temporary road construction, decommissioning of system roads and unauthorized routes, and improvement and relocation of system roads. Approximately 5,682 miles of roads currently in the forest system road network would be needed for the activities proposed in the action alternatives. Of this total mileage, 2,076 would be included from the re-opening of maintenance level 1 (ML1) roads. Temporary roads would also be constructed. It is important to note that not all the ML-1 roads will be opened or temporary roads constructed at the same time across the project area. Only those ML1 and temporary roads required for implementation in a certain area would be opened or constructed. These roads would be properly maintained during implementation and closed or decommissioned, following Forest Service policy and design features (see Transportation specialist Report (Rich 2019)), when they are no longer required for project activities.

Vehicle traffic associated with project implementation, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and alter flow regimes in streams. Road and stream intersections are the primary locations where sediments are delivered to stream courses. Sediment production from roads diminishes over time after proper closure and non-use (Beschta 1978). Roads induce surface runoff and can alter subsurface flow on hillslopes, and this could affect the magnitude and timing of surface runoff.

No long-term effect on water quality and quantity is expected from the action alternatives with regards to the proposed road activities. In the short term, it is possible that sediment inputs to area watercourses would increase slightly from re-opened roads, constructed temporary roads, or improved roads in the project area. However, all opened roads and temporary roads would be closed and decommissioned, respectively, when they are no longer needed. Short-term effects on water quality would be minimized by employing design features for road decommissioning and rehabilitation, including BMPs which are effective in preventing sediment from reaching streams when strictly followed.

A total of approximately 800 miles of existing system roads and unauthorized roads would be decommissioned under both action alternatives. Road decommissioning would entail obliteration whereby road surfaces could be ripped and seeded or mulched, inside ditches filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access. These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover, and reducing erosion. Upon completion of road obliteration activities, long-term erosion rates for decommissioned roads would be expected to approach natural erosion rates. Rehabilitation or removal of roads offers benefits including reduced sedimentation and decreased peak flows.

Rock Pits and In-woods Processing Sites

Rock Pits

The action alternatives include the use of 10 existing rock pits on the Coconino National Forest and 11 existing rock pits on the Apache-Sitgreaves National Forests. Since each of the rock pits analyzed is required to be operated so that they have internal drainage, none of the proposed pits or expansion areas would result in sediment outside the boundary of the pit and there would be no direct effect on water bodies. The lower hauling costs associated with having more rock pits closer to activity areas, would result in more miles of roads with better surfacing. This would also limit effects on water quality from roads. Water quality would be expected to remain the same or improve because of the greater number of road miles surfaced and maintained.

The site selection criteria used for rock pits and expansions greatly reduce the potential for effects on waterbodies. Increased truck traffic would create some finer sediment on road surfaces and could increase sediment yield. The main concern with increased sediment yields would be from dust caused by the construction and use of the rock pits and facilities. However, increased sediment yield by itself does not constitute an effect on water quality because the sediments leaving the road would have to enter a water body and in large enough quantities to cause a change in the beneficial uses of that water body.

In-woods Processing Sites

Twelve processing and storage sites are proposed and analyzed for use in the Rim Country EIS, ranging in size from 4 to 21 acres. These sites were screened so as to be located outside of riparian areas and away from nearby streams where some of the most productive forest soils are found, as well as in relatively flat areas. The siting of processing sites in relatively flat areas would minimize the need for extensive site grading.

In order to facilitate the types of tasks and equipment that may be used at these sites, the sites would typically be required to be cleared and grubbed (i.e., vegetative cover and trees removed), resulting in displacement of top soil and exposure of subsoil. The operation of equipment on these sites would result in compaction of the soil, reducing the ability of soils to infiltrate water. Areas of exposed soil would have to be covered with aggregate to minimize erosion and facilitate use of the site. The aggregate surfacing would cover the surface soil where it is not graded and would protect soil productivity. Various permits would need to be obtained for fuel storage, industrial site use, and stormwater pollution prevention. These permits would help to minimize effects on soil productivity and function.

Aboveground fuel storage tanks would have to be manufactured, installed, and operated in accordance with federal, state, and local requirements. For example, a permit for installation of an aboveground storage tank would have to be obtained through the Arizona State Fire Marshall's Office. Additionally, the processing sites would likely be regulated as industrial sites subject to permitting under the Arizona Department of Environmental Quality's Multi-Sector General Permit program. This permit program requires that certain industrial facilities, including those involved in the types of activities that would likely occur at the processing sites, implement control measures and develop site-specific stormwater pollution prevention plans to comply with Arizona Pollutant Discharge Elimination System requirements. Among other things, the prevention plan would have to identify best management practices that minimize non-point source water pollution, including measures to minimize or prevent soil erosion and contamination.

Following completion of the use of processing sites and removal of all equipment and materials, site rehabilitation would be accomplished, including but not limited to removal of aggregate, restoration of pre-disturbance site grades, de-compaction of soil for seedbed preparation, tree planting, and seeding and mulching of the site with native grasses and forbs.

The selection for processing sites included the following criteria: flat uplands less than 5 percent slope; more than 200 feet from ephemeral and intermittent stream channels, more than 300 feet from meadows, springs and karst features. These selection criteria considerations, in addition to the Rim Country design features for these sites, should greatly reduce the potential for effects on waterbodies.

Riparian Resources

Upland Mechanical Vegetation and Prescribed Fire Treatments

Upland mechanical thinning and prescribed burning treatments should reduce the risks to riparian communities and ecosystem integrity from scorching, and damaging peak flows associated with uncharacteristic wildfire. The effects of wildfire and prescribed burning activities on riparian areas are highly dependent on position of fire within the watershed, proximity to riparian areas, and position relative to mainstream channel and tributaries (Dwire et al., 2016). In general, the hotter a watershed burns, the greater the extent of burning within riparian areas.

In addition, the reduction of canopy cover near riparian areas would stimulate the development of understory vegetation including deciduous woody riparian vegetation (e.g., aspens, willows and cottonwoods). Reductions in upland tree density and the long-term maintenance of open stands and forest openings should respond with increased stream flow, and overall water yield (Brewer, 2008), which in turn would provide longer periods of intermittent stream flow. Increased infiltration resulting from the vegetative treatments would move excess moisture into sub-surface storage and groundwater, resulting in a slower release of water. Higher-intensity thinning would likely have the greatest potential for groundwater recharge, and stream and spring discharge, by reducing evapotranspiration rates. Increased water availability would support riparian vegetation abundance and vigor, and for stream channels minimize channel bank and bed instability (Fisher et al. 2008). Overall, the long-term effects of these treatments would likely improve riparian, stream channel, wet meadow, and spring conditions and functionality more quickly than the no action alternative. Adherence to project design features would limit the extent and degree of effects from mechanical thinning and burning activities both in the uplands and riparian areas. Treatments in AMZs would be limited in scope, space, and time to achieve multiple resource management objectives.

Riparian, Wet Meadow, Spring and Stream Restoration

Thinning activities and prescribed burning activities targeted for riparian resources including in around streams, wet meadows, and springs will have effects similar to those described in the prior section on effects to riparian resources from upland mechanical vegetative and prescribed fire treatments. Leaving riparian areas untreated and with higher fuel loading, while treating fuel loading in the uplands can produce high fire severities in these areas (Dwire et al., 2016). These higher severities can reduce riparian vegetation abundance and diversity and take several decades to recovery to pre-fire conditions.

Treatments can also produce other desirable effects such as potentially more groundwater and surface water to be available to promote riparian vegetation abundance and vigor. As stated previously adherence to project design features would limit the extent and degree of effects from mechanical thinning and burning activities both in the uplands and riparian areas. Treatments in AMZs would be limited in scope, space, and time to achieve multiple resource management objectives.

Activities included in the Aquatics and Watershed Flexible Toolbox Approach (AWFTA) would directly improve riparian conditions and functionality associated with stream channels and banks with stabilization techniques, and intensive treatments that modify stream sinuosity, width/depth ratio, and gradient. Grade control structures are useful for reconnecting stream channel and floodplains, reducing degrading stream energy and aggrading entrenched systems. Vertical instabilities such as headcuts can adversely affect riparian vegetation by scouring away of plants and soils and lowering of the water table. Reduction of bank erosion would increase stream stability and moisture-holding capacity of hydric soils, improving conditions for riparian vegetation production. Degraded wet meadows could be restored by transplanting native herbaceous species and reposing steep banks.

Upland soil stabilization would be completed at sites where soil conditions are contributing to gully formation. Stabilization techniques would include hand or mechanical installation methods, depending on site needs, access, and other resource concerns. Native vegetation would be expected to reestablish in these areas soon after restoration activities are completed (approximately one to three years). Additional benefits would include reduced susceptibility of sites to invasion by noxious or invasive weeds with the increased native vegetation recruitment over time. In some areas, riparian vegetation production would be augmented with planting of riparian herbaceous and woody species appropriate to those locations. Protective barriers around riparian areas would reduce the browsing and trampling effects from large ungulates, since continued heavy to extreme use of woody species could limit plants' ability to regenerate (Winward 2000).

Roads Activities

Riparian areas, wetlands, stream channels, and springs would not be directly affected by temporary road construction as it is prohibited in or near these resources in the project design features. Additionally, indirect effects are expected to be minimal. Poorly located roads and unauthorized routes can degrade soil conditions and cause channel instabilities resulting in excess erosion and deposition which may affect riparian diversity, extent, and vigor. Decommissioning of Forest Service system roads and user-created roads could improve functionality of riparian areas, stream channels, wetlands, and springs.

Rock Pits and In-woods Processing Sites

The selection criteria of processing sites included the following: flat uplands less than 5 percent slope, more than 200 feet from ephemeral and intermittent stream channels, and more than 300 feet from meadows and springs. These considerations, in addition to other relevant design features, should greatly reduce the potential for effects on adjacent riparian resources.

Effects Unique to Each Action Alternative and Differences among Them

Water Quality and Quantity

General Mechanical and Prescribed Fire Treatments

Proposed mechanical vegetative and prescribed burning treatments acres differ between the action alternatives, 817,870 and 427,786 for Alternatives 2 and 3, respectively. This amounts to a 48 percent difference between alternatives. There is an even greater difference, 28 percent more, in proposed treatment acres in the savanna vegetation type for Alternative 2 as compared to with Alternative 2Prescribed fire only acres are also lower in Alternative 3, with 40,630 acres proposed as compared to 54,070 acres in Alternative 2, a 26 percent difference.

Short-term water quality effects would be less for Alternative 3 as compared to Alternative 2 because of the decreased potential for sediment reaching waterbodies from ground-disturbing activities associated with mechanical vegetation and prescribed burning treatments. However, in the long-term, Alternative 3 would likely result in decreased long-term water quality benefits from fewer upland treatment acres that are currently not meeting desired conditions being treated. Thus Alternative 3 would have less of a benefit to downstream aquatic and riparian area habitat. Overall however, both alternatives would maintain compliance with the Clean Water Act through strict adherence to design features.

Regarding water quantity, Alternative 2 with more treated acres, could promote increased water yield, more stable hydrologic flow regimes, and increased discharge downstream. Springs would likely receive more groundwater recharge, promoting increased surface discharge.

Road Activities

More miles of temporary roads would be needed for Alternative 2 because more acres are proposed for mechanical and prescribed fire treatments. Up to 330 or 170 miles are proposed for implementation of Alternatives 2 and 3, respectively; a 49 percent difference. In the short-term, a greater number of temporary roads over the project area will remove more vegetation, exposing and compacting more bare soil, potentially leading to increased concentrated flows and sediment delivery to waterbodies. It should be noted that a potential increase in the magnitude or duration of effects from a greater number of temporary roads will likely be spread over a larger geographical area, including many additional watersheds, thus in essence spreading out potential effects. Overall, the short-term effects of temporary roads in either action alternative will be minimized with the use of road erosion control design features. All temporary road footprints are to be rehabilitated to as natural condition as much as possible, thereby mitigating potential long-term effects.

Riparian and Wetland Resources

General Mechanical Treatments and Prescribed Fire Including Treatments in Savannas
The general effects of mechanical treatments and prescribed fire, including treatments in savannas, on riparian and wetland resources are described in the Effects Common to Both Action Alternatives section, and apply to this section. Acres of mechanical and fire treatments differ Alternatives 2 and 3, amounted to a 48 percent difference. The difference in mechanical treatment and burning in grassland and savanna vegetation types acres treated was 28 percent comparing Alternatives 2 to 3. Prescribed fire only acres between the action alternatives resulted in a 26 percent difference.

As these proposed treatments are primarily upland treatments, direct effects on riparian and wetland resources are not expected. With regards to indirect effects, the additional treatment acres proposed in Alternative 2 (48 percent more mechanical and prescribed fire, 26 percent more prescribed fire only) as compared with Alternative 3, would bring more acres towards desired conditions. Therefore, Alternative 2, will to a greater extent reduce the potential for riparian impairment caused by impaired upland watershed conditions. Alternative 2 would also to a greater proportional extent promote longer periods of intermittent stream flow and groundwater recharge available to spring systems by bringing upland tree densities and forest openings to desired conditions. This would in turn support riparian vegetation vigor and wetland functionality.

Road Activities
More miles of temporary roads are required for Alternative 2 because more acres are proposed for mechanical and prescribed fire treatments. Up to 330 are proposed for implementation of Alternatives 2, a 49 percent increase, as compared to Alternative 3 with proposed 170 miles. With fewer miles of temporary roads proposed, there is likely less potential for negative effects to riparian and wetland resources with Alternative 3. Poorly located and high road densities can concentrate surface flow potentially causing increased peak flows damaging to these resources. The potential effects of temporary roads on riparian, spring, and wetland resources will be minimized with strict adherence to project design features. Specific design features which include the use of aquatic management zones, would be employed to protect these sensitive areas in both action alternatives. No temporary roads are to be located in close proximity (as defined as the AMZ width) to these resources. When no longer required for treatments, temporary roads are to be decommissioned through obliteration, and road footprints rehabilitated as to be returned to as natural condition as possible. The number of miles of Forest Service managed roads would return to pre-implementation numbers or those determined through the travel management rule (TMR) process for each forest. Thus, changes in open road density would be temporary, most likely two years or less.

Cumulative Effects Analysis

Spatial and Temporal Boundaries and Relevant Activities
The spatial boundaries appropriate for cumulative effects analysis of water quality, water quantity, and riparian resources are watershed boundaries. Water and riparian resources are primarily located in bottom lands which are strongly influenced by runoff from the surrounding topography. Multiple land-use

changes and activities in the uplands and upstream areas have can have an additive (cumulative) effect to these resources. Using the subwatershed (HUC12) hydrologic unit is consistent with the USFS Watershed Condition Framework (WCF) (USDA Forest Service 2011), which has attributes specific to these indicators. Temporally effects include those activities up to 20 years in the past and into the future.

Cumulative effects to water quality, water quantity and riparian resources include effects associated with past, present (ongoing) activities and those that are reasonably foreseeable. Aerially speaking, by far most the largest types of past, present, and reasonably foreseeable activities, excluding grazing, involve mechanical vegetative and prescribed burning treatments. Other activities include reforestation, spring and meadow restoration, and noxious or invasive weed and vegetative management along transmission lines. Reasonably foreseeable activities include projects with completed NEPA (planned) that are to be implemented and those anticipated occur in the future. Some of the more relevant projects include mechanical thinning in the Cragin Watershed Protection Project, the Rodeo Chediski Mastication Project, and several large prescribed burning projects such as the Haigler Fuels Analysis. Several woodland, grassland, and spring restoration projects are also proposed in the Heber, Pleasant Valley, and Northwest Grazing Allotments analyses and the Mogollon Rim Spring Restoration Project. Other projects in the planning stage include the Apache-Sitgreaves National Forests Travel Management Rule (TMR) with an expected decision in 2020. The Tonto National Forest is also in the process of finishing a TMR EIS. Superimposed on these activities are the effects associated with this project alternatives.

Water Quality and Quantity

Alternative 1

Cumulatively, when considering the past, present, and reasonably foreseeable future activities, the no action alternative will have fewer short-term effects on water quality than the action alternatives. This is primarily because ground disturbing associated with mechanical vegetative treatment activities, prescribed burning, riparian and wetland restoration, and transportation activities associated would not occur.

Cumulative effects from current livestock grazing would continue under alternative 1 and includes minor, generally localized soil compaction, puddling, displacement and erosion from livestock trailing and in areas where animals congregate. Livestock trails make up a very small portion of the total project area. There are no anticipated changes to the 303d listed impaired waters from the magnitude cumulative effects under alternative 1.

Alternatives 2 and 3

Long-term, cumulative positive effects would likely occur with Alternative 2 more so than 3. On average, the proportional extent of vegetative treatments (which comprise by far the greatest extent of all project activities) within HUC12 subwatersheds will increase by approximately 38 and 27 percent, respectively, as compared to the no action alternative by implementation of Alternative 2 and 3. Sixty-seven percent of Rim Country subwatersheds could receive an increase of up to 25 percent additional coverage of vegetative treatments acres in alternative 2 as compared to alternative 3. Increased coverage ranging from 25 to 50 and 50 to 75 percent would occur in seventeen and eleven percent more subwatersheds, respectively in alternative 2 as compared to alternative 3. Increases ranging from 75 to 100 percent would occur in 5 percent additional subwatersheds in alternative 2.

In addition to the vegetative treatments, the activities associated with the aquatic and watershed flexible toolbox approach and proposed road decommissioning activities included in the action alternatives will have additive positive cumulative effects.

Moving upland and bottom lands (riparian and wetland areas) vegetative cover and composition further towards desired conditions would reduce the risk of undesirable loss of overstory and ground cover, while stimulating vigorous plant growth, promoting infiltration rates, reduced overland flow, thus promoting overall stable hydrologic and sediment regimes. Riparian and wetland restoration activities and transportation footprint reduction activities will further complement the upland treatments from other projects in the cumulative effects boundary in promoting the improvement of water quality and water quantity indicators.

The short-term past, present, and reasonably foreseeable activities coupled with the action alternative would have similar incremental, short-term effects from ground disturbing activities to riparian and wetland resources. In the long-term, the combination of restoration activities in the project action alternatives including but not limited to: stream and wetland stabilization, riparian planting and protection barriers, road obliteration, and upland vegetative treatments, and other similar activities in the cumulative effects boundary would bring these systems closer to desired conditions, thus promoting the improvement of the riparian indicator based on the WCF.

Summary

The WCF water quality, water quantity, and riparian indicator scores are expected to be maintained or improved with the of past, present, and reasonably foreseeable actions combined with the activities proposed in the action alternatives. Although future watershed restoration activities are expected to have long-term benefits to watershed condition, the intensity of coincidental watershed activities (too large a proportion of a given HUC12 subwatershed over too short a time) could potentially lead to negative effects, including unstable hydrologic and sediment delivery regimes, and subsequent impacts to riparian vegetation.

Soils

Affected Environment

This section provides information about the existing conditions of the affected environment for soils and watershed resources within the project area of about 1,240,000 (with potential restoration treatment area of 953,130 acres). It also includes an analysis of watershed conditions at the 6th Hydrologic Unit Code (HUC) level. This section establishes the baseline against which the decision maker and the public can compare the effects of all action alternatives.

Appendix A of the Soils and Watershed specialist report displays the Terrestrial Ecosystem Survey (TES) map unit stratification and soil interpretations based on similar soils properties and behavioral characteristics, vegetation communities and management risks, limitations and potentials. Appendix B of the Soils and Watershed specialist report displays the existing and desired conditions, need for change and potential management strategies in tabular format by TES map unit stratum.

Affected environment of riparian resources, water quality, and water quantity is analyzed in the Water and Riparian Resources Specialist Report (Brown, 2018).

There were 186 TES map units from the 3 forests that were aggregated into 30 landscape unit strata. Each stratum has similar soils properties, slopes, climate regimes and vegetation communities. These soils also have similar limitations, hazards, suitability for various management activities and production potentials. The strata were used in part to design treatments, analyze effects and are based on the potential plant community and capabilities of the soils.

Assumptions and Methodology

This section describes the methodology and analysis processes used to determine the environmental consequences to soils and watershed resources from implementing the alternatives. Environmental consequences will be described with qualitative and quantitative descriptions supported by past studies and relevant literature.

Analyses for environmental consequences to soils and watershed resources that may result from implementation of each alternative were conducted using information contained in the Terrestrial Ecosystem Survey of the Apache-Sitgreaves National Forest, Coconino National Forest and Tonto National Forest, the Watershed Condition Framework, Ecological Response Unit (ERU) inventory maps (Triepke et al., 2014a and b), Forest Land Management Plans, Arizona Department of Environmental Quality (ADEQ), information obtained from other resource specialists, other agency reports, available literature, and input from collaborators, cooperators, and stakeholders. Geospatial analysis was used to quantitatively and qualitatively assess soils and watershed conditions using Geographic Information Systems (GIS) data obtained from a variety of sources.

Soil and Water Resources Condition Indicators

For soil resources, the units of measure of effects to soil resources will be the acres and severity of ground disturbance from equipment use and acres subjected to high soil burn severity. Most adverse effects to soils and water resources can be minimized or mitigated through appropriate use of resource protection measures and design features such as Soil and Water Conservation Practices (SWCPs) and Best Management Practices (BMP's) as outlined in Soil and Watershed Conservation Practices Handbook (Forest Service Handbook 2509.22) (USDA 1990), the National Core BMP Technical Guide (FS990a) (USDA 2012), and other relevant BMP guidance.

For water quality measures, no physical stream measurements will be taken to determine water quality. A narrative description will explain the effects to water quality by Alternatives.

Soils

Soils throughout the project area were mapped as part of the Terrestrial Ecosystem Survey (TES) of each forest. This information is available at the respective Forest Supervisor's Offices.

The TES follows National Cooperative Soil Survey Standards similar to Soil Surveys conducted by the Natural Resource Conservation Service (NRCS). The TES is the result of the systematic analysis, mapping, classification and interpretation of terrestrial ecosystems, also known as terrestrial ecological units that are delineated and numbered. A TES represents the combined influences of climate, soil and vegetation, and correlates these factors with soil temperature and moisture along an environmental gradient. It is an integrated survey and hierarchical with respect to classification levels and mapping intensities.

Interpretations based upon TES incorporate 1) soil physical and chemical properties, 2) climatic considerations, 3) topographic position and slope, 4) vegetation and anthropogenic influences as well as animal effects, 5) productive and successional potentials, and 6) geologic influences. As such the TES can form the ecological basis for describing existing conditions for resource areas including watershed, wildlife, fire, and timber.

Erosion Modeling

Erosion modeling was completed using the FSWEPP program ((Elliot, Hall and Scheele 2000) at https://forest.moscowfsl.wsu.edu/fswepp/) and with site specific data (climate, slope, soil surface texture, length to drainage, cover percentage, and rock content) to determine upland erosion and sedimentation into stream channels. Upland erosion and sedimentation into stream channels rates are estimated up to three years for prescribed burning and five years for wildfire scenarios. The WEPP model has been validated for use in the Southwest (i.e., Arizona and New Mexico) through research on hydrologic processes to predict responses of soils to disturbances (Bolton et al. 1991, Paige et al. 2003).

Watershed Condition Class and Prioritization Information

It is important to note that the condition class of a watershed integrates the effects of all activities within a watershed, including those of other landowners. The Watershed Condition Framework therefore provides an ideal mechanism for interpreting the cumulative effects of a multitude of management actions on soil and hydrologic function (USDA, 2011).

It is reasonable to expect that treatments resulting from implementation of the proposed action or other action alternatives would result in some short-term, localized negative effects due to soil disturbance caused by use of heavy machinery for mechanical forest restoration treatments (including commercial timber harvests), burning of piled woody debris, and broadcast prescribed fire (Debano 1998, Hungerford et al., 1991). These disturbances would also occur on soils where previously completed projects overlap proposed or future activities in watersheds across the project area, resulting in a cumulative effect to soils and watersheds. However, no long-term, cumulative adverse effects from ground disturbance caused by mechanical thinning or prescribed fire (compaction, topsoil displacement, extensive areas of high soil burn severity, etc.) are anticipated to occur at a severity or spatial extent to negatively affect overall soils and watershed conditions. In general, proposed restoration treatments are expected to result in improvement in overall soils and watershed condition in proportion to the areal extent of the restoration treatments within each watershed.

Environmental Consequences

This section describes the direct, indirect, and cumulative effects of implementing each alternative on the soil and water resources in the Rim Country Restoration Project analysis area. It presents the scientific and analytical basis for the comparison of the alternatives presented in Alternatives section and establishes the baseline against which the decision maker and the public can evaluate the effects of the action alternatives.

Alternative 1 – No Action

The No Action Alternative would result in no changes to current rates of vegetation management, commercial timber harvesting, pre-commercial vegetation treatments, or other mechanical or non-mechanical fuels reduction treatments; no changes to road construction, maintenance, decommissioning or obliteration; and no changes to prescribed fire implementation or wildfires managed for multiple resource benefits within the Rim Country Restoration project area. These activities would continue at the current scale and rate. Planned projects (e.g., Cragin Watershed Protection Project, etc.) would be implemented in accordance with official decisions and available funding. Therefore, there would be no changes to current direct effects to soils, water quality, ephemeral or intermittent stream channels, or watershed condition as a result of the no-action alternative. Other proposed activities such as restoration of springs, riparian habitats, grasslands, and meadows would continue at current rates rather than the accelerated rate proposed in the action alternatives. These important landscape features and wildlife habitats would be expected to remain in degraded or impaired conditions for longer periods than under the action alternatives.

Due to the substantially extended temporal timeframe and reduced scale under which restoration actions would occur under the No Action alternative (i.e., individual projects rather than landscape-scale restoration), it is reasonable to expect that short term adverse effects to soils and watershed conditions that result from mechanical and prescribed fire treatments would also occur at a reduced rate and scale.

Absence of Upland Vegetation Treatments and Prescribed Fire

Since tree basal area or density reduction of currently overstocked stands within the project area would not occur at the same rate as under the action alternatives, increased fuel loading in both living biomass and woody detritus would be expected through natural forest ingrowth and tree encroachment into existing openings followed by forest decadence caused by intraspecific and interspecific competition. Additionally, forest ingrowth would continue to increase "ladder fuels" which allow ground fires to ascend and spread quickly as crown fires. Coarse woody debris would be expected to increase over time as small, medium, and large diameter material begins to fall to soil surfaces and decay. While these conditions may improve soil quality in some regards (organic matter accumulation in subsurface horizons, microhabitat for soil organisms and increased organism populations, increased water holding capacity) they would also result in an increased risk of high severity wildfires where fuel loading becomes excessive.

The location, size and severity of future wildfires cannot be estimated with accuracy, although some generalizations can be made. High severity wildfires tend to occur in areas where fuel loading and fuel distributions are sufficient to carry a fire. Typically, uncontrolled wildfires occur during the drier times of the year, yielding higher severity fires than would occur under prescribed fire conditions. The adverse effects of a high severity wildfire, such as the loss of forest floor organic matter, increased soil erosion and sediment delivery to waterbodies, and changes in soil habitat and biota would be more widespread in an uncontrolled wildfire than under prescribed fire conditions (DeLong et al., 2017, Spigel and Robichaud 2005). The primary effect of high severity wildfire on soil productivity is the removal of understory vegetative cover and surface organic matter (i.e., loss of protective cover and nutrient stores), exposure of soil surfaces to erosion by wind and water, and exposure of soils to solar radiation, which increases soil temperatures and reduces soil moisture. If surface organic matter is reduced (as happens under high-severity, long-duration fire) the cation exchange capacity of the soil is also reduced and the ability of the soils to retain nutrients leached from ash also decreases.

In the absence of mechanical vegetation and fuels treatments and prescribed fire, a high severity wildfire would very likely result in increased surface runoff and downstream flooding, soil erosion, and sediment delivery to streamcourses as a result of loss of effective ground cover at the soil surface, reduced rainfall interception, and reduced soil water infiltration rates. The infrequent nature of ephemeral stream flow results in the potential for sediment and ash to be stored within these stream channels and then transported during the larger surface runoff events. This, in turn, could pose detrimental effects to surface water quality and water storage capacity in livestock and wildlife waters.

This alternative would result in no additional acres of ground disturbance over current levels from tree felling, piling of activity-related woody debris, use of prescribed fire, temporary road construction, or expansion of gravel pits. Risk of uncharacteristic wildfire would not be reduced at the same rate as the action alternatives. No improvement would be realized in forested areas, woodlands, savannas, and grassland vegetative types where vegetative ground cover conditions are departed from desired conditions. No road decommissioning, or rehabilitation of unauthorized routes or stream crossings would occur above current levels. The project area would therefore not move toward desired conditions as outlined in the Apache -Sitgreaves, Coconino, and Tonto Forest Plans as rapidly as under the Action Alternatives.

The No Action alternative would not adequately contribute to reduced forest vegetation densities, desired fire regimes, and forested conditions that would provide resilience against uncharacteristic disturbances such as high severity wildfire, insect and disease outbreaks, and prolonged drought or climate change induced mortality. Currently 37 percent of the Rim Country project area has a fire hazard index of moderate or higher, which presents difficult and dangerous suppression conditions during a wildfire and potential for adverse post fire effects on soils and surface water quality. Four percent of the landscape is in the very high category (Fire Ecology and Air Quality Specialist Report). Under dense forested condition, litterfall has resulted in thick forest floor litter layers that have displaced native plant communities. These native plant communities provided greater benefits to watershed condition and soil hydrologic function than litter alone through improved fine root turnover rates, increased fine litter, improved soil porosity and aggregate stability, increased water holding capacity, and increased organic carbon sequestration.

The effects of high severity wildfires on soils, watershed condition, water quality and water quantity are well understood. High severity wildfires can cause damaging flows to streams resulting in high levels of sediment and ash inputs as well as increased risk to riparian areas and other downstream values at risk, including forest infrastructure. It is likely that under any conditions, a wildfire entering these untreated watersheds under the no action alternative would have considerably greater effects to soil productivity, water quality and channel stability than wildfire occurring after implementation of the action alternatives. Increased water turbidity, and downstream flooding would be more widespread in an uncontrolled wildfire situation than under prescribed fire conditions where the size and intensity of the fire can be controlled. The bulking effect of sediment, ash, and debris in runoff increases the risk to surface water impoundments, infiltration basins, and public water treatment systems. Sediment and debris flows can damage water supply infrastructure (Blandon et al., 2014). Sedimentation of impoundments can decrease their effective life, resulting in a need for dredging and other mitigation measures.

In areas of high stand densities, long-term improvement in hydrologic processes will not occur in the absence of mechanical treatment and/or prescribed fire. The soils in these areas have reduced moisture storage and infiltration capacity and are easily overwhelmed by high intensity summer monsoon precipitation events, producing runoff with relatively high peak flows of short duration.

Other potential detrimental effects to hydrologic conditions in the project area and downstream locations could include the destabilization of the geomorphic conditions of stream channels due to excessive sediment delivery and debris loading, increased peak flows, and overall increases in average annual water yield resulting from loss of upslope interception, infiltration, and evapotranspiration. Ephemeral stream channels within high burn severity areas would lose their ability to buffer runoff from large rainfall events, resulting in increased channel scour and incision caused by accelerated runoff and erosion from severely burned watershed areas. Increased bedloads in stream channels effectively raises the elevation of stream bottoms, causing flood flows to exceed channel capacities, resulting in overland flooding.

In the absence of vegetation treatments proposed in Alternative 2, including prescribed fire, approximately 953,130 acres of soils resources and watersheds would not be improved.

In the absence of vegetation treatments proposed in Alternative 3, including prescribed fire, approximately 529,060 acres of soils resources watersheds would not be improved.

Absence of Riparian Area, Wet Meadow and Stream Restoration Treatments

Watershed condition is dependent on the condition of the riparian communities that exist within the watershed. The benefits of riparian areas in the project area cannot be over emphasized. Riparian areas help capture pollutants including sediment and nutrients, contribute to channel stability by providing protective vegetative cover and root biomass that anchors soils, regulate water temperatures by providing shade, provide areas for floodwater storage and dissipation and are important wildlife habitat features. The increased flows have resulted in vertical and lateral channel instability in many intermittent and perennial stream reaches. Riparian vegetation has either been scoured away or reduced through increased channel incision that has detached riparian communities from adjacent floodplains. Stream channel substrates have been altered through increased runoff and in-channel transport. In the absence of proposed riparian, wet meadow, and stream restoration activities, watershed condition would not be improved on 21,280 acres of riparian areas, wet meadows and stream channels. As a result, these areas will continue to not meet desired conditions as outlined in Forest plans and existing risks to water quality would persist.

Absence of Road Decommissioning

Roads are a major contributor to surface water quality degradation and long term loss of soil productivity. Additionally, system (permanent) roads convert productive soils to a non-productive condition for the long term (typically greater than fifty years). They therefore constitute an irretrievable, but not irreversible commitment of resources. Irretrievable is a term that applies to the loss of production, harvest or use of natural resources. Irreversible is a term that describes the loss of future options. It applies primarily to the effects of sue of nonrenewable resources, such as minerals or cultural resources, or those factors, such as soil productivity, that are renewable only over long periods of time. Since soil productivity can be restored through application of remedial measures such as disking, ripping, revegetating, etc., loss of soil productivity is not irreversible. However soil productivity is lost throughout the duration that a road exists on the landscape.

Under the No Action alternative, decommissioning of up to 200 miles of existing system roads on the Coconino and Apache-Sitgreaves National Forests, and up to 290 miles on the Tonto National Forest and 800 mile of unauthorized road would not occur. Based on an average width of 12 feet, there are approximately 1,877 acres of roads planned for decommissioning (713 acres of NFS system roads and 1,164 acres of unauthorized roads). These roads would remain on the landscape as unproductive sites and as chronic sources of sediment to streamcourses. Existing open roads and unauthorized routes would likely continue to be used for motorized travel and would remain as chronic sources of pollution, including sediment to stream channels throughout the Rim Country area, especially where the roads are poorly located in stream bottoms or hydrologically connected to streamcourses or have inadequate stormwater control or drainage.

Absence of Rock Pits and In Woods processing sites

Alternative 1 would have slightly more potential of increased sediment delivery to waterbodies than the action alternatives since road improvements proposed under the Action Alternatives would not occur. Selection of Alternative 1 would mean that road improvements would continue to occur at existing levels, which are currently insufficient to maintain road infrastructure adequately. Roads would therefore continue to serve as chronic sources of sediment to streamcourses and downstream waterbodies.

Expansion of rock pits under the Action Alternatives constitutes an irreversible and irretrievable commitment of resources since productive land is permanently altered and converted to an unproductive status and soils are permanently altered from their in situ condition through overburden removal and extraction of rock for road surfacing. Irreversible is a term that describes the loss of future options. It applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. Rock extraction limits future options for use of the converted sites and for of the material extracted. The No Action Alternative would mean that 66 acres of rock pit expansion would not occur, thereby eliminating this irreversible and irretrievable commitment of natural resources.

Alternative 1 would eliminate the need for 12 wood processing sites (128 acres). Activities such as drying, debarking, chipping stems and bark, processing and sorting logs to size, scaling and weighing logs and creating poles from suitable sized logs would therefore not occur. These sites constitute an irretrievable commitment of soils and vegetation resources since they remove soils and vegetation from productive status for several years while the sites exist. Selection of Alternative 1 would eliminate the need for this irretrievable commitment of soils and vegetation resources.

Effects Common to Both Action Alternatives

Upland Vegetation Treatments

Potential effects of the Action Alternatives on soil productivity would include localized soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and introduction of invasive and noxious weeds. These effects can result from both mechanical and non-mechanical vegetation treatments (i.e., forest thinning), mechanical and non-mechanical piling of activity-related debris, and road construction and maintenance activities necessary to support mechanical vegetation treatments. Mechanical forest vegetation treatments have the potential to adversely affect water quality through introduction of sediment and additional nutrients from decomposing woody debris, particularly where mechanical vegetation treatments occur in areas adjacent to stream courses.

Soil compaction, puddling and displacement would primarily be limited to the transportation systems and high traffic areas within mechanical vegetation treatments such as existing National Forest System roads, temporary access roads, skid trails, log landings, debris piling areas, and areas where fireline construction occur. Road closures and curtailment of mechanical vegetation treatments during wet weather conditions and designation of authorized access routes (skid trails and temporary roads) and log landings prior to project implementation would minimize adverse effects to soil productivity caused by these activities.

The effects of the proposed forest restoration activities on erosion and sediment yields depend on methods and equipment used, skills of the equipment operators and personnel conducting the treatments, site-specific conditions, storm event timing and intensity, and prescribed fire locations and burn severities.

The risk of short-term accelerated soil erosion would be highest in areas where forest thinning and use of prescribed fire results in soil disturbance or complete removal of vegetative ground cover. These areas are expected to include skid trails, log landings, temporary access roads, obliterated roads, installed firelines and fuels treatment areas to support prescribed burning efforts, and National Forest System roads.

The removal of forest cover can decrease raindrop interception and evapotranspiration, which can increase water yields from treated areas (Bosch and Hewlett 1982, Stednick 1996). In areas where the annual precipitation is less than 20 in (500 mm), removal of the forest canopy does not typically increase annual water yields (Bosch and Hewlett 1982). The decrease in interception and transpiration caused by forest thinning is usually offset by the increase in soil evaporative losses, resulting in no net change in runoff as long as factors affecting runoff processes are not changed (for example, soil compaction which causes a shift from subsurface flow to overland flow) (MacDonald and Stednick 2003). Evapotranspiration rapidly recovers with vegetative regrowth in partially thinned forests. Increases in runoff due to thinning operations rarely persist for more than 5 to 10 years (Robles et al. 2014, Cram et al. 2007).

Thinning of forest cover on soils currently characterized as unsatisfactory would improve soil conditions over the long-term by improving soil moisture and allowing greater sunlight penetration to the forest floor (for example sunflecks) resulting in an increase in grasses, forbs and shrubs in the forest understory where litter is currently the dominant soil cover (Griffis et al., 2000). The increased herbaceous vegetation would reduce soil erosion rates by providing vegetative ground cover that would intercept rain before it can reach soil surfaces and detach and entrain soil particles in runoff. Woody debris from forest thinning (i.e., slash) would be lopped and scattered where doing so would not result in excessive fuel loads, further mitigating potential adverse effects to soils and watershed resources. Finer litter and woody debris that is incidental to forest vegetation treatments (i.e., needles, leaves, twigs, cones, bark, etc.) would also remain on the ground following mechanical treatments to protect soil surfaces from wind and water erosion.

Prescribed Fire

Prescribed fire has the potential to affect water quality by increasing sediment, dissolved solids, and nutrients in streams. Dissolved nutrients in stream flow primarily originate from weathering of parent materials and soils, decomposition of plant material and other organic matter, and anthropogenic sources. Vegetative communities accumulate and cycle nutrients (Tiedemann et al. 1979, 1987). Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil and organic matter nutrients such as nitrogen, phosphorus, copper, iron, manganese, and zinc are volatilized and lost from the system, while other nutrients such as calcium, magnesium, and potassium are converted into oxides and accumulate in ash (DeBano et al. 1998).

The mobility and concentration of nutrients in soils determines whether or not nearby water sources are at risk of contamination when prescribed fire is used. Nitrate is highly mobile and is therefore subject to risk of being leached from burned areas and transported to either surface or ground water. Phosphorus adsorbs readily to sediment and organic materials. Thus, phosphorus is usually transported to streams and water bodies through soil erosion. Rates of soil erosion and phosphorus contamination are generally dependent on soil characteristics and topographic relief of the site.

Prescribed fire has the potential to alter short- and long-term soil productivity and moisture content by changing the amount and type of vegetation, the amount of forest floor organic matter, and surface soil texture and wettability(O'Donnell et al., 2014). Prescribed fires typically leave greater amounts of organic matter (duff, forest litter, and large and small woody debris) on soil surfaces than uncontrolled fires. These materials serve as nutrient sinks, prevent soil particle detachment caused by raindrop impact, and capture sediments that would otherwise be transported to stream channels and waterbodies. Following low-intensity prescribed fires, an increase in grasses and other herbaceous vegetation often occurs. This rapid regrowth of ground cover further immobilizes nutrients in plant material.

Prescribed fires that remove large amounts vegetation from a site have potential to alter watershed hydrology. As vegetation is removed, evapotranspiration in the watershed decreases, thus providing greater stream flow and overall water yield within the watershed. Water uptake from trees is species-specific. Conifers, which are the dominant vegetation type throughout the Rim Country analysis area, generally transpire greater quantities of water than hardwoods such as oaks and aspen. Dense foliage and longer growing seasons promote the higher overall water uptake in conifers. Additionally, conifers have relatively dense crowns that intercept rainfall and allow for greater evaporative losses.

Once a site has undergone loss of vegetation and removal of the litter layer, surface water can cause erosion problems and result in higher stream discharges. Fires not only consume portions of the litter layer, but at high temperatures fires can also cause hydrophobic soil conditions (water repellant soils), thus making soils more susceptible to erosion. DeBano and Krammes (1966) and Robichaud (2000) observed that water repellency was dependent on the heating temperatures of the soils. At typical wildfire soil profile temperatures (less than 500°F) when the soil was dry, soil hydrophobicity occurs at shallow depths (less than 1 inch). When soils are moist (i.e. conditions that commonly occur during prescribed fire in the spring and fall), soil hydrophobicity was less pronounced and only occurred after long heating times which would typically only occur during smoldering fires. Therefore, soil hydrophobicity under a prescribed fire scenario would likely be minimal in most cases.

Fire in southwestern ponderosa pine forests has been shown to generally increase soil moisture content (Ryan and Covington 1986, Ower 1985, Haase 1986). In a review of literature, Hungerford and others (1991) reported that burning can kill many kinds of bacteria, fungi and arthropods but the extent of this effect is dependent on the amount of heat generated by the fire and soil moisture content. To what extent these changes result in an impairment or degradation of soil productivity is not clearly understood. Hungerford suggests that low to moderate intensity prescribed fires may have minimal long-term negative effect on soil microorganisms. Kaye and Hart (1998) found that microbial nitrogen transformation rates increased under restored forest conditions, relative to the controls, suggesting higher microbial activity in the restored areas. Neary and others (1999) caution against the adverse effects to soil microorganisms caused by fires that become intense or are too frequent. Researchers have recommended maintaining soil carbon pools to maintain biologic activity (Stark and Hart, 1997), and recommend maintaining heterogeneity in burned areas to provide suitable sites from which the microflora and microfauna can reestablish in burned areas (Moldenke, 1999).

Prescribed fires proposed under the action alternatives are expected to be dominantly low soil burn severity with small areas of medium and high soil burn severity, retaining unburned islands and creating a mosaic of fire effects. Low and medium severity fires burn only a portion of the surface organic matter – leaving adequate soil cover over much of the burned area. In general, low severity prescribed fire does not cause excessive erosion or sediment transport since some soil cover is retained in a discontinuous pattern across the landscape. This type of prescribed fire would not have a long-term adverse affect on soil moisture content or biota. The increase in understory vegetation would improve long term soil structure and porosity through increased fine root volume and vegetative litter, which are important habitat components for soil fauna that then incorporate organic matter into soil profiles and facilitate nutrient cycling.

Installation of firelines where they do not currently exist would expose soil surfaces, increasing the risk of erosion by both wind and rain. Areas of high severity fire may consume forest floor organic matter, leaving soil surfaces hydrophobic (repellant to water) and susceptible to erosion. Initially, the greatest risk of soil erosion would be expected to occur in areas where prescribed fire is implemented prior to forest thinning treatments. This is due to greater amounts of woody debris on the ground, higher stand densities and crown bulk densities at these locations, resulting in increased risk of high severity fire. Rehabilitation of firelines installed during prescribed burning would minimize adverse affects to soil productivity from fireline installation. Implementing prescribed burning under conditions that would minimize high severity fire would minimize areas where soil organic matter is totally consumed and prevent hydrophobic soil conditions.

Piling of activity-related debris (slash) would disturb soil surfaces, exposing them to direct raindrop impact and wind. On steep terrain this would increase localized, short-term erosion rates in areas where pile burning is conducted. These areas would constitute a very small percentage of overall treatment area (10 to 15 percent), so these effects are expected to be minor. Use of appropriate design features and BMPs as outlined in Appendix F would mitigate most adverse effects from piling of woody debris created during forest thinning operations. Additionally, use of excavators with hydraulic bucket thumb attachments would minimize soil disturbance resulting from machine piling more effectively than dozer piling.

Burning of slash piles has been shown to negatively affect soil biotic and chemical properties due to intense soil heating (Korb et al, 2004 and Seymour and Tecle, 2004). It can result in soil sterilization, increased erosion risk and an increased risk of invasive and noxious weeds that displace native vegetation. Pile burning sites would constitute a very small portion of the project area (less than 10 percent). Employing piling techniques that would minimize soil burn severity (such as rack-and-pile technique) whereby the pile is elevated on a grid of logs would reduce soil of these sites for the presence of invasive or noxious weeds following pile burning, and treatment of any infestations found would mitigate most adverse effects to soils caused by pile burning of slash.

Soil organic matter serves as the long-term nutrient supply for all vegetation occupying a site. It also provides microhabitat for most soil organisms and improves soil chemical and physical properties including soil aggregate stability, increased porosity, improved water holding capacity, lower bulk densities, and nutrient cycling. Initially, there would be an expected short-term increase in soil organic matter as a result of mechanical vegetation treatments as fine litter and woody debris are deposited on soil surfaces during treatments. Forest thinning would also allow greater light penetration to soil surfaces resulting in warmer soil temperatures. The reduction in tree vegetative cover as a result of forest thinning would decrease overall evapotranspiration rates from trees, but this is typically offset by increased evapotranspiation of understory herbaceous vegetation within a few years following treatment. Warmer soil temperatures would result in increased soil biological activity. Increased soil biological activity results in a proportional decrease in soil organic matter as organisms consume soil detritus. The eventual increase in understory vegetation would result in increased litterfall and deposition of organic matter onto soil surfaces. Broadcast prescribed fire would result in rapid oxidation of surface organic matter and living understory biomass, causing a release or transformation of some soil nutrients. Over time, a balance would occur between soil organism activity and soil organic matter content. This balance is readjusted whenever fire is reintroduced. Low severity fire typically results in beneficial relationships between soil organism populations and soil organic matter content.

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to water courses is difficult to estimate since it occurs as non-point runoff. Sediments delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches. In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culverted crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to stream courses.

Temporary Road Construction and Road Improvements

Temporary road construction constitutes an irretrievable commitment of soils and vegetation resources to a project. This is because they commit soils to nonproductive status for the duration of the road's existence and for several years afterwards, soil profiles are permanently altered from the *in situ* conditions, and vegetation (timber and forage) is removed from the traveled way. However, temporary roads are not an irreversible commitment of these resources, since soils eventually return to productive status after the road has been decommissioned and vegetation, including trees, typically returns to the road corridor.

Temporary roads are minimum design standard roads and therefore have fewer negative environmental effects that permanent roads. Typically, temporary roads are native surface roads that are simply "bladed" soil surfaces to smooth the soil surface sufficiently for log transport for short distances (i.e., usually less than a mile). Temporary roads usually do not have culverted stream crossings or long segments of fill material.

Both Action Alternatives will require installation of temporary roads. Alternative 2 would require approximately 330 miles of temporary roads in order to access areas for mechanical vegetation treatments, while Alternative 3 would require 170 miles of temporary roads.

Depending on temporary road locations and timing of use, these roads can adversely affect soil productivity for the duration of the road use and for several years following decommissioning and abandonment. Design criteria and BMPs in Appendix F of the Soils and Watershed Specialist's Report would limit adverse effects of temporary roads by preventing them from being located in sensitive areas (Aquatic Management Zones, near spring ecosystems, and in riparian habitats) except where designated stream crossings are necessary. Upon decommissioning, temporary roads would have water control features installed as needed, would be stabilized using logging slash to protect soil surfaces from raindrop impacts, minimize soil erosion, and prevent visitors from using the road for motorized travel.

Temporary roads are therefore expected to have minimal long-term effects to soil productivity, water quality, and vegetation and therefore watershed condition.

Existing system roads may be improved or realigned to provide serviceable and safe access for forest mechanical vegetation and prescribed fire treatments. These improvements will protect soil productivity and surface water quality by: a) preventing roadbed erosion through application of aggregate to provide a more stable and reliable running surface, b) provide road drainage that prevents erosion and sediment delivery to streamcourses, c) reduce effects of stream crossings through improved road stream crossing designs.

Road Use

Approximately 5,682 miles of National Forest System roads would be needed to implement the Action Alternatives. Vehicle traffic associated with project implementation, particularly trucks, tend to pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and alter flow regimes in streams.

It is likely that traffic associated with mechanical restoration treatments and commercial timber sales would have short term adverse effects to surface water quality through sediment delivery to streamcourses and other water bodies and increases in turbidity. Use of Resource Protection Measures and applicable road BMPs would minimize and mitigate most adverse effects from road use, but would not eliminate them entirely. As previously noted, forest roads are typically one of the major sources of surface water quality degradation from forest operations.

Once mechanical treatments are completed and transportation of forest products and machinery no longer occur on a given road, adverse effects to water quality typically diminish and return to background level proportional to historic road use levels.

Road Decommissioning

Approximately 490 miles of poorly located and infrequently maintained system roads would be decommissioned under the Action Alternatives (200 on the Coconino National Forest and A-S National Forest and 290 miles on the TNF). Additionally, approximately 800 miles of unauthorized roads would be decommissioned on the A-S and Coconino National Forests.

Road decommissioning actions will vary, depending on road locations, conditions, and effects on other resources (e.g., soils, water quality and watershed conditon), but could include activities such as ripping, seeding, mulching, filling inside ditches, outsloping road prisms, removal of culverts and fill material, re-contouring of stream crossings, removal of unstable sidecast material or cutslope stabilization, and blocking of entrances to prevent future access. These activities would return unproductive or marginally productive soils to a more stable, productive status over the long term by improving water infiltration and vegetative ground cover and reducing erosion hazards. Stream crossings would be returned to a more natural condition, thus reducing runoff and sediment delivery into ephemeral stream channels or intermittent or pernnial waterbodies. Adverse effects to surface water quality caused by stormwater runoff from road surfaces would also be minimized. Modeled erosion rates of roads are, to a large degree, at or above tolerance erosion rates.

Use of residual woody debris from mechanical timber harvest (i.e., slash) or fuels reduction treatments for closing roads is a common practice for road decommissioning. However, this practice rarely improves hydrologic function where roads have interupted or redirected surface flows via ditches and cross drain culverts, road surfaces are severly compacted, or have channelized flow in the existing roadbed. Additionally, slash can be burned in wildfires and prescribed fires, leaving roads essentially reopened to unauthorized use. Slash alone does not appreciably contribute to native plant propagation within retired roadbeds. While slash can be used as a tool to prevent road use, it should be one component in a suite of road decommissioning practices described above that result in a more naturalized condition upon completion of road decommissioning.

Road decommissioning improves watershed condition by reducing open road densities within affected watersheds. Reducing the number of roaded miles per unit area of watershed reduces hydrologic impacts that roads have on that watershed. Hydrologic impacts such as stream crossings and hydrologic diversions that result from road ditches, cross drainages, etc. are therefore reduced. Road decommissioning typically results in improved soil productivity and water quality(Sosa-Perez and MacDonald, 2017).

Rock Pits and Wood Processing Sites

Rock Pits

As previously noted, expansion of rock pits under the Action Alternatives constitutes an irreversible and irretrievable commitment of 69 acres of soils, and geologic resources since productive land is permanently altered from its natural condition and converted to an unproductive condition in perpetuity and through the extraction of rock for road surfacing. Irreversible is a term that describes the loss of future options. It applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. Rock pit expansion limits future options for use of the converted sites and rock extraction eliminates future options for use of the extracted material. Both Action Alternatives would mean that 69 acres of rock pit expansion would occur, thereby making an irreversible and irretrievable commitment of natural resources.

Wood Processing Sites

The Action Alternatives would include 12 wood processing sites totaling 128 acres. The criteria for selection of sites suitable for wood processing included the following: flat uplands having less than 5 percent slope, more than 200 feet distance from ephemeral and intermittent stream channels, and more than 300 feet from meadows and springs. These design criteria, in addition to applicable Resource Protection Measures, would reduce the potential for adverse effects to surface water quality, stream channels, riparian resources, and spring ecosystems. However, these sites constitute an irretrievable commitment of soils and vegetation resources since soils would be committed to nonproductive status for the duration of each wood processing site's existence and vegetation removal would be required for establishing sites, reducing the areal extent of available forage or forest cover. The scale of this irretrievable commitment of soils and vegetation resources for the establishment of wood processing sites in the context of the total project area is minimal at 129 acres and would not likely have detectable adverse effects at the watershed scale.

Riparian, Spring and Stream Restoration

Comprehensive restoration activities included in the Action Alternatives and described in the Aquatic and Watershed Flexible Toolbox would directly improve stream channel morphology, riparian and slope wetland conditions, floodplain functionality and spring ecosystems. Restoring stream channel gradients and increasing channel sinuosity, restoring width-to-depth ratios and reconnecting stream channels to their historic floodplains would improve hydrogeological conditions at the watershed level. Surface flows, floodplain water storage, and sediment transport would all be improved. Activities such as installation of grade control structures has been shown to be effective for dissipating runoff energy, improving sediment storage, aggrading incised stream channels and reconnecting them to historic floodplains. Wet meadows would be effectively restored through implementation of these, and similar practices that eliminate single-thread streams and gullies that are drying out these wetlands. Planting native herbaceous riparian species, stabilizing stream banks, reducing bank steepness of entrenched channels and reconstructing riffle and pool formations would contribute to improved hydrologic function of stream channels

Since upland restoration actions (i.e., forest thinning and prescribed fire) could have a cumulative effect on restoration of riparian areas, springs and streams, it is imperative that upland restoration actions are staged in a manner that compliments comprehensive restoration activities. Upland restoration treatments are expected to produce varying levels of runoff and sediment delivery to riparian areas such as wet meadows and riparian stream corridors as well as stream channels themselves. Currently these areas are sediment deprived, meaning historic sediment loads originating from wildfires are absent. This, combined with historic overgrazing has resulted in gully and channel formation in meadows and incision of streamcourses. Conducting comprehensive restoration treatments prior to upland restoration actions would allow for sediment to deposit as alluvium where desired, rather than being transported through the system in a manner that increases surface scour. If staged optimally, upland restoration treatments combined with comprehensive restoration treatments would provide the greatest benefit to watershed condition through improved sediment capture and utilization, improved surface water quality through reduced suspended sediment loads, and nutrient storage and filtering in riparian areas.

There would likely be short-term, adverse effects to surface water quality through implementation of these restoration actions since they are often in-channel restoration practices, occur in wetland areas, or are in riparian areas immediately adjacent to stream channels and wetlands. With implementation of Resource Protection Measures and BMPs, adverse effects can be minimized or mitigated. Native riparian and wetland vegetation is expected reestablish in these areas soon after restoration activities are completed (1 to 3 years). In some areas, reestablishment of wetland or riparian vegetation would be hastened by planting of appropriate wetland or riparian herbaceous and woody species. Installation of protective exclosures around restored sites would reduce browsing and trampling by both domestic and wildlife ungulates.

Effects Unique to Each Action Alternative and Differences among Them

Mechanical Forest Restoration Treatments (Thinning)

One of the primary differences between Alternative 2 – Modified Proposed Action and Alternative 3- Focused Restoration is the number of acres and intensity of mechanical forest restoration treatments. Alternative 2 proposes to mechanically thin trees and/or implement prescribed fire on up to 953,130 acres, while Alternative 3 would mechanically treat slightly more than half (55 percent) of those acres at 529,060 acres. Alternative 2 addresses landscape-scale mechanical forest restoration across the majority of the Rim Country analysis area more effectively than Alternative 3. Alternative 3 is designed to focus restoration treatments in areas that exhibit the greatest departure from the natural range of variation (NRV) of ecological conditions, and/or that put communities at risk from undesirable fire behavior and effects. Therefore, Alternative 3 would leave the greatest number of acres that are moderately departed from desired ecological conditions and would benefit from mechanical restoration treatments to restore forest vegetation health and resilience.

Alternative 2 - The Modified Proposed Action

Since Alternative 2 would provide the greatest areal extent of forest mechanical restoration treatments, it would correspondingly result in a higher proportion of acres that are resilient and fire adapted. As a result, Alternative 2 would improve soil and watershed condition to a much larger degree that Alternative 3.

The greater number of acres that would be treated mechanically also means there would be a corresponding increase in short term adverse effects to soils, water quality and watershed condition. With the higher number of acres to be treated mechanically, adverse effects such as soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and risk of introduction of invasive and noxious weeds are likely. The extent and locations of such effects cannot be predicted with accuracy, although some generalizations can be made. Mechanical forest vegetation treatments under Alternative 2 would require more disturbance through construction of temporary roads and road use (330 miles of temporary roads under Alternative 2 vs. 170 miles of temporary roads under Alternative 3), and more log landings and skid trails. More frequent road maintenance would be required since there would be substantially more truck traffic under Alternative 2 than Alternative 3.

As previously noted, soil compaction, puddling and displacement would primarily be limited to the transportation systems and high traffic areas within mechanical vegetation treatments such as existing National Forest System roads, temporary access roads, skid trails, log landings, and debris piling areas.

At the watershed scale, it is possible that the greater areal extent of mechanical vegetation treatments under Alternative 2 would result in increased water yield from watersheds where large percentages of the watershed are mechanically treated in a short timeframe. However, any increases in water yield would be short lived (i.e., 5 to 10 years) since understory vegetation would increase and the water uptake by grasses, forbs and shrubs and warmer soil temperatures would soon offset evapotranspiration lost from forest thinning.

Forest thinning on soils currently characterized as unsatisfactory would improve soil conditions over the long-term by improving soil moisture and allowing greater sunlight penetration to the forest floor (i.e., sunflecks) resulting in an increase in grasses, forbs and shrubs in the forest understory where litter is currently the dominant soil cover.

Alternative 3 – Focused Restoration

Alternative 3 would result in substantially fewer acres being treated mechanically. There would therefore be correspondingly fewer acres that would exhibit adverse effects from mechanical forest restoration treatments such as soil compaction, puddling, displacement, erosion, loss of soil organic matter, short-term changes in soil moisture content or retention, changes in nutrient cycles, changes in soil fauna, and risk of introduction of invasive and noxious weeds. Adverse effects to surface water quality would also be reduced under Alternative 3. However, over the long term, there would be a much greater number of acres that would remain departed from vegetation and fuels desired conditions. These areas would likely remain at risk of high severity wildfire due to high fuel load levels.

Prescribed Fire

Alternative 2 – Modified Proposed Action

Alternative 2 proposed substantially more acres of prescribed fire than Alternative 3. Prescribed fire has the potential to impact soil productivity and surface water quality by increasing soil erosion rates and delivery of sediment, dissolved solids, and nutrients to streams and other waterbodies. Since more acres would be treated with prescribed fire under Alternative 2, it is reasonable to expect that there would be greater areal extent of short term adverse effects to soil productivity and water quality and therefore watershed condition. However, adverse effects of prescribed fire on soils, water quality and watershed condition would not be nearly as great as an uncontrolled wildfire.

Prescribed fire has the potential to alter short- and long-term soil productivity and moisture content by changing the amount and type of vegetation, the amount of forest floor organic matter, and surface soil texture and wettability. Prescribed fires typically leave greater amounts of organic matter (duff, forest litter, and large and small woody debris) on soil surfaces than uncontrolled fires. These materials serve as nutrient sinks, prevent soil particle detachment caused by raindrop impact, and capture sediments that would otherwise be transported to stream channels and waterbodies. Following low-intensity prescribed fires, an increase in grasses and other herbaceous vegetation often occurs. This rapid regrowth of ground cover further immobilizes nutrients in plant material.

The mobility and concentration of nutrients in soils determines whether or not nearby water sources are at risk of contamination when prescribed fire is used. Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil and organic matter nutrients such as nitrogen, phosphorus, copper, iron, manganese, and zinc are volatilized and lost from the system, while other nutrients such as calcium, magnesium, and potassium are converted into oxides and accumulated in ash (DeBano et al. 1998).

Prescribed fires can adversely affect watershed hydrology. As vegetation is removed, evapotranspiration in the watershed decreases, thus increasing stream flow and overall water yield within the watershed. The increase in water yield may result in a corresponding increase in sediment and nutrient loads in surface waters.

Trends indicate that fuel loading would continue to increase in areas that are not thinned mechanically. Increased fuel loads would be in the form of both living forest vegetation and woody detritus. Ingrown forest conditions would facilitate the existence of ‘ladder fuels’ which allow ground fires to ascend into the canopy and spread quickly as crown fires.

High severity wildfires tend to occur in areas where fuel loading and fuel distributions are sufficient to carry a fire. Typically, uncontrolled wildfires occur during the drier times of the year, yielding higher severity fires than would occur under prescribed fire conditions. The adverse effects of a high severity fire, such as the loss of forest floor organic matter, increased soil erosion, and changes in soil biota would be more widespread in an uncontrolled wildfire than under prescribed fire conditions where the size and intensity of the fire can be controlled. The primary impact of high severity wildfire on soil productivity is the removal of surface organic matter, exposing soils to erosion by wind and rain. If surface organic matter is reduced (as happens with a high severity wildfire) the cation exchange capacity, a measure of soil fertility, is also reduced and the ability of the soil to retain nutrients leached from ash decreases.

Cumulative Effects

Cumulative effects include the impacts on the environment which result from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other action (40 CFR § 1508.7). The geographic setting for the cumulative effects analysis for soils and watersheds includes all of the 6th level (HUC-12) hydrologic unit subwatersheds that include Rim Country project area, which comprises approximately 137,153 acres. The timeframe for past actions is twenty five years, based on soil productivity, vegetative response, and coarse woody debris recovery within treated areas. This timeframe accounts for the 20 years of project implementation, plus 5 years of recovery after the last project activity is implemented. Surface disturbing activities that are older than 20 years are assumed to be contributing negligible or no measurable cumulative effect within the analysis area.

Alternative 1 – No Action

The No Action Alternative would result in no additional mechanical forest vegetation or prescribed fire treatments, no additional road construction, realignment or decommissioning, no additional spring or riparian restoration, no stream channel restoration, no rock pit expansion, and no wood processing site beyond what has been planned under separate NEPA analyses. Therefore, there would be no cumulative effects to soils or watershed condition as a result of the No Action Alternative beyond those already planned or being implemented under separate NEPA decisions. As can be seen in Appendix G of the Soils and Watershed Specialist's Report, the majority of past, present and reasonably foreseeable future actions consist of forest restoration and fuels reduction treatments. Other restoration actions such as grassland and meadow restoration, spring restoration, and fire rehabilitation are occurring, have occurred in the past or may occur in the future. Restoration projects are designed to improve forest and grassland vegetation conditions and therefore contribute to improved soil and watershed condition.

A cumulative effect of the No Action alternative includes ongoing erosion and sediment delivery to ephemeral channels from roads proposed for obliteration under the Action Alternatives that would not be obliterated under this Alternative. When combined with other activities in the proposed project area, sediment production from these roads could contribute to adverse effects to downstream surface water quality if these roads remain in an unstable, eroding condition.

When combined with past, present and reasonably foreseeable future actions, the No Action alternative would not contribute to appreciable improvement in soils or watershed conditions in watersheds that encompass the Rim Country analysis area.

Alternative 2 – Modified Proposed Action

Mechanical Forest Restoration Treatments, including Timber Harvesting

Soil Stability and Erosion Processes

Proposed meadow and riparian restoration and stream channel restoration will improve soil stability, nutrient cycling, vegetative cover, and hydrologic processes and therefore watershed condition. Cumulative effects of Alternative 2, in combination with past, present and reasonably foreseeable future action includes meadows (slope wetlands) that are storing water and recharging groundwater systems, stable against extreme runoff velocities and therefore less prone to headcutting and gully formation. Sediment delivery to streamcourses would be greatly reduced and would return to historic, or background levels due to reduced fire burn severity, improved vegetative cover of native perennial grasses and forbs.

Poorly located roads proposed for decommissioning are, in some cases acting in a similar manner as gullies, channelizing runoff into ephemeral and intermittent drainages and other waterbodies. Decommissioning of 490 miles of system roads and 800 miles of unauthorized routes will contribute to improved watershed condition at the landscape scale through reduction of roaded miles per unit of land area, leading to greater areal extent of naturalized watershed condition. When combined with other past, present and reasonably foreseeable future actions, road decommissioning under Alternative 2 would improve watershed condition throughout most of the project area more effectively than is currently occurring under the No Action Alternative or would occur under Alternative 3.

Nutrient Cycling

Soil nutrient cycling would progress toward desired conditions as tree litter layers (thick layers of pine needles) are replaced with vegetative cover and fine litter. Fine roots of grasses, forbs, and shrubs would improve soil aggregate stability, water infiltration, and decrease soil bulk densities. These conditions allow nutrients to translocate both vertically and laterally as water infiltrates and moves through soil matrices rather than being transported to water bodies in runoff.

Continued reintroduction of fire to these fire-adapted systems will result in progressively lower soil burn severities over time, resulting in only partial consumption and light charring of organic matter, resulting in more recalcitrant forms of organic matter that contribute to improve C:N ratios and incorporation of other nutrients (phosphorus, sulfur, potassium, etc.) into upper soil horizons.

Soil Hydrology

Historic evidence indicates that existing landings, skid trails, and roads constitute approximately 5 to 10 percent of the total project area. As previously noted, roads proposed for obliteration tend to be compacted and rutted, and are often channelizing surface runoff to surface waters and are not exhibiting substantial recovery. In order to mitigate any additional compaction and displacement of soils, temporary roads, skid trails, and landings would be stabilized using Resource Protection Measures and BMPs, which may include ripping or decompacting and seeding to alleviate reductions in porosity and infiltration capacity. Therefore, it is not expected that the percentage of compacted areas would increase substantially (i.e., beyond an additional 1 to 2 percent over the current condition). Any soil compaction resulting from mechanical vegetation treatments would be ameliorated over time through pedoturbation caused by soil freezing and thawing and wetting and drying cycles, and root elongation.

Areas of water repellency, which form as a result of the prescribed fire use are expected to recover within 1 to 3 years as natural pedoturbation processes described above occur.

Watershed Response

When combined with other past, present and reasonably foreseeable future projects, Alternative 2 would be beneficial to watershed response. In the absence of maintenance treatments this benefit would decrease over time as a result of forest ingrowth that would increase evapotranspirational demand.

Recreational Activities

Recreational activities within the proposed project area include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Other common uses within the project area include firewood cutting, Christmas tree cutting, collecting boughs and cones, gathering antlers, and collecting food and medicinal resources such as berries, nuts, mushrooms, and medicinal plants. Of these, ORV/ATV use, dispersed camping, firewood collection and Christmas tree cutting have the greatest potential to result in adverse cumulative effects to soils through compaction, puddling, erosion, and displacement. These conditions would be limited to areas where such activities take place.

Restoration treatments will increase forest openings and provide more opportunity for recreational activities to be dispersed across the landscape rather than concentrated in a smaller number of areas. Dispersed recreation tends to have reduced impacts to soils, water quality and watershed condition in comparison to concentrated recreational use. In combination with past, present and reasonably foreseeable recreation activities, Alternative 2 would improve soils and watershed condition throughout the Rim Country analysis area through improved vegetative ground cover which provides for sustainable nutrient cycles and soil productivity, reduced erosion and sediment delivery to stream channels, and improved water quality and overall improved watershed condition.

Since Alternative 3 will result in fewer forest openings than Alternative 2, it is less likely to alter recreational patterns appreciably. Recreationists will continue to congregate in existing openings, resulting in excessive soil disturbance and loss of vegetative cover that reduce soil stability and hydrologic function. Soil erosion from such sites would likely continue to exceed tolerance thresholds.

Livestock Grazing

Currently, livestock grazing is authorized across most of the analysis area. While grazing results in discontinuous fuel patterns in grass, forb and shrub vegetative communities, it has not effectively reduced the densities in the ponderosa pine stands. As a result, excessive stand densities in the ponderosa pine vegetation type are causing a shift in understory vegetative communities toward more shade tolerant species such as bromes and mountain muhly.

Cumulative effects from livestock grazing when added to effects from restoration treatments would include minor, generally localized soil compaction, puddling, displacement and erosion from livestock trailing and in areas where animals congregate such as livestock waters and areas where mineral supplements are placed. Livestock trails make up a very small portion of the total project area and therefore have a negligible effect on soils or watershed condition. When added to the effects of the restoration treatments livestock grazing is not expected to increase the area of soils characterized as unsatisfactory within the cumulative effects area. Overall, in combination with ongoing livestock grazing and in the absence of increasing livestock numbers being grazed, Alternative 2 would benefit soils and watershed conditions to a greater extent than alternative 3.

Invasive and Noxious Weeds

The cumulative effect of the increased risk of spread on noxious weeds on soil productivity can only be described in general terms because of the large number of unknown variables. Areas where soil disturbance includes compaction, displacement, erosion, and excessive heating are at the greatest risk of invasion by noxious weeds. These include temporary roads, areas where concentrated harvesting operations occur and pile burning sites. To minimize cumulative adverse effects of invasive and noxious weeds, observed infestations would be managed in accordance with the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds Coconino, Kaibab, and Prescott National Forests (2005).

Fire Effects

In low burn severity areas, effects are mainly light ground char where the litter is scorched, charred, or partially consumed. The litter layer, or duff is largely intact, although it may be charred on the surface. Woody debris accumulations are partially scorched, charred, or consumed. Mineral soil properties are not adversely affected. In fact, low severity fire releases nutrients stored in surface organic matter and live vegetation. These nutrients facilitate rapid reestablishment of vegetative ground cover since root to shoot ratios are improved for grasses and forbs that survive fire, resulting in protection of soils from accelerated soil erosion soon after fire has occurred. Evidence of sheet and rill erosion as a result of low severity fire is typically very minor or nonexistent. In forested areas, much of the tree overstory is green with some scorch at the base of the trees and in the lower branches following low severity fire. Most trees survive; however, pockets of seedlings, saplings, and mature trees can be killed or consumed where moderate to high severity fires occur. While most of the shrubs, forbs and grasses are affected under low severity fire conditions, in most cases, much of this vegetation survives. Areas identified as low burn severity may also contain large unburned areas, resulting in a mosaic of burned and unburned conditions across the landscape or within a subwatershed. When combined with other past, present and reasonably foreseeable prescribed fire project, Alternative 2 would have beneficial effects on soils and watershed conditions.

Cumulative watershed effects

In summary, cumulative watershed effects from implementation of the Alternative 2 would include improved soils and watershed condition and restoration of the ecological interrelationships of soils, vegetation, and watersheds throughout the Rim Country project area. Streams, meadows and riparian areas that depend on stable upland soils would be better protected from potential adverse effects of high severity wildfire as a result of restoration treatments. The transportation system would provide necessary access for future management and would be more sustainable than the current transportation system. Short-term negative effects to soils, water quality, and watershed conditions, primarily through soil disturbance and loss of vegetative cover would be greater under Alternative 2 than Alternative 3. However, these effects will generally not persist beyond 3-5 years following each discrete disturbance. Since Alternative 3 results in greater areal extent of areas that remain untreated, these areas will remain at risk of high severity wildfire, concentrated recreational uses, and erosion and sediment delivery from roads that are not decommissioned. Alternative 2 therefore has greater long term benefit to soils and watershed condition than Alternative 3.

Alternative 3 – Focused Restoration

Cumulative effects of Alternative 3 would be similar to those of Alternative 2, but would occur at a substantially reduced areal extent with regard to forest mechanical thinning and prescribed fire treatments. Add a one or two sentences that clarify the substantially reduced areal extent blurb.

Other restoration actions (stream channel restoration, spring restoration, road decommissioning, etc. would be the same as Alternative 2.

Vegetation

The vegetation analysis is summarized from the Silviculture Report, which is incorporated by reference (Moore 2019).

Affected Environment

The cover types analyzed are limited to Aspen, Grassland/Meadow, Madrean Encinal Woodland, Madrean Pinyon-Oak, Mixed Conifer with Aspen, Mixed Conifer/ Frequent Fire, Pinyon-Juniper Woodland, Ponderosa Pine, and Ponderosa Pine/ Evergreen Oak and riparian for a total of 951,691 acres. For analysis purposes, the Madrean Encinal Woodland and Madrean Pinyon-Oak cover types will be combined into one category called Madrean Woodland due to limited acreage, data availability and similarity.

Of the 1,238,658 acres within the project area:

- Approximately 255,249 acres have been removed from this silvicultural analysis because they are part of an ongoing project or are being analyzed in a separate analysis (Figure 3). Silvicultural treatments and their effects within these areas will not be analyzed in this report.
- Approximately 30,263 acres are either non National Forest System lands, or are non-forested.
- An additional 1,141 of these acres identified as "Other" in Table 4 were determined to be either surface water, mineral pits, dams or road surface and will not be given a detailed description in this silvicultural analysis.
- The remaining 951,691 acres, considered the analysis area, will be analyzed in this report.

The descriptions of the existing condition are organized under the criteria determined to be part of a properly functioning ecosystem. An ecosystem that is properly functioning is thought to be resilient to perturbations in structure, composition, and biological or physical processes. Systems at risk are those that may be degraded beyond the range of resiliency and sustainability. The four ecosystem characteristics discussed below are cover type, composition, structure, pattern, and processes.

Post-European Settlement Era Ecological Changes

Open, frequent fire forest structure has been altered by logging, grazing, and fire suppression and has led to overly dense forest structure and fire regimes highly departed from their desired conditions.

Large, old ponderosa pines and oaks have become underrepresented in some areas. The remaining large, old ponderosa pines are suffering increased mortality rates as a result of competition with small trees, insects and disease, and climate change.

Ponderosa pine forests have increased in density as abundant tree seedlings have regenerated in canopy openings and replaced some open, multiple age class forest structure with a dense and predominately single age class structure. This resulted from logging practices, protection from fire, grazing, and a relatively wet climatic cycle during the early part of the 20th century (Schubert 1974). In other areas, uneven-aged stand structure remains as a result of historical mechanical harvesting as well as natural disturbance.

Frequent low-severity fire regime forests have increased densities from shade tolerant and fire intolerant species. Dry mixed conifer forests are far denser and with a species composition that is not necessarily representative of their NRV. Competition for moisture and nutrients is intense in currently dense stands, and results in stress that increases vulnerability to attack by insects such as pine bark beetles (*Dendroctonus* spp.) and ips beetles (*Ips* spp.) (Kane and Kolb, 2014).

While experts think that the extent of dwarf mistletoe has increased only modestly, the abundance and intensity of infections have increased substantially across the project area (Conklin and Fairweather 2010) due to closed forest conditions, lack of low severity fire, and lack of adequate mitigation management. This increased infection severity has been associated with decreased resilience to beetle- and drought-induced mortality (Kenaley 2008), reduced forest health and growth, accumulated ladder fuels (Conklin 2000), and negative effects from projected climate change.

Potential fire severity has changed from mostly low severity fire to mixed and high severity. The risk of stand replacing fires has increased. High severity fires often result in ecosystem conversions, increased soil erosion, loss of hydrologic function, and invasion by nonnative species. Stand-replacing wildfires within ponderosa pine ecosystems have resulted in conversion from forest to grass or persistent shrub for long periods or dense, even-aged structure. These areas would not again support old-growth forest structure for centuries. Trees have significantly encroached into historical grasslands and meadows.

Vegetation Composition

Vegetative composition refers to the vegetation cover types, species present and their relative abundance.

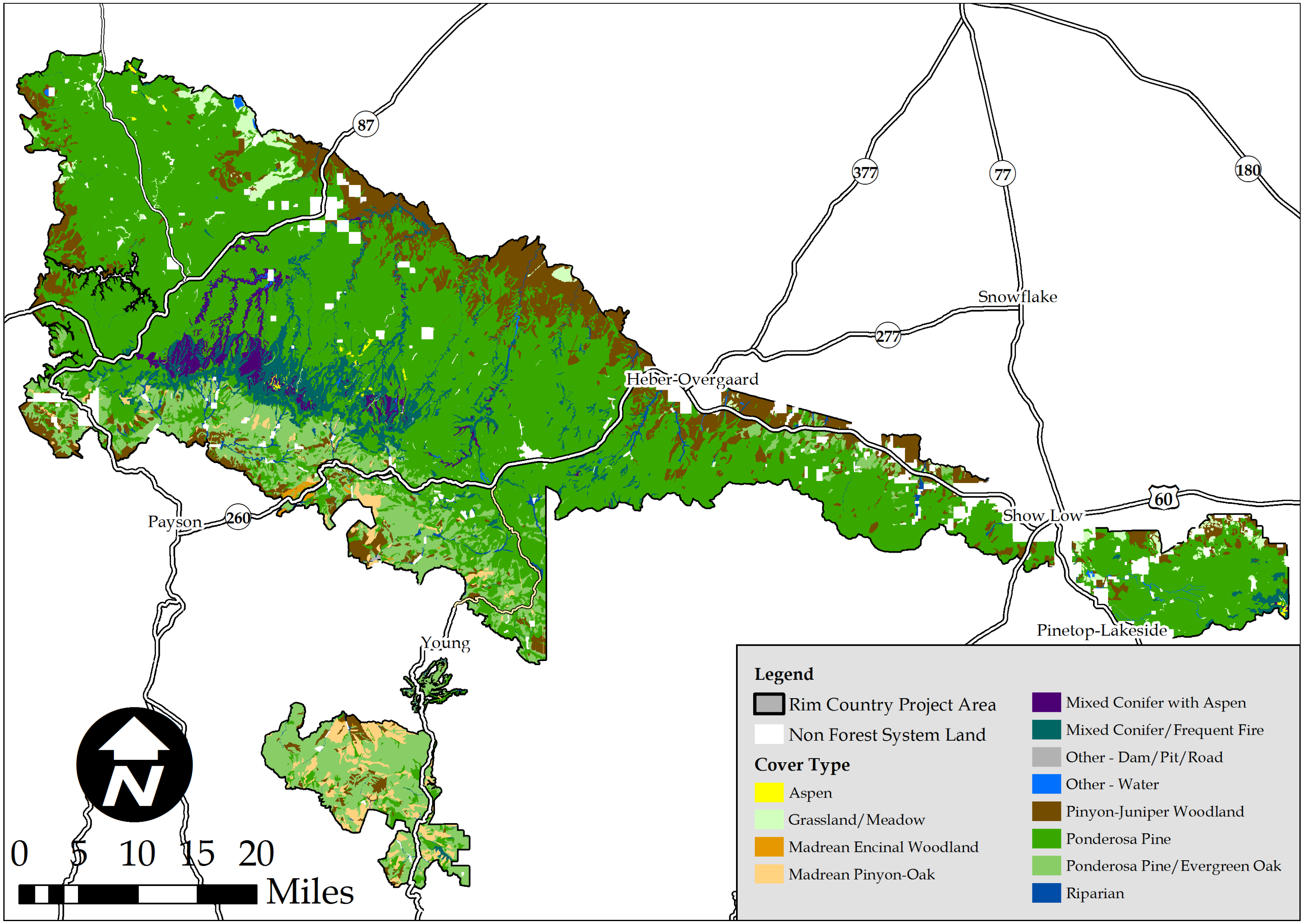


Figure 15. Existing condition – cover type

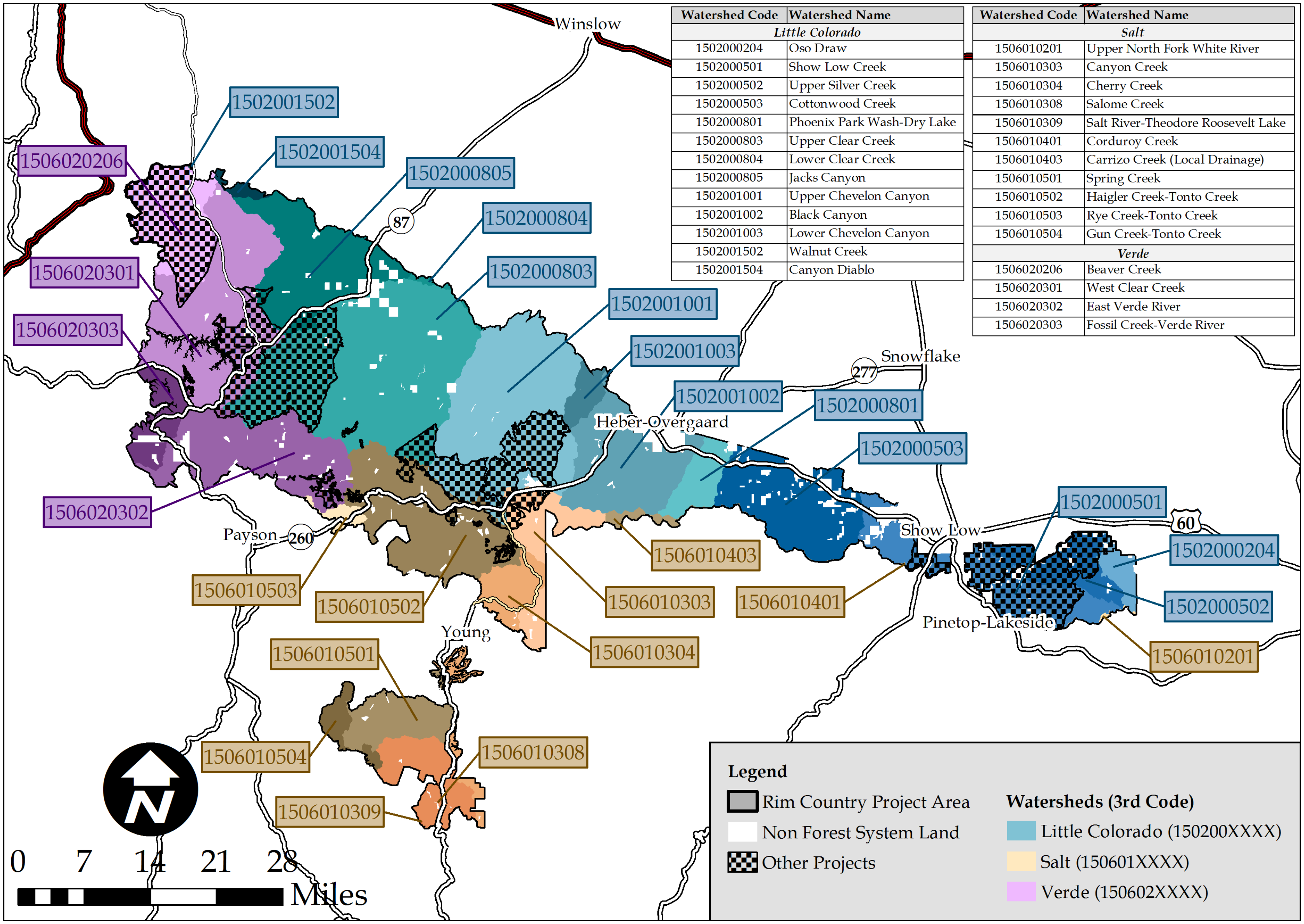


Figure 16. Existing condition – 5th HUC watersheds

Vegetation Structure

Uneven-aged Structure

Structure is a means to express the balance of age and size classes as well as the horizontal and vertical distribution of layers in the forest canopy. In a forested environment, vegetation structure can also include snags, down logs and woody debris, and canopy closure.

Uneven-aged forests are generally described as having three or more distinct age classes of trees (SAF 1998) and is a measure of vertical structure within a forest. Ponderosa pine is composed of trees in structural stages that range from young to old trees and are dominated by ponderosa pine. Currently, the arrangement of the tree cohorts (groups of trees of a similar age class) or size classes are in conditions conducive to crown fire with extremely dense and continuous overstory canopies in a closed condition and understory canopies acting as ladder fuels supporting a transition from surface fire to crown fire behavior. A size–class distribution by 5th HUC watershed shows that the majority of basal area (63 percent overall) is concentrated in the 5 to 12 inch and 12 to 18 inch size classes.

Density

Overall, basal areas are high for most cover types, especially Aspen, Dry Mixed Conifer, Ponderosa Pine/Evergreen Oak, and Mixed Conifer with Aspen. Average basal area of ponderosa pine cover type across the analysis areas is lower, largely due to the number of ponderosa pine stands that experienced stand replacing fire in the Rodeo-Chediski Fire in 2002 and are now dominated by stands with low basal area.

Large Tree and Old Tree Structure

Ponderosa pine stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15 inches and the basal area of trees greater that 16 inches is more than 50 square feet of basal area may be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure. Information on SPLYT stands across 5th HUC watershed is shown in Table 3-6.

Forest Process

Insects

A general bark beetle hazard model for southwestern ponderosa pine based exclusively on the tree density relationships developed in a Dendroctonus hazard model was validated by Chojnacky et al. (2000) The model indicates that stands of ponderosa pine within the analysis area with a relative density below 30 percent of SDImax have a low hazard rating and stands between 30 and 40 percent of SDImax have a moderate hazard rating. Using these relative density thresholds, approximately 19 percent of the analysis area has a low bark beetle hazard rating, while 7 percent of the area has a moderate rating and the remaining 74 percent has a high hazard of beetle attack.

Pathogens-Dwarf Mistletoe

Conklin and Fairweather (2010) indicate that stands with less than 20 percent of the ponderosa pine trees infected can be considered a light infection, stands with 20-80 percent can be considered moderately infected while stands with greater than 80 percent of trees infected with dwarf mistletoe are classified as severe. At moderate and severe infection levels there is evidence of decreased tree vigor, increased susceptibility to insect infestations, and stress-related (e.g., drought) mortality that accompany a changing climate.

Assumptions and Methodology

The basic unit for characterizing of vegetation conditions is the stand. All lands within the Apache-Sitgreaves, Coconino and Tonto National Forests are delineated into stands based on similar characteristics such as vegetation cover type, slope, aspect, species composition, aerial photo interpretation signatures, and management history. Stands vary in size depending upon their uniformity; within the Rim Country Project this is from less than one acre up to 1,324 acres. Spatial and general vegetation information about each stand is stored in the stand database for each forest within the Forest Service Field Sampled Vegetation (FSVeg) database.

Data Rounding

Data is typically reported to the nearest acre, mile, or percentage. Most values have been rounded from their actual decimal values. Totals were calculated before any values were rounded in order to give the most accurate sum. Any apparent inconsistency between the total values reported in a table and a sum resulting from adding up individual values in a table typically accounts for a discrepancy of about 1 percent in the case of rounding percentages or miles, and less than 2 acres in the case of acres.

In an attempt to avoid confusion over these kinds of inconsistencies, minor adjustments to the numbers in the EIS document were made to allow for numbers in tables to add up correctly as displayed. As a result, some numbers may not be exactly the same in the EIS document as compared to this report. The numbers in this report are the most accurate and any differences do not alter any determination of effects.

Stand Data and Modeling

Stand exam data is an average characterization of the area within the stand boundaries. It is limited by sampling intensity and the variability within the sampled area. Comprehensive tree data has been collected on a subset of the stands within the analysis area over the last 25 years. Within each sampled stand, tree characteristics were measured at sample points, using both variable basal area factor plot and fixed plot designs. Specific tree data collected includes species, class, diameter, height, age, growth, damage and disease. Other data sometimes collected depending on design included surface fuels and plant association (USDA 2013).

Modeling Assumptions

The following is a list of general modeling assumptions.

- All tree data was grown to the common year of 2019 and is considered to represent the existing condition.
- Beginning in the year 2019, using the Climate-FVS extension (N.L. Crookston 2014), the effects of climate change were incorporated in the data analysis using the Ensemble_rcp60 scenario
- All tree cutting and removal was modeled in the year 2019 as 2019 is the earliest anticipated first year of treatments
- Two prescribed burns were modeled, post-mechanical treatment in the year 2024, and then again in 2034 with the exception of the aspen treatment which modeled one prescribed burn in the year 2024, post-mechanical treatment.

- After treatment, the tree growth data was simulated to the common year of 2029 and 2039 and is considered to represent the post treatment condition.
- The tree data does not indicate tree age. Simulations initially use diameter as a surrogate for age based on the vegetative structural stage definitions. We acknowledge that there are trees on the landscape where age class overlaps size class. For example there may be: young trees that are larger than 11.9 inches; or mid-aged trees that are larger than 17.9 inches; or mature trees that are less than 18”.
- Within this project area, the majority of trees that meet the old tree definition are greater than or equal to 18”. On the ground cutting prescriptions would follow the Old Tree Implementation Plan (OTIP) and trees larger than 18” that do not meet the OTIP criteria may be cut during implementation.
- All cutting simulations assume 15 percent of the cut stems are left on site and 10 percent of the branchwood from the cut and removed stems are left on site. All other biomass resulting from the cutting is assumed to be removed.
- Snags and coarse wood amounts are based on the inventory or default parameters within the model if they were not inventoried. Snag fall rates and changes in surface fuels are based on default parameters.
- Stand exam data is an average characterization of the area within the stand boundaries. It is limited by sampling intensity and the variability within the sampled area.
- Default parameters within the model were used to predict tree growth, mortality, and dwarf mistletoe infection intensification.
  - Dwarf mistletoe infections are nearly impossible to detect from remote imagery. Therefore, any nearest neighbor imputation process may impute stand data showing mistletoe infections to stands that are not infected and visa-versa.
- FVS is a distance-independent growth model. It is not spatially explicit and cannot model tree groups and interspaces together. The modeling results are an average approximation of the desired forested structure at the stand level and all results are interpreted as “attribute values” per acre. Output from the FVS model used in this analysis is a characterization of the existing condition and absolute conditions are neither intended nor implied.

Discussions on Stand Metrics

Measures of stand density used in this analysis are Basal Area (BA), Trees per Acre (TPA) and Stand Density Index (SDI). Basal area is the cross-sectional area of all trees, measured in square feet per acre measured at 4.5 feet above the ground. Trees per acre (TPA) is simply a count of the total number of trees on an acre. Stand Density Index is a measure of the relative stand density within forest stands.

Density

Stand density, a measure of the degree of crowding within stocked areas (SAF 1998), is the dominant factor affecting the health and vigor of conifer forests in the western United States (Foresters 2005) and high stand densities leads to reduced ecosystem resilience (Reynolds et al 2013. One of the major factors affecting forest structure and development, specifically the rate at which individual trees grow and advance through successional stages, is inter-tree competition. Competition refers to density-related scarcity of one or more environmental factors necessary for growth (e.g., moisture, nutrients, and sunlight).

Trees per Acre

Trees per acre is simply a count of the number of stems per acre of an individual species or all species combined regardless of size. Trees per acre is much more informative when considered with an additional stand metric such as quadratic mean diameter or basal area. This additional information provides insight into the forest processes that may be occurring within a stand.

Basal Area

Basal area is the cross-sectional of all stems of a species or all stems in a stand measured at breast height (4.5 feet above the ground) and expressed as square feet per acre. This analysis uses basal area as a key measure of density. Higher basal areas can be indicators of increased competition, risk to insect outbreaks, and density-dependent mortality as well as closed canopy conditions.

Stand Density Index

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Reineke 1933). Percent SDIMax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both tree size (DBH) and numbers (TPA) into account.

Those who use SDI, or any index of stand density, as an estimate of growing stock, must assume that the index is proportional to site utilization (Long and Smith 1984). Since the contribution of individual stand components to both total SDI and total site utilization is additive, SDI can be used to assess control of growing stock in uneven-aged stands as well as even-aged stands (Long and Smith 1984). Although SDI and the maximum size-density relationship were originally described for pure, even-aged stands, Long and Daniel (1990) have proposed extension of its utility to uneven-aged and multi-aged situations.

Long (1985) divided SDI percentages into four zones which consider the percent of a stand occupied by trees. Based upon established forest density/vigor relationships, density-related mortality from competition begins to occur once the forest reaches 45-50 percent of maximum stand density (zone 3), and mortality is likely at density levels of 60 percent+ of maximum stand density (zone 4).

Openness

A key characteristic of historical ponderosa pine and mixed conifer forests was the grass-forb-shrub interspersed among tree groups; defined as interspace. This interspace typically comprised a large portion of the landscape. The term openness as used in this analysis conveys the percentage of the forested area that is grass-forb-shrub interspace.

Issues/Indicators/Analysis Topics

Issues

Issues are statements of cause and effect, linking environmental effects to proposed activities. Comments from the public, the 4FRI Stakeholder Group, other agencies, tribes, and Forest Service personnel were used to formulate issues concerning the proposed action. All comments received were reviewed and analyzed by the interdisciplinary team to "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review…" (Council on Environmental Quality, Sec. 1506.3; 40 CFR 1501.7(a) (3)).

Issue 3 – Large Tree Retention

This issue is addressed in the effects analysis for all alternatives. Large trees are addressed with treatment design and location, design features, mitigation measures, and BMPs to manage for desirable distributions of old trees and groups of large trees in all action alternatives. The Old Growth Implementation Plan and Large Tree Implementation Plan (OTIP/LTIP) were developed for the Rim Country to be responsive to these issues while also being appropriate to the specific ecology and existing conditions in this project area.

Indicators/Measures:

- Number of acres of stands meeting criteria for SPLYT designation.

Significant Issues Responded to in Alternatives to the Proposed Action

Issue 4 – Dwarf Mistletoe Mitigation

This issue will be addressed in the effects analysis for all alternatives. Dwarf mistletoe mitigation will be addressed with treatment design and location and collaboratively developed guidance in the implementation plan (appendix D). Some dwarf mistletoe will be retained as a natural component for wildlife, and limits will be placed on removal of large infected trees. The alternatives will propose a range of mitigation treatments depending on the severity and extent of infection.

Indicators/Measures:

- Acres of intermediate thinning proposed in stands with severe dwarf mistletoe infection
- Percent of acres in dwarf mistletoe severity rating classes

Environmental Consequences

In order to conduct a site-specific analysis, data from individual stands was used to calculate stand metrics. In order to scale these metrics up to a landscape level analysis, stand data was aggregated up to the 5th HUC watershed and then to the analysis area. The effects analysis period modeled is from 2019 to 2039.

Table 23. Desired and existing conditions for the project area

	Desired Condition	Existing Condition
Structure - Pattern	The majority of stands are in an open condition. Forest arrangement is in individual trees, small clumps, and groups of trees or randomly spaced trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat.	The majority of stands are in a closed condition and lacking groups and clumps of trees or randomly spaced trees. Grasses, forbs and shrubs are underrepresented compared to historic patterns. This is departed from desired conditions consisting of a matrix of groups, clumps and individual randomly spaced trees with interspaces,
Structure - Trees per acre	Trees are distributed across size classes with total number of trees per acre between 10 and 250. Below is an idealized tree distribution across size classes totaling 74 trees per acre and carrying 90 ft^2 of basal area Trees are distributed across size classes with total number of trees per acre between 10 and 250. An idealized tree distribution across size classes totaling 74 trees per acre and carrying 90 ft^2 of basal area would have 24, 18, 14, 10, and 8 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	Total trees per acre is higher than the desired condition and are overrepresented in the smaller diameter classes and underrepresented in the larger classes Total trees per acre is higher than the desired condition and are overrepresented in the smaller diameter classes and underrepresented in the larger classes. There are currently 813, 114, 35, 9, and 3 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.
Basal Area	Generally less than 90 square feet per acre to meet forest resilience goals while maintaining wildlife habitat desired conditions. For MSO protected and nest/roost replacement habitat 110 to 120 square feet per acre is the minimum.	The current average basal area within the analysis area is 129 square feet per acre. High densities in terms of basal area make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Stand Density Index	Maintain forest density between 25% and 45% of SDImax to maintain forest health and tree growth. For ponderosa pine this SDI range is between 112.5 and 202.5. For MSO protected and Nest/Roost replacement habitat, desired forest density is between 45% and 60% of SDImax or between 202.5 and 270.	Currently the average stand density index across the analysis area is 66% of MaxSDI. 21 % of stands meet the desired condition for SDI. High densities in terms of stand density index make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Forest Insects	Stands in the analysis area are in the Low or Moderate hazard for bark beetles	Currently 74% of acreage have a high bark beetle hazard rating. The remaining 26% of stands meet the desired condition for insect hazard.
Forest Disease	Stands in the analysis area have Low to Moderate dwarf mistletoe infection severity (Less than 20% of trees infected)	Currently 75% of acreage has a low dwarf mistletoe infection rating, 22% of acres have a moderate rating and 4% have a severe infection rating. 96% of the analysis area meets the desired condition for mistletoe infection severity

Alternative 1 – No Action

Direct and Indirect Effects

Under Alternative 1 no acres would receive either prescribed cutting or prescribed fire treatment. Although this alternative does appear to meet some of the desired conditions identified in the Forest Plan concerning forest structure, it would not move the forest forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem. For example, based on a broad array of research, current stand conditions would continue to develop so that the overabundance of trees in the smaller size classes (0-5 and 5-12 inch size classes) at the landscape scale, but they would likely develop at a slower rate due to increased competition and water stress. At the same time, the slow transition of intermediate and mature forests would lead to an increasing lack of young, developing forests. In the likely case of one or more large disturbance events (wildfire, drought, insects), the result would be an over-abundance of young forests. For a more thorough analysis of the effects of larges disturbance such as uncharacteristically large or severe wildfires, consult the Fire Ecology Specialist Report (USDA 2019).

Without treatment, stands in the analysis area would be much less resilient to disturbances such as multi-year drought, insects and disease such as bark beetle and mistletoe, and wildfire (Abella, et al., 2007). Increased drought stress and insect attacks are often associated with increased tree density, altered tree spatial arrangement, and shifted forest composition that have resulted from fire exclusion, grazing, and past logging. These changes in forest structure may exacerbate tree mortality due to increased competition among trees (Kane, Kolb, & McMillin, 2014, p. 171). At the fine scale, these disturbances would likely result in a greater mortality rate for areas with dense forest, which include groups and clumps of large trees (Zhang, Ritchie, Maguire, & Oliver, 2013).

Composition

Forest composition is not expected to change dramatically under this alternative if there are no large-scale disturbances such as wildfire or epidemic-level insect outbreaks. Ponderosa pine would still be the dominant cover type within the analysis area. Mixed conifer would make up a moderate proportion of the analysis area, though the composition of shade tolerant species such as white fir may increase considerably in this forest type. Juniper, grasslands, and other hardwoods would continue to make up a minor part of the analysis area. Without wildfire or other types of disturbance, aspen would continue to decline, as normal succession pressures continue to favor conifer establishment. This continued encroachment may result in the loss of aspen from parts or all of the analysis area.

In general, overstory density would increase and understory species richness would decline significantly (Korb & Springer, 2003). Without treatment, understory grass vigor would be expected to be reduced. Less sunlight would reach the forest floor. As a result, understory diversity would decrease, which would reduce the overall biodiversity found in frequent-fire forests.

Structure

Uneven-aged Structure

Uneven-aged forest structure is the Desired Condition. Under this alternative, there is little change to forest structure (Figure 17). Some trees would grow into larger size classes, but the overall the portion of stands that can be considered uneven-aged remains unchanged. The uncharacteristically high number of trees in the smaller and medium size classes provide excessive competition with larger trees in the stand, slowing growth and limiting diameter growth of the largest trees in the stand. While this meets the Desired Condition, it provides little improvement over the Existing Condition into the future.

While this indicator meets the desired conditions for uneven-aged structure in the forest plans, this does not account for the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. There are an abundance of small diameter trees across the analysis area, far above historic conditions. Because of the current structure, including overstocked forests and ladder fuels created when smaller trees grow directly beneath the canopy of larger trees, the current landscape would be less resilient if a catastrophic event were to occur. Many, if not most, of the trees would be killed, resulting in large areas lacking live trees. Natural regeneration or reforestation planting would create large even-aged, young forests, with little structural diversity for the foreseeable future.

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. The overall tree density continues to remain very high under this alternative, averaging nearly 1,000 trees per acre through much of the area. All 5th HUC watersheds currently do not meet the desired condition for trees per acre. In general trees are overrepresented in the smaller size classes and underrepresented in the larger size classes. Smaller trees and their aggregated spatial pattern on the landscape has resulted in dense thickets of "dog-haired" pine. While there would be some density-related mortality in the smaller trees as time goes by, this trend of "dog-haired" thickets of pine is expected to continue into the foreseeable future under this alternative. Across the analysis area, forested stands would continue to be dominated by small diameter trees into the future. This tree density would result in reduced tree growth and increased mortality, especially in older trees, stagnated nutrient cycles, decreased herbaceous and shrub forage quality and quantity (Covington & Moore, 1994a). Without cutting or fire disturbances, tree regeneration would be inhibited and the trend would be a shift to the larger size classes maintaining extremely dense conditions that are not resilient to disturbances such as fire, insects, and climate.

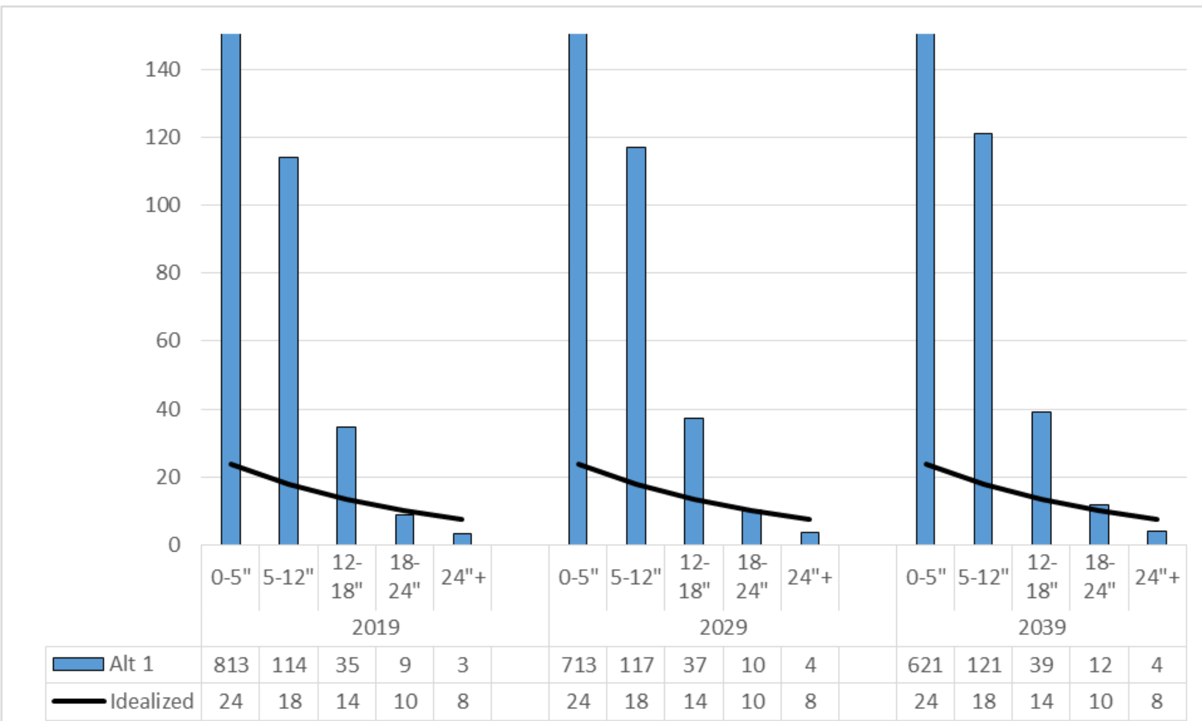


Figure 17. Alternative 1 – No Action – Distribution of trees per acre across size classes across the analysis area as well as an idealized distribution of trees per acre

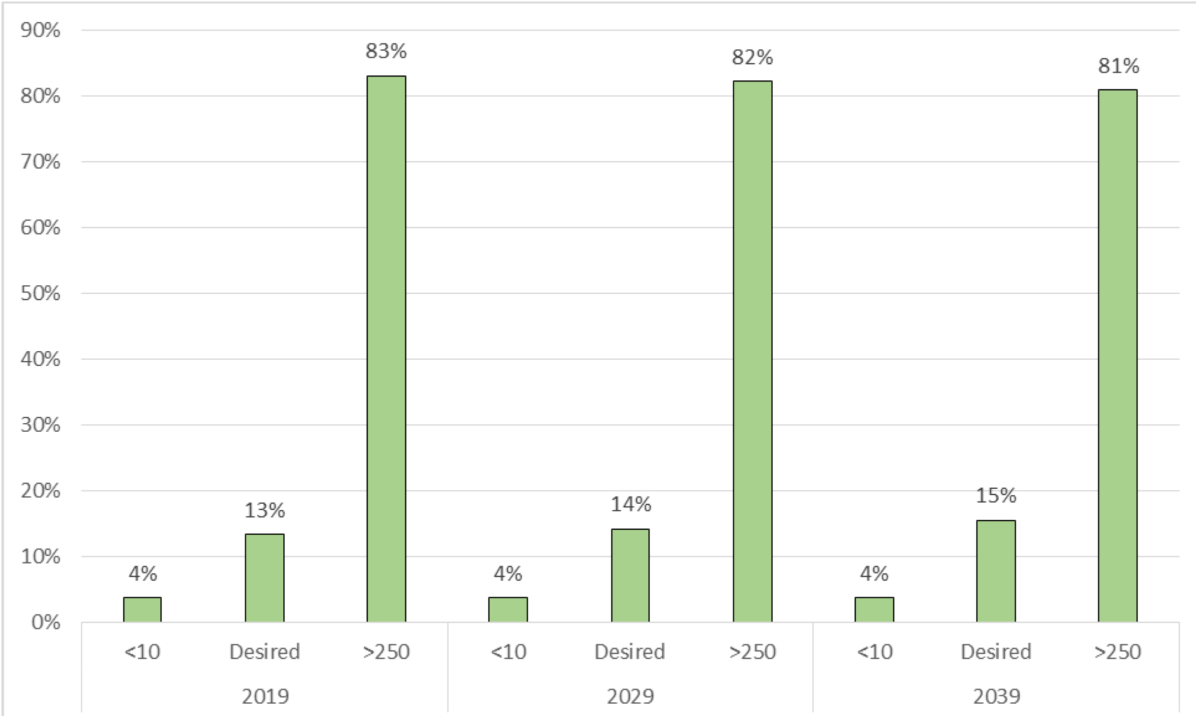


Figure 18. Alternative 1 – No Action – Percent of acres meeting desired condition for trees per acre across the analysis area

Under the No Action alternative, basal areas across the analysis area would average 129 square feet per acre, ranging from 60 square feet per acre in the Carrizo Creek watershed, which has experienced a considerable amount of uncharacteristic severity wildfire, to 166 square feet per acre in the Salome watershed, and Haigler Creek-Tonto Creek watershed, dominated by dense ponderosa pine evergreen oak cover type. This excessive stocking is expected to increase to, on average, 150 square feet per acre by 2039. Currently only 19 percent of acreage meets the desired condition for basal area. The percentage of stands that meet the desired condition would be reduced to 12 percent by 2039 under the No Action alternative.

Continuous tree growth would allow for forest stand densities to depart further from the desired condition. This would result in increasing competition for limited resources (water, light, growing space, and soil nutrients). Competition-induced mortality and growth stagnation would continue to increase, along with susceptibility to potential insect and disease outbreaks. The current conditions and effects of no action over the next thirty years support a shift away from frequent, low severity surface fires to increasingly larger high severity intensity crown fires (Cooper, 1960) (Swetnam, 1990) (Covington & Moore, 1994a) (Kolb, Wagner, & Covington, 1994) (Swetnam & Baisan, 1996). For more information consult the Fire Ecology Specialist Report (USDA 2019). These conditions would not meet the purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems.

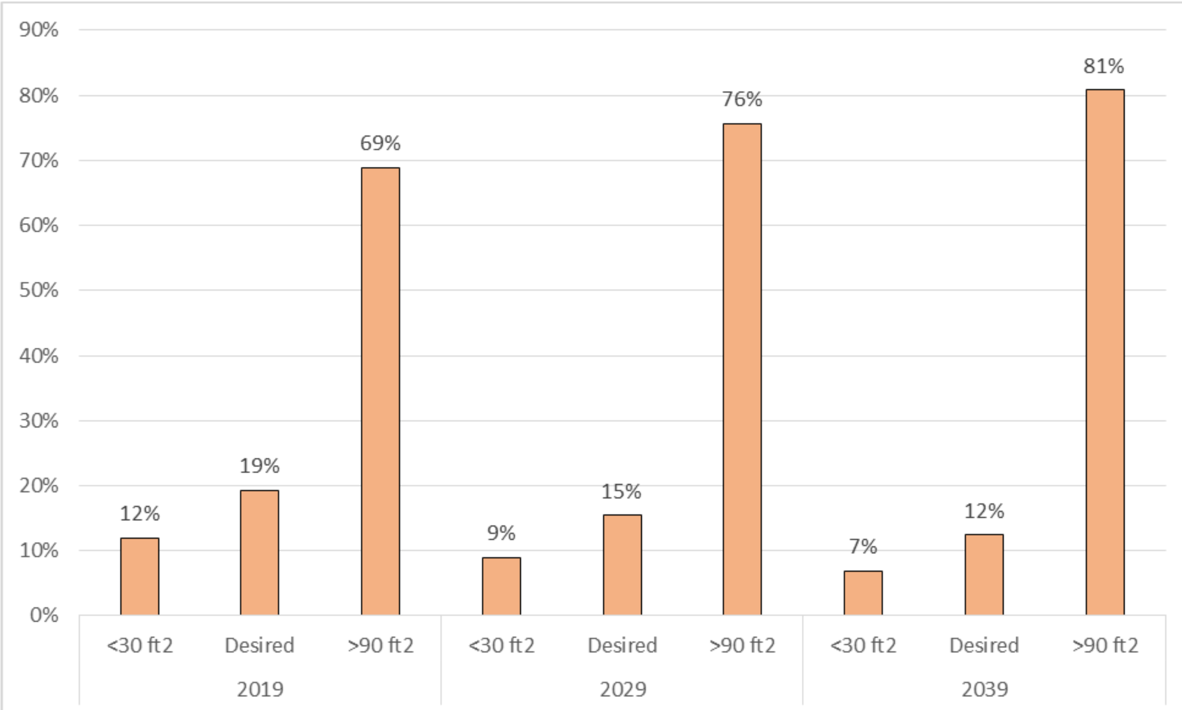


Figure 19. Alternative 1 - No Action – Percent of acres meeting desired condition for basal area across the analysis area

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species (SDIMax is 450 for this analysis). SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered in the zone where density related mortality is prominent and approaching the zone where imminent mortality would occur. Values range from 140 in the Carrizo Creek watershed, which has experienced a considerable amount of uncharacteristically severe wildfire to 400 in the Haigler Creek-Tonto Creek watershed which has a substantial amount of the ponderosa pine evergreen oak cover type. Overall, SDI and its relation to SDImax continues to increase to 324 or 70 percent of SDImax by 2039. In relation the desired condition, currently 15 percent of acres within the analysis area meet desired condition for SDI. This number would decrease to 11 percent by 2039.

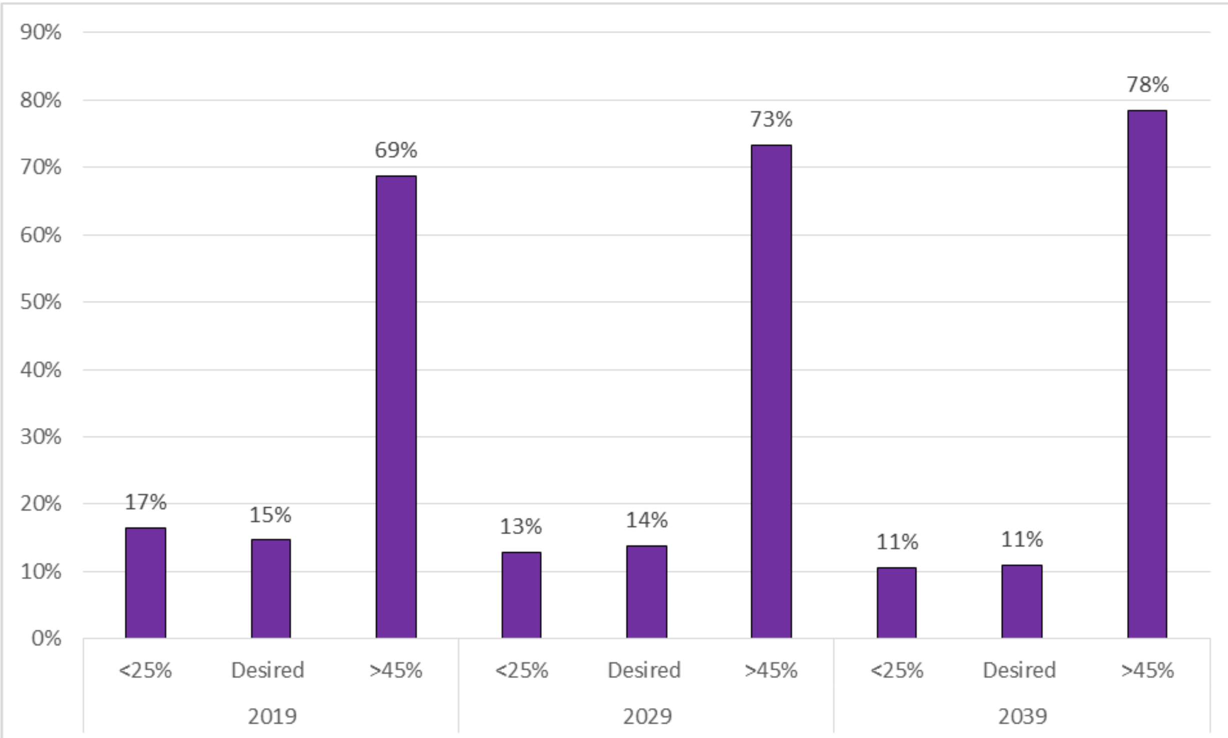


Figure 20. Alternative 1 - No Action – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15"and the basal area of trees greater that 16" is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Under this alternative, no trees would be removed through cutting. Therefore, all large and old trees are expected to remain, except they are likely to be more susceptible to mortality from drought, pests, and disease as well as wildfire (Das et al. 2011, Ritchie et al, 2008). Across all 5th HUC watersheds in the analysis area the number of acres meeting SPLYT criteria is currently estimated to be 36,265 acres with a QMD of the top 20 percent of trees to be 19 inches. This number would increase to 80,139 acres by 2039 with a QMD of the top 20 percent of trees remaining at 19 inches. This is the result of current trees continuing to increase in diameter growth and does not take into account the potential mortality from drought, insects, disease and wildfire.

This alternative would also result in higher risk of mortality, especially for larger trees, because of an increasing risk of infection from pests or disease (Fischer et al, 2010), high severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), or increased drought stress from competition (Erickson & Waring, 2014). A number of studies have found that higher forest density leaves large and old trees more susceptible to mortality. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." Modifying forest conditions to facilitate low severity fire on the landscape has been identified as a key condition to preventing increased mortality of large and old trees over the next several decades (Fiedler et al. 2007, Kolb et. al. 2007, Ritchie et. al. 2008). Thus, while this alternative may increase the amount of large and old trees based on model results, these results do not account for the likely substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristically severe wildfire), which would decrease the amount of old and large trees in the analysis area.

Under this alternative it is possible that one or more naturally caused wildfires would be managed to benefit forest resources. Depending on the ability to manage one or more naturally caused fires based on values at risk, fuel, and weather conditions under this alternative some wildfires could result in small openings that decrease areas of intermediate aged trees, which would then contribute to establishment of a new young cohort of trees. Management of naturally caused fires under this alternative may also have the effect of reducing basal area and SDI by killing small trees or groups of small and/or intermediate aged trees. These fires could also result in mortality of some large and old trees or large patches of high severity mortality. Based on those areas in recent wildfires that have been managed for resource benefits, this effect may be very limited across the landscape. The current condition of the Forest would limit the ability to manage naturally-occurring wildfires in the analysis area at low to moderate-intensity levels without potential unacceptable effects on values at risk.

Forest Process

Insects

Under the No Action Alternative the proportion of acreage with a high hazard rating for bark beetles would increase from 74 percent to 82 percent, a considerable majority of the landscape. The proportion of acreage with a low or moderate hazard rating would decrease. Some large watersheds such as Upper Clear Creek, Haigler Creek-Tonto Creek and East Verde River are currently over 90 percent high hazard for bark beetles. The existing condition is departed from the desired condition and would further depart between 2019 and 2039 as basal area and SDI continue to increase beyond the Desired Condition.

Drought, coupled with high tree densities, can lower resistance to beetle attacks. Bark beetle population dynamics suggest that homogenous, dense, even-aged stands are highly susceptible to beetle outbreaks. Susceptibility to western pine beetle would slowly increase over time. Areas with the greatest likelihood of infestation are those stands with densities greater than 120 square feet of basal area and average stand diameters greater than 12 inches dbh. Susceptibility to ips beetles would continue to increase with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

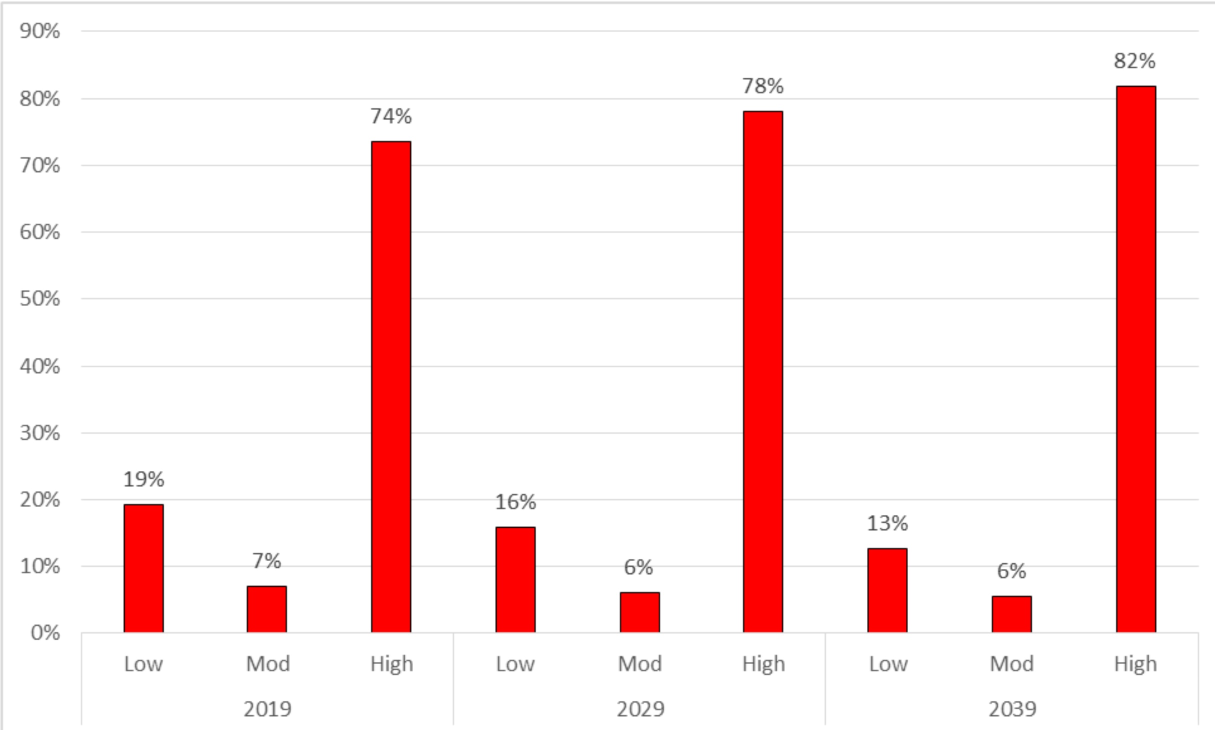


Figure 21. Alternative 1 - No Action Alternative – Distribution of bark beetle hazard rating classes across the analysis area

Disease

Across the analysis area, approximately 75 percent of the area is not infected or has a low infection level, 22 percent has a moderate severity rating and 4 percent has a high severity rating. This distribution shifts to higher severity ratings over time; by 2039, 25 percent of acres are classified as moderate and 9 percent of acres are classified as severe by 2039. This is an indication that mistletoe infection is intensifying and spreading over time. Dwarf mistletoe infections would not be reduced and may intensify in infected trees and the surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine. (Conklin 2000). Though most of the analysis area meets the desired condition of having a low or no dwarf mistletoe severity, 34 percent of the analysis area would have a moderate or severe dwarf mistletoe severity rating by 2039 and would not meet the desired condition. Stands would further depart from the desired condition over time as infected stands intensify their infections and infect adjacent areas (Conklin and Fairweather 2010).

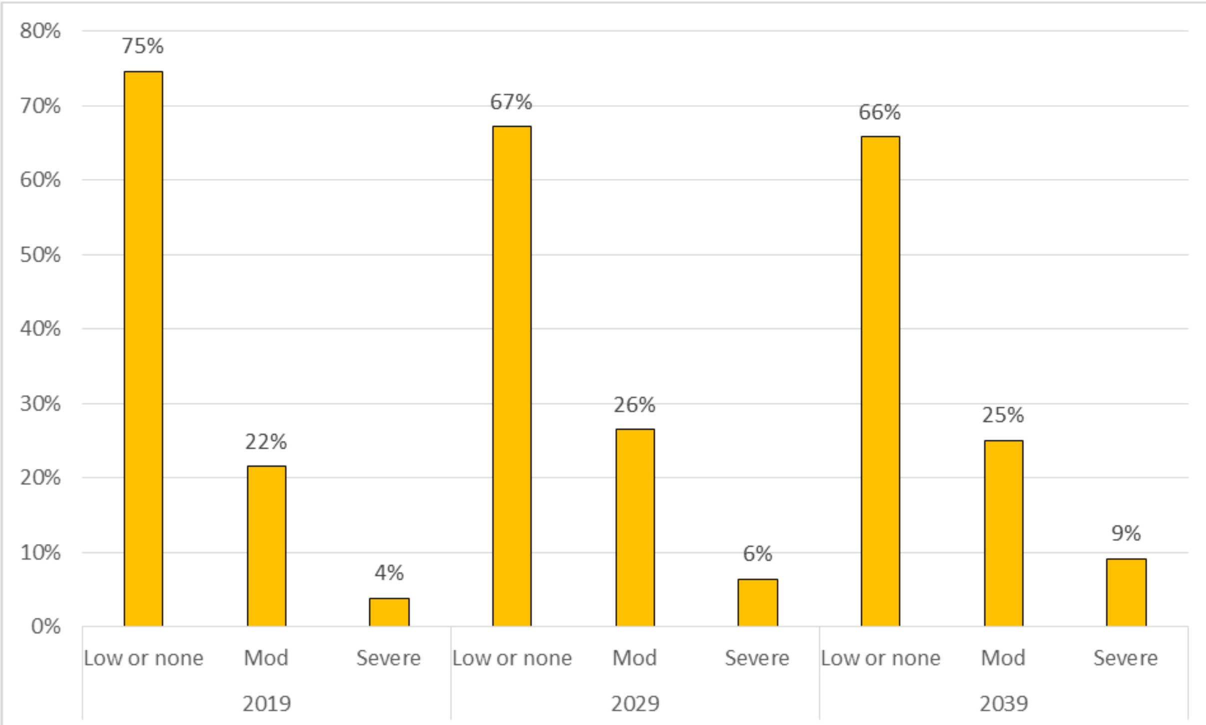


Figure 22. Alternative 1 - No Action Alternative – Dwarf Mistletoe severity rating classes across the analysis area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative does not support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. This alternative would continue to support the current shift away from frequent, low severity surface fires to conditions that are more likely to support increasingly larger high severity crown fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). The current forest structure is quite different from conditions from the NRV of the native microbes, plants, and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, this project area would remain susceptible to undesirable fire behavior and effect, and other disturbance agents, such as bark beetles and disease, over time.

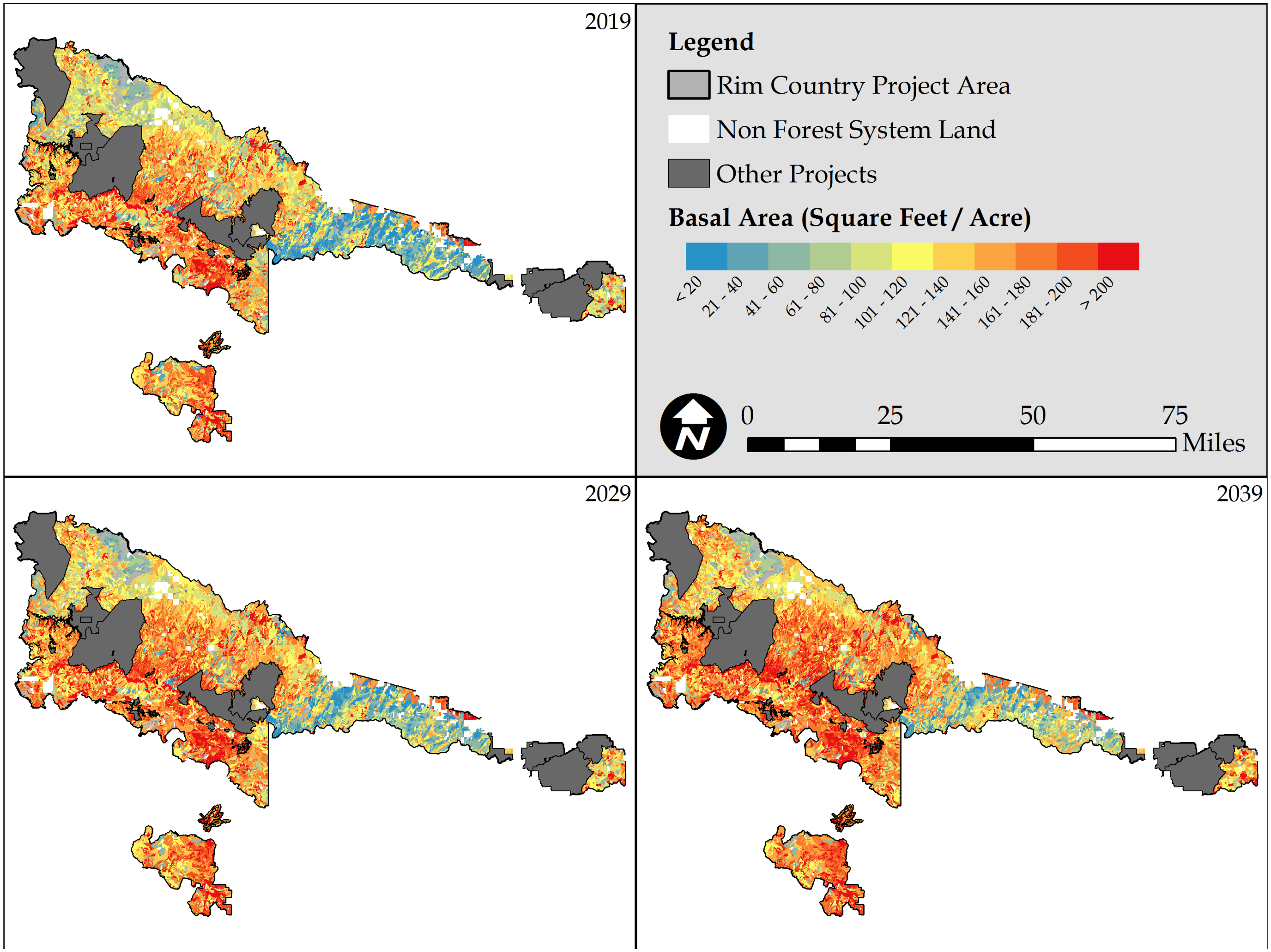


Figure 23. Alternative 1 – basal area

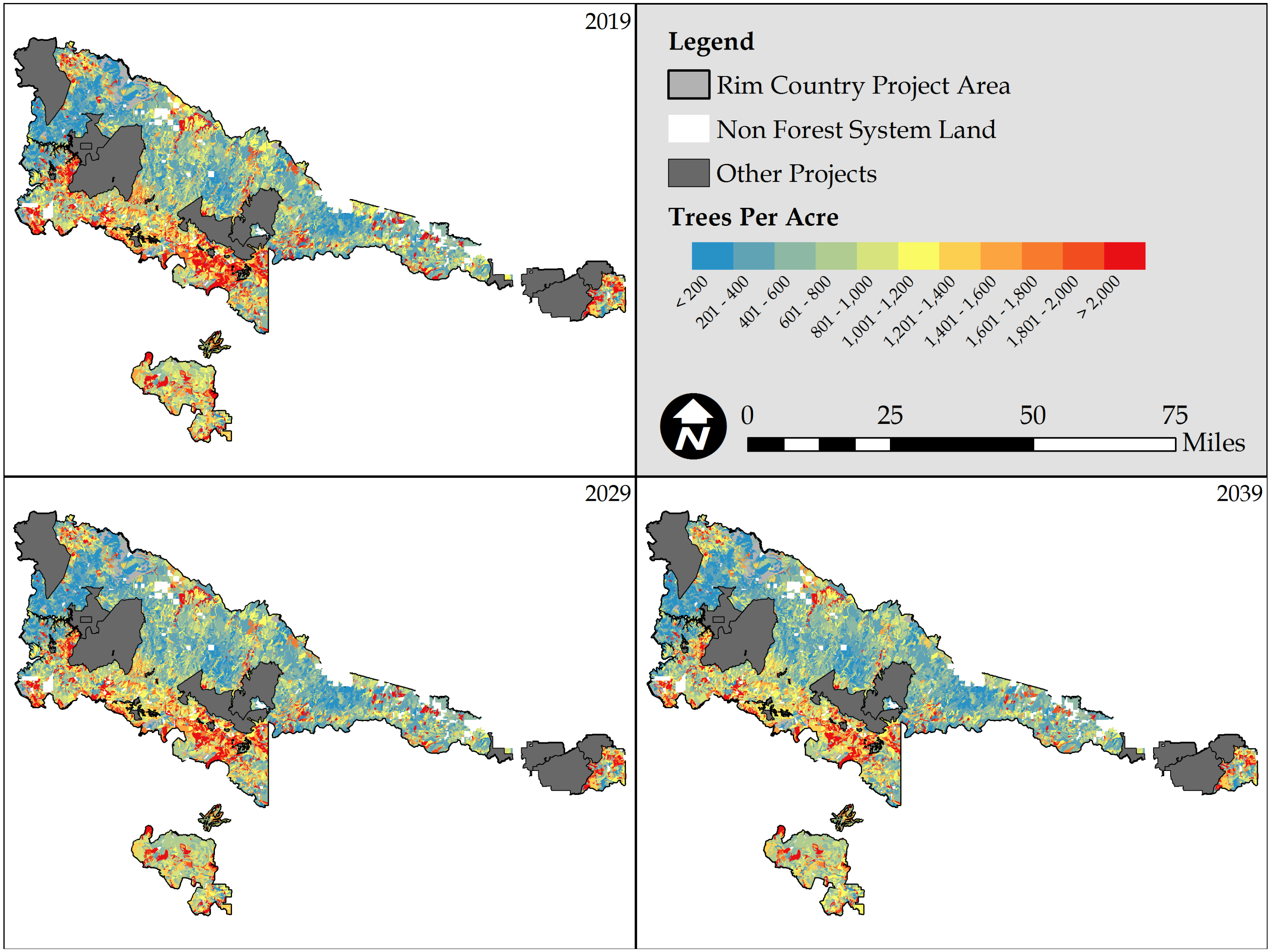


Figure 24. Alternative 1 –trees per acre

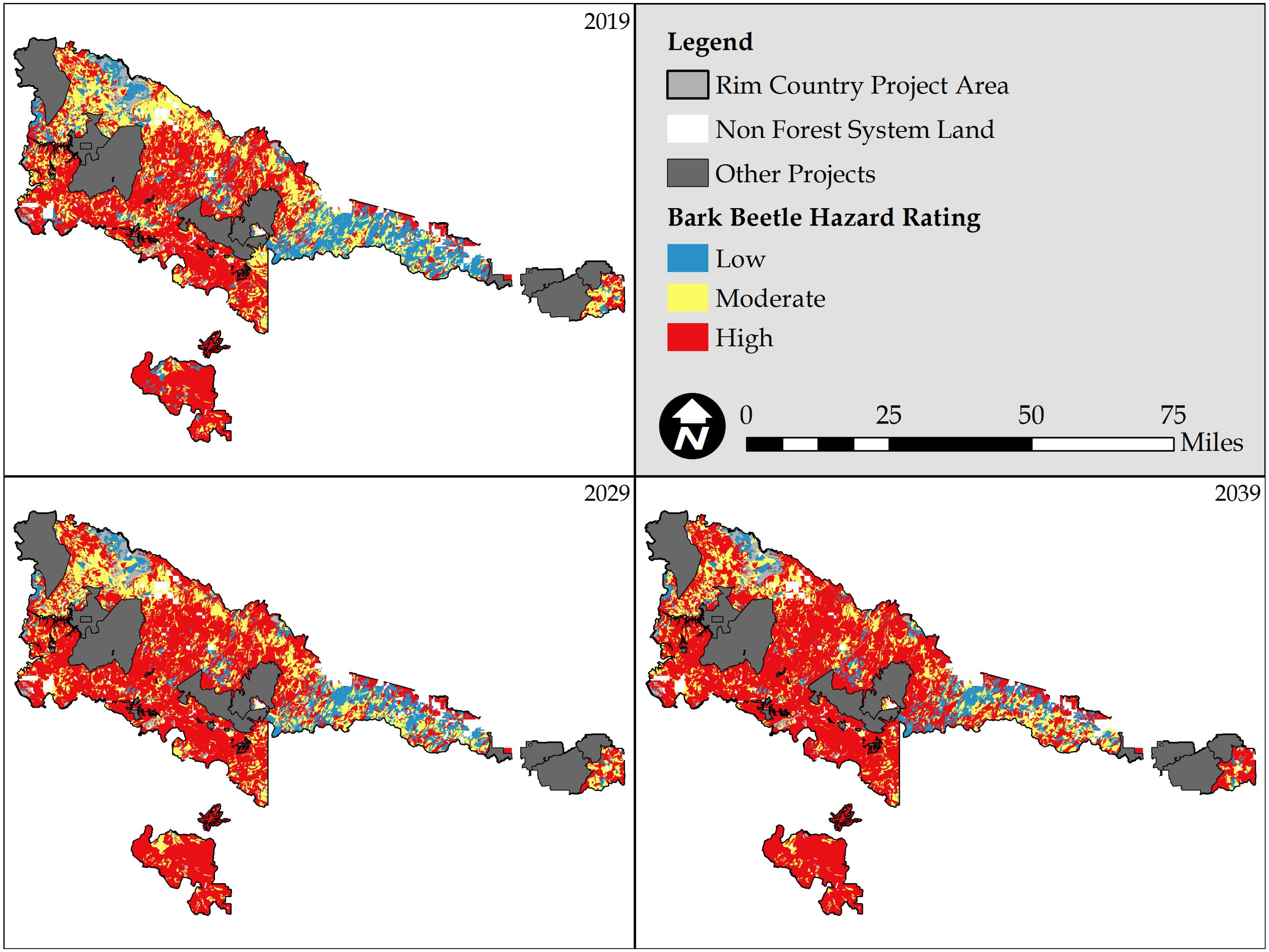


Figure 25. Alternative 1 – bark beetle hazard rating

Alternative 2 – Modified Proposed Action

Direct and Indirect Effects

Under Alternative 2, prescribed cutting and/or prescribed fire treatment would be applied in order to move towards or meet the desired conditions. This alternative meets or moves the project area toward the desired conditions identified in the Forest Plans and moves the project area forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem. The distribution of trees across size classes is more representative of a historic size class distribution as many trees in the smaller size classes have been removed or burned. At a landscape scale forest composition, structure, pattern, and process would all be improved.

Composition

Forest composition would improve under this alternative. Ponderosa pine would still be the dominant forest cover type. Mixed conifer would continue to make up a moderate proportion of the analysis area. As a result of prescribed cutting and prescribed fire, prevalence of later seral species such as white fir and corkbark fir in forested stands would be reduced and would better represent their role in the NRV. Pinyon juniper woodlands and oak species would continue to make up a considerable part of the analysis area. The treatment of conifer encroached grasslands would expand their range to more fully represent the Desired Condition to reestablish their historical extent. The protection and improvement of aspen stands would promote regeneration and reduce inter-tree competition and improve their condition under this alternative; however aspen is one of the species predicted to be most affected by a changing climate. The condition of less common but important species such as maple and Emory oak would be improved through the cutting of other species such as juniper and other species.

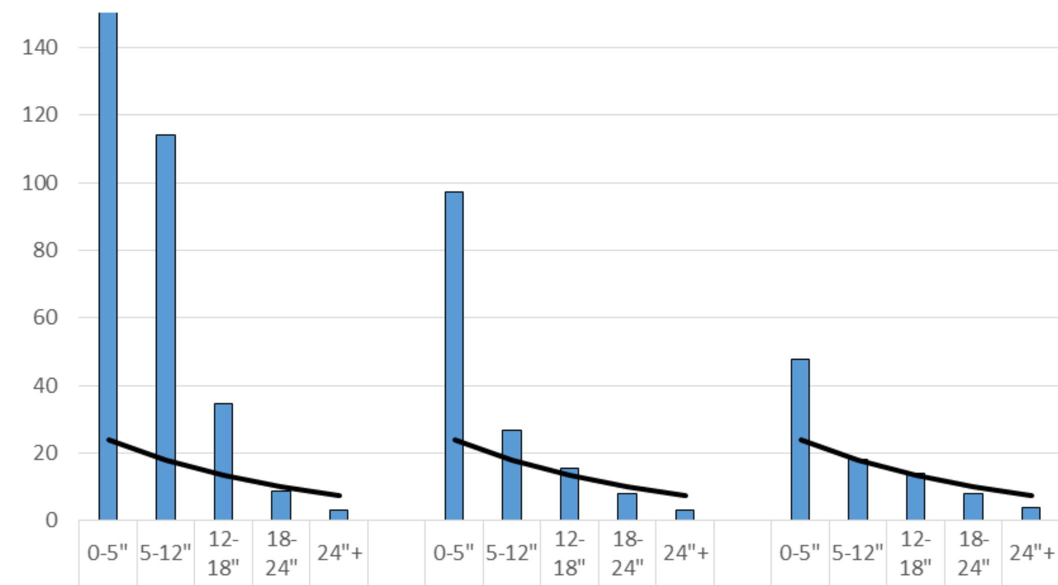
This analysis has considered the effects of a changing climate. Though this alternative would result in a landscape more resilient to climate change, climatic models for the southwestern U.S. predict continued warming, greater variability in precipitation, and increased drought. These climatic changes would likely contribute to some level of tree mortality; however, considerably less than the No Action Alternative. A changing climate may lead to large shifts and contractions in the range of dominant trees throughout much of the region (Kane et al, 2014).

Structure

Uneven-aged Structure

Uneven-aged forest are defined as forests composed of three or more distinct age classes of trees, either intimately mixed or in small groups. The Desired Condition is for uneven-aged forest structure to occur on a majority of acres. Under this alternative, there is considerable change to forest structure (Figure 3-12). Across the project, even-aged structure would dominate the landscape with a balance of trees in smaller, medium and larger size classes. The proportion of stands with uneven-aged structure would increase into the future. This alternative would meet the Desired Condition for uneven-aged structure in the Forest Plans and forest structure would more closely resemble the NRV. Modeling indicates that some stands would move towards more even-aged conditions in the dominant cover types proposed for treatment as a result of removal of trees from the smaller size classes and retention of trees in the larger size classes. Modeling the most intense extent of the range of the prescribed treatment, combined with the protection of large and old trees, produced even-aged stands of larger trees in some cases. However, as treatments are applied on the ground, the use of the large and old tree implementation plans, in accordance with an uneven-aged thinning strategy, would be able to produce uneven-aged conditions across much of the landscape. Individual tree growth would increase and trees would move into larger size classes as a result of a reduction in individual tree competition. Naturally-occurring regeneration would provide additional vertical structure over time.

An additional, and potentially more substantial, benefit to forest structure would be a reduction in the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. Under this alternative stands would be more resistant to uncharacteristic fire and insect outbreaks and more resilient to drought. The balance of size classes and uneven-aged structure would provide conditions favorable to restoration of a natural fire regime.



	2019					2029					2039				
	0-5"	5-12"	12-18"	18-24"	24"+	0-5"	5-12"	12-18"	18-24"	24"+	0-5"	5-12"	12-18"	18-24"	24"+
Alt 2	813	114	35	9	3	97	27	15	8	3	48	18	14	8	4
Idealized	24	18	14	10	8	24	18	14	10	8	24	18	14	10	8

Figure 26. Alternative 2 – Proposed Action – Distribution of trees per acres across size classes across the analysis area

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. With prescribed thinning and fire, there would be considerable change to the size class distribution in the near future. The Proposed Action would effectively meet the desired condition for trees per acre with a balance across size classes. The overall tree density would decrease considerably under this alternative, from 973 in 2019 to 151 in 2029 and 92 by 2039.

While the initial reduction in trees per acre would result from a combination of mechanical and prescribed fire activities, the reduction after 2029 can be attributed to the recurring prescribed fires over time. Prescribed fires with higher or lower severity (e.g., burning under hotter or cooler and/or wetter conditions) from 2029 to 2039 could be implemented to maintain a higher or lower number of trees per acre in the smaller size classes if desired. The reduction in tree density would increase individual tree growth and reduce density dependent tree mortality. Understory grasses, forbs herbs and shrubs would increase in quantity (Covington & Moore 1994a).

The desired condition is to retain a basal area of between 30 to 90 square feet per acre across most habitat types outside of MSO PACs. While the Forest Plans provide a desired condition with a range of basal areas ranging from 20 to 180 square feet per acre depending on cover type, for this analysis, at the project level, for ease of comparison of effects between alternatives, 90 square feet per acre is the breakpoint for the resource measure across the analysis area. For both mixed conifer and ponderosa pine cover types it is desired to maintain basal area at less than 90 square feet per acre though exceptions exist to provide heterogeneity across the landscape as well as specific wildlife needs for dense and closed canopy forest conditions. For a more thorough analysis of the effects of this alternative within MSO and Northern goshawk habitat, consult the Wildlife Specialist Report (USDA 2019).

Under the Modified Proposed Action alternative, basal areas across the analysis area would average 65 square feet in 2029 and 62 square feet in 2039. While currently only 19 percent of stands meet the desired condition, by the year 2029, 58 percent of stands would have met the desired condition, and by 2039, over 56 percent of stands would meet the desired condition. This would result in decreased inter-tree competition for resources such as water, light, growing space, and nutrients. Individual tree growth would increase and density dependent mortality would be dramatically reduced along with susceptibility to potential insect and disease outbreaks. These conditions would indicate a shift from the current larger and higher severity crown fires that the forest would currently experience to cooler, higher frequency, lower severity surface fires (Cooper 1960) (Swetnam 1990) (Covington & Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan 1996) that persisted prior to European settlement. The reductions in basal area would meet the desired condition and purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems at the landscape and watershed scales.

While all watersheds would have their average basal areas reduced to within the desired condition, some watersheds such as Gun Creek-Tonto Creek and Rye Creek-Tonto Creek would experience considerable additional mortality as a result of prescribed fire between 2029 and 2039. Prescribed fires with lower severity effects (e.g., burning under cooler and/or wetter conditions) in 2029-2039 could be implemented to maintain the desired basal area and continue to meet the desired condition.

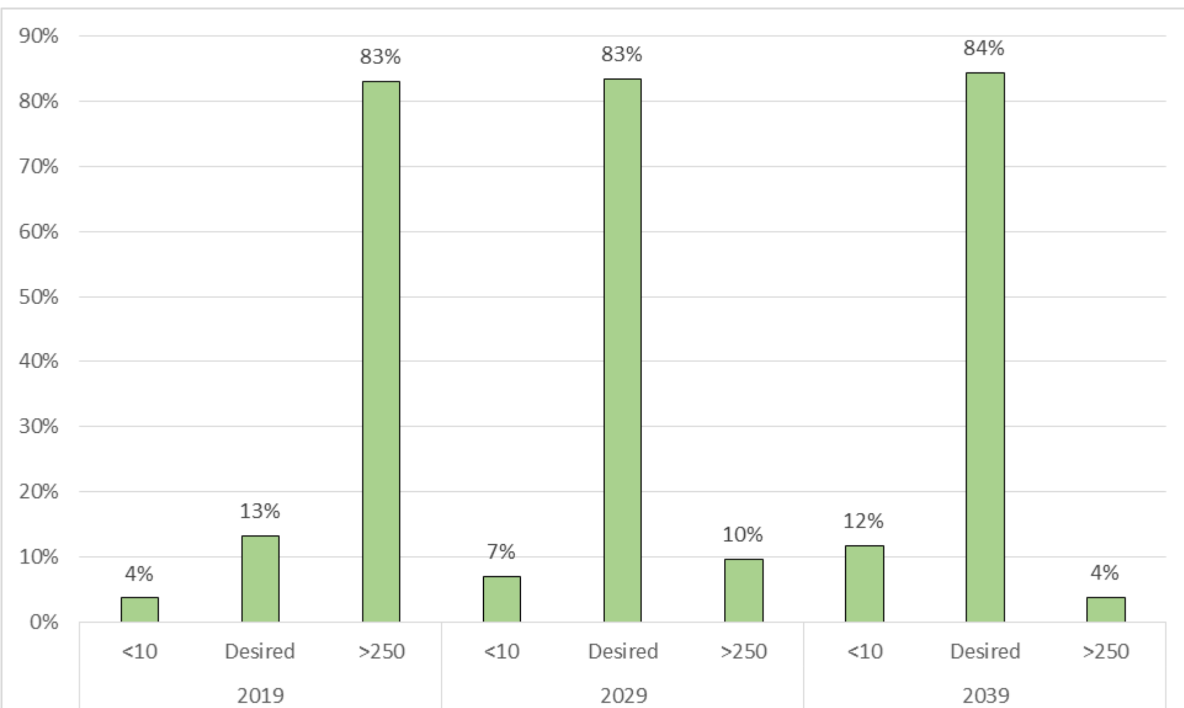


Figure 27. Alternative 2 – Proposed Action – Percent of acres meeting desired condition for trees per acre across the analysis area

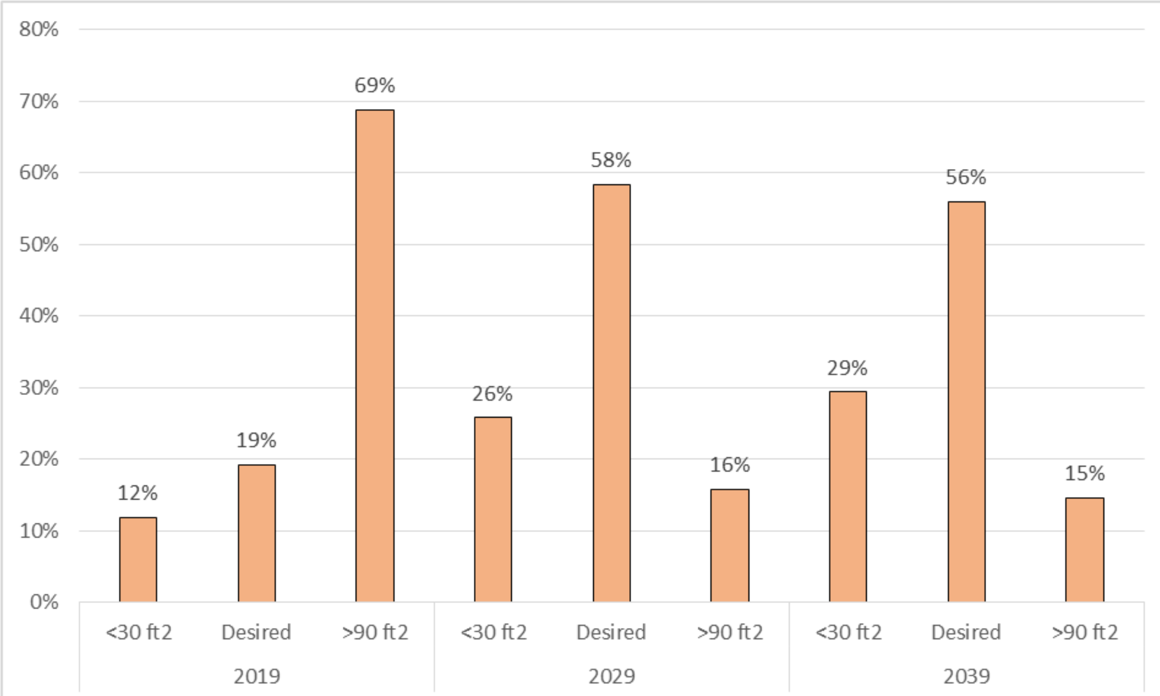


Figure 28. Alternative 2 - Proposed Action – Percent of acres meeting desired condition for basal area across the analysis area.

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Reineke 1933, Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

The desired condition for SDI is to be between 25 and 45 percent of SDIMax or between 112.5 and 202.5. Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered extremely high. As a result of the proposed action, SDI would be reduced to 116 or 26 percent of SDIMax by 2029 and 103 or 23 percent of SDIMax by 2039. While the proportion of acres meeting desired condition in 2019 is 15 percent, the proportion meeting the desired condition would increase to 27 percent in 2029 and to 21 percent by 2039. Prescribed fires with lower severity effects (e.g., burning under and/or wetter conditions) from 2029 to 2039 could be implemented to maintain a higher or SDI if desired. SDI values between 25 percent and 45 percent of SDIMax are associated with high understory production and intermediate levels of individual tree diameter growth as overall stand growth is concentrated on fewer number of trees than in more dense forests. Depending on the level of tree aggregation, little inter-tree competition would be occurring. Competition could still be occurring within dense tree groups.

Over time, with the proposed action, stand densities should stabilize as the reintroduction of fire returns natural disturbance processes to the landscape. This would result in reduced susceptibility to insect epidemics, particularly bark beetles, as well as reduced density dependent mortality, increased individual tree diameter growth and forage production over time, and continued attainment of the desired condition.

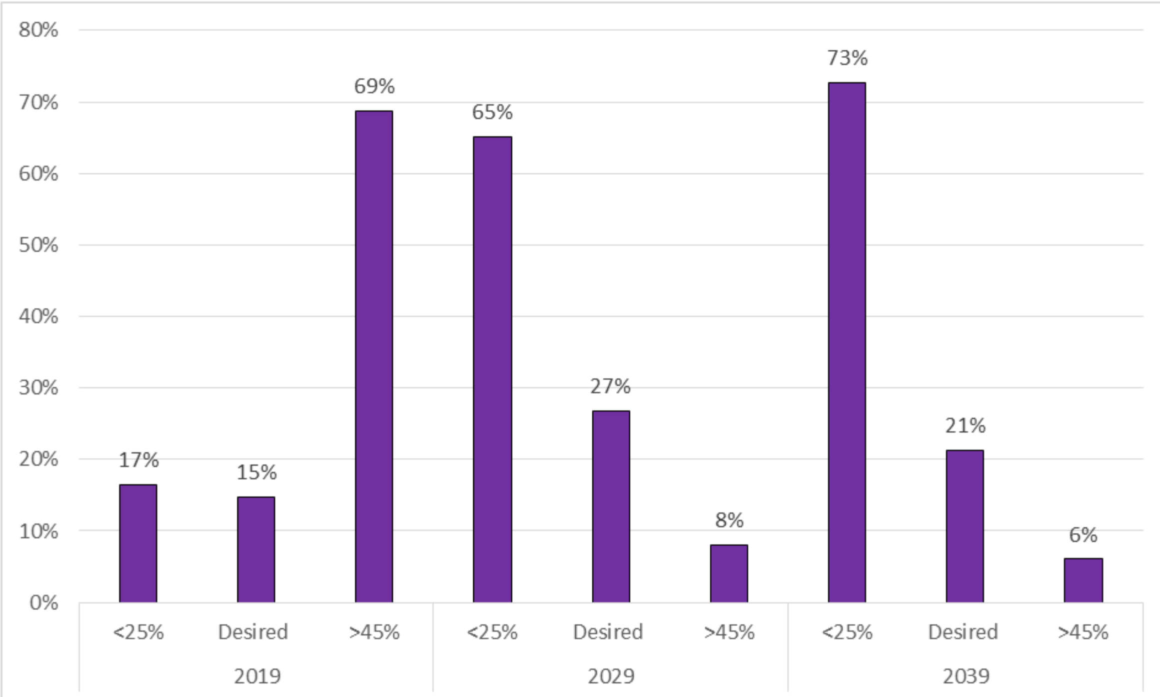


Figure 29. Alternative 2 - Proposed Action – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15"and the basal area of trees greater that 16" is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Across all 5th HUC watersheds in the project area, the average number of acres currently meeting SPLYT criteria is 36,325 with a QMD of the top 20 percent of trees being 19 inches. Under the proposed action, this number would increase to 64,774 acres with a QMD of the top 20 percent of trees being 24 inches. While this acreage is lower than the acres meeting SPLYT criteria in 2039 for the no action alternative it does not take into the account the potential large scale mortality of trees as a result of a large fire or insect outbreak. Under this alternative, prescribed cutting and prescribed burning would occur over much of the landscape. Modeling indicates that the number of acres meeting SPLYT criteria would increase as a result of the proposed action, but at a slower rate than the Proposed Action. With design features in place during implementation, large trees meeting the large and old growth tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the number of SPLYT acres to increase over time. During implementation, some large trees would be cut in accordance with the large and old growth tree implementation plans. Remaining larger trees would be less susceptible to mortality from drought, insects, disease, and wildlife (Das et al. 2011, Ritchie et al, 2008). This reduction in the number of SPLYT acres over the no action alternative does not take into account the application of the LTIP that would effectively increase the number of large trees remaining across the landscape.

This alternative would result in a lower risk of mortality, especially for larger trees, because of a decreasing risk of infection from pests or disease (Fischer, Waring, Hofstetter, & and Kolb, 2010), high severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), or increased drought stress from competition (Erickson & Waring, 2014). A number of studies have found that lower forest density leaves large and old trees less susceptible to mortality as a result of these factors. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." Modifying forest conditions to facilitate low severity fire on the landscape has been identified as a key condition to preventing increased mortality of large and old trees over the next several decades (Fiedler et al. 2007, Kolb et. al. 2007, Ritchie et. al. 2008). While this alternative may increase the amount of SPLYT acres at a slower rate than the No Action Alternative, the resulting forest would be far less likely to experience substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire). A potential result of this alternative would be additional SPLYT acres than the No Action alternative in the presence of large scale disturbances.

Under this alternative, Forests would be able to manage more acres of naturally occurring wildfires for resource benefit. Forest structure, including openings, interspace, and groups and clumps of trees would allow for low to moderate fire severity that would maintain openings and have little potential effect on the vegetation resource except for trees in the smaller size classes. For a more thorough description of post treatment fire behavior consult the Fire Ecology Specialist Report in the project record.

Forest Process

Insects

Under the Modified Proposed Action, the proportion of acreage with a high hazard rating for bark beetles would decrease from 74 percent to 11 percent in 2029 and to 8 percent by 2039. Stands with a low or moderate beetle hazard rating, the desired condition, would increase from 26 percent in 2019 to 89 percent in 2029 and then 92 per cent by 2039. This demonstrates a considerable shift towards the desired condition for this indicator. While the proportion of acreage with a moderate rating would change only slightly, the proportion of acreage with a low hazard rating would increase considerably as the analysis area approaches desired condition for this indicator.

Stands with lower tree densities and basal area are more resilient to drought and beetle attacks. Bark beetle population dynamics suggests that homogenous, dense stands are highly susceptible to beetle outbreaks. The proposed action would create heterogeneous, open, uneven-aged stands that would dramatically reduce susceptibility and maintain that reduced susceptibility over time. Susceptibility to western pine beetle would decrease over time with mechanical treatment and reintroduction of low severity surface fire. Areas with the greatest likelihood of infestation from bark beetles are areas treated at a low intensity as to not considerably affect beetle hazard rating. Additionally, areas with large amounts of slash remaining post treatment are at risk for ips beetles. Some susceptibility to ips would continue to increase, with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

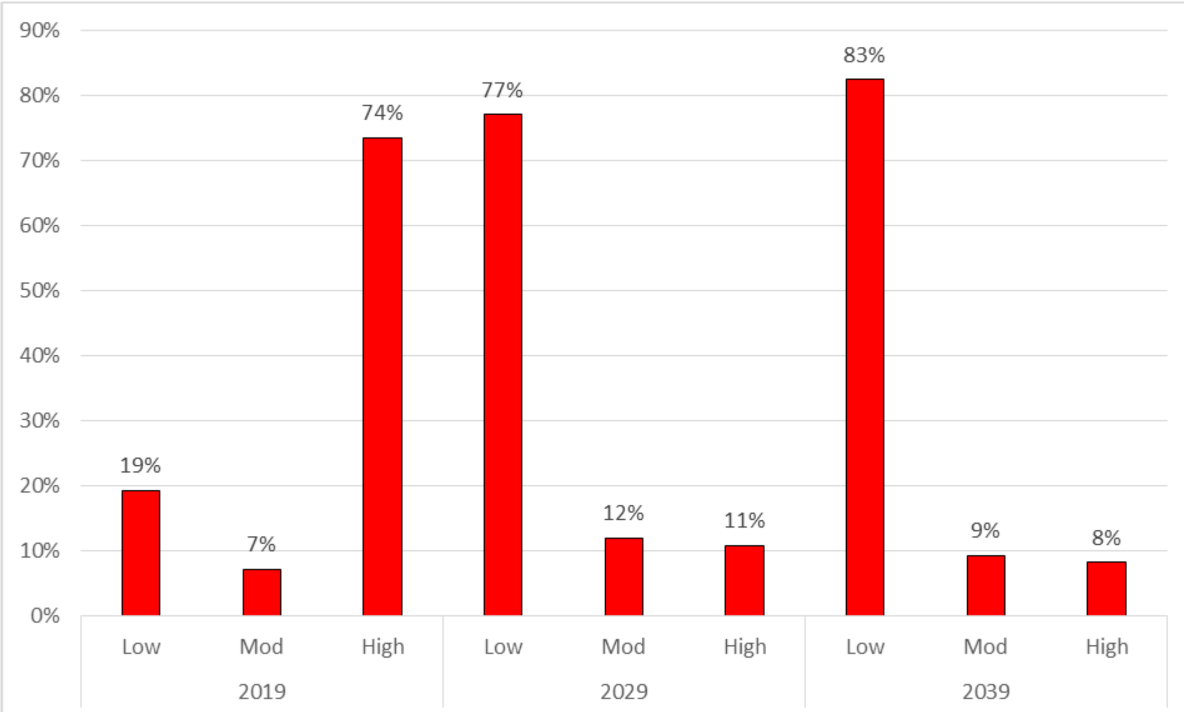


Figure 30. Alternative 2 - Proposed Action – Distribution of Bark Beetle Hazard Rating classes across the analysis area.

Disease

Across the analysis area, approximately 75 percent of the area would not be infected or have a low infection level, 22 percent would have a moderate severity rating, and four percent, or 36,058 acres, would have a high severity rating. As a result of the Modified Proposed Action, stands with a high severity rating would drop to two percent and stands with a Low or None rating drop to 69 percent. Acres with a moderate rating would increase to 31 percent as infection intensification and spread occur even after mechanical treatment. Dwarf mistletoe infections may be reduced as a result of the Proposed Action but may intensify in remaining or latent infected trees, surrounding trees, and infected residual overstory trees, reducing the growth, vigor and longevity of ponderosa pine (Conklin and Fairweather 2010). However, across the analysis area, growth, longevity, and vigor of ponderosa pine trees would be increased. Though most of the analysis area would meet the desired condition of having low or no dwarf mistletoe severity, 34 percent of the analysis area would have a moderate or severe dwarf mistletoe severity rating by 2039 and would not meet the desired condition. This would be an improvement in dwarf mistletoe severity rating over the No Action Alternative by the year 2039.

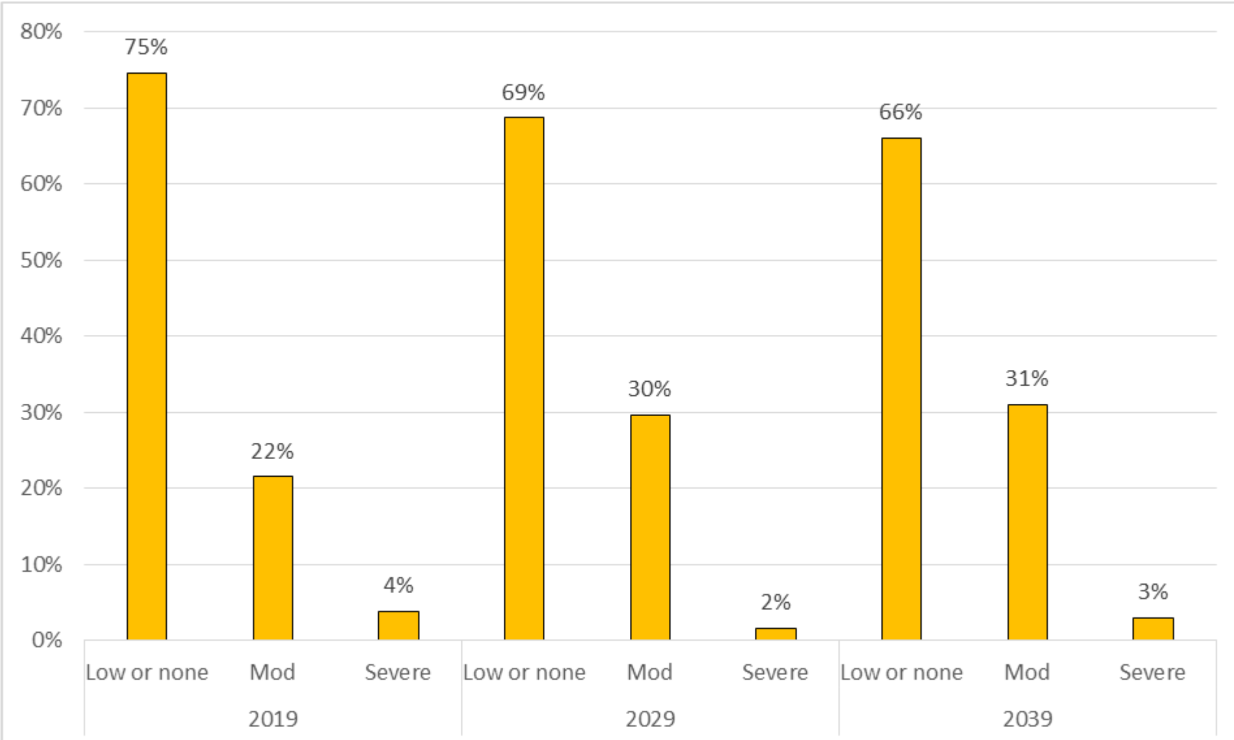


Figure 31. Alternative 2 - Proposed Action – Dwarf Mistletoe Severity Rating classes across the analysis area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative would support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. This alternative would support the shift away from larger high severity crown fires to conditions that are more likely to support increasingly frequent, low severity surface fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). Over time this alternative would create conditions that resemble the NRV of the native microbes, plants, and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, the analysis area would have reduced susceptibility to undesirable fire behavior and effects as well as other disturbance agents, such as bark beetles and disease, over time.

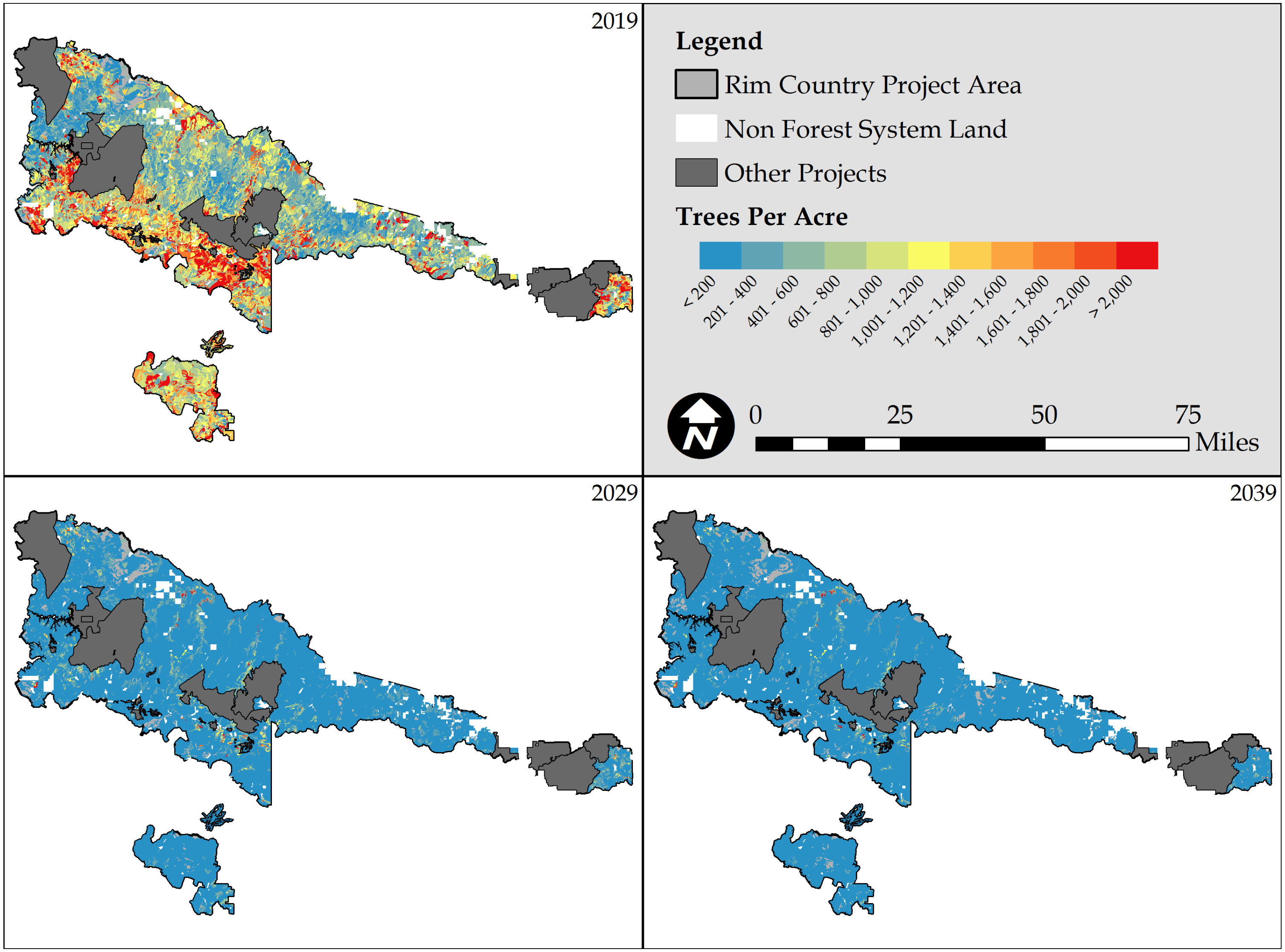


Figure 32. Alternative 2 – trees per acre

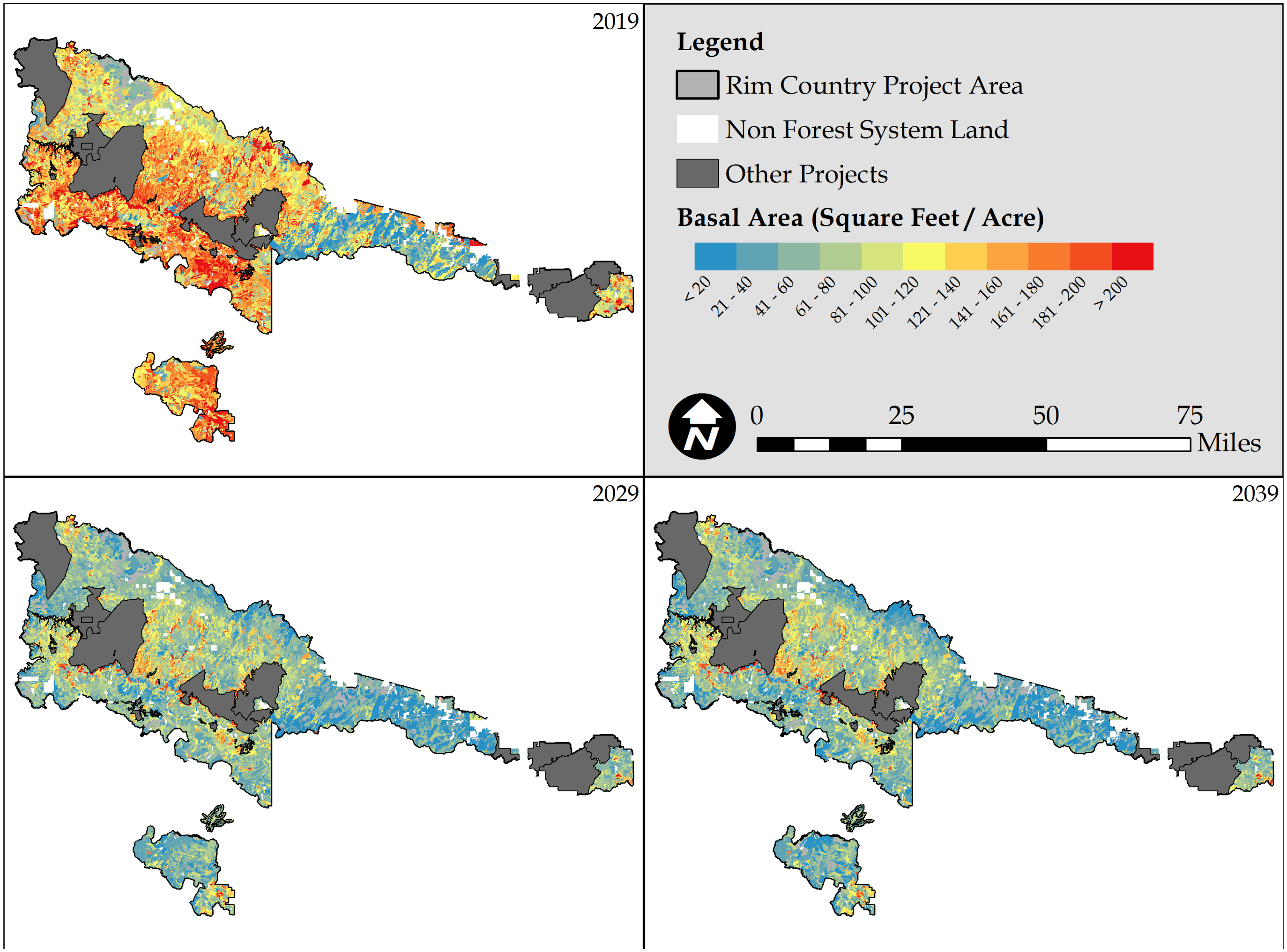


Figure 33. Alternative 2 – basal area

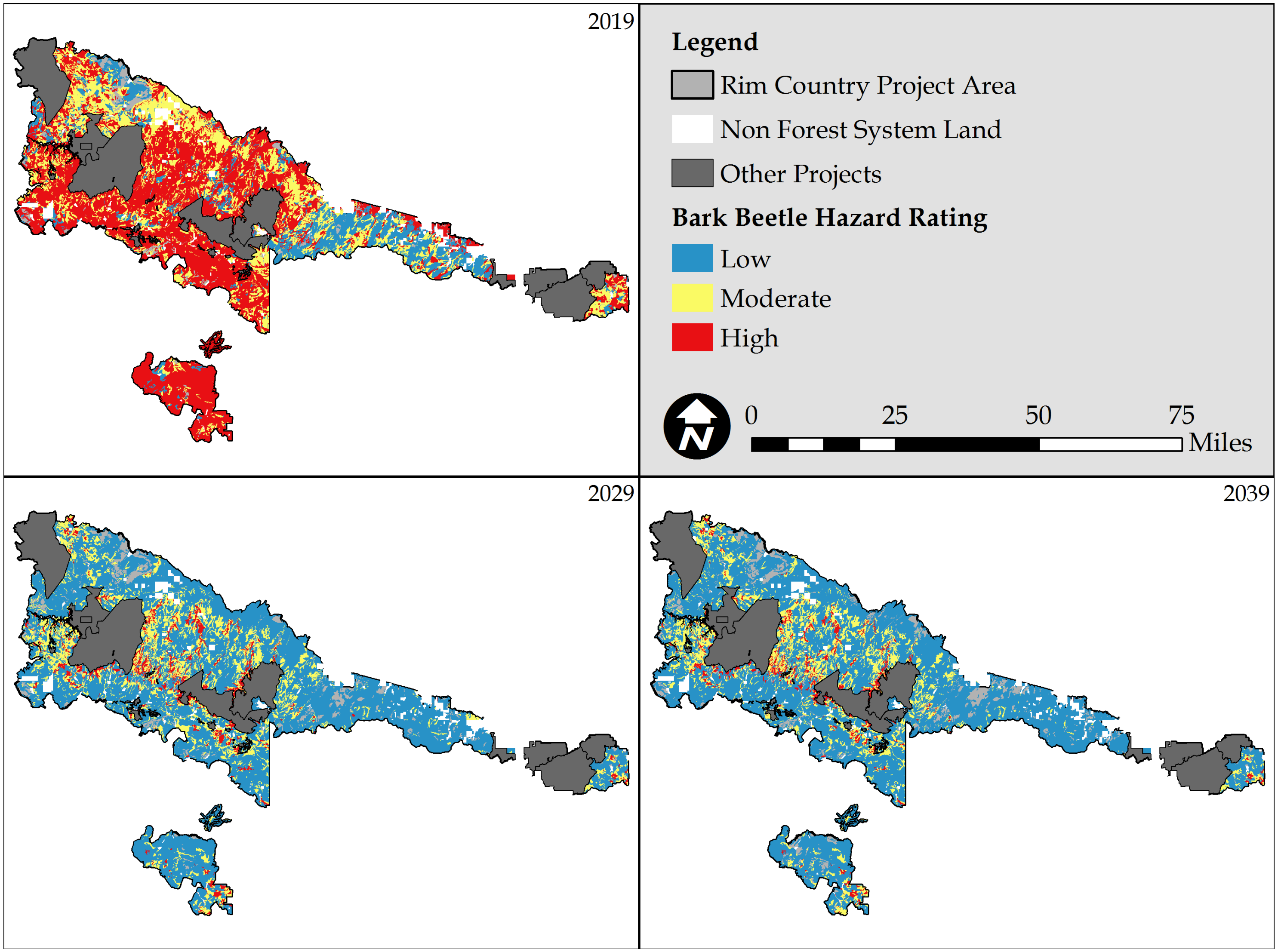


Figure 34. Alternative 2 – bark beetle hazard rating

Alternative 3 – Focused Restoration

Direct and Indirect Effects

In general, many of the direct and indirect effects of Alternative 3 would fall somewhere between those of the Alternative 1 and Alternative 2 or similar to Alternative 2 with somewhat muted effects due to the limited number of acres treated. Under Alternative 3, prescribed cutting and/or prescribed fire treatment would be applied over a portion of the analysis area in order to move towards or meet the desired conditions. This alternative meets or moves the project area toward the desired conditions identified in the Forest Plans and moves the project area forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem over the portion of the project area that would be treated. For a more thorough analysis of the effects of this alternative on the wildfire hazard, consult the Fire Ecology Specialist Report (USDA 2019). Many other areas that did not receive treatment would not move toward the desired conditions identified for this project. The distribution of trees across size classes is more representative of a historic size class distribution as many trees in the smaller size classes have been removed or burned. At a landscape scale, forest composition, structure, pattern, and process would all be improved, but to a lesser extent than the Proposed Action.

Stand and landscape resilience to disturbances such as multi-year drought, pests and disease such as bark beetle and mistletoe, and wildfire would increase (Abella, et al. 2007), although to a lesser extent than with the Proposed Action. Drought stress and insect attacks associated with increased tree density, altered tree spatial arrangement, would be reduced. These changes in forest structure would reduce tree mortality due to decreased competition among trees in stands that were treated (Kane et al 2014). At the fine scale, forest structure and pattern would be improved in treated areas as vegetation management activities would maintain or improve the level of tree aggregation (groups and clumps of trees), and as existing groups are maintained and new groups are created (Zhang et al 2013).

Composition

Forest composition would improve under this alternative, although to a lesser extent than the Proposed Action. Ponderosa pine would still be the dominant forest cover type. Mixed conifer would continue to make up a moderate proportion of the analysis area, however shade tolerant species such as white fir may increase compositionally in untreated stands. As a result of prescribed cutting and prescribed fire in areas proposed for treatment, prevalence of later seral species such as white fir and corkbark fir would be reduced and would better represent their role in the NRV. Pinyon Juniper woodlands and oak species would continue to make up a considerable part of the analysis area. The treatment of encroached grasslands would expand their range to more fully represent the NRV, although to a lesser extent than the Alternative 2. The protection and improvement of aspen stands would promote regeneration and reduce inter-tree competition and improve their condition under this alternative. The condition of less common but important species such as maple and Emory oak would be improved in treated areas.

This analysis has considered the effects of a changing climate. Though this alternative would result in a landscape more resilient to climate change than the No Action Alternative, climatic models for the southwestern U.S. predict continued warming, greater variability in precipitation, and increased drought. These climatic changes would likely contribute to some level of tree mortality; however, considerably less than the No Action Alternative. A changing climate may lead to large shifts and contractions in the range of dominant trees throughout much of the region (Kane et al, 2014).

Structure

Uneven-aged Structure

It is desirable for uneven-aged forest structure to occur on a majority of acres. Under this alternative, there would be a change to forest structure (Figure 35) on the acres proposed for treatment, however large untreated areas would see little change to existing forest structure. This alternative would meet the Desired Condition for uneven-aged structure in the Forest Plans, however forest structure would more closely resemble NRV in treated stands. Modeling indicates that some stands would move towards more even-aged conditions in the dominant cover types proposed for treatment as a result of removal of trees from the smaller size classes and retention of trees in the larger size classes. However, as treatments are applied on the ground, the use of the large and old tree implementation plans, in accordance with an uneven-aged thinning strategy, would be able to produce uneven-aged conditions across much of the landscape. In treated stands, individual tree growth would increase and trees would move into larger size classes as a result of a reduction in individual tree competition. Naturally-occurring regeneration would provide additional vertical structure over time.

An additional, and potentially more substantial, benefit to forest structure would be a reduction in the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. Under this alternative, treated stands would be more resistant to uncharacteristic fire and insect outbreaks and more resilient to drought. The balance of size classes and uneven-aged structure would provide conditions favorable to restoration of a natural fire regime in the areas proposed for treatment. In areas of untreated stands, the potential for uncharacteristic fire or other substantial disturbances would persist as well as their associated effects on forest structure.

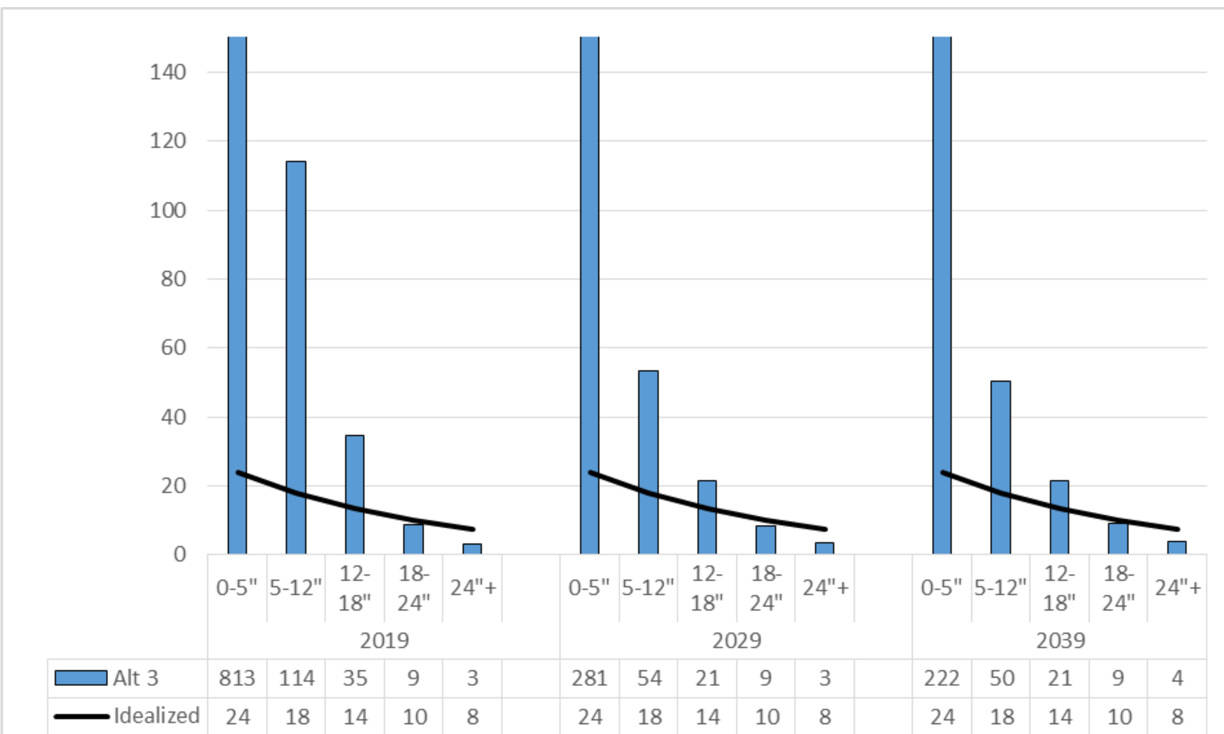


Figure 35. Alternative 3 – Focused Alternative – Distribution of trees per acres across size classes across the analysis area

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. On a portion of the project area prescribed fire and thinning would change the size class distribution of trees. Alternative 3 would meet the desired condition on a smaller portion of acres as compared to the Proposed Action. The overall tree density would decrease under this alternative, with 973 trees per acre in 2019, 368 in 2029 and 307 trees per acre in 2039. While the initial reduction in trees per acre would result from a combination of mechanical and prescribed fire activities, the reduction after 2029 can be attributed to the recurring prescribed fire over time. Prescribed fire could more likely be used to balance the size classes at the lower end of the VSS distribution and move the landscape toward the desired condition. For example, prescribed fires with higher severity effects (e.g., burning under hotter and/or dryer conditions) from 2029 to 2039 could be implemented to maintain the desired size class distribution at the lower end and better meet the desired condition.

Similar to the Proposed Action, the reduction in tree density would increase individual tree growth and reduce density dependent tree mortality. Understory grasses, forbs, herbs, and shrubs would increase in quantity in treated areas (Covington & Moore, 1994a).

Like many of the other indicator measures, the effects of the Focused Alternative on trees per acres would resemble those of the Proposed Action, only to a lesser degree. It is important to note that this is because fewer acres would be treated compared to the Proposed Action; however those acres that would be treated would still be treated at the same intensity as the Proposed Action.

The desired condition is to retain a basal area of between 30 and 90 ft^2 per acre across most habitat types outside of MSO PACs. While the Forest Plans provide a desired condition with a range of basal areas ranging from 20 to 180 ft^2 depending on cover type, for this analysis, at the project level, for ease of comparison of effects between alternatives, 90 ft^2 is the breakpoint for the resource measure across the analysis area For both mixed conifer and ponderosa pine cover types it is desired to maintain basal area at less than 90 ft^2 though exceptions exist to provide heterogeneity across the landscape as well as specific wildlife needs for dense and closed canopy forest conditions. For a more thorough analysis of the effects of this alternative within MSO and Northern goshawk habitat, consult the Wildlife Specialist Report (USDA 2019).

Under the Focused alternative, basal areas across the analysis area average would be reduced to 87 square feet per acre in 2029 and 89square feet per acre in 2039. While currently only 13 percent of stands meet the desired condition, by the year 2029 52 percent of stands would meet the desired condition and by 2039, 55 percent of stands would meet the desired condition. This would result in decreased inter-tree competition for resources such as water, light, growing space and nutrients in treated areas. Individual tree growth would increase and density dependent mortality would be dramatically reduced along with susceptibility to potential insect and disease outbreaks. These conditions would indicate a shift from the current larger and higher intensity fires that the forest would currently experience to cooler, higher frequency, lower severity surface fires (Cooper, 1960) (Swetnam, 1990) (Covington & Moore, 1994a) (Kolb, Wagner, & Covington, 1994) (Swetnam & Baisan, 1996) that persisted prior to European settlement.

While some effects such as increased diameter growth and reduced competition would be reduced only in treated stands, other effects, such as landscape level insect hazard and fire severity, may extend to untreated areas. The reductions in basal area would allow the treated areas to meet the desired conditions and purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems at the landscape and watershed scales.

While some watersheds would have their average basal areas reduced to within the desired condition as a result of proposed activities, some watersheds such as Rye Creek-Tonto Creek would experience considerable additional mortality as a result of prescribed fire between 2029 and 2039. This is a similar effect as with the Proposed Action and is a result of the intensity of the prescribed fire modeled, as well as the fact that most of the acres proposed for treatment in Alternative 2 were also proposed for treatment in the Focused Alternative. Prescribed fires with lower severity effects (e.g., burning under cooler and/or wetter conditions) from 2029 to 2039 could be implemented to maintain the desired basal area and continue to meet the desired condition in some watersheds.

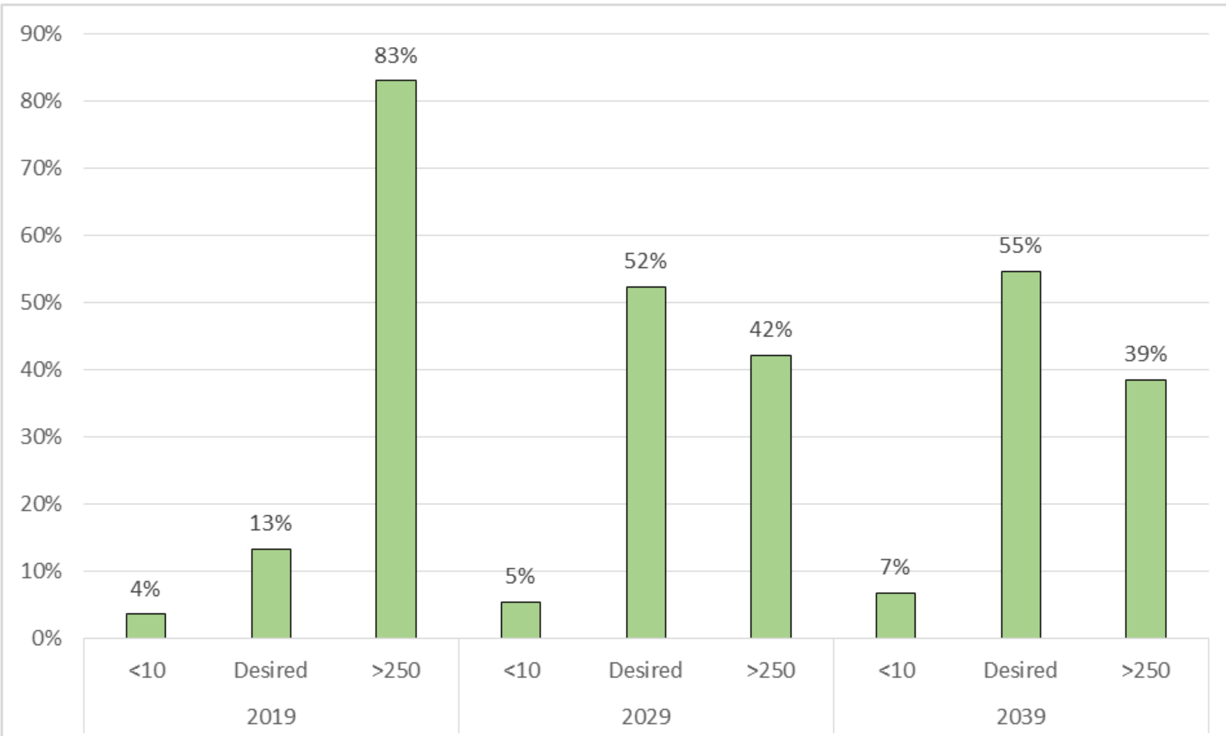


Figure 36. Alternative 3 – Focused Alternative – Percent of acres meeting desired condition for trees per acre across the analysis area

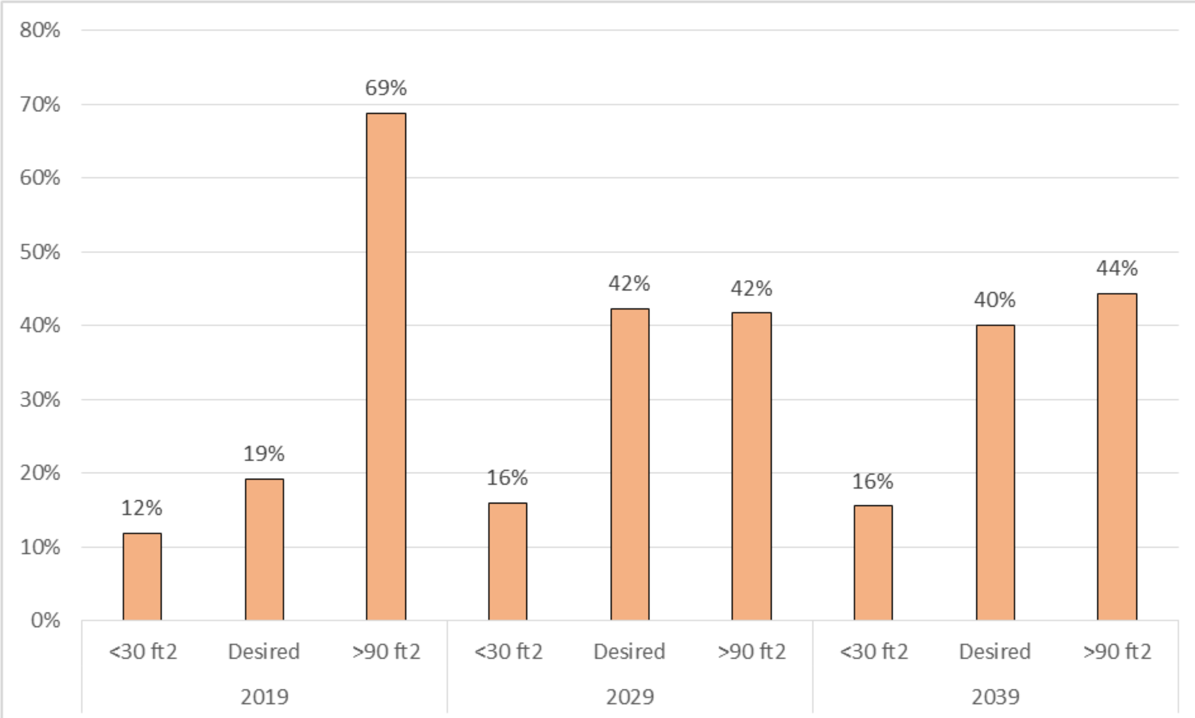


Figure 37. Alternative 3 – Focused Alternative – Percent of acres meeting desired condition for basal area across the analysis area

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

The desired condition for SDI is to be between 25 percent and 45 percent of SDIMax or between 112.5 and 202.5. Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered extremely high. As a result of Alternative 3, SDI would be reduced to 172 or 38 percent of SDIMax by 2029 and 170 or 38 percent of SDIMax by 2039. While currently 15 percent of the acres in the analysis area meet the desired condition, as a result of the Focused Alternative, 27 percent would meet the desired condition and 21 percent would in 2039.

SDI values between 25 percent and 45 percent of SDIMax are associated with maximum understory production and maximum individual tree diameter growth as overall stand growth is concentrated on fewer trees. Depending on the level of tree aggregation, little inter-tree competition would be occurring. Competition may still be occurring within dense tree groups regardless of stand level SDI values.

Over time with the Focused Alternative, stand densities should stabilize in treated areas as the reintroduction of fire returns natural disturbance processes to the landscape. This would result in reduced susceptibility to insect epidemics, particularly bark beetles as well as reduced density dependent mortality, increased individual tree diameter growth, and forage production over time and continued attainment of the desired condition.

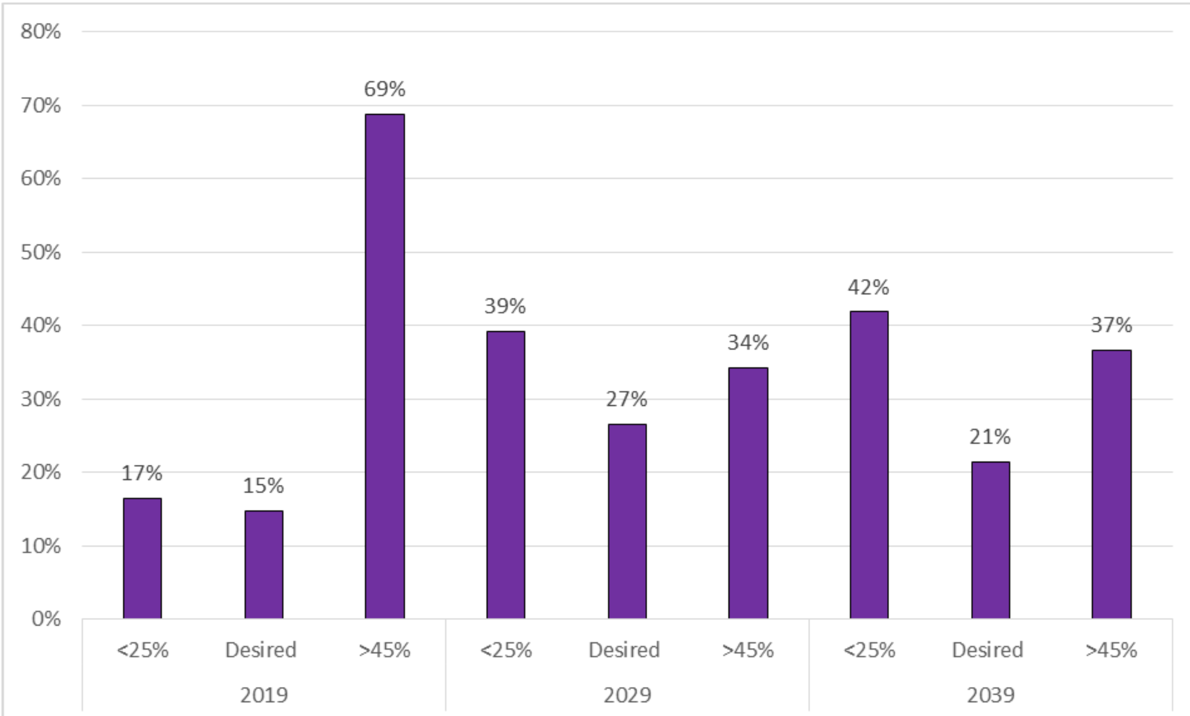


Figure 38. Alternative 3 – Focused Alternative – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15 inches and the basal area of trees greater that 16 inches is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Currently, across all 5th HUC watersheds in the analysis area the number of acres meeting SPLYT criteria is 36,325 a QMD of the top 20 percent of trees being 19 inches. Under the focused alternative, this number would increase to 72,424 by 2039 with a QMD of the top 20 percent of trees being 22 inches. The number of acres meeting SPLYT criteria would increase as a result of the Focused Alternative, but at a slower rate than the Proposed Action. With design features in place during implementation, large trees meeting the large and old growth tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the proportion of stands meeting desired condition for large trees to actually increase over time. During implementation, some large trees would be cut in accordance with the large and old growth tree implementation plans in order to meet the desired condition. In treated areas, remaining larger trees would be less susceptible to mortality from drought, insects, disease, and wildlife. (Das et al. 2011, Ritchie et al 2008), whereas in untreated areas, susceptibility to these disturbance agents would continue to increase. This slower rate of SPLYT acre recruitment does not take into account the application of the Large Tree Implementation Plan that would effectively increase the number of SPLYT across the landscape at the expense of trees in the smaller size classes.

This alternative would result in a lower risk of mortality in the stands that were treated, especially for larger trees, because of a decreasing risk of infection from pests or disease (Fischer et al, 2010), high-severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), and drought stress from competition (Erickson & Waring, 2014). A number of studies have found that lower forest density leaves large and old trees less susceptible to mortality as a result of these factors. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." While this alternative may increase the amount of acres meeting SPLYT criteria as a slower rate than the No Action Alternative, the acres proposed for treatment would be far less likely to experience substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire).

In untreated areas, the effects would be similar to the no action alternative and would result in a higher risk of mortality, especially for larger trees, because of an increasing risk of infection from pests or disease (Fischer et al, 2010), high-intensity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010) or increased drought stress from competition (Erickson & Waring, 2014). While this alternative may increase, on untreated areas, the amount of SPLYT acreage based on model results, these results do not account for the likely substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire), which would decrease the amount of old and large trees and SPLYT acreage in the analysis area.

Forests would have the ability to manage more acres of naturally occurring wildfires to benefit forest resources, mainly within watersheds that have a considerable portion proposed for treatment. In treated areas, forest structure, including openings, interspace, and groups and clumps of trees would allow for low to moderate fire severity that would maintain opening and have little potential effect on the vegetation resource except for trees in the smaller size classes.

Under this alternative, on untreated acres where wildfires are managed for resource benefit, they may have the effect of reducing basal area and SDI by killing small trees or groups of small and/or intermediate aged trees. These fires could also result in mortality of some large and old trees. Based on those areas of recent wildfires that were managed for resource benefits, this effect would be very limited across the landscape in untreated areas. For a more thorough description of post treatment fire behavior consult the Fire Ecology Specialist Report in the project record.

Forest Process

Insects

Under this alternative, the proportion of acreage with a high hazard rating for bark beetles would decrease from 74 percent to 39 percent in 2029 and to 40 percent by 2039. The majority of acres that would remain with a high hazard rating are as a result of a lot of acres remaining untreated. While the proportion of acreage with a moderate rating would change only slightly, the proportion of acreage with a low hazard rating would increase considerably as the analysis areas approaches desired condition for this indicator. Stands with a low or moderate bark beetle rating, the desired condition, would increase from 26 percent in 2019 to 61 percent in 2039 and 60 percent by 2039

Stands with lower tree densities and basal area are more resilient to drought and beetle attacks. Bark beetle population dynamics suggests that homogenous, dense stands are highly susceptible to beetle outbreaks. The proposed action would create heterogeneous, open, uneven-aged stands that would dramatically reduce susceptibility and maintain that reduced susceptibility over time. Susceptibility to western pine beetle would decrease over time with mechanical treatment and reintroduction of low severity surface fire. Areas with the greatest likelihood of infestation from bark beetles are areas treated at a low intensity as to not considerably affect beetle hazard rating. Additionally, areas with large amounts of slash remaining post treatment are at risk for ips beetles. Some susceptibility to ips would continue to increase with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

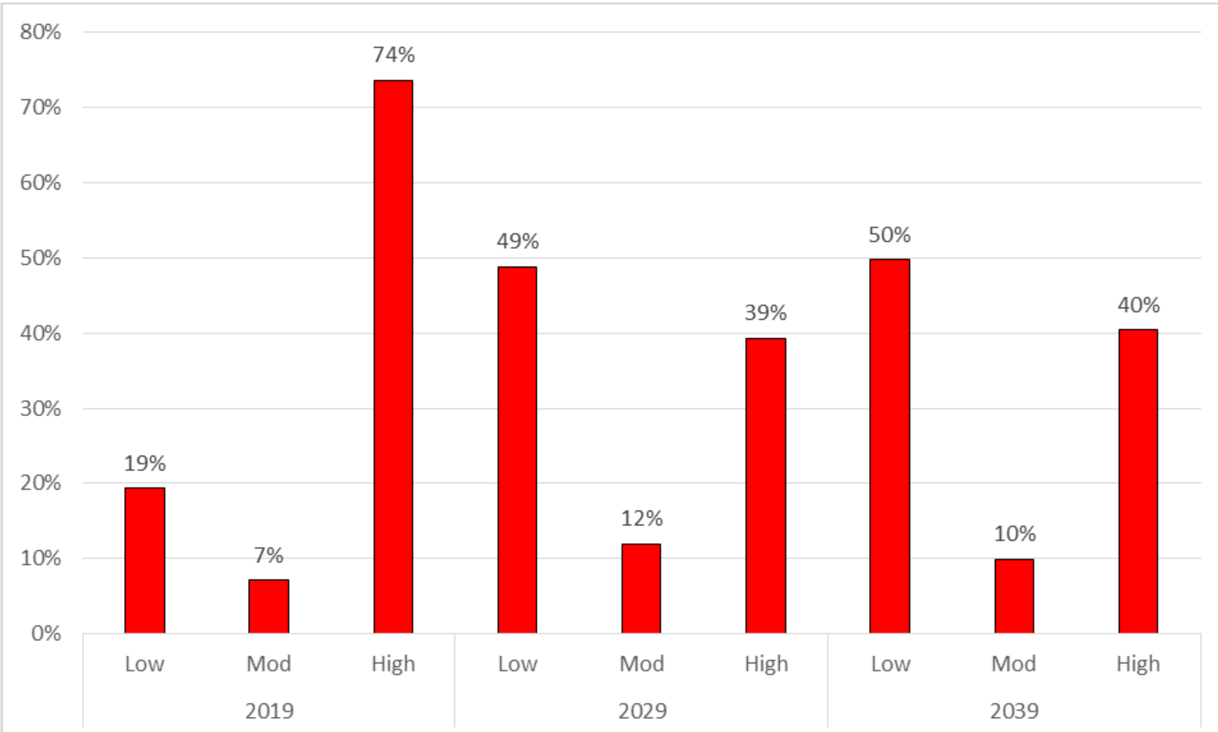


Figure 39. Alternative 3 – Focused Alternative – Distribution of Bark Beetle Hazard Rating classes across the analysis area

Disease

Currently, across the analysis area, approximately 75 percent of the area is not infected or has a low infection level, 22 percent has a moderate severity rating and 4 percent has a high severity rating. Initially, as a result of the Focused Alternative, stands with a high severity rating would drop to 2 percent and stands with a Low or None rating would increase to 84 percent by the year 2029. The effects of the mechanical treatment and prescribed fire would diminish over time as acres with a severe rating increase to 4 percent and acres with a Low or None rating decrease to 66 percent by 2039, as a result of infection intensification and spread occurring even after treatment over some of the analysis area. With the exception of the change in severe infection, this result would be similar to the effects from the Proposed Action.

In areas not treated under this alternative, dwarf mistletoe infections may intensify and spread to surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine (Conklin and Fairweather 2010). However, across the analysis area, growth, longevity, and vigor of ponderosa pine trees would be increased, approaching the desired condition. This is an improvement in dwarf mistletoe severity rating over the No Action Alternative by the year 2039, as the reduction in severely infected stands substantially affects forest health, growth, vigor, and resilience. In the untreated and severely infected stands, mistletoe infection would intensify and spread over time. Dwarf mistletoe infections would not be reduced in these areas and may intensify in infected trees and the surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine. These stands would further depart from the desired condition over time as infected stands intensify their infections and infect adjacent areas (Conklin and Fairweather 2010).

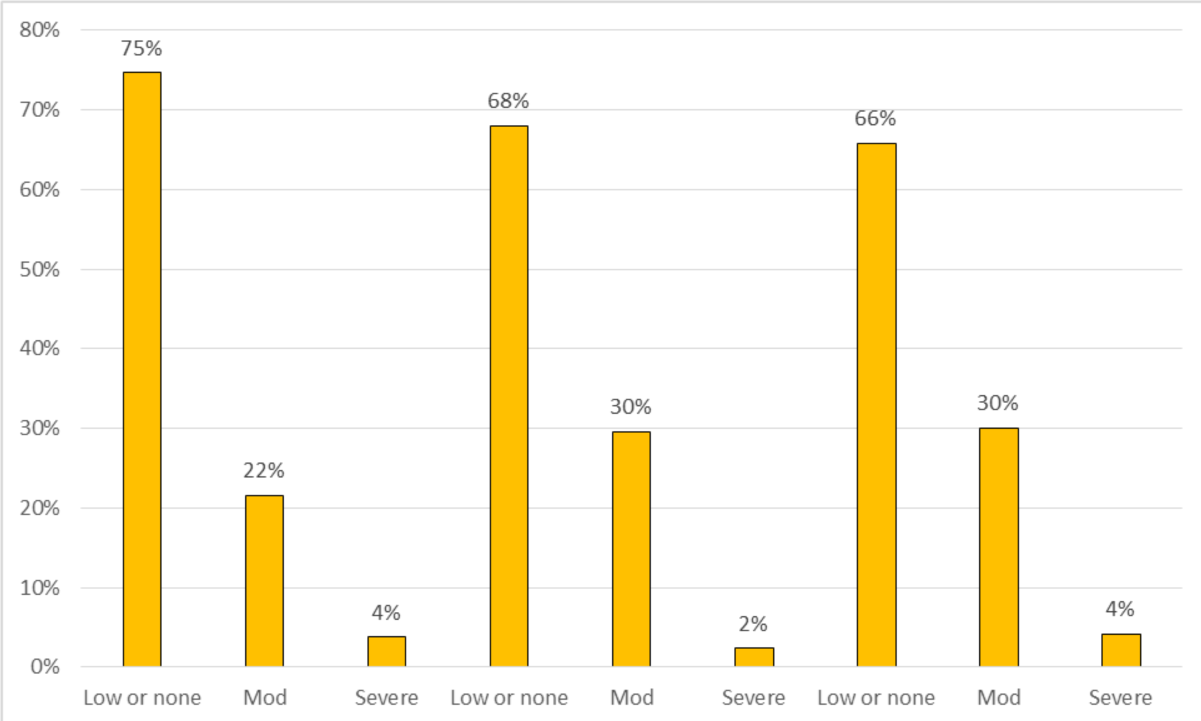


Figure 40. Alternative 3 – Focused Alternative – dwarf mistletoe severity rating classes across the analysis area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative does support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. In areas where treated, this alternative would support the shift away from larger high severity fires to conditions that are more likely to support increasingly frequent, low severity surface fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). Over time this alternative would create conditions that resemble the NRV of plants and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, in areas where treated, this alternative would reduce the susceptibility to uncharacteristically severe fires and other disturbance agents, such as bark beetles and disease, over time. Many areas not treated would remain susceptible to uncharacteristically severe fires and increase in vulnerability to other disturbance agents, such as bark beetles and disease, over time.

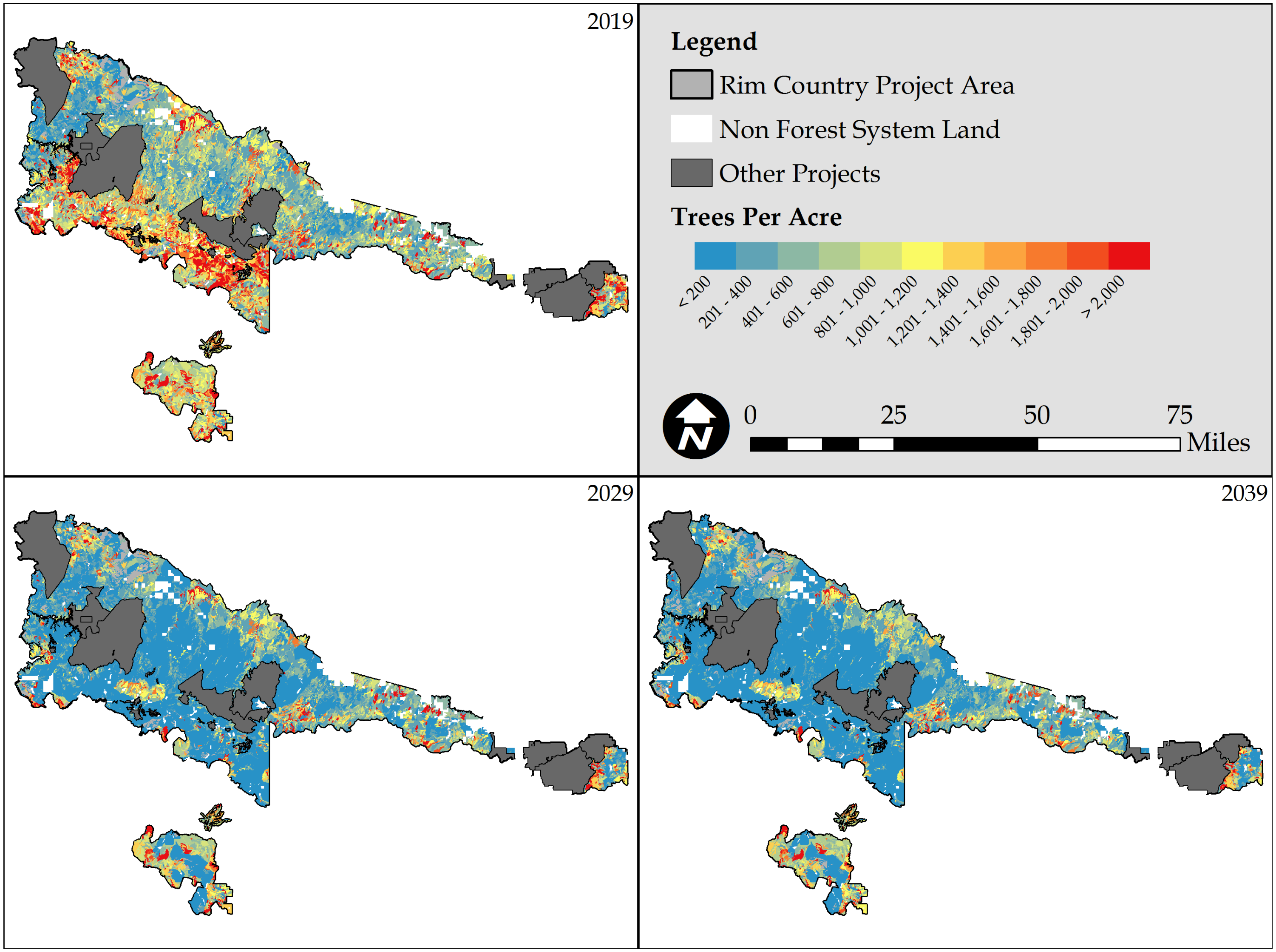


Figure 41. Alternative 3 – trees per acre

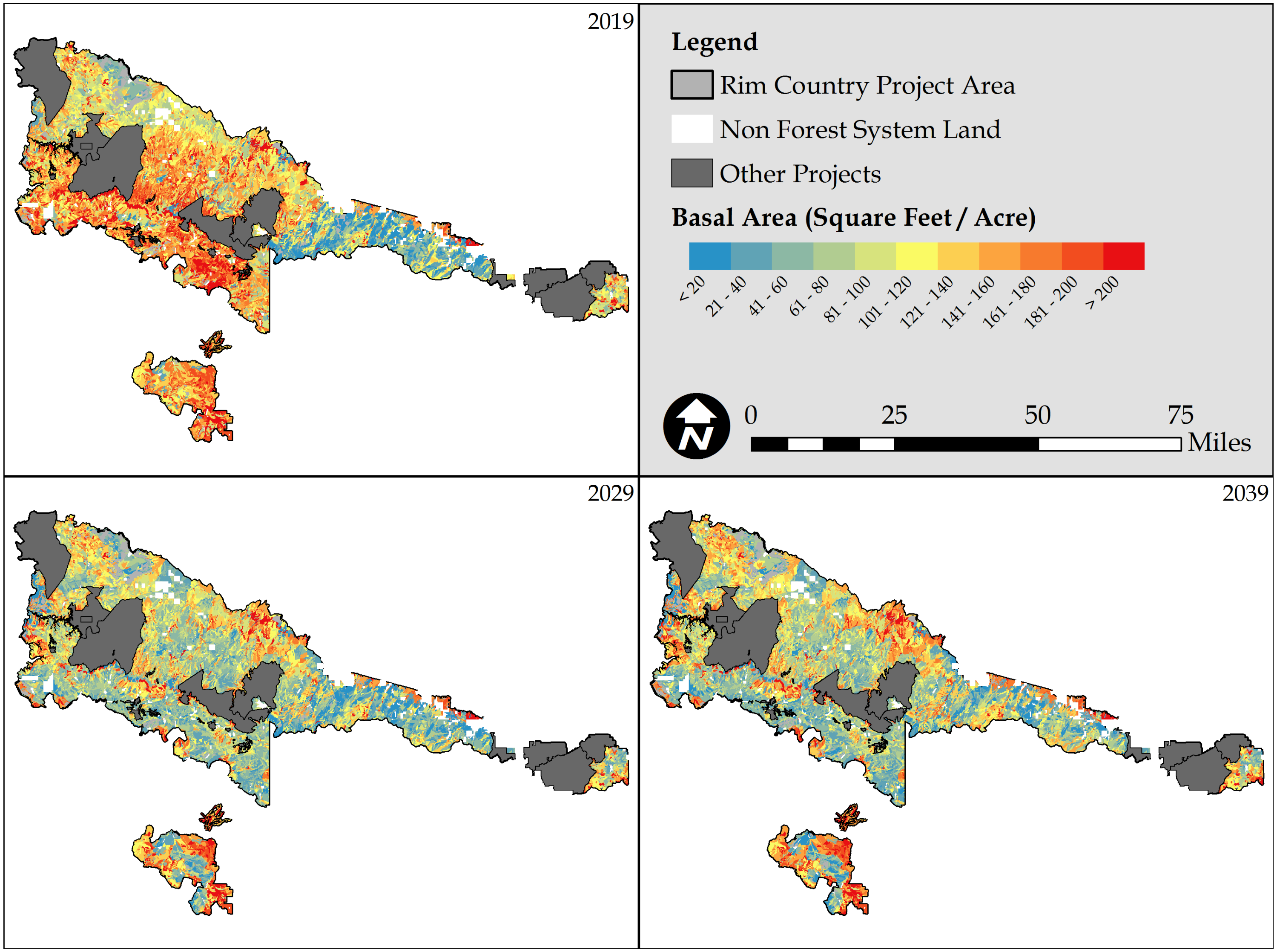


Figure 42. Alternative 3 – basal area

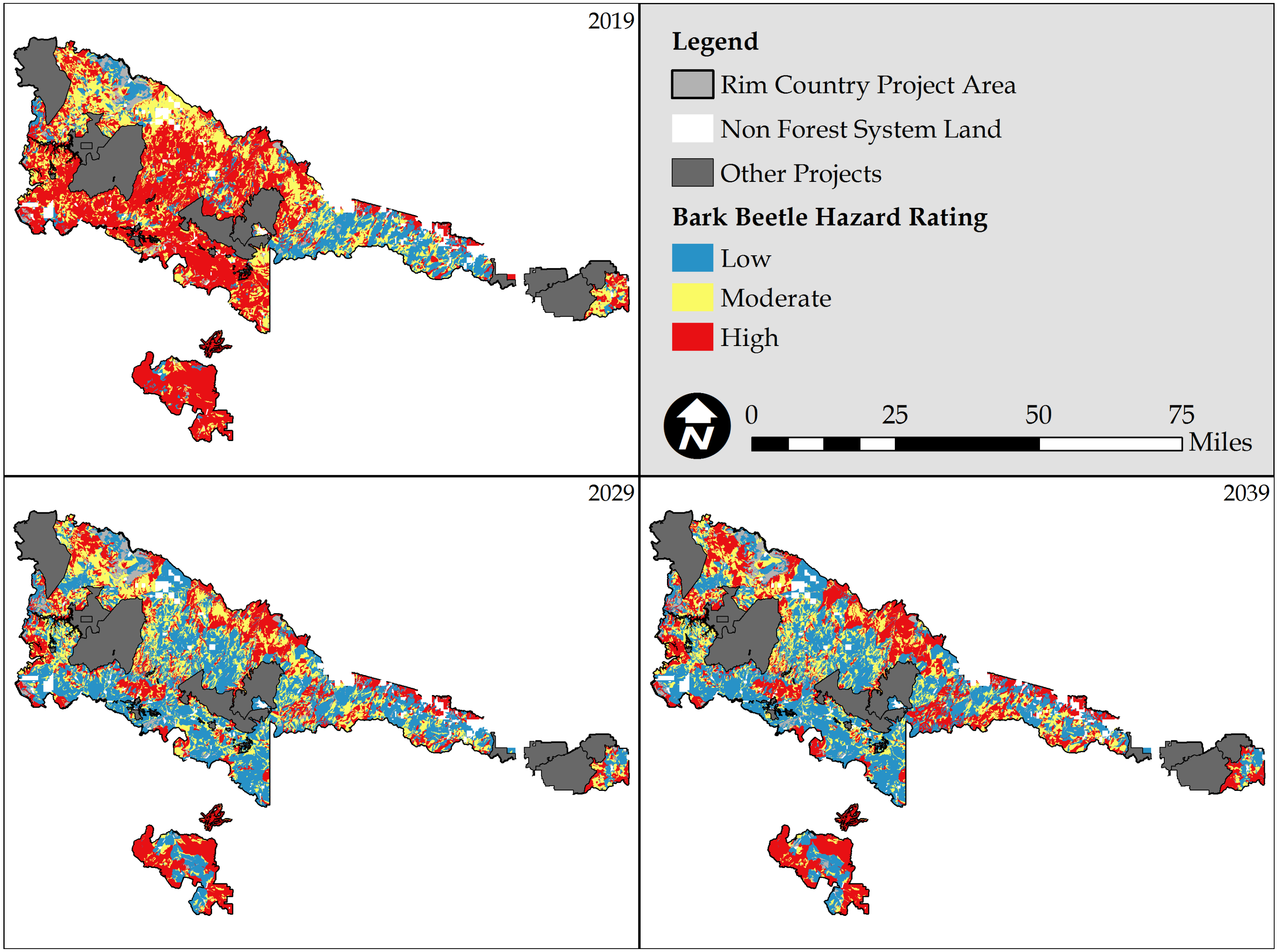


Figure 43. Alternative 3 – bark beetle hazard rating

Table 24. Summarized effects of the Alternatives

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Forest Structure - General	Stand structure would continue to not meet the desired conditions as smaller trees are overrepresented. This trend would be expected to continue, leading to increased density dependent mortality, while basal area and stand density index (SDI) would continue to increase. The number of trees per acre and basal area and SDI would move further away from the natural range of variation (NRV) and the desired conditions. This trend would be expected to continue. Insect hazard rating and severity of dwarf mistletoe infections would continue to increase.	Stand structure would move toward desired conditions as trees would be well distributed across size classes. The number of trees per acre, basal area, and SDI would decrease considerably, trending toward desired conditions within NRV as a result of thinning and prescribed fire activities. Insect hazard rating and dwarf mistletoe severity would be reduced in treated areas, thus moving toward the desired conditions.	In general, the effects would be similar to the effects of Alternative 2, with a muted effect due to the fewer number of acres treated, and would only be observed in the stands treated. The number of trees per acre, basal area, and SDI would decrease considerably, trending toward desired conditions within NRV as a result of thinning and prescribed fire activities. Insect hazard rating and dwarf mistletoe severity would be reduced in treated areas, thus moving toward the desired conditions.
Forest Structure - Pattern	Stands would continue to remain in a closed condition, lacking groups and clumps of trees or randomly spaced trees. Grasses forbs and shrubs would continue to be underrepresented. Forest structure would continue to be departed from historic conditions.	This alternative would generally meet the desired condition. The majority of stands would be in an open condition. Forest arrangement would be in individual trees, small clumps, and groups of trees or randomly spaced trees that are similar to historic patterns and are as a result of the proposed action Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat.	This alternative would generally meet the desired condition on the acres that were treated, however the acres that were not treated would resemble the conditions described in the no action alternative. Forest arrangement would resemble historic forest structure in some places, while many other areas would not meet the desired condition for forest pattern and structure.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Forest Structure – Trees per Acre	Total trees per acre continues to remain above the desired condition. The percentage of acreage in the project within desired condition moves up from 13 percent in 2019 to 15 percent in 2039 as a result of density-dependent mortality. Tree distribution does not approximate the idealized distribution with too many trees in the smaller size classes. By 2039 there would be 621, 121, 39, 12, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	The percentage of acreage within desired condition for trees per acre increases dramatically from 13 percent in 2019 to 84 percent in 2049. The distribution of trees across size classes approximates the idealized distribution by 2039 better than any of the other alternatives. By 2039 there would be 48, 18, 14, 8, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.	Trees per acre: The percentage of acreage within desired condition for trees per acre increases from 13 percent in 2019 to 55 percent in 2039. Tree distribution does not approximate the idealized distribution with too many trees in the smaller size classes. By 2039 there would be 222, 50, 21, 9, and 4 trees in the 0-5", 5-12", 12-18", 18-24" and 24"+ size classes, respectively.
Forest Structure – Basal Area	Average basal area would continue to increase across the project area from 129 square feet per acre in 2019 to 150 square feet per acre in 2039. The percentage of acres that would meet desired condition decreases from 19 percent in 2019 to 12 percent by 2039.	Average basal area would decrease across the project area from 129 in 2019 to 65 in 2029 and 62 in 2039. The percentage of acres that meet desired condition would increase from 19 percent in 2019 to 58 percent in 2029 and then to 56 percent in 2039.	Average basal area would decrease across the project area from 129 in 2019 to 87 in 2029 and 89 in 2039. The percentage of acres that meet desired condition for basal area would increase from 19 percent in 2019 to 42 percent in 2029 and then to 40 percent in 2039.
Forest Structure – Stand Density Index	Average stand density index would continue to increase across the project area from 296 in 2019 to 324 in 2039. The percentage of acres that would meet desired condition decreases from 15 percent in 2019 to 11% in 2039.	Average stand density index would decrease across the project area from 296 in 2019 to 116 in 2029 and 103 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then 21 percent in 2039.	Average stand density index would decrease across the project area from 296 in 2019 to 172 in 2029 and 170 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then to 21 percent in 2039.
Forest Insects	The proportion of acreage that would meet the desired condition for bark beetle hazard decreases from 26 percent in 2019 to 19 percent in 2039 as a result of increased stocking and lack of disturbance over time.	The proportion of acreage that would meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 92 percent in 2039.	The proportion of acreage that meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 60 percent in 2039.

Resource Area	Alternative 1 No Action	Alternative 2 Modified Proposed Action (Preferred Alternative)	Alternative 3 Focused Restoration
Forest Disease	The proportion of acreage with a severe dwarf mistletoe rating would increase from 4 percent in 2019 to 9 percent in 2039. The proportion of acreage that meets the desired condition decreases from 96 percent in 2019 to 91 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating would decrease from 4 percent in 2019 to 3 percent in 2039. The proportion of acreage that meets the desired condition would increase from 96 percent in 2019 to 97 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating remains essentially unchanged from 4 percent in 2019 to 4 percent in 2039. The proportion of acreage that meets the desired condition also remains unchanged from 96 percent in 2019 and 2039.

Cumulative Effects

For the cumulative effects analysis, the spatial context being considered is the 1,238,658 acre project area. Cumulative effects are discussed in terms of vegetation management and prescribed fire activities as well as the effects of wildfire that have occurred since as early as 1990 and as changes in the existing condition due to present and foreseeable activities, including the effects of the alternative being discussed. The baseline year used for this analysis is the year 2019 as the existing condition. In this analysis, all past activities and events are included in the existing condition description. In the effects discussion, post treatment refers to the time the final activity is accomplished (year 2019), "short-term" effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2029). Beyond 20-years we will be considering effects as "long-term" (year 2049). All alternatives are compared across forest boundaries (Apache-Sitgreaves, Coconino and Tonto Forests combined).

Vegetation Management Activities and Prescribed Fire

Table 25 lists approximate acres of the various vegetation management activities, prescribed burning, and other activities that have occurred within the project area as part of vegetation management projects from as early as 1990 to 2017. This includes 469,036 acres of mechanical vegetation management activities that mainly consisted of tree thinning involving heavy equipment and 567,935 acres of prescribed fire. Additionally, 122,264 acres of other activities have occurred in the project areas including 4,645 acres of wildlife habitat improvement, 7,694 acres of range vegetation control, 39,708 acres of range vegetation manipulation, 17,475 acres of tree encroachment control, 45,561 acres of tree release and weed, 15 acres of fuel compaction, 571 acres of fuels chipping, 2,749 acres of range forage improvement, 96 acres of special products removal, 203 acres of insect control and prevention, 1,256 acres of fuel breaks, 1,238 acres of planting, 616 acres of cultural site protection, 321 acres of scarification and seeding of landings and 116 acres of pruning. Table 56 includes projects such as right of way, habitat improvement, reforestation, spring/meadow and other activities within the cumulative effects area. Table 27 includes reasonably foreseeable projects and activities with approximate acres of within the cumulative effects area. For additional information on the actions considered in this cumulative effects analysis, see Chapter 3 of this EIS.

Table 25. Approximate acres of vegetation management activities and prescribed fire within and adjacent to the cumulative effects area 1990-2017

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Mullen Saw timber and Whitcom Multiproduct Offerings	1990	0	130	685	Apache-Sitgreaves
Jersey Horse Timber Sale	1991	1,452	351	0	Apache-Sitgreaves
Amended Elk Timber Sale	1993	834	466	0	Apache-Sitgreaves
Brookbank Multi-Product Timber Sale	1994	5,624	4,981	0	Apache-Sitgreaves
Cottonwood Wash Ecosystem Management Area	1995	516	2,447	0	Apache-Sitgreaves
Blue Ridge-Morgan	1997	14,471	14,552	0	Apache-Sitgreaves
Gentry	1997	451	191	0	Apache-Sitgreaves

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Sundown Ecosystem Management Area	1997	2,075	24	7,023	Apache-Sitgreaves
Wiggins Analysis Area	1998	0	4,224	0	Apache-Sitgreaves
Show Low South (#22297)	1999	0	2,696	0	Apache-Sitgreaves
Larson Rx Burn	2001	0	3,015	0	Apache-Sitgreaves
Treatment of Dead Trees in the Rodeo-Chediski Fire (#20740)	2002	5,730	1,880	15	Apache-Sitgreaves
Heber-Overgaard WUI	2003	5,089	686	1,208	Apache-Sitgreaves
Hidden Lake Rx Burn	2003	0	2,828	0	Apache-Sitgreaves
Camp Tatiyee / Camp Grace Fuel Reduction	2004	0	172	0	Apache-Sitgreaves
Country Club Escape Route	2004	524	1,848	915	Apache-Sitgreaves
High Value Ponderosa Pine Tree Protection	2004	985	826	203	Apache-Sitgreaves
Rodeo-Chediski Fire Salvage	2004	25,913	626	1,667	Apache-Sitgreaves
Forest Lakes WUI Treatment	2005	1,691	1,645	0	Apache-Sitgreaves
Rim Top Rx Burn (formerly Woods Canyon Fuel Treatment)	2005	0	665	0	Apache-Sitgreaves
Show Low South (#4456)	2005	10	585	0	Apache-Sitgreaves
Dye Thinning	2006	247	0	0	Apache-Sitgreaves
Hilltop WUI	2006	1,534	45	616	Apache-Sitgreaves
Bruno Thinning and Slash	2009	0	70	0	Apache-Sitgreaves
Whitcom WUI	2009	925	0	0	Apache-Sitgreaves
Hilltop II Fuels Reduction	2011	0	799	616	Apache-Sitgreaves
Little Springs WUI	2003	4,376	4,227	2,500	Apache-Sitgreaves
Nagel	2005	19,611	18,231	2,802	Apache-Sitgreaves
Los Burros	2006	30,237	13,059	29	Apache-Sitgreaves
Nutrioso WUI	2006	19,476	9,870	1,254	Apache-Sitgreaves
Show Low South (#29987)	2011	3,372	0	0	Apache-Sitgreaves

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Rodeo-Chediski Fire Rx Burn	2012	0	9,506	14,832	Apache-Sitgreaves
Timber Mesa/Vernon WUI	2012	18,781	39,760	20,441	Apache-Sitgreaves
Rim Lakes Forest Restoration	2013	12,483	1,335	6,447	Apache-Sitgreaves
Larson Forest Restoration	2015	1,867	0	2,516	Apache-Sitgreaves
Upper Rocky Arroyo Restoration	2016	696	5,411	3,960	Apache-Sitgreaves
Section 31 Fuels Reduction	2017	44	0	0	Apache-Sitgreaves
Pocket Baker	2000	0	5,450	0	Coconino
Blue Ridge Urban Interface	2001	416	6,225	2,325	Coconino
IMAX	2002	0	6,008	0	Coconino
Pack Rat Salvage	2004	0	0	0	Coconino
Bald Mesa Fuels Reduction	2005	2,485	5,150	0	Coconino
APS Blue Ridge 69kV Transmission Line	2005	0	1,600	0	Coconino
Good/Tule	2006	1,389	2,025	0	Coconino
Post-Tornado Resource Protection and Recovery	2011	765	0	0	Coconino
Lake Mary Road ROW Clearing (ADOT)	2016	788	0	0	Coconino
Lake Mary Meadows Two Fuel Reduction	2005	117	10,223	803	Coconino
East Clear Creek Watershed Health Improvement	2006	40,020	38,470	40,000	Coconino
Victorine 10K Area Analysis	2006	9,015	29,585	0	Coconino
Upper Beaver Creek Watershed Fuel Reduction	2010	20,608	64,000	0	Coconino
Blue Ridge Community Fire Risk Reduction	2012	0	45,000	0	Coconino
Clints Well Forest Restoration	2013	11	6,639	0	Coconino
Hutch Mountain Communication Site	2017	1	0	0	Coconino
Ridge Analysis Area	1994	33,311	0	1,094	Tonto
Lion Analysis Area	2001	5,664	6,900	664	Tonto
Verde WUI	2004	10,648	48,500	5,000	Tonto
Parallel Prescribed Burn	2014	0	4,759	0	Tonto
Pine-Strawberry WUI	2006	41,086	19,868	200	Tonto
Chamberlain Analysis Area	2008	9,044	19,000	1,675	Tonto
Christopher/Hunter WUI	2009	10,763	19,000	939	Tonto
Cherry Prescribed Burn	2012	0	6,582	0	Tonto
Myrtle WUI	2012	103,891	75,800	1,835	Tonto

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Grand Total		**469,036**	**567,935**	**122,264**	

*Other activities include but not limited to fuels chipping, range forage improvement or manipulation, range vegetation control, wildlife habitat improvement, tree encroachment control, tree release, fuels compaction, special products removal, insect control and prevention planting, fuel break creation, cultural site protection, scarification and seeding, pruning,

Table 26. Right of way, habitat improvement, reforestation, spring/meadow and other activities within the cumulative effects area

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Right-of-Way (ROW) Projects with Herbicide Use					
Noxious Weeds and Hazardous Vegetation on State Highway ROWs	2004	25	0	11,005	Tonto
Grand Total for ROW Projects		25	0	11,005	
Wildlife Habitat Improvement, Grassland Restoration Projects/Allotment Projects					
Park Day Allotment	1994	2,193	0	701	Apache-Sitgreaves
Clear Creek Allotment	2000	2,397	0	3,237	Apache-Sitgreaves
Wallace Allotment	Unknown	0	0	1,747	Apache-Sitgreaves
Railroad Allotment (Formerly Carlisle Complex Vegetation Treatments)	2007	2,873	0	561	Apache-Sitgreaves
Apache Maid Grassland Restoration	2004	54,528	6,770	0	Coconino
Bar T Bar/Anderson Springs Allotment	2005	1,304	132,938	41,351	Coconino
Grand Total for Habitat and Grassland Projects		63,295	139,708	47,597	
Reforestation/Planting Projects					
Bison Reforestation	2003	356	312	583	Apache-Sitgreaves
Clay Springs Reforestation	2004	0	0	338	Apache-Sitgreaves
Jacques Marsh Elk Proof Fence & Riparian Planting	2006	0	73	0	Apache-Sitgreaves
Pierce Reforestation	2009	0	0	406	Apache-Sitgreaves
Rodeo-Chediski Riparian Planting	2010	0	0	1	Apache-Sitgreaves
Rodeo-Chediski Reforestation (#18675)	2007	0	150	1,056	Apache-Sitgreaves
Conifer Weeding for Aspen Enclosure	Unknown	65	0	0	Coconino

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Grand Total for Reforestation Projects		421	535	2,384	
Spring and Meadow Restoration Projects					
Bill Dick, Foster, and Jones Springs Enhancement	2013	0	0	0	Coconino
Long Valley Work Center Meadow Restoration	2018	0	0	16	Coconino
Grand Total for Spring and Meadow Projects		0	0	16	
Other Projects					
ASNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	42,763	74,202	16,656	Apache-Sitgreaves
COF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	16,049	15,175	4,695	Coconino
TNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	15,565	26,386	43,711	Tonto
Grapevine Interconnect (Grapevine Canyon Wind Project)	2012	0	0	0	Coconino
APS Line Maintenance	Unknown	87	0	0	Coconino
Sixteen Rock Pits and Additional Reclamation	2017	0	0	0	Coconino
Glen Canyon-Pinnacle Peak 345kV Transmission Line Vegetation Management	2014	0	0	0	Coconino
Noxious Weed Treatment Projects	2005	61,015	1,008	2,032	Tonto
Grand Total for Other Projects		135,479	116,771	67,094	
Grand Total		**199,220**	**257,014**	**128,096**	

*Other activities include, but not limited to pesticide control of invasives, control of range vegetation, control of tree encroachment, range cover manipulation, control of understory vegetation, wildlife habitat improvement, planting, animal damage control, tree release, site preparation, and biocontrol of invasives.

Table 27. Approximate acres of reasonably foreseeable activities within the cumulative effects area

Project Name	Mechanical	Prescribed Fire	Other Activities*	Forest
Rodeo-Chediski Mastication	301	301	0	Apache-Sitgreaves
Heber-Overgaard Insect and Disease Farm Bill CE	0	0	0	Apache-Sitgreaves
Heber Allotment	0	0	39,000	Apache-Sitgreaves
Pierce Wash Allotment-Section 18 Analysis of Vegetation Treatments	0	0	0	Apache-Sitgreaves
AGFD Fairchild Draw Elk Exclosure	0	0	0	Apache-Sitgreaves
Four Springs Trail Realignment	0	0	0	Apache-Sitgreaves
Heber-Overgaard Non-motorized Trail System	0	0	0	Apache-Sitgreaves
Navopache Electric Cooperative Trunk Line Addition	0	0	0	Apache-Sitgreaves
APS-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	0	0	2,136	Apache-Sitgreaves, Coconino, and Tonto
SRP-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	0	0	7,469	Apache-Sitgreaves, and Tonto
Cragin WPP	41,046	63,656	0	Coconino
Mogollon Rim Spring Restoration Project	0	0	5	Coconino
WAPA Glen Canyon-Rogers 230/345kV Integrated Vegetation Management	13,338	0	0	Coconino, and Tonto
Flying V&H Prescribed Fire	1,798	59,124	0	Tonto
Haigler Fuels Analysis	43,435	43,435	0	Tonto
Flying V and Flying H Allotment	10,875	0	0	Tonto
Hardscrabble Allotment Juniper Clearing	100	0	0	Tonto
New Delph Tank & Bear Tank Maintenance	0	0	0	Tonto
Pleasant Valley Northwest Grazing Allotments	0	0	0	Tonto
Red Lake Tanks	0	0	1	Tonto
Emory Oak Restoration	0	0	0	Tonto
Cragin-Payson Water Pipeline and Treatment Plant	350	0	350	Tonto
Grand Total	**111,243**	**166,516**	**48,961**	

Other activities include, but not limited to pesticide control of invasives, control of range vegetation, control of tree encroachment, range cover manipulation, control of understory vegetation, wildlife habitat improvement, planting, animal damage control, tree release, site preparation, and biocontrol of invasives,

Fire

Wildfires from 1943 to 2017 (Table 28) have burned on approximately 509,447 acres in or adjacent to the project area. Of these acres, it is estimated that the overall average fire severity to the vegetation was 20 percent high severity, 30 percent mixed severity and 50 percent low severity. There is wide variability among these percentages from fire to fire. For more information on the history of wildfires in the project area consult the Fire Ecology Specialist Report (USDA 2019).

Many of the wildfires that burned within the project area in the last 10 years were managed primarily for resource objectives instead of primarily for suppression, and they produced primarily low-severity fire effects. The vast majority of the mechanical thinning projects in the area have decreased the potential for active crown fire and crown fire initiation on acres thinned (469,036 acres from Table 25 and 199,220 from Table 26), and the potential for crown fire initiation, and high severity effects from surface fire (567,935 acres from Table 25 and 257,014 acres from Table 26). Past mechanical and prescribed fire treatments decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels.

Table 28. Wildfire acres within the project area 1943-2017

Year	Acres
1943-1989	40,994
1990-1999	37,369
2000-2009	262,531
2010-2017	168,583
Total	509,447

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on the majority of the project area. From the late 1880s to the 1940s, logging that facilitated construction of the railroads was conducted by several lumber and timber companies in the areas of Holbrook to Flagstaff (Lightfoot 1978). By 1940, the railroads had removed much of the profitable lumber that could be easily accessed. In terms of vegetation structure, many of the largest and oldest tree sizes larger than 18” DBH were removed from many areas. Extensive regeneration with no large trees interspersed within the younger age classes occupied many of the harvested areas. The pattern on the landscape no longer resembled the Desired Condition outlined in the LRMP.

Past timber sales within the project area such as the Ridge Analysis Area (1994), and Brookbank Multi-product Timber Sale (1994), implemented prior to the Southwestern Region’s 1996 amendment of forest plans, targeted the harvest of medium and large diameter trees. In some cases, all trees over 12 inches in diameter were removed. This affected the presence of pre-settlement trees and old forest structure.

Today, at the landscape (project area) scale, pre-settlement trees are underrepresented in many areas. The focus on even-aged forest management continued until the mid-1990s, leaving the legacy of current forest conditions. Approximately 50 percent of the project area that received some type of regeneration or shelterwood harvest has regenerated. Many stands are even-aged, dense, and lack age class diversity. Today, the majority of acreage can be classified as young and mid-aged forests with a moderately closed to closed tree canopies.

Post 1996 Vegetation Treatments – Uneven-aged Management, Fire Hazard and Restoration

After the region-wide 1996 amendment, vegetation objectives included uneven-aged management () (Table 96 & 97). A review of the Forest Activity Tracking System (FACTS) timber database indicates that treatments designed to promote uneven-aged management began being recorded as early as 1991 on the Apache-Sitgreaves National Forest, in 1987 on the Coconino National Forest and 2001 on the Tonto National Forest. However, acres treated in this category continued to be minor in comparison to acres treated with even-aged methods until about 2005. These acres treated using uneven-aged silviculture systems should today, still be moving these acres towards their desired conditions. Acres still assigned to even-aged silviculture may, or may not, be moving towards desired conditions depending on whether or not the stands can/could be converted to an uneven-aged structure or have been successfully regenerating. Forests in the project area use even-aged management to some extent and the use of this silvicultural system is not precluded in current Forest Plans.

After 1996, the objective of most vegetation projects in the project area was to reduce the risk of high-severity fire, improve forest health (stand and tree resilience and vigor), and improve understory diversity. Retention of snags and managing for coarse woody debris was further enhanced with the 1996 amendment and made part of project requirements. The 1996 forest plan amendment also changed treatments in Gambel oak and the species was recognized for its role in managing for ecological diversity and high quality wildlife habitat.

With the exception of older projects that removed large, old trees and promoted even-aged management, most vegetation projects that contributed to the current condition within the project area occurred from 2000 to 2015. From 2000 to 2015, across the three Rim Country forests, examples of projects designed primarily to address the risk of undesirable fire behavior and effects in the project area include Heber-Overgaard WUI, Camp Tatiyee/Camp Grace Fuel Reduction, Forest Lakes WUI Treatment, Rim Top Rx Burn, Hilltop WUI, Whitcom WUI, Hilltop II Fuels Reduction, Little Springs WUI, Los Burros, Nutrioso WUI, Section 31 Fuels Reduction, Blue Ridge Urban Interface, Bald Mesa Fuels Reduction, Lake Mary Meadows Two Fuels Reduction, Upper Beaver Creek Watershed Fuels Reduction, Verde WUI, Pine Strawberry WUI, Christopher Hunter WUI, Cherry Prescribed Burn, Myrtle WUI and Haigler Fuels Analysis among others (Table 25). A variety of other projects have modified vegetation for other objectives such as grassland restoration, wildlife habitat improvement, maintaining rights of way, reforestation, noxious weeds as well as transportation system management (Table 26).

Natural Disturbances – Insect and Disease

Though many of the treatments identified in Table 23 and Table 26 were designed to reduce hazard of insects and diseases, these natural disturbance mechanisms are still present in these forests. Though prescribed fire, or any fire, increases the short-term risks to bark beetle infestations, mechanical and prescribed fire treatments have worked to reduce insect and disease risk by reducing density in terms of basal area, stand density index and trees per acre. Historic treatments as well as the treatments in the Rim Country analysis have worked together to reduce insect and disease risks. A comprehensive account of insect and disease activity occurring within the project area and cumulative effects area was provided by USDA Forest Health Protection (USDA 2016). Much of the information in that report comes from a combination of the Historical Reports for the three forests (Lynch et al. 2008, 2010, 2015), and aerial detection survey (ADS) data collected every year by Forest Health Protection (FHP) (USDA, Forest Service 2018).

For the Rim Country Project area, ADS indicates that activity of most agents has been relatively low for the past five years. In fact, much of the recent insect activity mapped in the project area occurred during the drought years from 2001-2005. Treatments listed in Table 25 and Table 26 have maintained these low levels and additional treatments in the Rim Country Project should improve the resilience of these forested systems. More details on the specific agents are discussed within their specific forest type below. We should also note that there are many insects and diseases which cause little damage or tree mortality (Furniss and Carolin 1977). Their effects are not considered extensive and will not be discussed in this cumulative effects analysis.

Generally speaking, current stands of ponderosa pine and mixed conifer are much denser with smaller average diameters than what was historically present prior to European settlement (Covington and Moore 1994). This change in stand structure appears to have favored certain insects and diseases, primarily bark beetles and Southwestern dwarf mistletoe Chojnacky 2000, Conklin 2000). Details on these are provided below. Root rot pathogens, although not specifically discussed by forest type, are present in all forest types. Root diseases can cause direct tree mortality and are often associated with secondary mortality such as bark beetle attacks (Fairweather et al 2013). Root diseases are often missed during surveys because their deleterious effects are gradual. Some management activities in the cumulative effects area have targeted trees with root rot and reduced its prevalence.

Bark Beetles

The primary two genera found in ponderosa pine, *Dendroctonus* spp. and *Ips,* spp. are capable of causing substantial tree mortality. Historical activity of mountain pine beetle in ponderosa pine in Arizona has been limited to areas on the North Rim of the Grand Canyon (Blackman 1931, Lynch et al. 2008). There are also multiple species of ips beetles found in the ponderosa pine forests of north central Arizona (Williams et al. 2008).

Historical reports indicate that both the size of bark beetle outbreaks and the beetle species involved in the outbreaks have shifted since the early part of the century. Most tree mortality in the ponderosa pine early in the 1900s was predominately attributed to beetles in the Dendroctonus genus. While periodic ips beetle attacks were also reported on all three forests, earlier ips beetle outbreaks were localized events, associated with slash management issues from forest management activities, windthrow, and drought. In contrast, the widespread, landscape-level tree mortality which occurred across the Rim Country Project area in the early 2000's was primarily attributed to ips beetle species, and correlated with a widespread drought. Within infected ponderosa pine stands, all three forests experienced substantial tree mortality from this outbreak with stand basal area declining by 32 percent, 62 percent and 37 percent for the Coconino, Tonto, and Apache-Sitgreaves National Forests, respectively (Negrón et al. 2009). Also observed was a reduction in tree density, SDI and average tree diameter. Probability of tree mortality was positively correlated with initial tree density and negatively correlated with elevation and initial average tree diameter (Negrón et al. 2009).

Dwarf Mistletoe

Southwestern dwarf mistletoe incidence has increased on all three Forests, with an estimated 47 percent, 52 percent and 32 percent of commercial acres infected in the 1980s for, the Tonto, Apache-Sitgreaves, and Coconino National Forests, respectively, versus only 19 percent 41 percent, and 30 percent, respectively, in the 1950s (Lynch et al. 2008, Lynch et al. 2010, Lynch et al. 2015). High dwarf mistletoe ratings increase tree stress and the likelihood of ips beetle attacks during drought (Kenaley et al. 2006, 2008). The prevalence of Southwestern dwarf mistletoe seems to be particularly high along the Mogollon Rim. For instance, incidence of mistletoe is higher on the Mogollon Ranger district than on any other district on the Coconino (48 percent of commercial timber infected) and is higher on the Black Mesa district than on the Lakeside district (Hessburg and Beatty 1985, as reviewed in Lynch et al. 2008, 2010).

Denser stand conditions and fire suppression have increased mistletoe abundance in current forest stands, despite the fact that its distribution has likely not changed extensively (Dahms and Geils 1997).

Alternative 1 – No Action

Alternative 1 is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. The effects of 469,036 acres of mechanical vegetation treatments, 567,935 acres of prescribed fire and 122,264 acres of other activities in the form of past and ongoing projects would continue to impact the landscape. Approximately 111,243 acres of vegetation treatments, 166,516 acres of prescribed fire projects, and 48,961 acres of activities in other projects would continue to be implemented in the reasonably foreseeable future within the project area. It is expected that when these actions are completed that these acres would be moving towards the desired conditions. Alternative 1 is the point of reference for assessing action alternatives 2 and 3. The thinning and prescribed fires treatments in the prior 10-year period were designed to set up the stands to reach their desired conditions according to the then approved forest plans. In conjunction with mechanical treatments, there were prescribed fire only treatments designed as fuels treatments to reduce surface fuels as well as reduce ladder fuels and crown fire risks. To those ends, the prior treatments would move the treated acres toward their desired conditions.

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on the majority of the project area. The focus on even-aged forest management continued until the mid-1990s, leaving the legacy of current forest conditions. Approximately 50 percent of the project area that received some type of regeneration or shelterwood harvest has regenerated. Many of these stands are two-aged, dense, and lack age class diversity as a result of these historic practices. Historically, wildfire would have maintained a diverse matrix of age class diversification. Reintroduction of an historical fire return interval would aid in converting, and maintaining, an uneven-aged forest at the landscape level. Currently planned forest treatments should move these stands towards a trajectory for their desired conditions. Untreated stands would continue to move away from desired conditions as densities increase, beetle risks increases and risks of crown fire increase. Under alternative 1 the potential for uncharacteristically large scale wildfires that dramatically impact the landscape is increased.

The Cragin Watershed Protection Project on the Coconino National Forest would mechanically treat 41,046 acres and apply prescribed fire to 63,656 acres to move stands in that project area towards the desired condition. In most cases, fuels reduction treatments do not necessarily provide adequate change in stand structure and do little to move towards desired conditions. However, fuels treatments following mechanical treatments to balance age classes provide the best chance to set these stands on a trajectory towards desired conditions. The Haigler Fuels Analysis on the Tonto National Forest planned to treat over 43,000 acres with mechanical and prescribed fire, but is still in the scoping phase and no impacts can be assigned other than to say that there is a need to reduce high fuel loadings and return to a natural regime.

Forest Structure

In Alternative 1few treatments would be implemented to create a mosaic of interspaces and tree groups. In locations not identified for treatment under other decisions, existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. The risk of undesirable fire and/or effects would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups. While the forests in the project area have an emphasis to favor uneven-aged management, this silvicultural system does not assure interspaces and groups. These forests have latitude to create openings and groups but have not implemented large areas of openness to date except within WUI treatments. In terms of a mosaic of interspaces and tree groups at the landscape level the prior treatments have not significantly moved the forest towards the desired conditions at this time.

Forest Structure - All age and size classes represented

Prior thinning treatments with restoration objectives were similar to the goshawk habitat and MSO restricted other habitat treatments proposed under the first EIS as well as this project and have resulted in similar diversity in age and size class, and should move these stands towards desired conditions. Uncharacteristically severe wildfires caused large scale mortality across all age and size classes resulting in a non-stocked or single age class representation. Wildfires that burned with a low severity and prescribed burn only treatments had similar effects to forest structure as the post thinning prescribed fires. Restoration treatments and 4FRI treatments are designed to lessen the probability of these uncharacteristically severe wildfires.

The main objective of thinning with a fuels reduction emphasis was to reduce canopy fuels and the potential for crown fire initiation. Generally, this type of treatment focused on removal of trees in the subordinate crown positions and retaining those trees in the dominant and co-dominant crown positions and any pre-settlement trees. This type of treatment resulted in a moderately open canopy, even-aged forest structure with very little age and size class diversity. Prescribed burning and mechanical fuels treatments associated with the above thinning treatments resulted in periodic tree mortality of seedling/sapling size trees and susceptible pre-settlement trees further reducing age class diversity.

Old Forest Structure

Many prior thinning treatments retained pre-settlement trees and the largest post-settlement trees. Sanitation treatments may have removed some old forest structure. Prescribed burning and low severity wildfire resulted in periodic tree mortality of susceptible pre-settlement trees. Mixed and high severity wildfire killed a large proportion of the old forest structure. Powerline treatments removed any old forest structure that was a hazard to the powerline.

Old forest structure has been reduced over many years by past management practices. The change in direction in 1996 to manage more for an uneven-aged stand structure would aid the forest to reach the Desired Conditions over time. The structure of the past and most of the proposed treatments, while planned out as uneven-aged treatments, would have a distinctly different spatial layout than is being planned in this project. Treatments designed in the Rim Country project have identified distinct interspaces of varying sizes with groups of varying sizes as well as randomly spaced trees to aid in forest diversity (horizontal and vertical) while at the same time breaking up areas of continuous canopy to reduce risks to crown fire. Past uneven-aged treatments would have trees more uniformly spaced with more of a closed canopy (moderately closed to closed).

Forest Process

Past thinning treatments resulted in low to moderate stand density index, which is associated with minimum competition between trees, and maximum individual tree growth. This in turn had a beneficial effect of improved forest growth, and reducing the potential for density- and bark beetle-related mortality. Where they occurred, thinning treatments also removed dwarf mistletoe infected trees, reducing the percent of trees infected as well as potentially creating conditions that slowed or inhibited mistletoe spread, even if only for a couple of decades (Conklin and Fairweather 2010). Prescribed fire and low severity wildfire also led to localized reduction of forest density and dwarf mistletoe infection (Conklin and Fairweather 2010). The thinning treatments reduced risks associated with dense forest conditions and improved resilience to the impacts of large-scale disturbance under drier and warmer conditions (Zhang 2019).

Alternatives 2 and 3

Alternative 2 restoration treatments would contribute an additional 953,130 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions within the cumulative effects area.

Alternative 3 restoration treatments would contribute an additional 529,060 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions within the cumulative effects area

Prescribed Fire

Prescribed fire is considered to be an integral component to stand treatments and is a necessary complimentary treatment to mechanical treatments to attain and maintain the desired conditions. Without prescribed fires it would be more difficult to maintain desired conditions or reduce unintended results from uncharacteristically high wildland fire at the landscape level. Approximately 40,000 acres of prescribed fire would be implemented annually across the project area from a combination of this project as well as other projects such as Cragin Watershed Protection Project and the Haigler Fuels Analysis.

For the analysis period, prescribed fire (Table 25 and Table 26) such as broadcast burns reduced fuels, modified fire behavior, and lowered crown fire risks. The majority of these acres occurred since 2004 and many may require reintroduction of a prescribed fire within the next 5 years in order to maintain the benefits of the prior burn. The proposed acres of mechanical treatment and/or prescribed fire of the Rim Country 4FRI project (953,130 acres in Alternative 2 and 529,060 acres in Alternative 3), combined with the reasonably foreseeable treatments proposed (Table 57, 166,516 acres) would reduce uncharacteristically severe fire behavior on approximately 1,119,646 acres in Alternative 2 and 695,576 acres in Alternative 3 over the next 20 years. The prior treatments should allow prescribed fire-only treatments, with burns within the same stands as this project, to reduce emissions. Cumulatively, the prior treatments and the proposed prescribed fire create some of the best possible outcomes to reduce undesirable fire behavior and/or effects.

Forest Structure

From the 1970s until 1996 treatments were designed primarily to manage for even-aged stand structure. Alternatives 2 and 3 would treat the area to move stands towards an uneven-aged structure where possible. Treatments after 1996 had an uneven-aged silviculture emphasis and those treatments have moved those stands towards their desired conditions at the time of treatment. When added to projects like CC Cragin and Haigler Fuels Analysis structure would be improved under alternative 2 and to a lesser extent under alternative 3. Prior treatments have reduced densities within and outside PFAs, but very little treatment has occurred within MSO PACs and Cores. Stands treated prior to 1996 would be treated within this proposal as the project moves these stands towards an uneven-aged structure and putting them on a trajectory to achieve their Desired Conditions, with Alternative 2 treating approximately 424,000 more acres than alternative 3. Cumulatively alternative 2 improves stand structure more than alternative 3.

Most past treatments in the cumulative effects area left the forest with denser stands when compared to the proposed restoration treatments in this project. Spatially, the prior treatments, until recently, focused on a uniform distribution of trees with only natural canopy gaps and meadows for openings. When added to more recent past treatments the restoration prescriptions in alternatives 2 and 3 would leave a more open forest, post treatment, than was prescribed in past treatments, with distinct interspaces, groups, and regeneration openings of varying sizes as well as randomly spaced trees across the landscape to enhance structural diversity. Due to fewer acres being treating in alternative 3 the cumulative effects would occur on few acres. Planned interspaces would average between 10 to 90 percent at the stand level from closed forests to open grasslands in both alternatives. The proposed restoration treatments are a departure from past management and have desired conditions for interspaces and groups that would move these stands towards the LMPs Desired Conditions.

Forest Health

Density related mortality

Stand density is a dominant factor affecting the overall health and vigor of conifer forests in the western US (SAF 2005) and high stand densities leads to reduced ecosystem resilience (Reynolds et al 2013).

Prior treatments have used prescriptions, both even-aged and uneven-aged, to reduce stand densities. Table 25 and Table 26 lists some of the treatments that were or will be completed in the analysis area during the analysis period and most all vegetation manipulation treatments were designed to reduce stand densities to some extent. Even with the reduced stand densities some stands were susceptible to the drought period during the early 2000's. This is probably an indicator of stand behavior at these treatment densities in context with climate change. Because of these treatments these stands have moved towards the desired conditions. However, not all were designed as a restoration treatment, especially those implemented earlier in the analysis period. Therefore, these stands may not be moving towards the restoration desired conditions of this project and could be treated again in order to aid in moving them to their desired conditions, or onto a trajectory to achieve the desired conditions.

Proposed treatments in the foreseeable future would be more closely allied with a restoration-based desired condition and prescription such as that in the Rim Country project. The newly published Forest Plans of the Coconino and Apache-Sitgreaves National Forests clearly spell out the intent to treat widely across the forest with a restoration desired condition. The foreseeable acreages for projects such as Cragin Watershed Protection Project and the Haigler Fuels Analysis demonstrates this intent. When this is combined with the foreseeable treatments (Table 27) Rim Country treatments (Table 25 and Table 26) would move a considerable portion of the landscape towards a desired condition of reduced stand densities with an open grass/forb/shrub matrix in a heterogeneous landscape. These changes would occur in both alternatives, however in alternative 3 the movement toward the desired condition would only occur on the treated acres.

Bark beetle related mortality

Bark beetles are normal endemic insects in ponderosa pine and mixed conifer communities and the pine type has evolved with such disturbances (Reynolds et al 2013). But when conditions are conducive to beetle outbreaks insects can become a strong determining factor in stand structure and composition that can become even more pronounced during and following extended droughts and under dense stand conditions (Reynolds et al 2013, Negrón 1997). Consult USDA (2014) for a history of epidemic bark beetle infestations within the analysis are from the 50's thru 2014. The current stand structures reflects the occurrences of these epidemic outbreaks.

Prior treatments within the analysis area were completed with a desire to reduce hazardous fuels and reduce stand densities. The drought period from 2000 until now has challenged many stands with bark beetle infestations. The current conditions are still dense in many stands as attested to by their high SDIs. Post 1996 treatments were effective in reducing density related mortality. Even with the reduced densities some stands were susceptible to the drought period during the early 2000's. Rim Country treatments would further restructure stands towards the restoration-based desired condition and when added to the past treatments this should aid in relieving further stresses in both alternative's 2 and 3, but in more stands in alternative 2. Because bark beetles can fly considerable distances and have multiple generations in one season, treatments outside, and adjacent to, the analysis area would have an important influence of beetle activity within the analysis area.

Dwarf mistletoe infection

Activities identified in Table 25, Table 26 and Table 27 treat acres mechanically and with the use of prescribed fire. Many of these treatments had a considerable effect on the distribution, but more importantly, the abundance of dwarf mistletoe. Mitigation strategies for dwarf mistletoe (DM) attempt to reduce stand dwarf mistletoe ratings (DMR). Where DM is present, silvicultural prescriptions prioritize removal of infected trees (at or above a predetermined infection level). Due to the limited transmissivity of dwarf mistletoe, treatment of stands outside the analysis area do not have as great a potential impact to DM spread in the analysis area as do stands adjacent to the analysis area. While seeds of the dwarf mistletoe are forcibly ejected, the spread of DM throughout and between stands is relatively slow (Conklin 2000). However, infection from outside of the analysis area from adjacent stands and into stands within the analysis area is possible, though infections outside the analysis area would have little impact to growth or mortality to the overall analysis area.

Prior treatments within the analysis area would have reduced, but not eliminated, DM from the treated stands. The DM infections would continue to slowly intensify. Foreseeable treatments would potentially reduce infection levels further and would benefit the overall analysis area in terms of improved tree growth and vigor and reduced bark beetle risks. Where possible, the Rim Country project would target stands with moderate and severe DM infections at an appropriate intensity level to lower the infection rating. Infected trees can grow at near the rate of uninfected trees on good sites if individual tree infections remain at or below a dwarf mistletoe rate of 3 (Hoffman 2010). Combined with other treatments in the cumulative effects area such as Cragin Watershed Protection Project and Haigler Fuels Analysis, occurrence of dwarf mistletoe infection severity would move towards desired conditions. However, DM is a natural component of the ponderosa pine and dry mixed conifer communities and eradication is neither desirable nor possible, and latent infections (those not visible at the time of treatment) would remain within the stands.

Other Direct and Indirect Effects

Climate change

Risks associated with dense forest conditions would be reduced and resilience to the impacts of large scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternatives 2 and 3. Prior treatments would benefit the forest by reducing densities and reducing stresses associated with completion. Treated forest would be more resilient to climate change than untreated forest (Kerhoulas et al 2013). Within-forest carbon stocks would be reduced under alternatives 2 and 3, however large scale stand replacing wildfires such as the Rodeo-Chedeski and Wallow fires that emitted enormous amounts of carbon dioxide would be less likely to occur. Individual tree growth would improve, resulting in larger average trees size and increased carbon storage over time offsetting short term losses of carbon removed through the mechanical thinning. Some of the carbon biomass removed by mechanical thinning would be sequestered for a considerable period of time in the form of forest products.

Residual Tree Damage

Some damage to residual trees would be expected in Alternatives 2 and 3 with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine. Damage rates should be similar or less than current silviculture practices due to the more open conditions created. The Proposed Action would result in the most potential damage because of the extensive harvesting in overly dense stands. Damage would be minimized through contract administration, on-site inspections, and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Prescribed fire is expected to damage some residual trees and increases short-term risks to low level bark beetle activity.

Fire Ecology and Air Quality

Only a summary of the fire ecology analysis is presented here. The Fire Ecology and Air Quality Specialist Report includes the complete analysis and is incorporated by reference.

Affected Environment

Background and Historic Conditions

Across the Rim Country landscape, the disruption of Fire Regimes over the last century is largely responsible for the deteriorating health of the ecosystems in Northern Arizona (Covington 1994). In the latter part of the 19th century, unsustainable practices in fire management, grazing, and logging began to change the structure and composition of landscapes, making them more homogenized. As a result ecological functions are now impaired across the landscape of northern Arizona (Leopold 1924; Covington 1994; Heinlein *et al.* 2005; Rodman *et al.* 2017).

Fire is a keystone process affecting the ecological functions of large areas. As Europeans settled into the area, roads and trails increasingly broke up the continuity of surface fuels and contributed to the reduction of the frequency and size of wildfires (Covington and Moore 1994). Long periods without fire changed the species composition and fuel structure of southwestern ecosystems (Swetnam 1990b; Huffman 2017). There are about 800,000 acres of cover types targeted for restoration in Rim Country that historically were maintained by frequent fires.

Fire Occurrence & Fire Regime

There is little doubt that fires, started by lightning or by Native Americans, were frequent before the arrival of the Europeans and in the early years of settlement. Historically, fires occurred frequently, with return intervals ranging from a few years to a decade or more. These historic fires were typified by low severity. Not until the mid-20th century were a limited number of large scale stand replacing fires recorded (Cooper 1960).

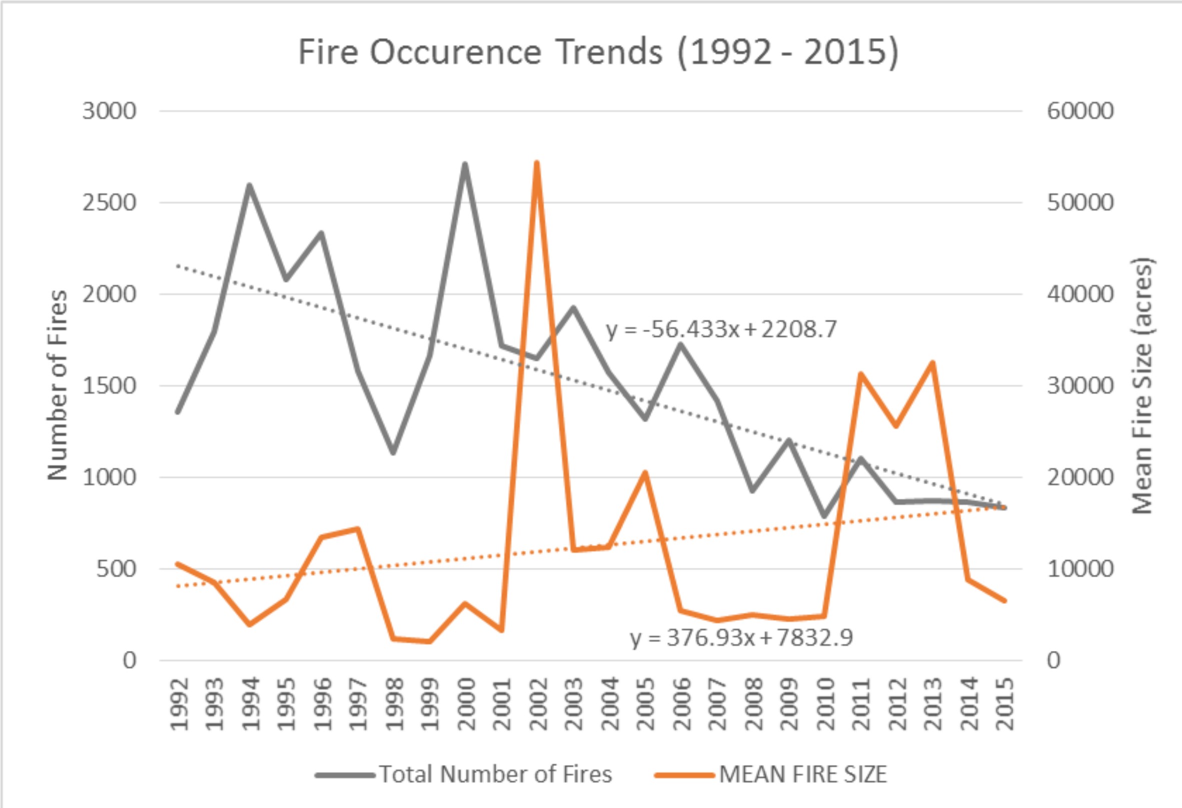


Figure 44. Trends in mean fire size and total number of wildfires from 1992 to 2015

Contemporarily, the number of fires reported in and adjacent to the project area has decreased over the last 25 years (1992 – 2015), while the average size has increased (Figure 14). While fire size is certainly an indicator of the trends in wildfire, it is primarily those areas that burn with uncharacteristic severity that are of concern.

Currently, the number of acres burning with high severity is much larger than historic data indicates was typical of ponderosa pine in the southwest (Weaver 1951; Covington 1994; Swetnam and Betancourt 1998; Westerling *et al.* 2006). Of the annual acres burned by large fires since 1992, about 73 percent burned at low severity on average, and 27 percent burned at moderate to high severity. However, the 2002 Rodeo-Chediski fire, which burned with a much higher percentage of moderate and high severity, serves as an outlier to this pattern. Overall, the annual acres burned by large fires has increased since 1992 (Figure 45), while the proportion of acres burned in each severity class has remained about the same (Figure 46). If these patterns continue into the near future (10 years), the total acres of high severity fire is likely to increase proportional to fire size increases.

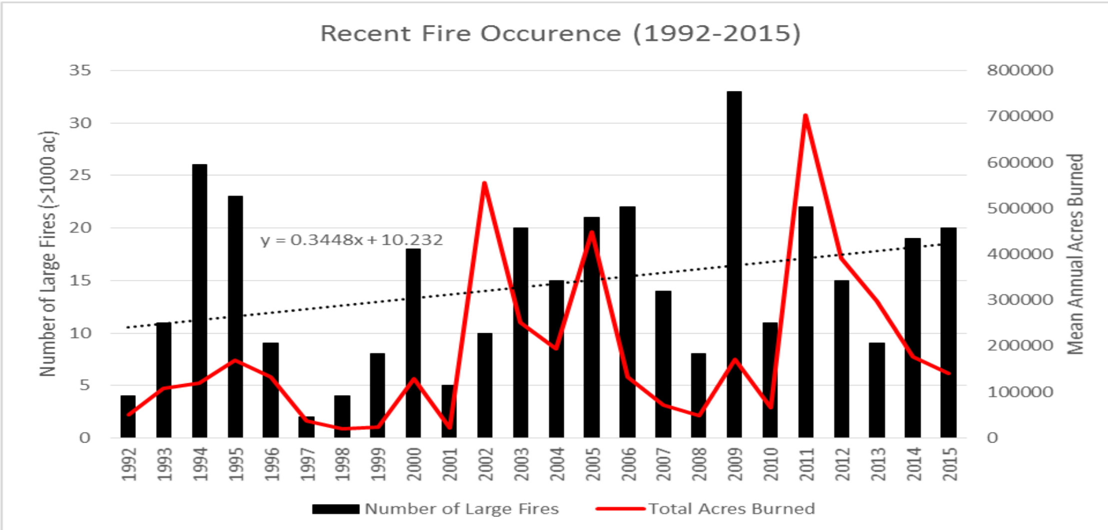


Figure 45. Trends in the number of large fires (>1,000ac) and total acres burned from 1992-2005 within the Arizona/New Mexico Mountains Ecoregion

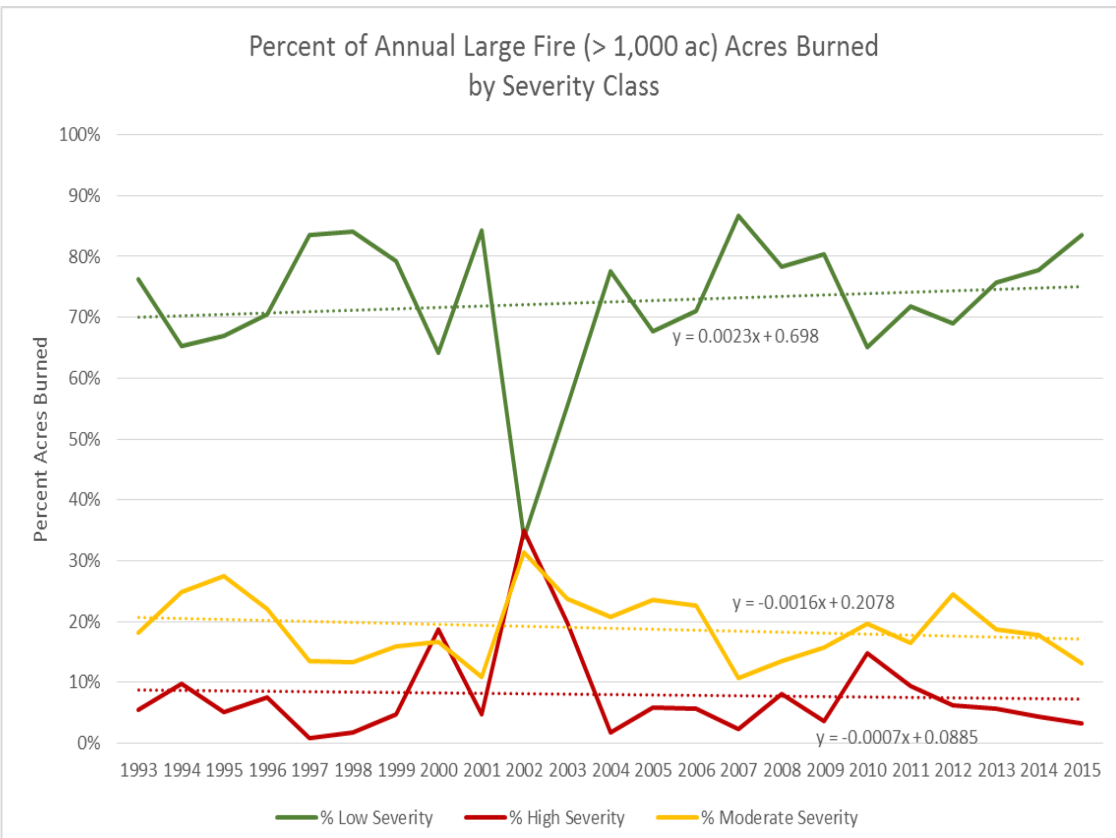


Figure 46. Percent of annual large fires burned by severity class

Figure 47. Conditions in dry mixed conifer in the project area that could easily support high severity fire

Figure 48. Locust dominated area in the Sierra Anchas where the Coon Creek Fire produced high severity effects in 2000

Areas of high severity fire can have detrimental impacts that extend far from the actual fire perimeter both temporally and spatially. Many of the areas that burned under high severity have been slow to regenerate and in places are now dominated by herbaceous and shrubby vegetation such as New Mexican Locust (*Robinia neomexicana*) (Figure 48). High severity fire, especially over large areas also leaves surface soil layers vulnerable to erosion. Additionally, debris flows and floods associated with severely burned areas may have severe, long term effects on areas downstream, downslope, and adjacent to the burned area.

Current conditions inhibit the survival and recruitment of large trees by fueling increasingly extensive high severity fires. These fires have the potential to alter the successional trajectories of post-burn vegetation, creating entirely different communities than those existing before such events (Savage and

Mast 2005; Strom and Fulé 2007b; Kuenzi *et al.* 2008). Figure 47 shows dense forest conditions (numerous trees with dense, contiguous canopy fuels) that occur within the project area and would support high severity fire. Even without crown fire, a surface fire burning though this area could do enough damage to trees to cause widespread mortality (Van Wagner 1973).

Fire Return Interval (FRI)

Fire Return Interval (FRI) can be used as a coarse indicator of how departed an area is in regards to the fire regime. The FRI calculated for this analysis does not take into account seasonality, severity, size, spatial complexity, or other important characteristics of a fire regime. However, particularly when combined with cover type/s, and severity, it is a useful indicator for evaluating how far an area has departed from a sustainable fire regime.

Fire Return Interval is a component of the fire history of an area. The Mogollon Rim, and the Sierra Anchas areas have a high density of ignitions, both lightning and human. In the past 31 (1987 – 2017) years, 850,215 acres of the 1,238,658 acre project area burned, for a mean annual acres burned of 27,426 acres. In addition to wildfire, 242,028 acres of Rx fire have occurred in the project area from 1995 – 2018 for another 10,084 acres per year. Prescribed fire is often focused on areas strategic to values at risk, and therefore is concentrated on the landscape, rather than distributed throughout (Figure 49). Taken together, the mean fire return interval for the entire project area is 33 years.

For Montane Ponderosa Pine forest types, the recent FRI is 38 years. This is almost double the desired maximum average for maintenance burning in ponderosa pine on the Mogollon Rim. The FRI is 59 years for Ponderosa Pine-Evergreen Oak, 65 years for dry mixed conifer, and 113 for grasslands in the project area. These FRIs represent an average that includes areas that have burned much more frequently and areas that have burned at a much longer frequency. These higher than natural fire return intervals have contributed to the degree of departure from historic conditions that puts over 51 percent of the area proposed for treatment area at risk of moderate to high severity fire effects based on recent severity proportions.

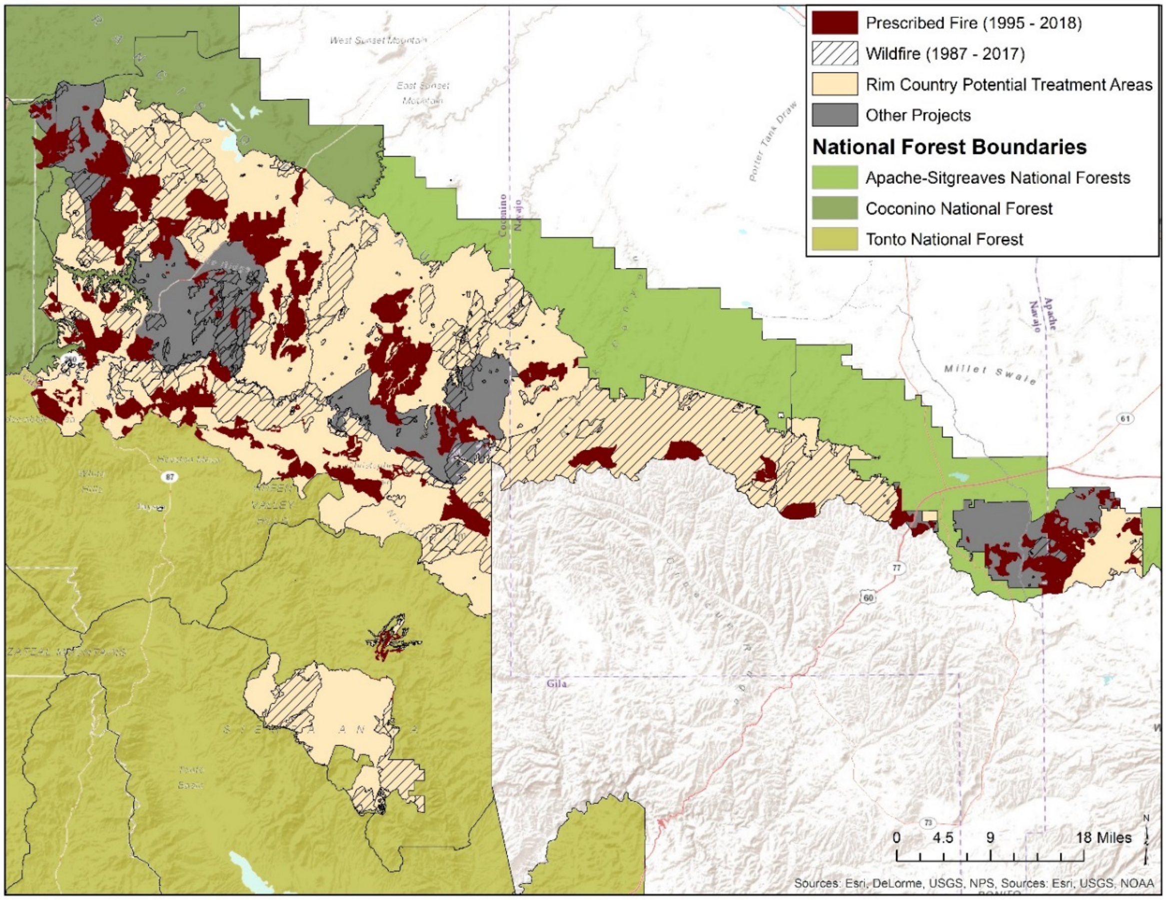


Figure 49. Location of recent wildfire (1987-2017) and prescribed fire (1995-2018) within the project area

Table 29: Vegetation cover types targeted for restoration, and their desired and current fire regimes across the project area

Cover type	Acres of each cover type	FRI Desired (average)	FRI Current+	High Severity Fire: Desired %	High Severity Fire: Recently Burned w/ High Severity++	High Severity Fire: Expected to Burn with High Severity	Average Annual Acres burned +	Average annual acres needed to burn to meet desired conditions
Ponderosa Pine (montane)	543,058	2 – 22 (12)	38	< 20 (<5% active crown fire)	27% High	23% active crown fire	14,495	~45,000
Ponderosa Pine – Evergreen Oak**	146,445	1 – 60 (7)	59	< 25 (with <10% active crown fire)	29% High	36% active crown fire	2,477	~20,000
Dry Mixed Conifer	47,993	2 – 61 (15)	65	< 20 (with <7% active crown fire)	19% High	54% active crown fire	743	~3,200
Aspen	1,436	5 - 150	739	N/A	N/A	17% active crown fire	2	~15
Grasslands	43,000	2 – 40 (12)	113	<10%	12% High	<1% active crown fire	379	3,600
Riparian	9,931	Related to, but not the same as, adjacent cover types.	Related to, but not the same as, adjacent cover types.	Related to, but not the same as, adjacent cover types.	Related to, but not the same as, adjacent cover types.	Related to, but not the same as, adjacent cover types.	N/A	N/A

+ Average calculated across all stands with that cover type for the past 30 years (1987 – 2017) for wildfire plus the past 24 years (1995 – 2018) for prescribed fire

++Data from Monitoring Trends in Burn Severity from 1992 – 2015

**Evergreen Shrub Subclass included in acres, but not in desired condition surface wind speed, which, in turn, affects surface fire intensity and rate of spread. Across the project area, canopies have become much more closed, resulting in elevated potential for crown fire and decreased surface vegetation.

Surface fuels

Historically, fine surface fuel loads were made up primarily of herbaceous material and fire burning though it would move relatively quickly, with a short residence time and a high rate of consumption. Repeated fires would consume coarse woody debris a little at a time, allowing natural recruitment of more from branches or snags to maintain equilibrium based mostly on fire frequency. (Covington and Sackett 1984).

Currently, across much of the project area, surface fuels are dominated by needle litter and duff that has accumulated over years to decades and is more closely packed than herbaceous fuel. Fire burning through these fuels will have a longer residence time than in herbaceous fuels, and the lower layers may smolder for extended periods, transferring more heat to the soil, roots, and boles of trees (Lutes *et al.* 2009, Valette *et al.* 1994; Sackett and Haase 1996). Litter and duff cones have accumulated around the base of many large and/or old trees in the project area and are likely to cause, or contribute to, undesirable mortality (Egan 2011). Prescribed fire can produce fire behavior that is less likely to cause lethal damage.

These fuel layers cannot be addressed by mechanical means across the entire area proposed for treatment under any of the action alternatives, even if it was ecologically sound to do so. Mechanical treatments may move duff and litter around, creating temporary discontinuities in the surface litter layer, but the biomass remains on site.

Wildfire Management

Initially, and through most of the 20th century, wildfires burning in frequent fire regimes in the Southwest were relatively easy to suppress. Fuels were mostly light and flashy, and forests were open with high canopy base heights, and suppression was a common response. Many areas were increasingly overgrazed to the point where some areas couldn't burn at all and/or fires were easy to suppress. Settlers saw fire as a threat, and actively suppressed it whenever they could. The subsequent accumulation of fuel, through litter-fall, logging debris, and development of ladder fuels that can initiate crown fire (Covington and Moore 1994) made fire suppression more difficult. As wildfires became more difficult to suppress, firefighting technology, tactics, strategies, equipment and support improved dramatically, allowing suppression forces to succeed in suppressing all but the most intense and extreme fires.

Wildland Urban Interface

The Wildland Urban Interface (WUI) is the area where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels ((NWCG) 2018). It is that portion of the landscape where structures and vegetation are sufficiently close that a wildland fire could spread to structures, or a structure fire could ignite vegetation. Many WUI areas are scattered across the project area, though areas of the greatest concern are relatively focused around towns or along travelways. For this analysis, the wildland urban interface is defined by a 0.5 mile buffer surrounding non-Forest Service lands where structures are present (Figure 50). Other critical infrastructure (Transmission Lines and Communication sites) and high value Forest Service Infrastructure (Buildings and Recreation Sites) were also included within the WUI for this project.

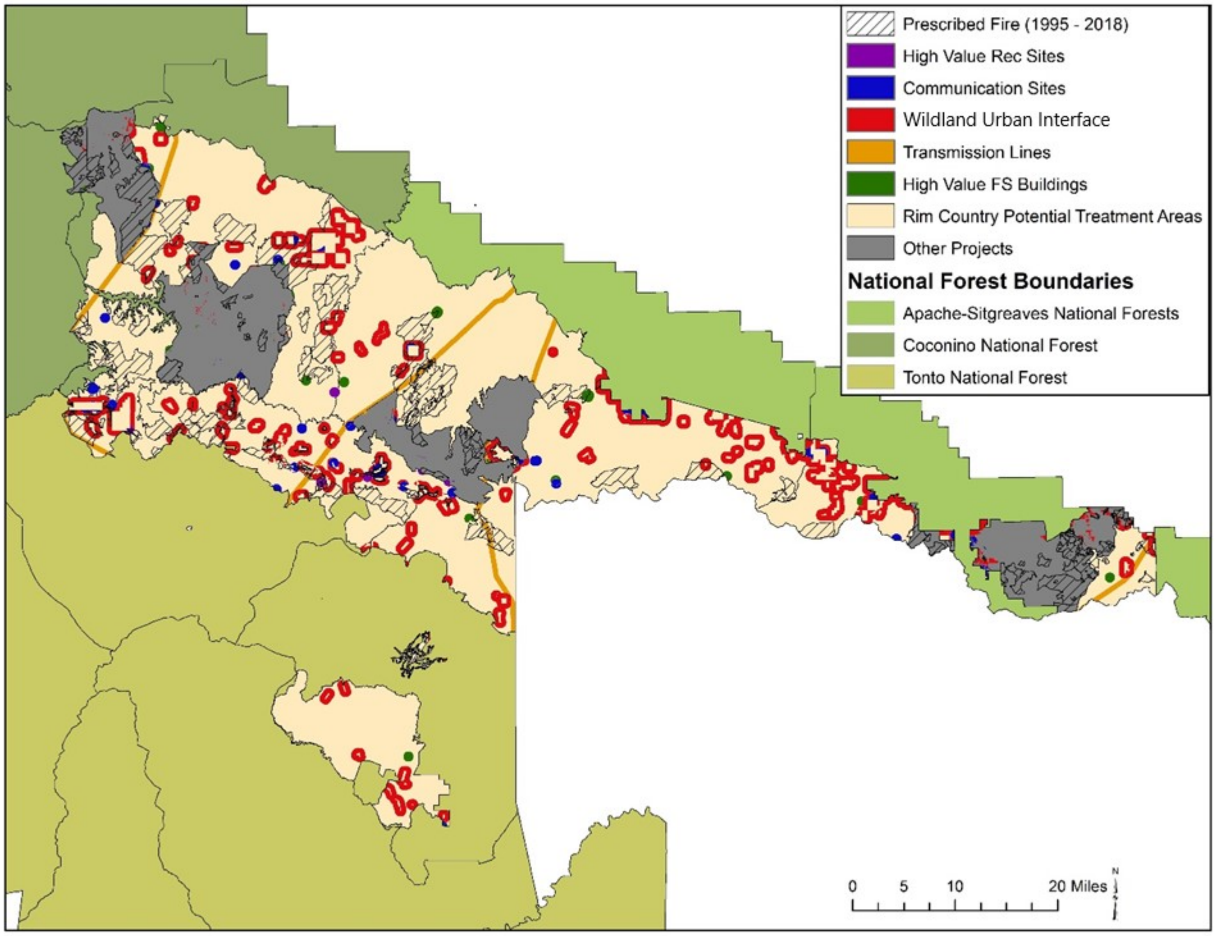


Figure 50. Wildland urban interface, as defined and mapped by the project. Recent prescribed fires are shown by hashed polygons.

Large and/or old trees

Large and/or old trees in the project area increase structural diversity, improving habitat for birds, insects, and other animals. Old trees have greater genetic diversity than even-aged groups of young trees, and provide forests a better chance of adapting to changing climate conditions and other environmental stressors (Minard 2002). Large and/or old trees within the project area are threatened by the increasing size and severity of wildfires.

Crown damage is an important factor in the mortality of old trees for which the death is attributed to fire (Fowler and Sieg 2004; Haase and Sackett 2008; Hood 2010b). The proximity of dense young trees and ladder fuels is problematic because it is so wide spread. In the transitional pine areas various species of juniper and oak are components of the forest, often centuries old. The overtopping of these trees by ponderosa pine allows a buildup of needles in the crotches and forks. This can lead to greater mortality and/or damage to very old trees when highly flammable needle accumulations burn than would occur without the needle accumulations.

Vegetation Cover Types

Ponderosa Pine (Montane)

This cover type includes all ponderosa pine other than the ponderosa pine/evergreen oak and transitional pine described in the next section. There are about 543,058 acres of this kind of ponderosa pine forest within the area being considered for restoration treatments.

Fire Ecology

Ponderosa pine forests are widespread in the Southwest occurring at elevations ranging from 6,000-7,500 feet on soils from igneous, metamorphic, and sedimentary parent materials with good aeration and drainage, and across elevational and moisture gradients. The dominant species is Ponderosa pine (*Pinus ponderosa* var. *scopulorum*). Other trees, such as Gambel oak (*Quercus gambelii*), pinyon pine (*Pinus edulis*), and juniper (*Juniperus* spp.) may be present. There is sometimes a shrubby understory mixed with grasses and forbs, although this type sometimes occurs as savannah with extensive grasslands interspersed between widely spaced clumps or individual trees. Canopy cover in the savanna areas is between 10 and 30 percent.

Historically, once fires ignited in ponderosa pine forests, they could burn until extinguished by rain, or until they ran out of fuel, which typically occurred when they reached an area that had recently burned. Fires could burn for months and cover thousands of acres (Swetnam and Betancourt 1990; Swetnam and Baison 1996; Swetnam and Betancourt 1998). Effects from these long burning fires would vary as conditions changed over the weeks or months they burned. As a result, most ponderosa pine in the southwest burned every 2 to 22 years as mostly low-severity, often area-wide fires (Weaver 1951; Cooper 1960; Deterich 1980; Swetnam *et al.* 1990; Swetnam and Baison 1996; Covington *et al.* 1997a; Fulé *et al.* 1997; Heinlein *et al.* 2005; Kaib 2011).

History

Although the popular early descriptions of the ponderosa pine forest call attention to the park-like stands, there are some descriptions which refer to areas with dense cover (Woolsey 1911). An accurate picture of the pre-settlement ponderosa pine forest would probably describe a mosaic of mostly open, grass savanna and clumps of large, yellow-bark ponderosa pine and open forest with an occasional dense patches or stringers of small, blackjack pines (young ponderosa pine).

Extensive stand-replacing fires are unreported in the documentary records prior to circa 1950 (Cooper 1960; Allen *et al.* 2002a). Ponderosa pine does not sprout, so crown fire generally produces 100 percent mortality. There are few data available to indicate how much high severity fire was typical across the ponderosa pine in northern Arizona, but simulations suggest that presettlement forest structure would have supported very little crown fire, passive or active (Roccaforte et al. 2008, Covington 2002).

The ponderosa pine/evergreen oak (PPEO) cover type in this analysis includes vegetative associations which have been referred to by various classifications and names, including transitional pine, Arizona highlands, Ponderosa Pine/Evergreen Oak ERU, Mogollon highlands, various Madrean fringe types (Fleischner *et al.* 2017; Wahlberg *et al.* 2017 (in draft); Huffman *et al.* 2018). In order to be consistent, this analysis will use the broadest classification, 'Ponderosa Pine/Evergreen Oak' (PPEO) to refer to this broad cover type, with more detailed discussion as needed to include unique characteristics.

It is well understood that 20th century fire exclusion in montane ponderosa pine forests has led to substantial increases in tree establishment and associated changes in ecological function (Covington and Moore 1994; Fulé *et al.* 1997; Moore *et al.* 1999; Savage and Mast 2005; Strom and Fulé 2007a). Much less is known about historical changes associated with modern land use in the PPEO. It appears that cover of long-lived sprouting shrubs has increased in many transitional ponderosa pine forests as a result of fire exclusion (Huffman *et al.* 2018).

Mixed Conifer

Mixed Conifer includes a wide range of vegetation types and fire regimes. Mixed conifer has been classified into warm/dry, or cool/moist (Romme *et al.* 2009; Korb *et al.* 2013; Wahlberg *et al.* 2017 (in draft)), which can also be distinguished by their natural fire regimes. In this analysis, mixed conifer will be referred to as WMC (Mixed Conifer with Aspen, or Wet Mixed Conifer) or DMC (Mixed Conifer - Frequent Fire, or Dry Mixed Conifer).

Historically, mixed conifer in the southwest had highly diverse composition and structure. This diversity was largely driven by topography, with the scale of the mosaic of cover types dependent on the scale of topographic variation. Ridgetops and low elevation sites were (and largely still are) characterized by open stands dominated by ponderosa pine and had frequent surface fires. South and west-facing slopes likely were similar, but were less open and had less ponderosa and more Douglas-fir, aspen and white fir. These stands likely also were characterized by frequent surface fires. North and east-facing slopes were likely more dense and had still less ponderosa and more white fir, as well as Engelmann spruce and subalpine fir, especially at higher elevations.

Mixed Conifer with Frequent Fire (Dry Mixed Conifer)

Dry Mixed Conifer (DMC) covers approximately 63,000 acres within the area proposed for treatment in Rim Country. It generally occurs at elevations between 6,000 and 10,000 feet, with some variability depending on aspect. DMC is generally situated between ponderosa pine or pinyon-juniper woodlands below wetter mixed conifer or and spruce-fir forests above. Historically, DMC was dominated by ponderosa pine (*Pinus ponderosa* var. *scopulorum*) in an open forest structure (Reynolds *et al.* 2013; Rodman *et al.* 2016; Huffman *et al.* 2018), with minor occurrence of aspen (*Populus tremuloides*), Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and Southwestern white pine (*Pinus strobiformis*).

Fire Ecology

Historical fire regimes were probably similar to those widely reported for montane ponderosa forests of the Southwest. Frequent surface fires likely kept forests in open structural conditions and limited the abundance of woody understory species. Available evidence in DMC forests suggests that high severity patches would have been generally been less than 60 acres, with the larger patches being less common (Huffman *et al.* 2015; Yocom Kent *et al.* 2015).

History

The historical fire regime on this landscape was one of high frequency, low-severity fires (Huffman *et al.* 2015). This would have supported a finer grained pattern of vegetation than is currently present. Current conditions show a coarser pattern that would be more consistent with a less frequent, mixed to high severity fire regime, increasing the susceptibility to stand-replacing fire, even where such regimes were uncommon historically (Abella and Springer 2014; Rodman *et al.* 2016). Fire and drought tolerance have decreased since pre-settlement times, driven largely by increases in the relative importance of white fir (*Abies concolor*) and southwestern white pine (*Pinus strobiformis*), but also shifts from shade intolerant species to shade tolerant species (Strahan *et al.* 2016).

Emissions and Air Quality

Wildland fire emissions can cause adverse health effects and/or become a nuisance, but are fundamental to the disturbance ecology associated with healthy ecosystems that are adapted to frequent fire. Fire will occur in the project area in some form, regardless of the decision made based on this EIS, so air quality impacts are evaluated for all the alternatives. Air quality within the project area currently meets EPA air quality standards.

Wildfire vs. Prescribed Fire

Smoke is inevitable in the airsheds of fire adapted ecosystems, such as those of Northern Arizona. Federal land managers have the role of protecting and meeting air quality standards while simultaneously allowing fire, as nearly as possible, to function in its natural role in the ecosystem (USDA and USDOI 1995). Smoke and visibility impairment from wildland fire that closely mimics what would occur naturally is generally viewed as acceptable (Peterson 2001).

Currently, prescribed fires are regulated and their emissions are monitored and regulated in the same manner as emissions sources that are more controllable (such as dust, vehicle emissions, smoke from wood-burning stoves, industrial emissions, etc.), and included in air quality assessments used to approve burn plans. Smoke impacts from wildfire can be more difficult to mitigate than prescribed fire, whether the expected effects of the fire are desirable or not.

Fire managers are able to manage smoke impacts to some degree by implementing prescribed fire when ventilation conditions are favorable. Various Emissions Reductions Techniques (ERTs) are utilized and documented as a standard part of implementing prescribed fires. Prescribed burning is implemented only with approved site specific burn plans and with smoke management mitigation and approvals. All burning is conducted according to Arizona Department of Environmental Quality standards and regulations, including the legal limits to smoke emissions from prescribed burns as imposed by Federal and State Law. The Arizona Department of Environmental Quality ADEQ) enforces these laws by regulating acres that are treated based on expected air impacts. These regulations ensure that effects from all burning within the area are mitigated and that Clean Air Act requirements are met.

Meteorological, Climatological and Topographical Effects on Air Quality

Climatological limits are set by weather and fuel moisture, which profoundly affect fire behavior, fire effects, and the behavior and effects of emissions. As weather varies from year to year, so does the risk of high severity fires and the ability to use prescribed burns and wildfires to achieve resource objectives. Large fluctuations in the number of days of opportunity vary widely from year to year, creating large fluctuations in the number of acres treated with wildland fire. Running averages over many years must be used in order to view trends in fire use or fire effects (Kleindienst 2012).

During the winter, weather conditions can trap emissions in a layer of cold surface air (inversion). Under these conditions, particulates can be trapped close the surface in local airsheds, including the communities of Flagstaff, Young, Payson, Pumpkin Center, Roosevelt, St. John, and the Verde Valley. Visibility is also an air quality consideration, and tends to be lowest in the summer due to regional haze and smoke from fires.

Emissions and Public Health

There are six pollutants identified by the Environmental Protection Agency (EPA) that are considered to be 'fire-related' pollutants (Hyde *et al.* 2017), are: Carbon monoxide, Lead, Nitrogen Dioxide, Ozone, Particulate Matter, and Sulfur Dioxide.

The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone, and sulfur dioxide. All of these pollutants except lead are monitored and reported by the daily Air Quality Index (AQI), which ranging from Good to Hazardous (Figure 51). This index focuses on adverse health effects from exposure to unhealthy air. Each day, monitors record concentrations of the major pollutants at more than a thousand locations across the country. These raw measurements are converted into a separate AQI value for each pollutant (ground-level ozone, particle pollution, carbon monoxide, and sulfur dioxide) using standard formulas developed by EPA. The highest of these AQI values is reported as the AQI value for that day.

AQI Value	Actions to Protect Your Health From Particle Pollution
Good (0 - 50)	None
Moderate (51 - 100*)	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups (101 - 150)	The following groups should reduce prolonged or heavy outdoor exertion: - People with heart or lung disease - Children and older adults
Unhealthy (151 - 200)	The following groups should avoid prolonged or heavy exertion: - People with heart or lung disease - Children and older adults Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy (201 - 300)	The following groups should avoid all physical activity outdoors: - People with heart or lung disease - Children and older adults Everyone else should avoid prolonged or heavy exertion.

Figure 51. AQI table with levels of health concerns. Taken from the Environmental Protection Agency's airnow.gov website: https://airnow.gov/index.cfm?action=aqi_brochure.index

While it is difficult to determine exactly how much emissions from wildfire fires contributes to the overall AQI compared to other polluters such as vehicles, dust and industrial pollutants, trends in AQI can help identify areas with increased need for mitigation of wildfire emissions. The pollutant most directly linked to AQI and wildfires is Particulate Matter (both PM10 and PM2.5).

Particulate Matter (PM)

Air pollutants called particulate matter (PM) include dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires and natural windblown dust. This pollutant is the greatest concern of wildland fire emissions, from wildland fire (Ottmar 2001; Graham 2012-2014), although fire also creates other criteria pollutants and visibility impacts. Particulate matter is defined as tiny particles of solid or semi-solid material suspended in the air. Particles may range in size from less than 0.1 microns to 50 microns. Particles larger than 10 microns tend to settle out of the air quickly and are not likely to affect public health; smaller particles remain airborne, are considered inhalable, and have the greatest health effects. The EPA has used 'PM10' since 1987 to refer to particles of 10 micrometers or less in the ambient air. In 1997, the EPA added 'PM2.5', which includes only those particles with aerodynamic diameter smaller than 2.5 micrometers.

The Clean Air Act defines the NAAQS for PM 2.5 as an annual mean of 15µg/m3, and a 24 hour average of 35µg/m3. At this concentration or above, PM 2.5 is considered to have a detrimental effect on public health. It is important to note that it is not the total amount of emissions from a fire that have effects on human health, but rather how concentrated pollutants in ambient air are for a period of time.

Fugitive dust

Heavy equipment used on paved and unpaved roads during the implementation of projects has the potential to create localized impacts from fugitive dust. With high wind events, this fugitive dust has the potential to be carried for several kilometers. Control measures developed for site specific projects can reduce these localized particulate matter emissions, such as reducing travel speeds on unpaved surfaces, ceasing work activities during periods of high winds, applying gravel or soil stabilizers on dust problem areas, covering loads, and covering ground surfaces with water during earth moving activities (BLM 2011).

Radioactive emissions

During the Cerro Grand fire of 2000, there was also considerable public concern regarding the potential release of radionuclides from fires burning on lands managed by the Los Alamos National Laboratory (LANL). The following risk summary is from "2002 Fact Sheet: Cerro Grand Fire Releases to Air" which may be viewed at:

http://www.nmenv.state.nm.us/OOTS/PR/2011/NMED_Monitoring_Air_Quality_in_Los_Alamos.pdf
"The primary health risks during the Cerro Grande fire were associated with breathing materials released into the air. It was estimated the risk of cancer from breathing any LANL-derived chemical or radioactive material that may have been carried in the smoke plume to be less than 1 chance in 10 million. Potential exposures in the surrounding communities to LANL-derived chemicals that are not carcinogenic were about 10 times lower than acceptable intakes established by the U.S. Environmental Protection Agency (EPA). The risk of cancer from breathing chemicals and radioactive materials in and on the natural vegetation that burned in the Cerro Grande Fire was greater than that from LANL derived materials, but still less than 1 chance in 1 million. The vegetation that burned contained naturally occurring chemicals and radioactive materials and radioactive fallout produced during atmospheric tests of nuclear weapons. These materials and the risks they posed are present during any forest fire. The evidence suggests that some adverse health effects did result from breathing high concentrations of particulate matter in the smoke. Such exposures are associated with any forest fire. Deposition of LANL-derived chemicals and radioactive materials from the smoke plume to the soil was minimal."

Following the Cerro Grande fire that burned the city of Los Alamos and the Los Alamos National Laboratory (LANL) in New Mexico in 2000, the US Environmental Protection Agency (EPA), New Mexico Environment Department (NMED), and LANL partnered with Department of Energy to operate radiological monitoring systems as well as to initiate several studies to assess the impacts of the fire. The results of these efforts with regard to air quality and human health impact indicated that radionuclides originating from the LANL site during the Cerro Grande Fire were restricted to naturally occurring radionuclides.

LANL, the Department of Energy, and NMED monitored radionuclide concentrations in smoke from the Las Conchas fire that burned through the Los Alamos area in the summer of 2011 and reported no significant detection levels (http://www.nmenv.state.nm.us/nmrcb/documents/LasConchasFireAirMonitoring.html).

Mercury

Mercury is present at some background level around the world, and is sometimes present in emissions from wildland fires (Friedli *et al.* 2003; Biswas *et al.* 2007; Wiedinmeyer and Friedli 2007; Obrist *et al.* 2008; Selin 2009; De Simone *et al.* 2016; Webster *et al.* 2016). However, there is insufficient science to support conclusions about specific effects from the prescribed fires proposed in the Rim Country EIS. General conclusions may be possible, but no valid effects could be presented so, even if we did have the means of providing an estimate of mercury emissions, we would still not know the effects.

There is little question that there would be more mercury in emissions from high intensity wildfires than from the low intensity fires that would typify the prescribed fires proposed by the Rim Country (Friedli *et al.* 2003; Biswas *et al.* 2007; Obrist *et al.* 2008; Lahm 2014; Webster *et al.* 2016). Mercury is not a Criteria Pollutant, that is, it is not one of the six substances for which there are National Ambient Air Quality Standards, because it is not considered an 'ambient' substance. Mercury is regulated as a "point source", meaning emissions are regulated by the specific sources which discharge pollutants into the air from a specific and clearly discernable discharge point, such as a power plant. Additionally, prescribed fires help reduce the intensity of ensuing wildfires for several years, depending on the pre-burn condition of the burn unit (Brennan and Keeley 2015).

Smoke Sensitive Areas and Sensitive Receptors

The Regional Haze State Implementation Plan for Arizona defines 'sensitive receptors' as "population centers such as towns and villages, camp grounds and trails, hospitals, nursing homes, schools, roads, airports, mandatory Class I Federal areas, etc. where smoke and air pollutants can adversely affect public health, safety, and welfare" (State Implementation Plan, Appendix A-10 page 36). Several smoke sensitive areas lay within the airsheds of the areas proposed for treatment (Table 30). The list is not inclusive, and we recognize that there are a number of communities within, adjacent, or sometimes downwind of the project that are likely to have some impacts of smoke from Rim Country activities and are not listed. While these areas do not necessarily meet the official definition of smoke sensitive, we are aware of smoke-sensitive populations in airsheds that could be impacted by prescribed fire, and experience has shown that these areas need to be considered when planning and executing prescribed fires.

A 'Class I' is an area classification that requires the highest level of protection under the Clean Air Act of 1963. Projects which may potentially impact Class I areas must address efforts to minimize smoke impacts on visibility. Class I areas most likely to be impacted by activities in the Rim Country project area are Petrified Forest National Park, Mazatzal Wilderness, and Sierra Anchas Wilderness (Figure 52).

Table 30. Smoke sensitive areas and sensitive receptors

Area	Proximity to implementation area	Concerns
Verde Valley	Less than 10 miles downslope south and southwest of project area	Hospitals, schools, human habitation, young children, senior citizens,
The Navajo Reservation	Northeast and east of the project area	Hospital, schools, human habitation, young children, elders
Fort Apache Reservation	Adjacent to project area to the south and east	Hospital, schools, human habitation, young children, elders
The Hopi Reservation	Northeast and east of the project area	Hospital, schools, human habitation, young children, elders
Snowflake / Taylor	About 15 miles north of the project area	Human habitation, schools, young children, seniors
Tonto Basin /Roosevelt	About 10 miles south southwest of the project area	Human habitation, schools, young children, senior citizens
Show Low	Project area to the east and west of Show Low	Hospital, human habitation, schools, young children, seniors
Heber Overgaard	Project area is adjacent to town in multiple directions	Human habitation, young children, school, seniors
Strawberry / Pine	Project area is on all sides of the both towns	Human habitation, young children, school, seniors
Blue Ridge	Project area is on all sides of the developed areas	Human habitation, young children, seniors
Pinetop/Lakeside	Project area is on all sides of the project area	Human habitation, young children, school, seniors
Payson	Project area is on all sides of the project area	Hospital, schools, human habitation, young children, seniors

The national visibility goal of the Clean Air Act is, “the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I areas in which impairment results from manmade air pollution.” Wildfires are considered to be natural sources of visibility impairment, and generally outside state control or prevention.

No NAAQS are in non-attainment over the project area. On rare occasions, pollution from distant, large population centers in California affects the air quality in the area. Huge dust storms (haboobs) that occur in the Phoenix valley can produce large amounts fugitive dust that has also been known to affect air quality in Northern Arizona, but these events are generally limited to a few days a year.

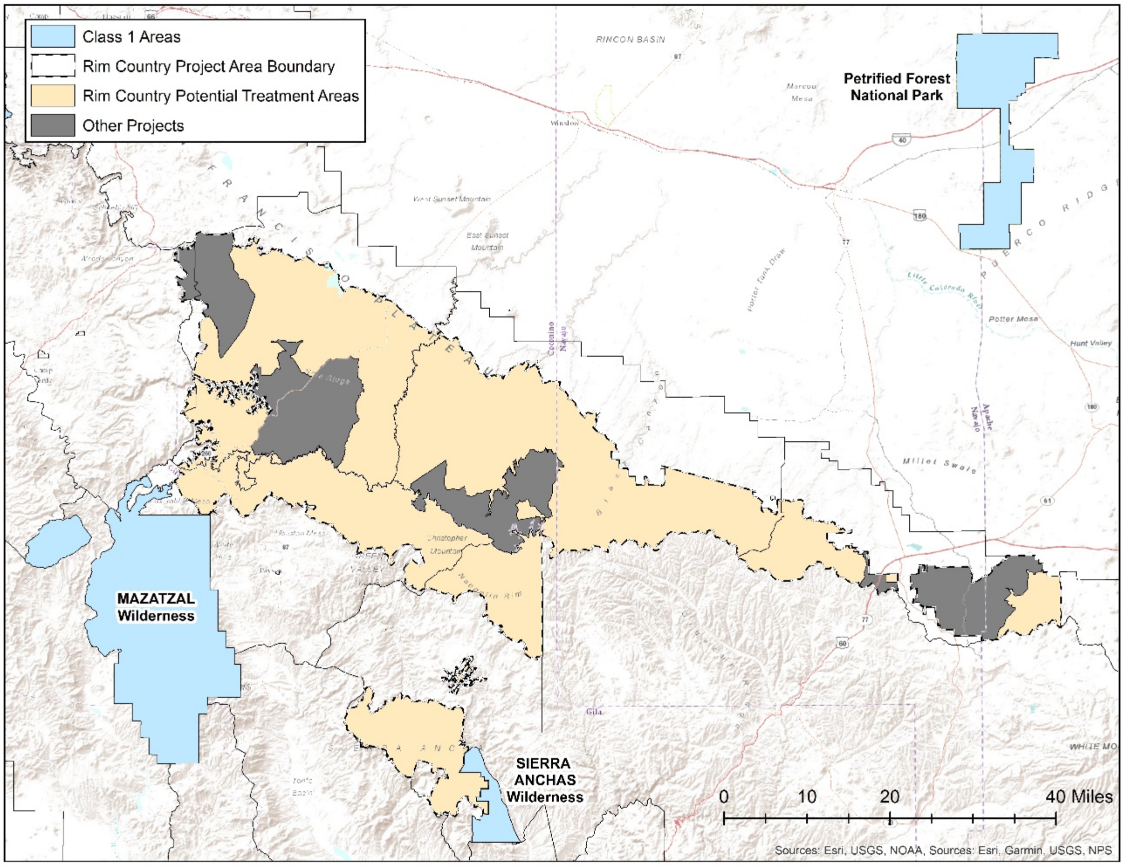


Figure 52. Class 1 areas with greatest potential to be impacted by Rim Country Smoke

Cumulative effects from prescribed fires and from wildfires that are not being actively suppressed in Federal, State, and Tribal lands are largely mitigated through implementation of the Enhanced Smoke Management Program in the Arizona Smoke Implementation Plan (SIP) by the Smoke Management Group. When the Federal land managers actively began prescribed burn programs in the 1970s, they became rapidly aware that a pro-active program for the coordination of prescribed burns would be vital to obtain and continue support of prescribed burning programs by ADEQ and the public. An interagency Smoke Management Group was developed in partnership with the State, and housed in the ADEQ offices in Phoenix. The personnel in the group are funded largely by Federal agencies, demonstrating the initiative of the agencies to, in some degree, self-regulate emissions production from prescribed burns, across Federal and State boundaries. This group assists land managers in not exceeding NAAQS or visibility thresholds

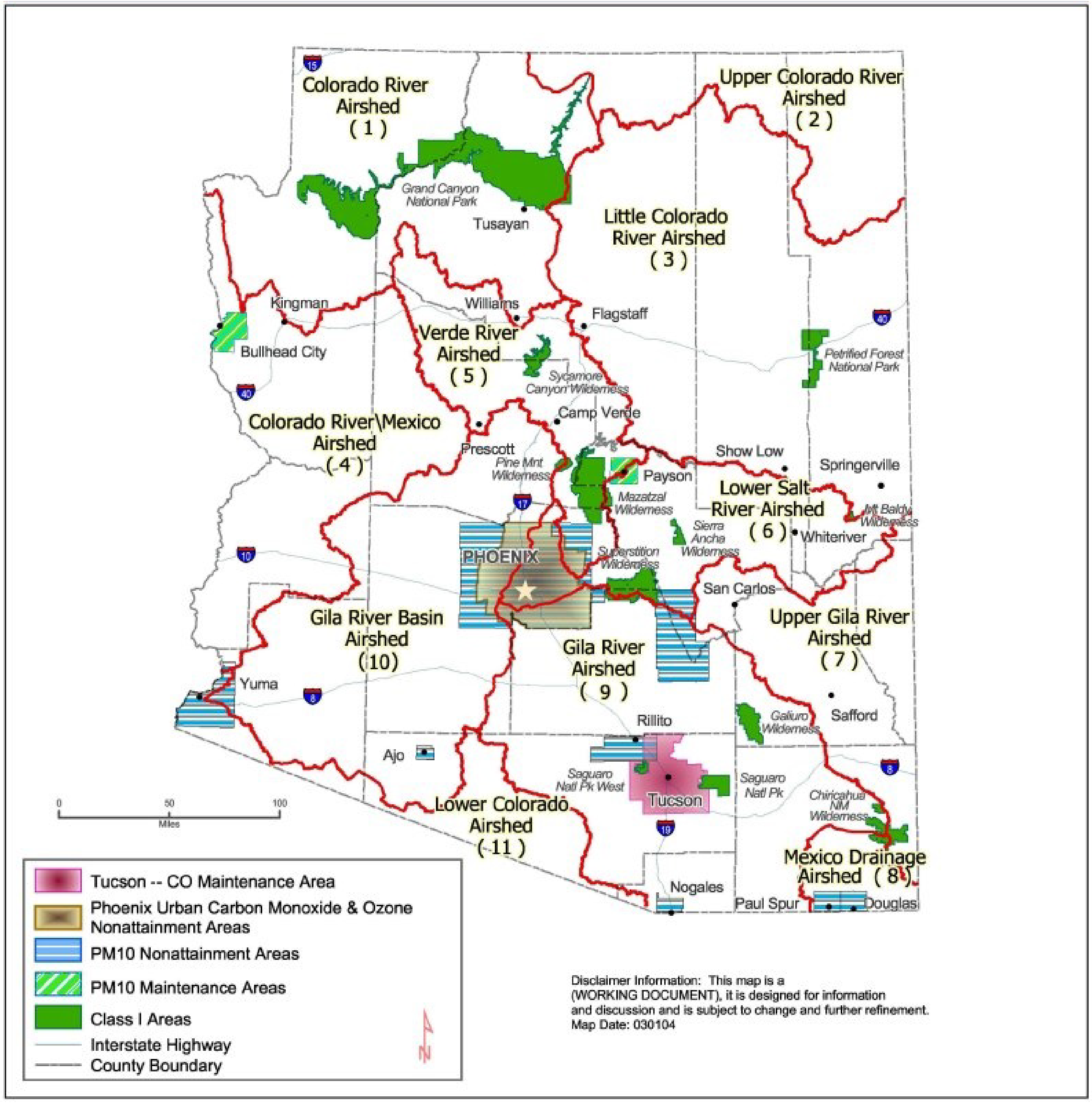


Figure 53. Arizona State airsheds

The Forest Service will continue to adhere to requirements in the Arizona State Implementation Plan to meet natural condition visibility goals. The most sensitive smoke receptor in the State of Arizona is the Verde Valley, which is easily impacted with nuisance smoke from the cumulative burning on the southern part of the KNF, the eastern side of the COF, and the Western side of the Prescott National Forest, as diurnal drainage of smoke from fires settles into this valley. Considerable coordination between Forests takes place when burns and wildfires that can affect the Verde Valley take place, facilitated by the interagency Smoke Management Group housed at ADEQ.

Public Influence

Public acceptance of smoke varies greatly from year to year. Acceptance of smoke from prescribed fires and beneficial wildfires is high following seasons with high profile, high severity events, and during extremely dry years when the threat of large, high severity incidents is elevated. Conversely, acceptance wanes during wetter year when the threat of uncharacteristic fires is low, despite climatology in milder years being more favorable for achieving desired fire effects, especially in areas highly departed from reference conditions (Kleindiest 2012).

Ecological effects of smoke

Fire has historically played an important role in defining the character of ecosystems in Northern Arizona. The cover types in the Rim Country analysis that are targeted for restoration treatments are adapted to frequent fire, often area-wide fires (Cooper 1960; Covington *et al.* 1997b; Kaib 2001; Fulé *et al.* 2003; Huffman 2017), indicating an even more frequent smoke regime. Research in Northern Arizona has shown that the emergence of many species is enhanced by exposure to smoke from ponderosa pine needle litter (Abella 2006; Abella *et al.* 2007; Lata 2015).

Assumptions and Methodology

In the analysis of this resource the following assumptions were made:

All mechanical treatments were modeled to have occurred in 2019, and all areas proposed for burning were modeled to have burned in 2024 and again in 2034. In reality, treatments would be spread out over years. The specific timing of mechanical treatments would depend on the contract/contractor, road conditions, and numerous factors that are impossible to predict years in advance. Prescribed fire implementation depends on weather conditions, fuel conditions, other fires in the area, available resources, and multiple other variables that are impossible to predict weeks in advance. During the implementation period, untreated areas would be vulnerable to the effects as described in the Existing Condition and/or the Alternative 1 (no action), depending on the applicable time period. Modeling results presented do not include partial treatment, such as would be the case partway through implementation. Details on the treatments modeled can be found in the Silvicultural Specialist report' (Moore, this DEIS).

The prioritization of treatment areas will be a part of the implementation of Rim Country, though broad recommended methodology is presented here. Results were analyzed to compare the effectiveness of each action Alternative Against the "No-Action" Alternative (Alternative 1). Concepts that are necessary for a thorough understanding of this analysis are discussed when they are first presented. Additional information on modeling and concepts may be found in the Fire Ecology and Air Quality Specialist Report, the Silvicultural Specialist Report and the associated appendices.

The discussion of effects assumes that all BMPs, design features, and mitigations are applied during implementation. Effects discussions are based on modeled fire behavior, modeled emissions, and proposed treatments for which the methods and assumptions are detailed in this section and in the Fire Ecology and Air Quality Specialist Report and the Silviculture Specialists' Report (Moore, this DEIS).

Scales of analysis

The alternatives in this analysis are evaluated at multiple scales to ensure the expected effects are being considered in the appropriate context.

In order of decreasing size, with the largest first:

1. **Rim Country Project Area:** This includes the entire area analyzed for treatment, including comprehensive restoration, at 1,240,000 acres. It includes large areas on which the Rim Country analysis is not recommending treatments. (Figure 3)
2. **Hydrologic Unit Code (HUC):** Proposed treatments will be analyzed and evaluated at the 6th level HUC. In order to be included in this report, at least 30 percent of the watershed had to be

within the Rim Country Project Area, resulting in 80 watersheds being analyzed. The watersheds range in size from 7,176 acres to 39,135 acres, with a mean size of 18,465 acres. (Figure 54).

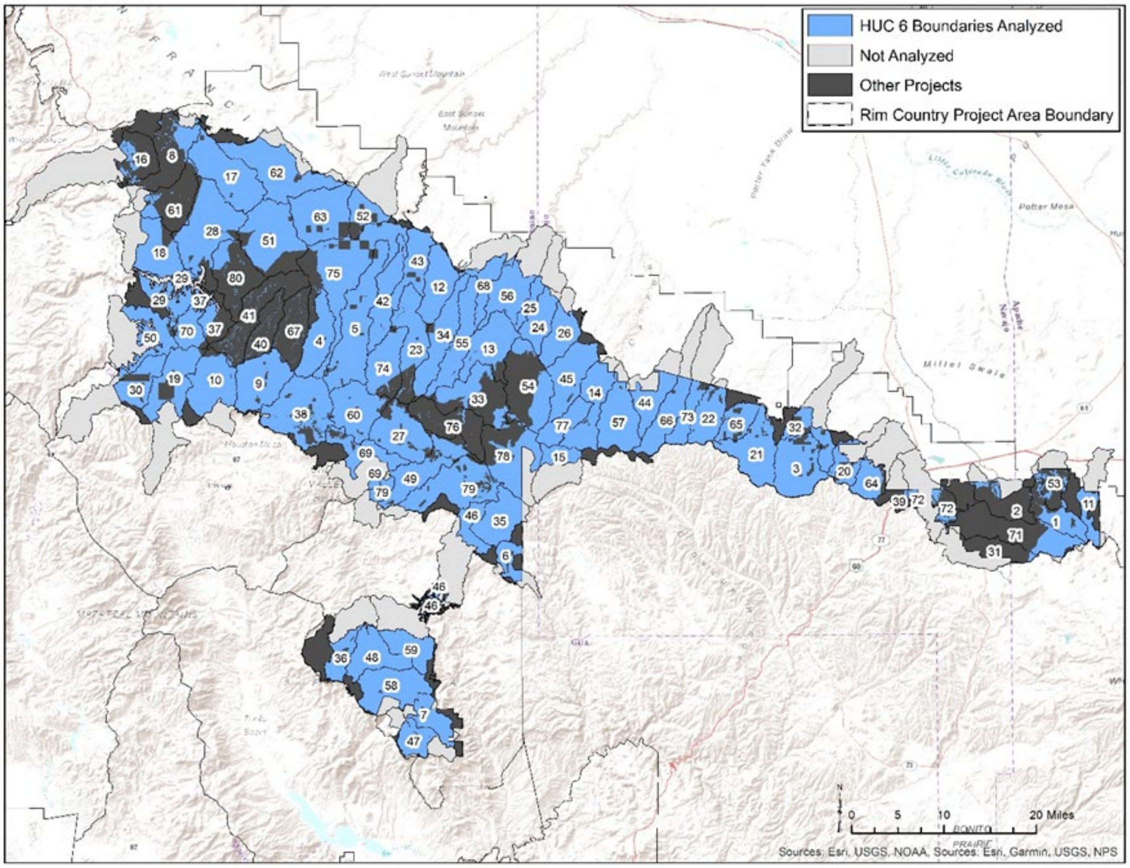


Figure 54. HUC 6 Boundaries. Dark gray areas are those areas within the project area that have current NEPA projects, and are not being fully re-analyzed in this report. Light gray areas are HUC 6 boundaries that fall outside the project area and were not analyzed in this report

Metrics & Measures

Throughout this analysis, there are references to 'undesirable fire behavior and effects'. Where it is legally and practically possible, 'desirable' fire behavior and effects align with reestablishing natural fire regimes, and that is the intent across the majority of the project area. Examples of where it is not possible to restore the natural fire regime include, but are not limited to, the following:

Example 1: Mexican Spotted Owl habitat: Where there are nest cores, in particular, there is a need, legally and biologically, to manage those areas for denser vegetation than may have existed there historically. That means that, in most cases, fire will need to be less frequent than it would have been historically, and there is a desire to prevent high severity fire in those areas.

Example 2: Proximity to infrastructure for certain vegetation types. Some of the ponderosa pine/evergreen oak and adjacent Chaparral/Madrean cover types historically would have had components of high severity fire as part of their natural fire regimes. Where these cover types occur on steep slopes above vulnerable assets, it may be necessary to manage these areas for lower severity fire.

The metrics used to evaluate the effectiveness of the alternatives in meeting the purpose and need of the project are described in detail below. A comparison of the outputs of these metrics between alternatives is displayed in Table 31.

Table 31. Brief description of the metrics used in this analysis

Metric	Application	Issue/s Addressed	Assets and Resources Addressed
Fire Type	Indicates potential fire behavior at all scales analyzed. Crown fire is one an indicator of high severity fire.	Landscape and habitat resilience to wildfires burning under extreme conditions, vulnerability of values	Fire Management, Wildland Urban Interface, Old Trees, Vegetation Cover Type, Watershed Response
Fire Hazard Index	See page 219 for details.	Landscape/habitat resilience to wildfires burning under extreme conditions, including both first and second order fire effects, and wildfire suppression difficulty.	Fire Management, Wildland Urban Interface, Vegetation Cover Type, Watershed Response
Total Surface fuel loading (Litter + Duff + Fine Woody Debris + Coarse Woody Debris)	Surface fuel loading is used to indicate potential for surface fire severity and intensity, particularly in areas where there may not be crown fire. It is also an indicator of potential emissions.	Potential for emissions and for high burn severity and high severity effects from both prescribed fire and wildfire from first and second order fire effects.	Old Trees, Vegetation Cover Type, Watershed Response, Air Quality
Emissions	National Ambient Air Quality Standards for six pollutants: Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Ozone (O_3), Particle Pollution 2.5 (PM2.5), Particle Pollution 10 (PM10), and Sulfur Dioxide (SO_2) were modeled based on various treatment types, and discussed in context with each alternative.	Air quality concerns; particularly human health and visibility.	Air Quality

The effects of wildfire as quantified by the metrics and measures have direct implications for a variety of highly valued resources and assets. For this report, the resources and assets analyzed will include:

1. Fire management
3. Wildland Urban Interface
4. Old Trees
5. Vegetation Cover Type
6. Air Quality

Fire Modeling

The intent of the fire modeling in this analysis is to identify the areas at greatest risk of undesirable fire behavior and first and second order fire effects, and what the expected effects would be for each of the alternatives. Additional details for fire modeling can be found in the Fire Ecologist Specialist Report 2019.

One of the objectives of the Rim Country EIS is to reduce the likelihood of uncharacteristic wildfires, including large, high severity fires. Modeling fire behavior using conditions under which an uncharacteristic fire is known to have occurred allows for increased accuracy of post-treatment modeling results (McHugh, 2006). This analysis used the Rodeo/Chediski (RC) Fire, which was a large, complex fire that burned in 2002 on the Tonto and Apache-Sitgreaves National Forests, including about 100,000 acres within the Rim Country project area.

Data for modeling fire behavior is based on a landscape file with describes the fuel and topographic characteristics of an area, at a 30 square meter (0.22 acre) resolution. The landscape file was created using a combination of Landfire 2014 data (LF1.4.0), Lidar data, USFS stand data (Moore, this report) and satellite imagery (NAIP, USFS Resource Photography). Existing condition fuel models were assigned based on a combination of Landfire Existing Vegetation Type (EVT), canopy cover, canopy height and past disturbance. The predominant Landfire EVT was modified in order to match the FSVeg stand vegetation cover type, while non-burnable surfaces and riparian corridors were left unmodified regardless of stand vegetation cover type. Lidar data was used to create canopy cover and canopy height rasters. Mapped disturbances including mechanical treatments, prescribed fire and wildfire from 2008 – 2017 were used to further modify fuel model assignments.

Fire behavior for alternative future conditions used outputs from the Forest Vegetation Simulator Fire and Fuels Extension (Dixon 2003; Rebain 2016) to adjust data for modeling the effects of actions, or no actions, proposed in the alternatives. Post-treatment landscape files were modified from the existing conditions using the percent of change to canopy characteristics output from FVS-FFE. The resulting stand characteristics informed the assignation of post-treatment fuel models using the Landfire Total Fuel Change tool (LFTFC v0.160).

Fire Type

In ponderosa pine and most of its associated vegetative communities, the expected type of fire is a good indicator of the health and resilience of the ecosystem. Crown fire in ponderosa pine is lethal to the tree, therefore the amount and distribution of crown fire activity is an important indicator of the health of a frequent fire forest. Fire types include active crown fire, conditional crown fire, passive crown fire, and surface fire as described below.

Active Crown fire: A fire that advances from crown to crown in the tops of trees or shrubs (NWCG 2008). Active crown fires generally produce high severity effects and are considered ‘stand replacing’ because they top-kill, kill and/or consume most of the dominant overstory vegetation. Active crown fire is linked to surface fire, perpetuated by a combination of surface and canopy fuels.

Conditional Crown Fire: Conditional crown fire is a type of crown fire that moves though the crowns of trees, but is not linked to surface fire. Crown fire must initiate in an adjacent stand and spread through canopy fuels alone. Conditional crown fires burn in areas where canopy base heights are too high for crown fire to initiate within the stand, but there is sufficient horizontal continuity of canopy fuels to carry a crown fire if initiated. In the fire modeling used, Conditional Crown Fire was combined with Active Crown Fire.

Passive Crown Fire: Individual trees or groups of trees 'torch', as fire moves up into the canopy, ignited by the passing front of a surface fire. The fire climbs up ladder fuels (low branches, shrubs, or herbaceous vegetation that can produce flame lengths long enough to allow a fire to 'climb' into the crown of a tree) into the crown of a tree, igniting the crown ('torching' it), but does not spread very far into adjacent crowns (NWCG 2008).

Surface Fire: These are fires that burn in surface fuels only. Such fires consume surface fuels such as litter, duff, dead/down woody fuels, and herbaceous or shrubby fuels that are cured enough to be available fuel. Surface fire can be beneficial or detrimental in ponderosa pine, depending on the fuel loading, and the conditions under which the fire burns.

Fire type was evaluated at the Rim Country project area level and at the 6th level hydrologic unit code (HUC) and in order to facilitate an analysis of specific fire effects in different areas. Watershed impacts from fire increase with the proportion of the watershed burned at high severity (Cannon 2010; Neary 2011). Therefore, fire type is considered at all scales in those areas proposed for thinning and/or prescribed fire.

Fire Hazard Index (FHI)

Five datasets were used to identify areas of high probability for severe fire effects, extreme behavior and a complex fire management environment. These datasets are crown fire potential, fireline intensity, heat per unit area, slope, and soils with high erosion potential.

The FHI classified the landscape as shown in Table 32 below. The FHI was evaluated at the Rim Country project area level and at the 6th level hydrologic unit code (HUC) and in order to facilitate an analysis of specific fire effects in different areas. Resource impacts and fire management responses will change with the proportion of the watershed in high hazard classes. Therefore, FHI is considered at all scales in those areas proposed for thinning and/or prescribed fire.

Table 32. Fire Hazard Index scores used to identify the need for treatment for resources, values and assets

Rating	Comments
1 – very low	Conditions are such that expected fire behavior will have minimal negative impacts to resources and suppression efforts, where needed, are expected to be very effective
2 – low	From a fire perspective, areas where crown fire is expected will not pose a threat to soil stability. Areas of high erosion potential are not expected to burn with active crown fires or high intensity conditions. Use of ground resources for suppression efforts becomes increasingly difficult.
3 – Moderate	Either extreme fire behavior resulting in difficult to control fires, or moderate soil severity. Presence of steep highly erodible soils may coincide with crown fire and higher intensity fires. Control of wildfire by suppression efforts will be difficult.
4 – High	These areas have the highest expected levels of all the fire behavior metrics. Control of wildfire by suppression efforts will be difficult and complex.
5 – Very High	These areas have the highest expected levels of all the fire behavior metrics, as well as steep slopes and highly erodible soils, making them prone to adverse second order effects such as debris flows. Control of wildfire by suppression efforts will be difficult and complex.

Surface Fuel loadings

In this analysis, total surface fuel loading includes fine dead woody debris (FWD) $\leq$ 3 inches in diameter (FWD), dead coarse woody debris (CWD) > 3 inches in diameter, litter, and duff. FWD and litter contribute significantly to fire behavior as well as fire effects, while and CWD and duff are mostly of interest in regards to fire effects (both direct and indirect). All three forest plans provide specific direction on desired conditions for CWD, but are silent or do not quantify any other components of surface fuel loading. As such, in this analysis, CWD, FWD, litter, and duff were combined as "total surface fuel loading" in tons/acre, which is evaluated both qualitatively and quantitatively regarding potential fire effects. Recommended surface fuel loadings are estimates, based on the best available science and expert opinion (Ottmar 2015) on the interaction of surface fuel loading with fire behavior and fire effects

Fuel loadings were evaluated at the Rim Country project area level and the 6th level hydrologic unit code (HUC) and in order to facilitate an analysis of specific fire effects in different areas. Water, soil and wildlife impacts from wildfire are also related to surface fuel loadings. Additionally, fuel loadings have direct influence on wildfire emissions, and therefore will be discussed in those sections as well.

There are no desired conditions for total surface fuel loading, but 20 tons/acres is a reasonable recommendation for average maximum surface fuel loading for the area of this analysis (see related discussion in the Fire Ecologist Specialist Report 2019). Historic levels were estimated to be 5 - 20 tons/acre for CWD alone.

Emissions Modeling

Smoke/emissions were evaluated both qualitatively and quantitatively by modeled emission quantities in pounds/acre for the most common stand condition under different treatment and non-treatment scenarios using the First Order Fire Effects Model (FOFEM CITATION). Fuel loadings were calculated for a representative Ponderosa Pine stand using FVS. The resulting modeled emissions shows the relative differences that the same piece of ground would be expected to produce before, during and after treatments.

For a landscape analysis, changes in those fuel components which produce the greatest percentages of emissions when they burn were modeled, and mapped using Forest Vegetation Simulator (Moore, this report). The components include litter, duff, FWD and CWD>3 inches (Lutes et al. 2009), which were combined into a single total surface fuel loadings metric in tons per acre.

Environmental Consequences

Throughout this section, changes directly attributable to proposed actions, such as thinning or prescribed fire, are direct effects. These include changes to shading, canopy continuity, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of future wildfires that result from the direct effects are considered indirect effects. Effects of proposed actions for stream restoration and roads are discussed separately from those of thinning and prescribed fire.

Alternative 1 – No Action

Direct and Indirect Effects

Under Alternative 1, there would be no changes to current management. Alternative 1 would not meet the purpose and need of this project because most of the ecosystems and natural resources within the treatment area would continue to degrade. The treatment area would not move towards desired conditions. This alternative would not reduce the risk to human lives nor would it result in safe, cost-effective fire management that would protect, maintain, and enhance National Forest System lands, adjacent lands, and lands protected by the Forest Service under cooperative agreements. As required by FSM 5100 (page 9).

The direct and indirect effects of Alternative 1 relate to the effects of the continued degradation of surface and canopy fuel conditions, and the effects of the continued interruption of the natural fire regimes. These include the potential for the direct effects of large, high-severity wildfires occurring within the project area. The indirect effects of such burns could also compromise water resources due to post-fire flooding and debris flows. Indirect effects could also include impacts to air quality downwind and downslope of fires. The most likely impacts to air quality being locations northeast of the project area, and in low areas, such as the Verde Valley, Snowflake, and Showlow.

Fire Type

Fires that did occur in the project area would be wildfires; some of which could be beneficial, and some could be catastrophic or detrimental, depending on environmental conditions at the time of the fire, and the condition of the forests at the time they burn. If historic patterns of burn severity were to continue, approximately 73 percent of the area burned in wildfires larger than 1,000 acres would burn with low severity effects that could be beneficial. However, given extreme weather conditions, there would be an increased potential for crown fire compared to the existing conditions. All crown fire types (both active and passive) can be expected across approximately 80 percent of the project area under extreme weather conditions (Figure 55), up from 73 percent in the existing conditions. Approximately 33 percent of the projected area has the potential to burn with active crown fire, up from 31 percent in the existing conditions.

Post wildfire watershed effects increase with the percentage of the watershed that burns at moderate to high severity (Cannon, 201; Neary 2011). Under Alternative 1, 47 watersheds are expected to burn with active crown fire under extreme weather conditions for over 30 percent of the watershed, resulting in high severity effects Figure 56). Thirteen watersheds are have over 50 percent of the watershed expected to burn with active crown fire. Watersheds 56 (Durfee Draw-Chevelon Canyon) and 7 (Reynolds Creek) have the highest proportion of potential for active crown fire (68 percent for both). If a wildfire were to burn within these watersheds, detrimental post wildfire effects would be expected.

Fire Hazard Index

The short term (< 20 years) effects of Alternative 1 would include an increased risk of undesirable wildfire behavior and effects. Wildfire behavior and effects could threaten lives, resources, and infrastructure. Forty percent of the project area is within the moderate to extreme FHI, which presents difficult and dangerous suppression conditions during a wildfire and potential for adverse post fire effects on soils and surface water quality, up from 37 percent in the existing conditions (Figure 58).

There are 25 watersheds with over 50 percent of the watershed in the moderate to very high FHI categories (need reference). Watershed 7 (Reynolds Creek, 80 percent) and 107 (Upper Spring Creek, 77 percent) have the highest proportion of FHI in the moderate to very high class. Large wildfires in these watersheds have a high potential to be difficult and dangerous to suppress, and have a high potential for adverse post fire effects.

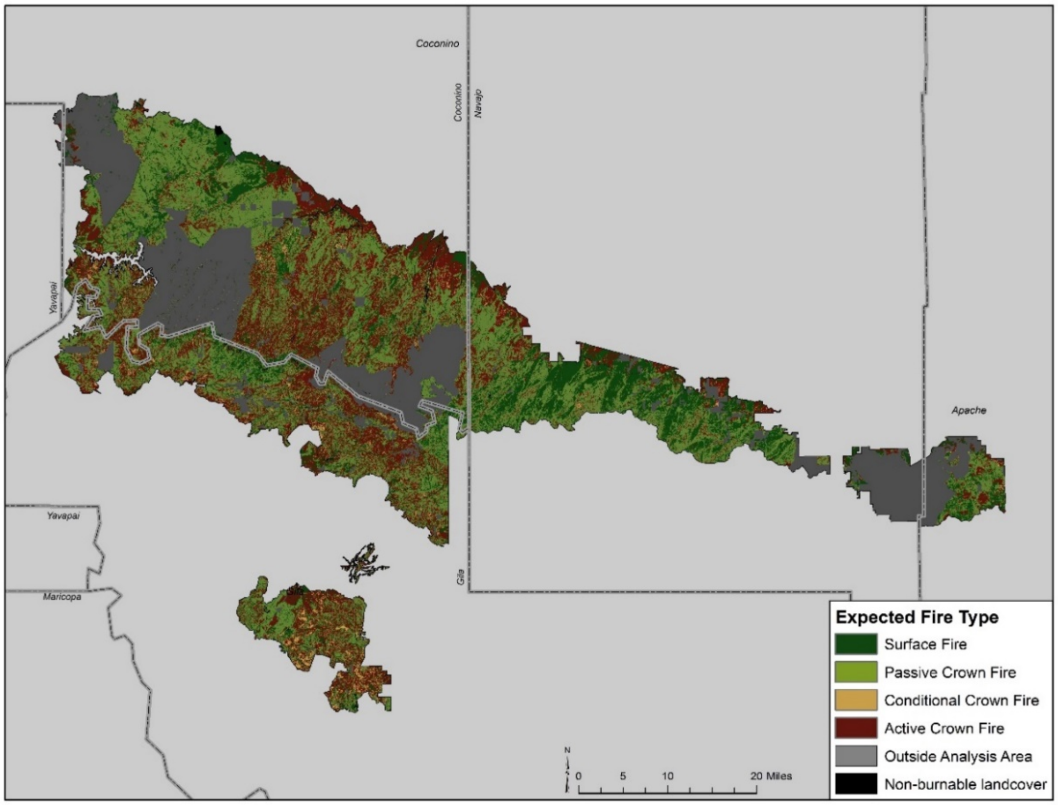


Figure 55. Expected Fire Type for Alternative 1, under modeled weather conditions

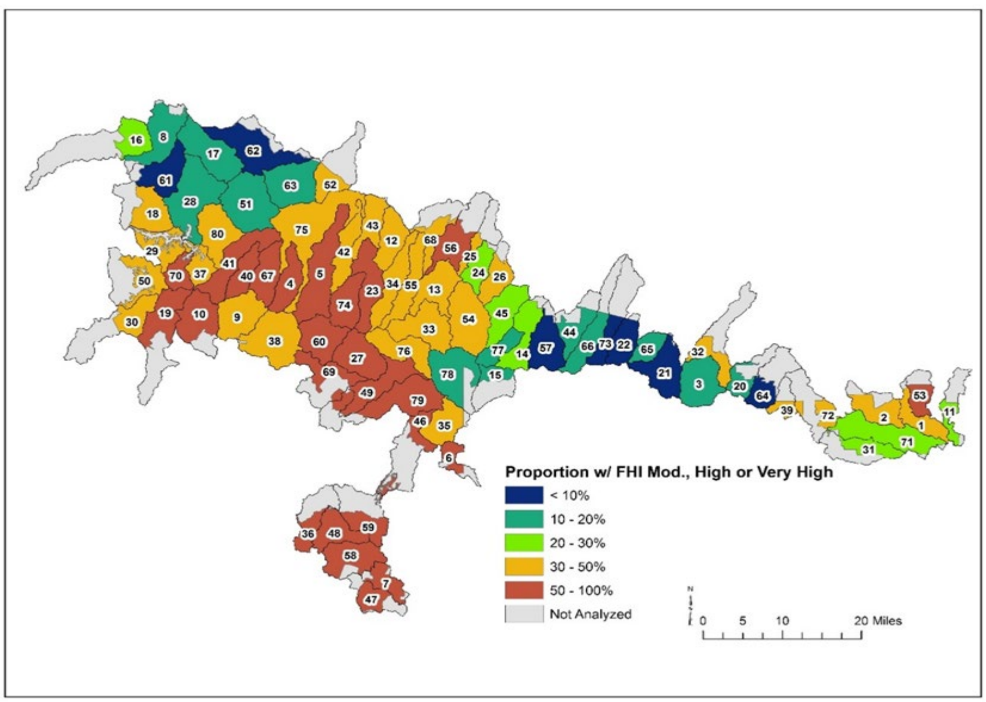


Figure 56. Proportion of each HUC6watershed with FHI in the moderate, high, or very high category for Alternative 1 under modeled fire weather

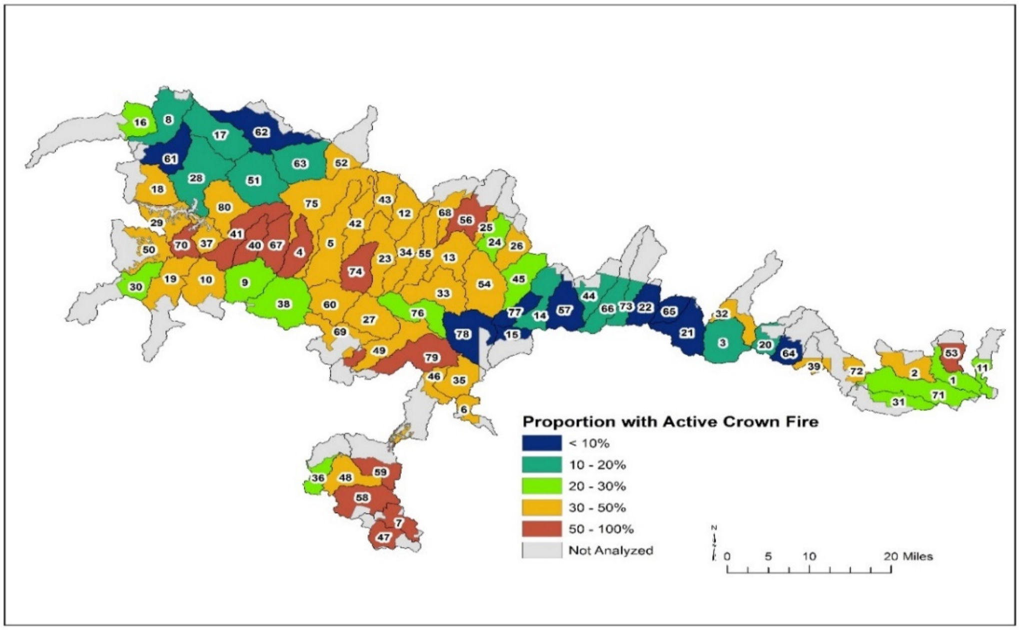


Figure 57. Alternative 1 proportion of HUC6 watersheds with expected Active Crown Fire, under modeled weather conditions

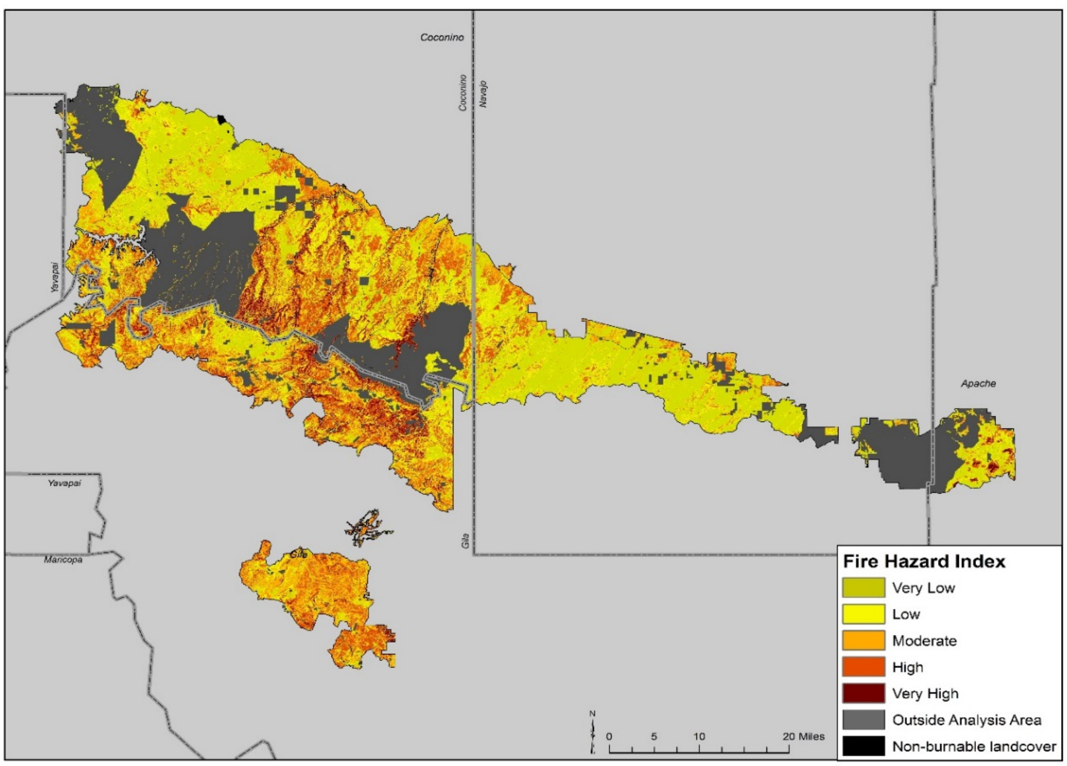


Figure 58. Fire hazard index for alternative 1, under modeled fire weather

WUI

Under the No Action Alternative, WUI areas across the treatment area would be threatened by the increasing extent of high severity of wildfires (Table 33). Active crown fire (CFA) and fire hazard index

(FHI) both increase. The potential for home and asset loss from crown fires, high intensity surface fires and ember lofting would continue to increase.

Table 33: WUI Measures and Metrics for Alternative 1

WUI CLASS	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
High Value Rec Sites	375	45%	19%	18%	19%	83%	40%
Communication Sites	2074	63%	16%	18%	3%	79%	28%
Non FS Lands w/ structures	22638	63%	17%	18%	3%	73%	29%
Transmission Lines	4083	61%	17%	18%	4%	74%	33%
FS Buildings	1683	49%	14%	29%	9%	85%	43%

FS – Forest Service, WUI – Wildlife Urban-Interface

Vegetation Cover Types

In the long term (>20 years), tens of thousands of acres (the actual amount would be a subset of the 334,800 acres in the treatment area that would likely burn with high severity effects) would potentially be converted to non-forested systems as a result of high severity fire, while other acres of non-ponderosa pine would be increasingly encroached upon by pine, including aspen, grasslands, and oak. Aspen stands would continue to decline, and some stands would be likely to disappear. Woody species continue to encroach into grasslands and shrublands, and sprouting shrubby species would increasingly occupy understories in Ponderosa Pine Evergreen Oak. Table 34 shows the metrics for each vegetation cover type.

Table 34: Vegetation Cover Type Measures and Metrics for Alternative 1

Vegetation Cover type	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
Ponderosa Pine	556284	75%	7%	16%	3%	81%	22%
PIPO Evergreen Oak	147989	36%	33%	26%	5%	85%	30%
Dry Mixed Conifer	49281	26%	17%	28%	29%	77%	54%
Wet Mixed Conifer	3130	29%	4%	26%	41%	74%	70%
Aspen	1438	95%	1%	3%	2%	6%	5%
Pinyon Juniper	135085	36%	33%	28%	3%	71%	67%
Madrean Pinyon Oak	23318	19%	33%	41%	7%	86%	80%

Vegetation Cover type	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
Grasslands	18851	98%	2%	0%	0%	16%	3%
Riparian Areas	14567	70%	11%	13%	6%	48%	19%

Large and old trees

Under the No Action Alternative, large and old trees across the treatment area would be threatened by the increasing extent of high severity of wildfires (Swetnam 1990a; Covington and Moore 1994; Swetnam and Betancourt 1998; Westerling *et al.* 2016). In areas where a wildfire would be a first entry burn and there had been no prescribed fire or thinning, there would be a much greater potential for mortality than in treated areas. In this alternative, many old trees would be killed or damaged by wildfire, as well as those trees that die or decline slowly from the cumulative effects of fire and other stressors (Minard 2002).

Surface Fuel Loadings

Under the No Action Alternative, surface fuel loading would continue to accumulate. This would lead to high burn severity (fire effects to soil) as residence time increases with increasing surface fuel loading. Coarse Woody Debris (dead/down woody fuels greater than 3” in diameter) could be expected to switch from predominantly sound to predominantly rotten debris after about 15 years with no fire, with the highest CWD loading expected from 6 – 12 years after the last fire (Roccaforte *et al.* 2012). Desired conditions for total surface fuel loadings are less than 27 tons/ac in Ponderosa Pine vegetation types and less than 30 tons/ac in Dry Mixed Conifer. Under Alternative 1, 171,440 acres exceed 27 tons per acre, up from 105,528 acres in existing conditions. 123,077 acres of Ponderosa Pine and 25,967 acres of Dry Mixed Conifer vegetation types exceed recommended fuel loadings (Figure 59).

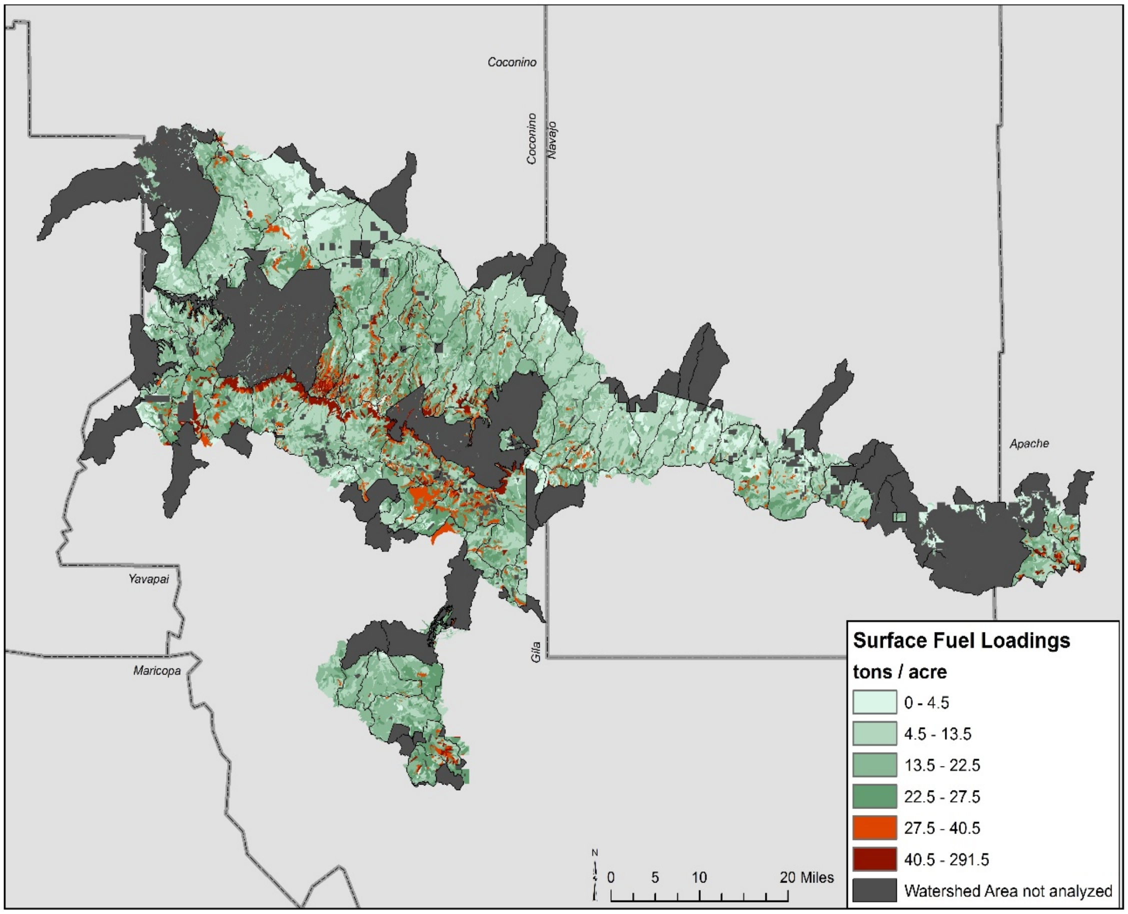


Figure 59. Surface fuel loads for alternative 1, under modeled fire weather

Emissions and Air Quality

In this alternative, smoke impacts generated from the proposed treatment area would only come from wildfires. The impacts would be infrequent (a few times a year); more severe when they occur; and the duration, location, and extent of area/s affected would be largely unpredictable. In the absence of wildfire, air quality would remain at current levels. In the short term, there would be no additional impacts on air quality from prescribed fires. Smoke impacts would be from wildfires. Wildfire smoke is less predictable, less frequent, and more concentrated than emissions from prescribed fires.

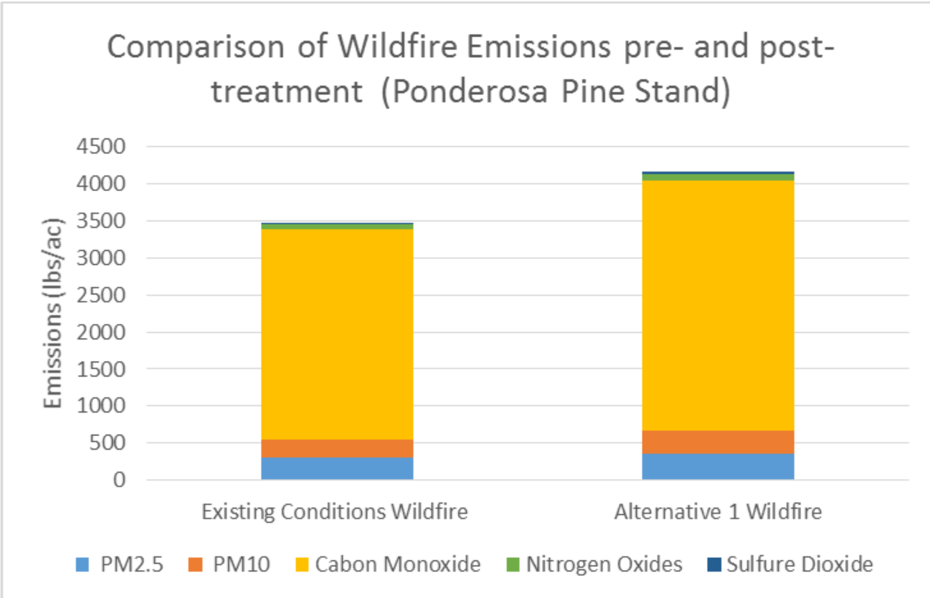


Figure 60. Emissions for alternative 1

If the current average annual acres burned by wildfire remained the same (27,426 acres), it is possible that much of the treatment area could burn with wildfire by 2065, and these fires would produce associated air quality impacts. Due to increased potential for crown fire and increased total surface fuel loadings, a wildfire burning under Alternative 1 conditions in 2029 would produce more emissions than one burning under current existing conditions (Figure 60). Wildfire would be the only source of emissions from the treatment area under this alternative. On a per acre basis, emissions increase approximately 17 percent, due to the increase in surface fuel loadings. This in combination with the expected increase in annual acres burned will lead to an increase in overall emissions from wildfires.

This alternative would not increase potential smoke impacts during the times of the year when smoke impacts are largely from prescribed fire (pile burning, broadcast burns, and jackpot burning), generally, mid/late fall, winter, and early spring.

The timing and type of smoke effects would change little initially, but as the likelihood of large fires increase so does the potential for air quality levels that exceed National Ambient Air Quality Standards (NAAQS), and nuisance smoke. The likelihood and degree of potential impacts from wildfire smoke would continue to increase as fuel loading increased, since much of the lingering smoke comes from duff, CWD, litter, stumps, and other fuels that can smolder. Watersheds 75 (East Clear Creek-Clear Creek) and 79 (Haigler Creek) have the greatest potential to produce emissions because of surface fuel loading. Under Alternative 1 all watershed increased in total surface fuel loadings, with watershed 58 (Upper Salome Creek) and 37 (Clover Creek) increasing the most (33 percent increase from existing conditions. Watershed 75 (East Clear Creek / Clear Creek) has the highest total surface fuel loadings and therefore has the potential to produce the most emissions should it burn (Figure 61). Watersheds 4 (Barbershop Creek) and 27 (Christopher Creek) have the most dense total surface fuel loading, both with an average of 24 tons/acre.

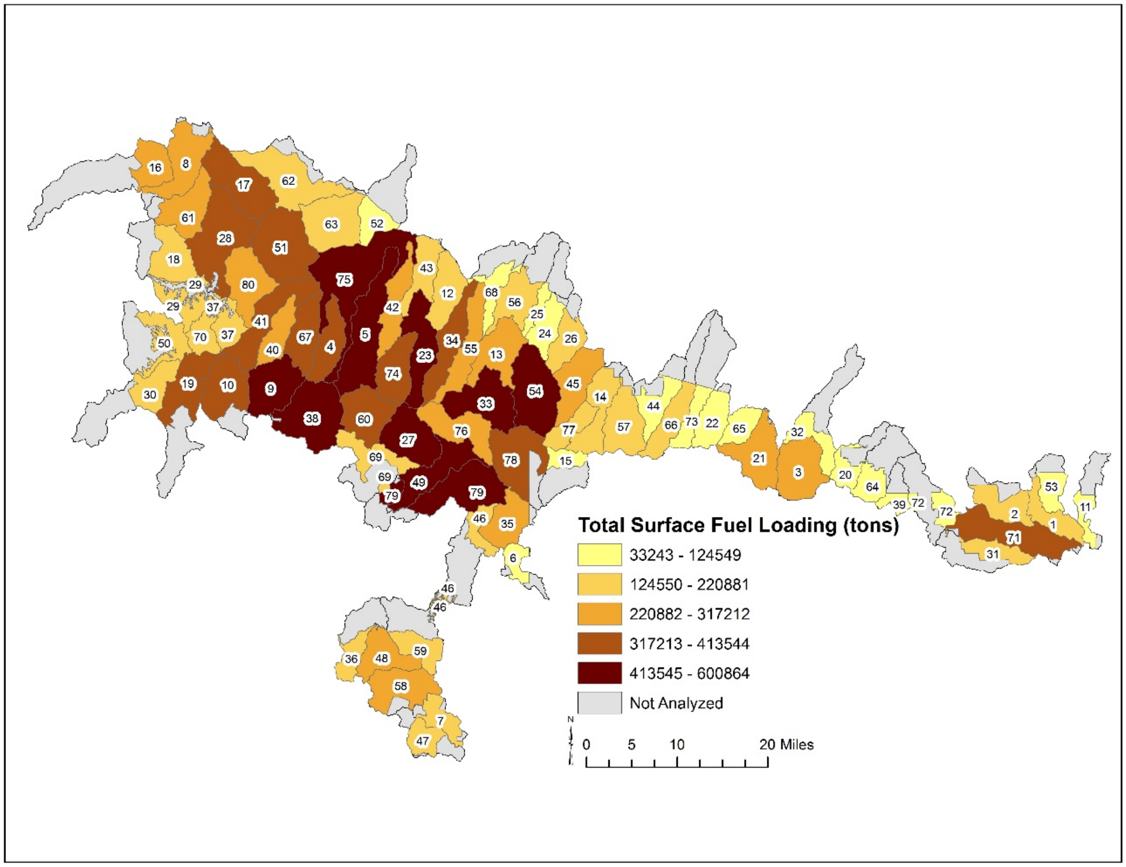


Figure 61. Total surface fuel loads in each HUC6 watershed alternative 1, as modeled using FVS

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources

As described above, with no treatment, high severity fire effects would become more widespread, and extreme fire behavior would become more common. In recent years, fires in the area have taken human lives, destroyed homes/property/infrastructure, and produced high severity effects across large areas not adapted to high severity fire including Rodeo/Chediski 2002 (469,000 acres), Wallow 2011 (538,000 acres), and Whitewater 2012 (~297,000 acres). There is broad consensus that such fires will continue to burn in this area if no action taken, though the specific extent and location of the negative effects could not be known until an incident occurs. First order effects would include (but are not limited to): chemical and physical changes to soil, high levels of mortality across ~27 percent or more of the burned area (assuming ~27 percent high severity), consumption and/or killing of the seed bank, consumption of organic material in soil, including flora and fauna, conversion of forested habitat to non-forested habitat. Second order fire effects would include (but are not limited to) erosion, flooding, debris flows, destroyed infrastructure, changes in visitation to the forest and the economies of local businesses that depend on visitors and natural resources, and degradation of water resources for wildlife, livestock, and humans. Some of these effects would last just a few days or weeks, some would take much longer. For example, topsoil is critical to healthy surface vegetation and would take centuries to recover though, with climate change, it is unknown exactly what the ecological trajectory would be. The loss of old growth and old trees would require decades to centuries to recover.

Effects Common to Both Action Alternatives

Activities that will effect fire and fuels include mechanical treatments and/or prescribed fire. While the number of acres of prescribed fire and mechanical treatments varies by Alternative, their effects, where implemented, will be the same.

Mechanical treatment alone has the potential to alter fire behavior primarily through a reduction of CBD, but it can also increase surface fuel loadings through the placement of slash on the ground (Carey and Schuman, 2003). Carey and Schumann (2003) further note that the use of mechanical thinning alone has a varied effect on modifying fire behavior, primarily because of the created slash. All of the thinning treatments proposed within this analysis are paired with prescribed burning, therefore, the effects will be a combination of thinning and burning. Various researchers have concluded that the combination of thinning and burning as the most effective way to alter fire behavior (Strom 2005; Graham et al. 2004; Peterson et al. 2005; Cram et al. 2006).

The effectiveness of using prescribed fire as a tool, alone or combined with mechanical treatment, to restore ponderosa pine to a healthier, more sustainable and resilient condition is well documented (Fulé et al. 2001b, Roccaforte et al. 2008, Strom and Fulé 2007, Fulé et al. 2012). Prescribed fire is used as a proxy for wildfires which allows for more control over where and when fire burns and often leads to lower overall severity and emissions.

Most of the effects of the natural role of fire could not be effectively replicated by means other than fire. These effects include nutrient recycling; seed scarification (by both heat and smoke); promotion of a mosaic of seedlings, shrubs, forbs, and grasses; regulating surface fuel loads, changes in soil moisture, changes to albedo, etc.. (Laughlin *et al.* 2008; Pyke *et al.* 2010; Laughlin *et al.* 2011). Over time, prudent use of prescribed burning, particularly when combined with mechanical thinning, would reduce the potential for damage from wildfires, as well as the costs associated with fire suppression (Jaworski 2014). Fire increases structural heterogeneity and diversity and promotes natural regeneration of ponderosa pine, providing favorable seedbeds and enhancing the growing environment for survival (Harrington and Sackett 1992).

The proposed treatments would create a mosaic of interspaces and groups (of ponderosa pine) of various sizes that would be maintained with fire. This mosaic is also a mosaic of crown fire potential, with some groups having potential for crown fire under some circumstances, with the surrounding interspaces causing crown fire to transition back to surface fire.

Post-treatment conditions for the action alternatives would include openings that would be managed to promote regeneration. Prescribed fire would be an important tool for creating receptive seedbeds for successful regeneration by consuming surface fuels, creating bare, mineral soil, allowing seeds better contact with soil. As seedlings and small saplings mature, fire and competition would thin trees, maintaining the desired trajectory for a fire-adapted landscape, so that an appropriate number of seedlings survive to maintain healthy forest conditions.

The longevity of the effects of a prescribed fire depends on the specific effect being evaluated; the condition of the burned area before a burn; the conditions under which it burned, and post-treatment conditions (such as precipitation). For example, a denser forest will accumulate litter faster than a more open forest; soil conditions and moisture affect the rate of decay; the germination and survival of seedlings depends on cone production and environmental conditions for the first 2-3 years.

In the long term, fire would help maintain a shifting, sustainable, resilient mosaic of groups, interspaces, and openings. Without regeneration openings, even with fire, the space occupied by incoming regeneration would begin to fill in the interspaces and, in the long run, as the seedlings mature, it would increase horizontal and vertical canopy continuity so that, if crown fire did initiate, there would be potential for larger areas of high severity effects.

Up to two prescribed fires would be implemented, on all acres proposed for burning year which may include pile burning months in advance of broadcast burns. Ideally, prescribed fires would occur on an average of every 10 years, depending on yearly fluctuations in climate/weather at different locations within the treatment area. Some areas will have had prescribed fire or wildfire within the last 10 – 15 years, so prescribed fires that are implemented would be maintenance burns (see below). Limitations (wildlife concerns, smoke, funding, resource availability, etc.) may make it difficult to attain an average of a 10 year fire return interval across the proposed treatment area. Burning some areas on a slightly longer return interval may be warranted to reduce smoke in sensitive receptors as mitigation for prescribed fires.

Direct and Indirect Effects

In the short term (<20 years), where treatments are implemented, the potential for undesirable fire behavior and effects would be reduced by breaking up the vertical and horizontal continuity of canopy fuels, decreasing excessive surface fuel loads of litter and duff (direct effects). It would be expected that the growth of light, flashy fuels would be stimulated by post-treatment conditions (second order effects). Wildfire behavior would benefit the ecosystems in which it burned, and would not threaten lives, resources, or infrastructure, except where they are adjacent to, or near areas (such as MSO habitat or Wet Mixed Conifer) that were not treated as intensively as the rest of the treatment area at this time. Air quality impacts (indirect effects) could increase some as prescribed fires are implemented.

In the long term (>20 years), potential for undesirable fire behavior, as assessed by changes to surface and canopy fuels, would remain lower than existing condition for about 37 percent of the Rim Country area proposed for treatment. Potential for undesirable fire effects, as assessed by changes to canopy and surface fuels, would remain lower than existing condition for about 31 percent of the ponderosa pine in the treatment area. Impacts to air quality as a result of fire related pollutants emitted as a result of prescribed fire could decrease some as the majority of the treatment area would be in maintenance burn mode, producing fewer emissions per acre. However, since there would be more acres burned, the number of days of air quality impacts could increase.

Thinning, whether or not slash was removed from the site, would give managers more control of the amount and timing of emissions. As thinning and first-entry burns are completed, burn windows would expand for larger areas so more burning could occur when ventilation was good. Fewer and healthier trees, as a result of thinning and would be more fire resistant, and understory and surface vegetation would become established. With lower surface fuel loading, and canopy fuels adapted to fire, burn windows would be broader than for initial entry burns. Decision space for managing unplanned ignitions would expand as Rim Country (and other projects) are implemented.

Fire Type

Decreasing the horizontal and vertical continuity of canopy fuels is a direct effect of the proposed treatments that would allow sunlight to reach the surface, increasing surface temperatures, and decreasing dead fuel moisture content at the surface. This, combined with increased surface winds with fewer trees blocking the wind, could increase surface fire intensity, flame length, and rate of spread even if surface fuels were the same before and after thinning (Omi and Martinson 2004, Scott 2003). Therefore, canopy fuel treatments reduce the potential for crown fire (indirect effect) at the expense of slightly increased surface fire behavior (fireline intensity, flame length, and rate of spread). However, critical levels of fire behavior (limits of manual or mechanical control) are less likely to be reached in stands treated to withstand crown fires, as all crown fires are uncontrollable. Although surface intensity may be increased after treatment, a fire that remains on the surface beneath a timber stand is generally more controllable (Scott 2003). After the first prescribed fire, surface fuels would be lower so, even with the changes described above, the potential fire behavior and effects would be improved following the treatments under Alternatives 2 & 3.

Fire Hazard Index

Some components of the fire hazard index are fixed and not susceptible to changes due to proposed treatments. These components include slope and soil erodibility. While these components are necessary for determining potential fire behavior and/or post fire effects, treatments will not result in changes to these parts. The rest of the components, which relate more directly to fire behavior, will be influenced by proposed treatments in manors consistent with those discussed above in the Fire Type section and below in the Surface Fuels section.

Surface fuels

Mechanical thinning alone can contribute significantly to decreasing the potential for crown fire by breaking up vertical and horizontal canopy fuel continuity, but does little, in the long run, to decrease surface fuel loading. Initial thinning impacts may include temporary fire 'breaks' where there are skid trails, or other surface disturbances, but surface fuels that are not removed from the treatment area remain a potential source of heat and emissions. Effects may be spottier but, where fuels have been pushed into piles or furrows (intentionally or otherwise), they may smolder for days or weeks.

Litter, Duff, and CWD greater than 3" diameter contribute more than other fuels to emissions. Mechanical thinning alone can contribute significantly to decreasing the potential for crown fire by breaking up vertical and horizontal canopy fuel continuity, but does not decrease surface fuel loading (Fulé et al. 2012). Initial thinning impacts may include temporary fire 'breaks' where there are skid trails, or other surface disturbance, but surface fuels are generally not removed from the treatment area, and remain a potential source of heat and emissions. Surface effects may be spottier following thinning because residual fuels often include jackpots or small piles. Where fuels have been pushed into piles or furrows, by design or happenstance, they may smolder for a long time.

A direct effect of prescribed fires would be the consumption of some CWD and, although more is often produced as an indirect effect of the burn it may be of a different stage of decay that does not fill the same ecological niche. Surface fuel loading can be managed with fire and felling techniques to increase or decrease woody debris in different size classes. A direct effect of Alternatives 2 and 3 could be that some areas would be deficit in CWD for a few years following treatment but, given the trend shown, it would only be a few years before it met desired conditions again and, with maintenance burning, it should be possible to maintain desired levels.

CWD could be expected to switch from predominantly sound to predominantly rotten debris after about 15 years with no fire, with the highest CWD loading expected from 6 – 12 years after the last fire (Roccaforte *et al.* 2012).

Large/old trees

Ponderosa pine (*Pinus ponderosa* Dougl. ex P. & C. Laws) stands with late-seral features are found infrequently, owing to past management activities throughout western North America. Thus, management objectives often focus on maintaining existing late-seral stands. Observations over a 65 year period of stands with no past history of harvest showed substantial ingrowth in the smaller diameter classes and elevated rates of mortality among the largest mature trees in the stand. Adjacent stands, with combinations of thinning and prescribed fire, had far fewer high-risk mature trees and generally lower rates of mortality after treatment. Forecasts using individual-tree diameter growth and mortality models suggest that observed declines in these stands with remaining old trees and a dense understory will continue in the absence of any treatment.

Where site specific mitigation is needed to limit damage or mortality to large or old trees, it is best accomplished by reducing accumulations of fuels within the dripline and in the immediate vicinity of the trees. These fuels may include litter, duff, accumulations of woody fuels, ladder fuels, or any fuel that could produce sufficient heat to lethally damage a tree, whether by high or low intensity fire. This can be accomplished manually, mechanically, or though fire treatments. Potential measures include implementing prescription parameters, ignition techniques, raking, wetting, leaf blowing, thinning, or otherwise mitigating fire impacts to the degree necessary to meet burn objectives.

Throughout the life of this project, it is likely that some large and/or old trees would be damaged or killed by prescribed fire. It would not be possible to mitigate every large and/or old tree over 40,000 to 60,000 acres of prescribed fire units each year. Data collected from restoration treatments in the White Mountains indicates that mortality of pre-settlement trees increased with thin/burn, or burn only treatments over controls, although those that survived grew significantly faster than those in untreated stands. Managers will have to consider tradeoffs between treatment options, and the increasing likelihood of the trees burning in wildfires under conditions that would be more extreme than conditions under which a prescribed fire would be conducted.

Mechanical treatments and prescribed fire would be implemented to help sustain large/old trees across the landscape, and make them more resistant and resilient to natural disturbances such as fire. Throughout the life of this project, it is likely that some large and/or old trees may be damaged or killed by prescribed fire, by direct and/or indirect effects, despite mitigation measures. However, under both alternatives thinning and prescribed fire would decrease potential fire effects in the vicinity of most old and/or large trees, decreasing the likelihood of lethal damage in the event of a wildfire.

Mitigation measures are unpredictable, and site specific (Kolb et al. 2007, Hood 2007), and some can have negative effects of their own. Raking, for example, can remove fine, live roots in the surface organic layers, which may compound the effects of additional shallow roots being damaged by fire, though it is unlikely to actually kill the tree (Progar *et al.* 2017). Low intensity fire that causes little crown scorch can stimulate resin production in old trees that may attract bark beetles, increasing tree mortality. Mitigation measures implemented a year or more before a burn, such as thinning or raking, may improve the health of the tree, improving its response to fire.

Air Quality and Smoke

All acres are not equal when it comes to emissions. Open stands support surface fire over crown fire under most conditions, and surface fire produces fewer particulates than crown fire. Stands that have burned more recently and more frequently also produce lower emissions. Figure 62 shows differences in emissions from wildfire or prescribed fires that burn at different stages in burn only and mechanical plus burn treatment cycles.

The management action that has the greatest potential effect on air quality is prescribed burning. All prescribed fires are expected to achieve the desired conditions for air quality under the action alternatives, and hence, Air Quality is not expected to be a primary driver in selecting one alternative over another.

Some comparison between alternatives can be made by looking at the indirect effects of management activities that reduce the likelihood of active crown fire and heavy surface fuel loading. Active crown fire and heavy surface fuel loading produce large quantities of emissions that may be heavily concentrated. The alternatives that best alter stand structure to promote surface fire over active crown fire and decrease surface fuel loading would have the least negative environmental consequences to Air Quality, and are the focus of comparison between alternatives regarding Air Quality in this report.

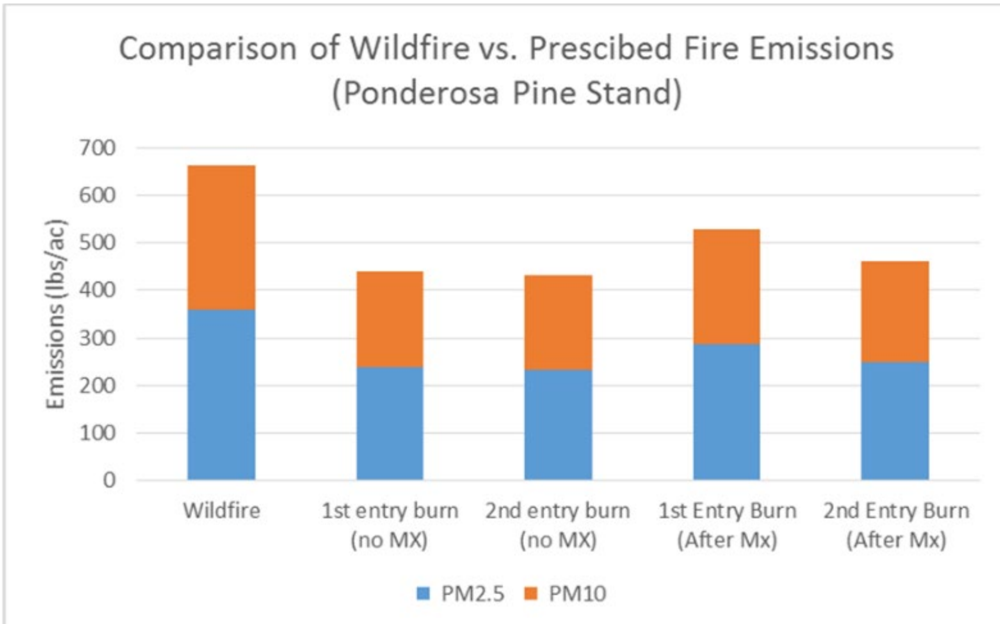


Figure 62. PM 2.5 and PM10 emissions from wildfires vs. prescribed fire at different stages of treatments

Up to two prescribed fires would be implemented, which may include pile burning months in advance of broadcast burns. Ideally, prescribed fires would occur on an average of every 10 years, depending on yearly fluctuations in climate/weather at different locations within the treatment area. Some areas will have had prescribed fire or wildfire within the last 10 – 15 years, so prescribed fires that are implemented would be maintenance burns. Limitations (wildlife concerns, smoke, funding, resource availability, etc.) may make it difficult to attain an average of a 10 year fire return interval across the proposed treatment area. Burning some areas on a slightly longer return interval may be acceptable and/or may specifically be target to reduce smoke in sensitive receptors as mitigation for prescribed fires.

The combination of prescribed fire and mechanical thinning is the most effective means of limiting emissions from wildland fires by reducing and breaking up fuel continuity. Mechanical treatments proposed by Rim Country would reduce fuels by combinations of cutting and burning. In some cases, thinning would be implemented prior to prescribed burning, allowing higher intensity fire to be used where appropriate, and effectively minimizing potential wildfire emissions by removing some canopy fuels. Disturbance of surface fuels may provide temporary fuel breaks by re-arranging surface fuels where there are skid trails, tire tracks, and other surface disturbances which break up surface fuel continuity while slightly increasing the amount.

In other areas, prescribed fire may precede thinning. This may be appropriate if an area would not be thinned for several years in order to reduce flammability in the interim by beginning the process of reducing surface fuel loads, increasing canopy base height, and decreasing canopy bulk density. It may also occur if there is an opportunity to expand an adjacent burn unit to include part of the treatment area to increase efficiency. It may also facilitate timelier implementation of prescribed fires if there is no need to wait a year or two for the mechanical treatments to be completed. In some cases, it may be preferable to use fire as a thinning agent when the site is too steep or remote to access with mechanical methods.

Air quality provides an example of short- and long-term trade-offs in implementing restoration across large areas. There is a risk of short-term human health impacts from prescribed fire. The emissions from prescribed fires, as opposed to wildfires, can be managed by carefully distributing (prescribed) fire over time and space, as well as under appropriated weather conditions (Cohesive Strategy 2002, page 39). In the long term, once an area has been burned once, there is less fuel and, thus, lower emission potential. The combination of lower fuel loads and larger burn units would allow more acres to be burned without exceeding NAAQS.

In the short term, as '1st entry' burns are implemented, impacts would increase noticeably. Acres with high fuel loading would be burned, in a first step toward restoring the natural fire regime. In the long term, the same acres would produce less smoke, along with maintaining an ecosystem that is resilient to fire, and benefits from it.

Air quality impacts can be predicted from prescribed fire, and the public notified of when and where to expect impacts in advance of a burn. Wildfires are less predictable and, though general patterns of smoke movement on the landscape are known, there is much less surety of where and when there would be impacts.

During the day, when units are ignited, smoke would be expected to travel on prevailing winds, away from sensitive receptors, and dissipate. Most smoke would dissipate, but some may surface. Short-term nighttime nuisance smoke could settle down the drainages into the towns below, particularly during early morning hours. Nighttime smoke would be expected to reside in low areas down slope from the burn units, because night time winds are generally calm. Daytime smoke would be expected to dissipate mostly downwind from the burn unit. Burn plans written for implementation of the proposed prescribed fires would include modeling to determine the most appropriate conditions under which to burn in order to minimize smoke impacts.

Under Alternative 2, air quality impacts would be most likely to those portions of the Little Colorado River Airshed east and northeast of Flagstaff; the Colorado River Airshed north of Williams and including all of the treatment area in RU6; and the Verde River Airshed. There is a small chance that there could be some impact to the northern portions of the Lower Salt River Airshed.

The difference in emissions between the treatments stays roughly the same, with no statistical difference and can generally be attributed the initial difference in fuel loading. The first prescribed fire following a mechanical treatment produced a little over 500 pounds/acre of emissions. The first prescribed fire without thinning produced a little over 400 pounds/acre of emissions. Since stands receiving mechanical treatment prior to prescribed fire start out with more surface fuel than those that are not mechanically treated prior to burning, additional emissions are produced.

Effects Unique to Each Alternatives

Alternative 2 – Modified Proposed Action

Alternative 2 proposes to conduct about 889,344 acres of mechanical and prescribed fire treatments and an additional 63,788 acres of prescribed fire only treatments over about 10 years or until objectives are met. On average, 88,934 acres of vegetation would be mechanically treated annually. On average, 95,313 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Up to two prescribed fires would be conducted on all acres proposed for burning over the 10-year period.

When analyzed at the scale of the treatment area, Alternative 2 would meet the purpose and need by moving the project area towards the desired condition of having potential for less than 10 percent active crown fire under extreme weather conditions, lessening post fire detrimental effects and creating a safer and more effective firefighting environment.

This alternative would meet direction in the Forest Service Manual 5100 (page 9) which includes direction on USFS use of prescribed fire to meet land and resource management goals and objectives. Objectives of fire management on lands managed by the USFS include:

> Forest Service fire management activities shall always put human life as the single, overriding priority. The proposed actions of the Rim Country fully support incorporation of the highest standards for firefighter and public safety and are expected to improve and enhance the safety of the public as it relates to wildland fire.
>
> Forest Service fire management activities should result in safe, cost-effective fire management programs that protect, maintain, and enhance National Forest System lands, adjacent lands, and lands protected by the Forest Service under cooperative agreement. Rim Country proposes to achieve restoration by restoring ecosystems within the treated area to a condition so that fire, when it occurs, would be beneficial to the ecosystems in which it burns without threatening lives, property, or resources. This would be achieved by fully integrating local industry, mechanical and fire prescriptive treatments, and providing for sustainable supplies of goods, services, and social values though implementation of appropriate fire management activities.

Direct and Indirect Effects

From a fire ecology perspective, direct and indirect effects of Alternative 2 relate primarily to treatments that include mechanical thinning, prescribed fire, or both to meet the purpose and need of the project.

Changes to potential fire behavior are the indirect effects of changes to fuel loading and structure. A direct effect of implementing Alternative 2, would be changes to the horizontal and vertical continuity of canopy fuels. As that continuity is broken up, an indirect effect would be decreased potential for crown fire.

Thinning, whether or not slash was removed from the site, would give managers more control of the amount and timing of emissions. As thinning and first-entry burns were completed, burn windows would expand for larger areas so more burning could occur when ventilation was good. Trees would be more fire resistant, and understory and surface vegetation would become established. With lower surface fuel loading and canopy fuels adapted to fire, burn windows would be broader than for initial entry burns. Decision space for managing unplanned ignitions would expand as Rim Country is implemented.

Fire Type

Once fully implemented, Alternative 2 is expected to reduce the potential for active and conditional crown fire to within desired conditions for all vegetation cover types (see Table 36 below). Over the rim country project area, 12 percent of the area burned under extreme weather conditions would be expected to be active or conditional crown fire, down from 31 percent given existing conditions (Figure 63). Passive crown fire increases slightly (57 percent up from 47 percent EC) under extreme conditions, due to the desired clumpy canopy characteristics of the mechanical treatments. Under less extreme wind conditions (5 MPH instead of 20 MPH), the majority of the landscape (95 percent) is expected to burn as a surface fire, and only 43,396 acres are expected to burn with passive crown fire, and 270 acres with active or conditional crown fire.

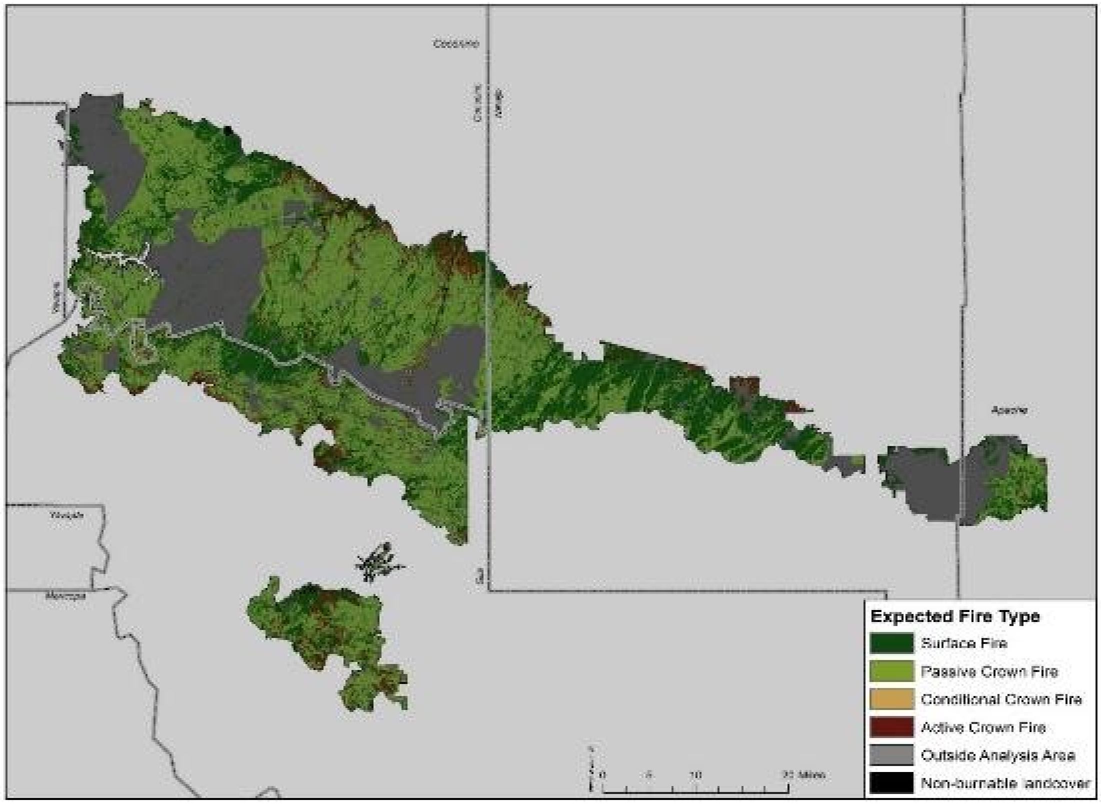


Figure 63. Expected Fire Type for Alternative 2, under modeled weather conditions

Post wildfire watershed effects increase with the percent of the watershed burns with moderate to high severity fire (Cannon 2010; Neary 2011). Under Alternative 2, 9 watersheds are expected to burn with active crown fire under extreme weather conditions for over 30 percent of the watershed, which would result in moderate to high severity effects (Figure 64). Three watersheds are have over 50 percent of the watershed expected to burn with active crown fire. Watersheds 67 (Bear Canyon) and 40 (Miller Canyon) have the highest proportion of potential for active crown fire (55 percent for both). If a wildfire were to burn within these watersheds, detrimental post wildfire effects, such as debris flows, would be expected.

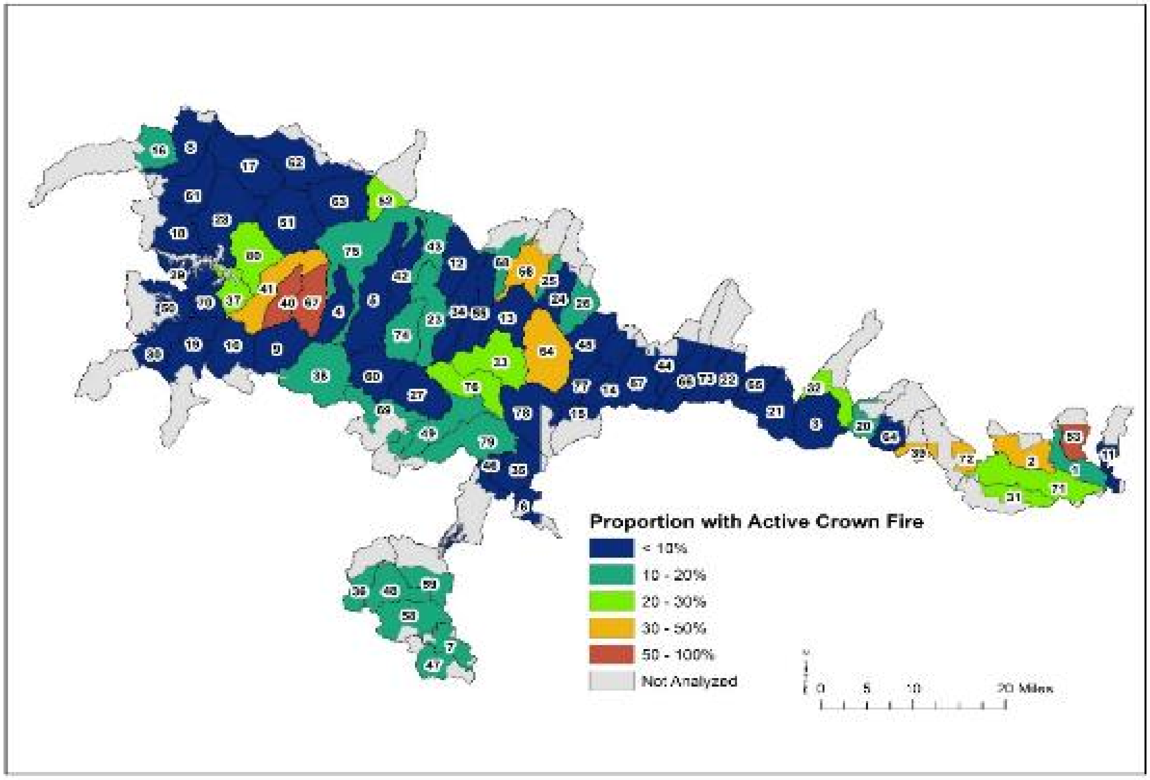


Figure 64: Proportion of each HUC6 watershed with Active Crown Fire for Alternative 2, under modeled weather conditions

Fire Hazard Index

Alternative 2 would decrease the risk of undesirable wildfire behavior and effects that could threaten lives, resources, and infrastructure. After implementation, the fire hazard index decreases resulting in 15 percent of the project area is within the moderate to extreme FHI, down from 37 percent in the existing conditions (Figure 65). The areas of moderate to extreme FHI presents difficult and dangerous suppression conditions during a wildfire and potential for adverse post fire effects on soils and surface water quality.

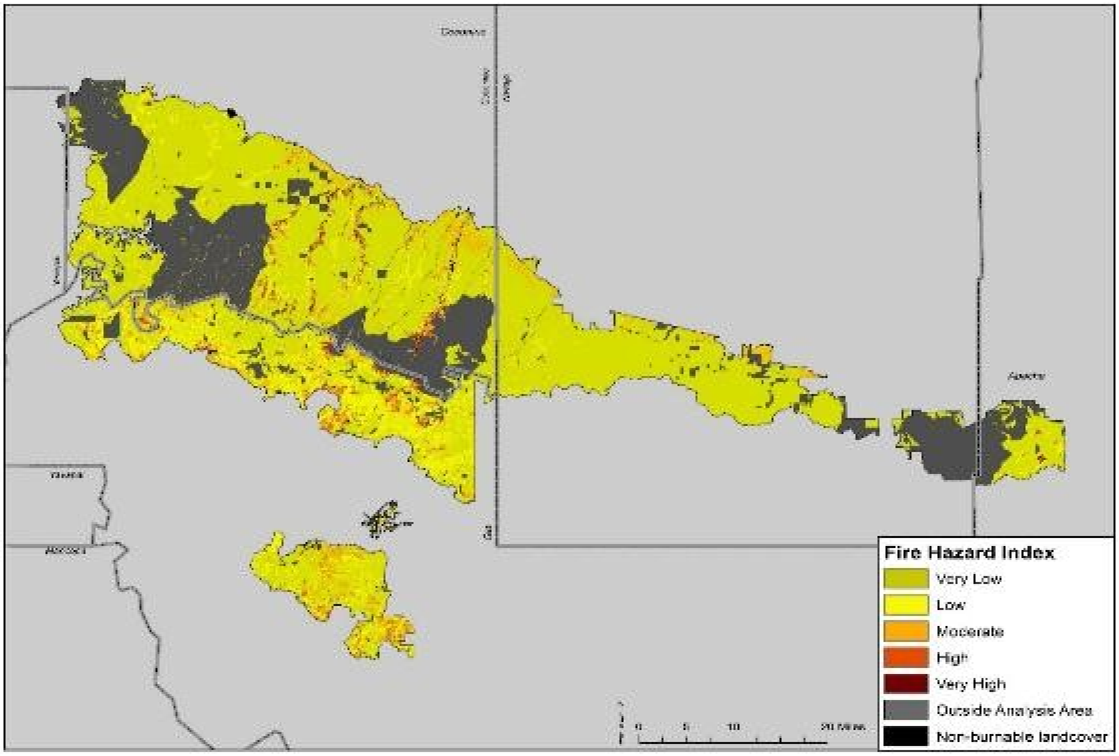


Figure 65: Fire Hazard Index for Alternative 2, under modeled weather conditions

There are 3 watersheds with over 50 percent of the watershed in the moderate to extreme FHI categories (Figure 66). Watershed 40 (Miller Canyon, 61 percent) and 67 (Bear Canyon, 65 percent) have the highest proportion of FHI in the moderate to very high class. Large wildfires in these watersheds would still have a high potential to be difficult and dangerous to suppress, and have a high potential for adverse post fire effects.

Surface Fuels loadings

Under the Alternative 2, surface fuel loading would initially increase with mechanical treatment. As first and second entry prescribed burns are implemented, these fuel loadings would decrease in most areas except those proposed for MSO treatments, which are designed to maintain a higher level of fuel loading, especially Coarse Woody Debris (dead/down woody fuels greater than 3” in diameter).

Desired conditions for total surface fuel loadings are less than 27 tons/ac in Ponderosa Pine vegetation types and less than 30 tons/ac in Dry Mixed Conifer. Figure 67 highlights those areas where surface fuel loading is expected to exceed desired conditions under Alternative 2.

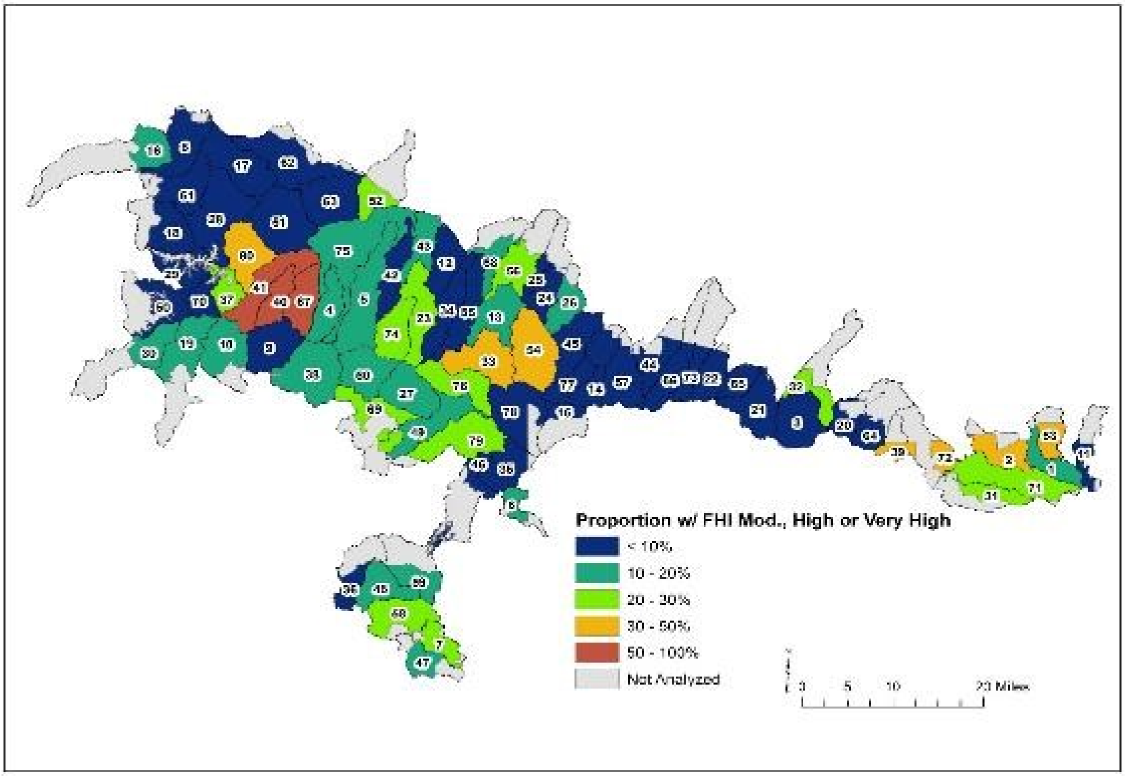


Figure 66. Proportion of each HUC6 watershed with moderate, high, or very high fire hazard index for Alternative 2, under modeled weather conditions

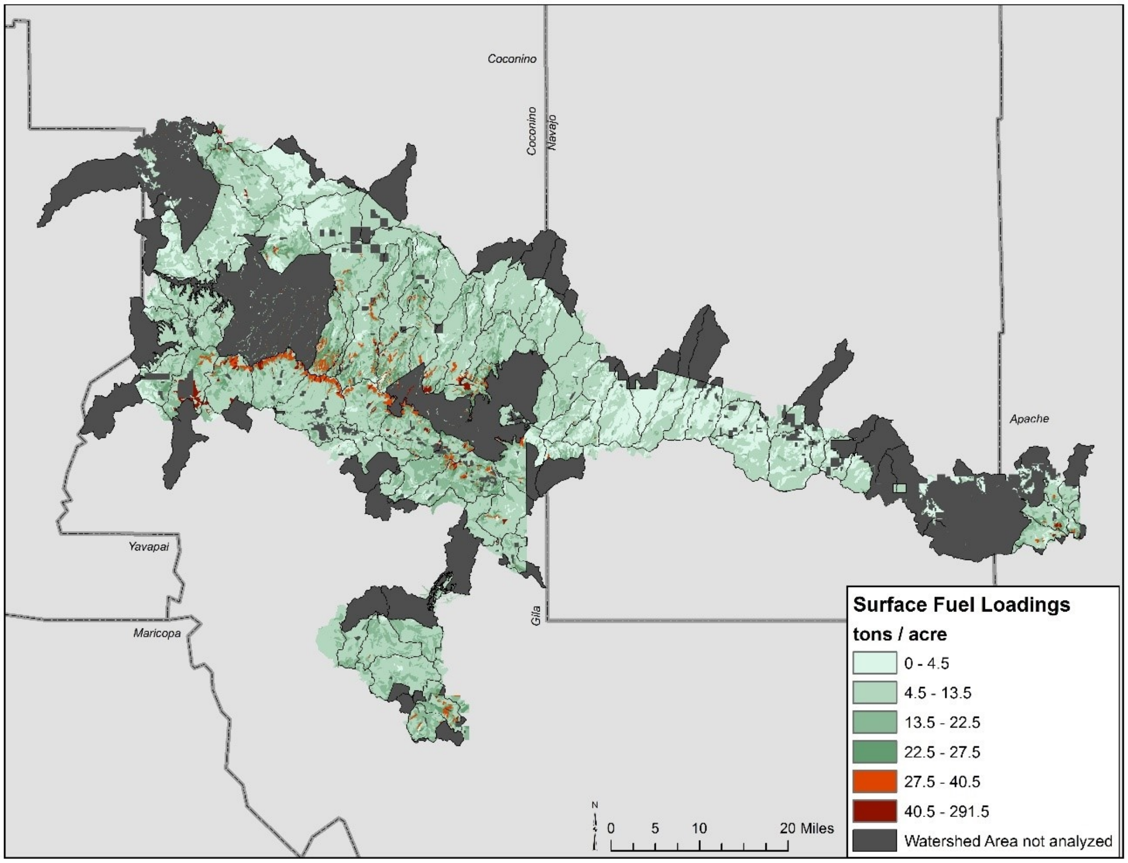


Figure 67. Surface fuel loading in tons per acre for alternative 2, areas in orange and red exceed recommended levels.

Effects on Values, Resources and Assets

Wildfire Management

Wildfire management environment would become safer and more effected as both active crown fire (CFA) and fire hazard index (FHI) decrease. Even under extreme fire weather, suppression tactics would be more effective than current conditions. Decision space for managing unplanned ignitions would expand as Rim Country is implemented.

WUI

Under the Alternative 2, WUI areas on Forest Service lands across the treatment area would be more fire adapted, however increasing smoke from prescribed fires would be present next to homes. CFA and FHI both decrease on Forest Service lands (Table 35). The potential for home and asset loss from crown fires, high intensity surface fires and ember lofting from fires on Forest Service land would decrease. The need for private and non-forest service land owners to manage fuels on their lands in order to compliment Rim Country initiatives will be imperative to fully mitigate risk and impacts from wildfires.

Table 35. Alternative 2 metrics for the Wildland Urban Interface (WUI)

WUI CLASS	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
High Value Rec Sites	375	36%	6%	6%	5%	64%	10%
Comm Sites	2074	35%	6%	2%	0%	65%	6%
Non FS Lands	22638	43%	6%	1%	0%	57%	6%
Transmission Lines	4083	39%	6%	1%	0%	61%	6%
FS Buildings	1683	33%	6%	4%	1%	67%	5%

FS – Forest Service

Vegetation Cover Type

At the project scale, active crown fire and fire hazard index are reduced for all target vegetation cover types (Table 36). At the project area scale, ponderosa pine would meet desired conditions for active crown fire (less than 10), under Alternative 2 even under the extreme conditions modeled.

Table 36. Alterative 2 metrics for vegetation cover type

Vegetation Cover type	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
Ponderosa Pine	556284	97%	2%	1%	0%	81%	**1%**
PIPO Evergreen Oak	147989	95%	4%	1%	0%	85%	**0%**
Dry Mixed Conifer	49281	74%	10%	9%	7%	77%	11%
Wet Mixed Conifer	3130	83%	4%	7%	6%	74%	13%
Aspen	1438	98%	1%	1%	0%	6%	2%
Pinyon Juniper	135085	74%	22%	4%	0%	71%	25%
Madrean Pinyon Oak	23318	55%	25%	19%	1%	86%	41%
Grasslands	18851	100%	0%	0%	0%	16%	**0%**
Riparian Areas	14567	92%	5%	2%	1%	48%	2%

Large and old trees

Under Alternative 2, the potential for fire-related mortality of large and/or old trees would be reduced across the landscape. Ignition techniques or other mitigations would be employed to minimize residence time in duff adjacent to old trees whenever possible. Under this alternative, low severity fire would be used in the vicinity of old trees and, to the degree it is practicable, ladder fuels and excessive surface fuel buildups adjacent to old trees would be removed before burning. Scorch is one of the primary factors in large and old tree mortality (Jerman et al. 2004), and is influenced by the vertical arrangement of fuels.

Prescribed fire and mechanical treatments in the vicinity of old and/or large trees would decrease fuel loading in the immediate vicinity of these trees, decreasing the potential for crown scorch.

Emissions and Air Quality

This alternative would meet the purpose and need, and desired conditions for Air Quality. During windows of opportunity, whenever fire weather and expected fire effects are favorable, fire managers on the Apache-Sitgreaves, Coconino and Tonto National Forests strive to treat as many acres with wildland fire as possible every year, while remaining within legal, climatological, social, and logistical limits. This means that the only change that is likely to occur under this Alternative would be from the greater flexibility in blocking out burn units, because so much more area would have been treated and/or planned and analyzed for prescribed fire. There may also be room some potential for increased coordination of resources between forests in the area. Impacts on air quality are indirect effects of implementing prescribed fire. Although the impact of this is not quantifiable at this time, it would likely be an increase in annual acres burned with no increase in air quality impacts, because it could increase the number of acres that could be burned in a single burn period.

The number of days (duration) of smoke impacts, as well as the intensity (concentration) of the impacts are of concern to the public. While the variability from year to year would be large, under this alternative, prescribed fire would need to be implemented on up to 58,333 acres annually to produce an average fire return interval of 10 years across 583,330 acres proposed for prescribed fire. Potential air quality impacts during implementation of Alternative 2, and the necessary maintenance burning after the initial implementation has been completed may be noticeable, although National Ambient Air Quality Standards would not be exceeded.

First entry burns produce much more emissions per acre than subsequent burns. However, even if the slash was removed from the forest and although the prescribed burning would be spread over many years, the area to be burned would increase significantly and periodic burning would be required across the treatment area to maintain a low fuel load and a healthy forest. Any wildfire that burned subsequent to implementing Alternative 2 would result in lower emissions than if the area burned in a wildfire given current conditions because there would be less biomass to burn Figure 68).

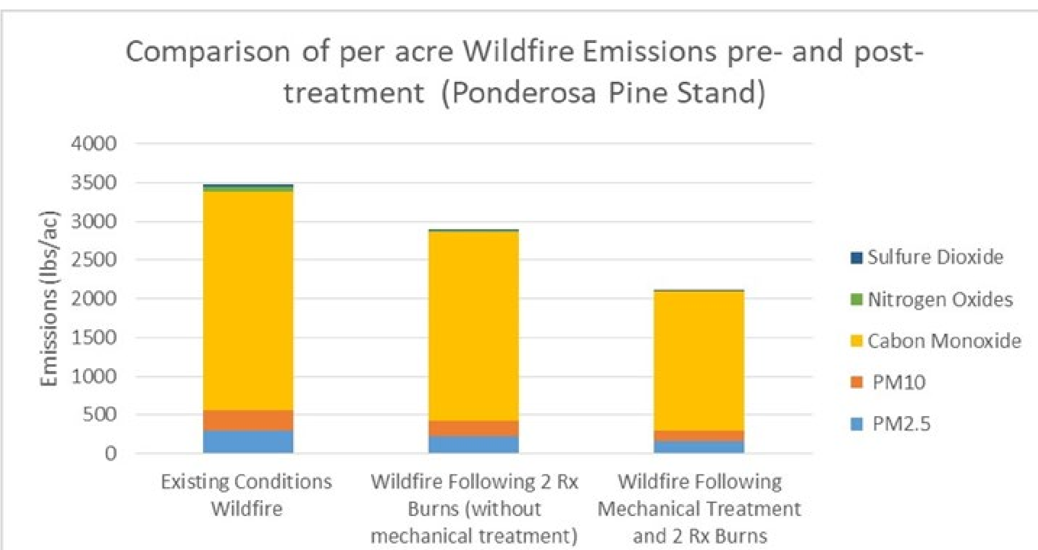


Figure 68. Comparison of per acre wildfire emissions pre- and post- treatments for a Ponderosa Pine Stand

The amount of smoke allowed by the DEQ would not increase, and any burning done in the proposed treatment areas would comply with the National Ambient Air Quality Standards (NAAQS). The number of days of smoke impacts, as well as nuisance smoke (emissions that comply with NAAQS but are considered by the public to be a nuisance) may increase under this alternative, for the following reasons. The Apache-Sitgreaves, Coconino and Tonto National Forests already burn on the high end of what would be their maximum acres and allowed emissions.

Under Alternatives 2, the number of acres available for prescribed fire would increase by 953,132 acres, which could average an additional 58,333 acres a year with prescribed fire and wildfire. This, in turn, would increase the flexibility for the forests in laying out burn units and managing prescribed fires. With potential for larger burn units, it would be possible to burn 'hotter', so that, although more acres may be burned at one time, the heat created by increased fire behavior is could provide more 'lift' for the smoke, increasing dispersal and minimizing smoke impacts.

Overall, surface fuel loading would decrease with a corresponding decrease in the volume of potential emissions from wildfires and future prescribed fires. However, there is no projected change in CWD fuel loading for Very Low (PAC Burn Only) treatments, and in these areas, smoldering fuels would produce high levels of smoke, as well as a high likelihood of high severity fire effects.

The likelihood and degree of potential impacts from wildfire smoke would decrease as fuel loading decrease after prescribed burns. After implementation, Watersheds 75 (East Clear Creek-Clear Creek) and 33 (Long Tom canyon-Chevelon Canyon) have the greatest potential to produce emissions because of surface fuel loading. Under Alternative 2 all but 22 watersheds decrease in total surface fuel loadings. One remains effectively the same (56, Durfee Draw – Chevelon Canyon), and 20 increase in fuel loadings Watershed 2 (Upper Rocky Arroyo) and 41 (East Clear Creek) increase the most (29 and 23 percent respectively).

Alternative 3 – Focused Restoration

From a fire ecology perspective, direct and indirect effects of Alternative 3 relate primarily to treatments that include mechanical thinning, prescribed fire, or both to meet the purpose and need of the Rim Country. This alternative proposes to conduct about 528,060 acres of restoration activities over about 10 years or until objectives are met. On average, 48,316 acres of vegetation would be mechanically treated annually. On average, 52,806 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Up to two prescribed fires would be conducted on all acres proposed for burning over the 10-year period.

Direct and Indirect Effects

From a fire ecology perspective, direct and indirect effects of Alternative 3 relate primarily to treatments that include mechanical thinning, prescribed fire as described in the section Effects Common to All Action Alternatives, page 229. Areas without treatments will have the indirect effects associated with Alternative 1.

Rim Country Project Area Metrics and Measures

Fire Type

Alternative 3 is expected to reduce the potential for active and conditional crown fire closer to desired conditions for all vegetation cover types (see Table 38 below), however desired conditions will not be fully attained. Over the rim country project area, 18 percent of the area burned under extreme weather conditions would be expected to be active or conditional crown fire, down from 31 percent given existing conditions (Figure 69). Passive crown fire increases slightly (56 percent up from 47 percent EC) under extreme conditions, due to the desired clumpy canopy characteristics of the mechanical treatments. Under less extreme wind conditions (5 MPH instead of 20 MPH), the majority of the landscape would be expected to burn as a surface fire, and only limited acres would be expected to burn with active crown fire.

Post wildfire watershed effects increase with the amount of a watershed that burns at high severity fire (Cannon 2010; Neary 2011). Under Alternative 3, 16 watersheds have expected active crown fire under extreme weather conditions for over 30 percent of the watershed, which would result in high severity effects (Figure 73). Six watersheds are have over 50 percent of the watershed expected to burn with active crown fire. Watersheds 67 (Bear Canyon) and 56 (Durfee Draw-Chevelon Canyon) have the highest proportion of potential for active crown fire (55 percent and 67 percent respective). If a wildfire were to burn within these watersheds, detrimental post wildfire effects would be expected.

Fire Hazard Index

Alternative 3 would decrease the risk of undesirable wildfire behavior and effects that could threaten lives, resources, and infrastructure. After implementation, the fire hazard index decreases resulting in 22 percent of the project area is within the moderate to very high FHI (Figure 70), down from 37 percent in the existing conditions. The areas of moderate to extreme presents difficult and dangerous suppression conditions during a wildfire and potential for adverse post fire effects on soils and surface water quality.

There are 6 watersheds with over 50 percent of the watershed in the moderate to very high FHI categories (Figure 72). Watershed 67 (Bear Canyon, 65 percent) and 59 (Upper Spring Creek, 77 percent) have the highest proportion of FHI in the moderate to very high class. Large wildfires in these watersheds have a high potential to be difficult and dangerous to suppress, and have a high potential for adverse post fire effects.

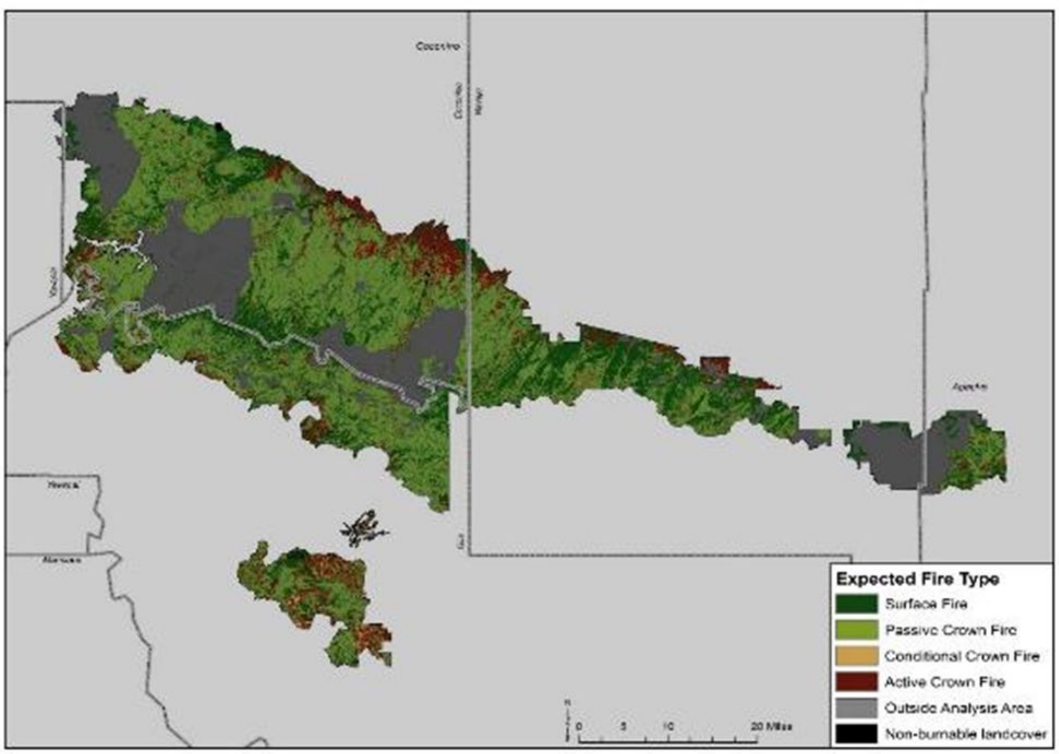


Figure 69. Expected Fire Type for Alternative 3, under modeled weather conditions

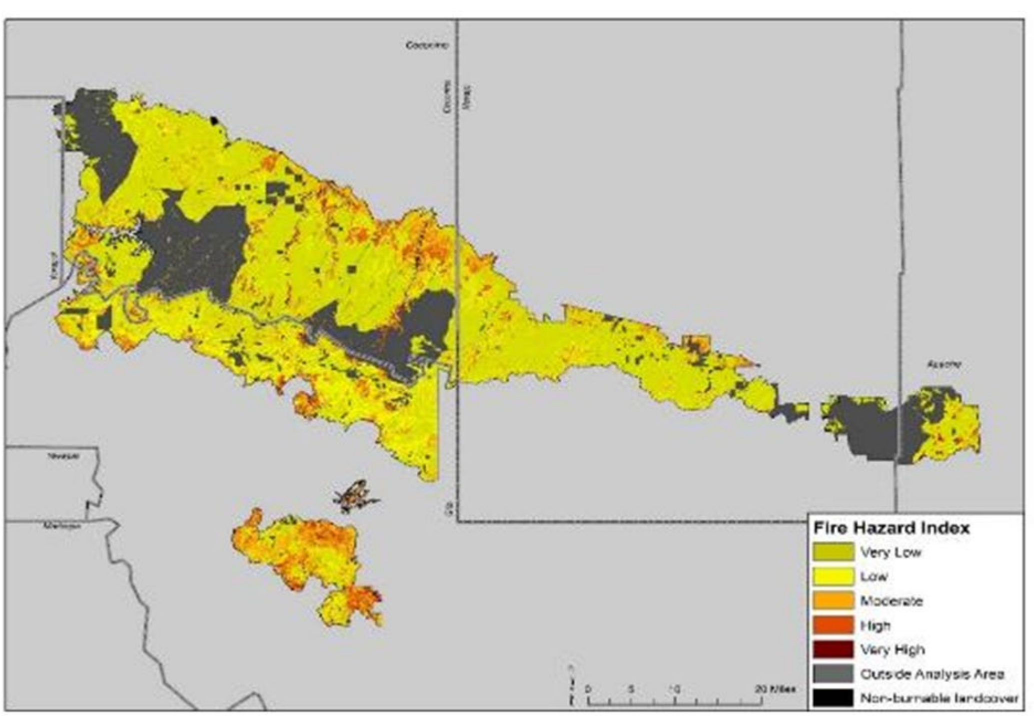


Figure 70. Fire Hazard Index for Alternative 3, under modeled weather conditions

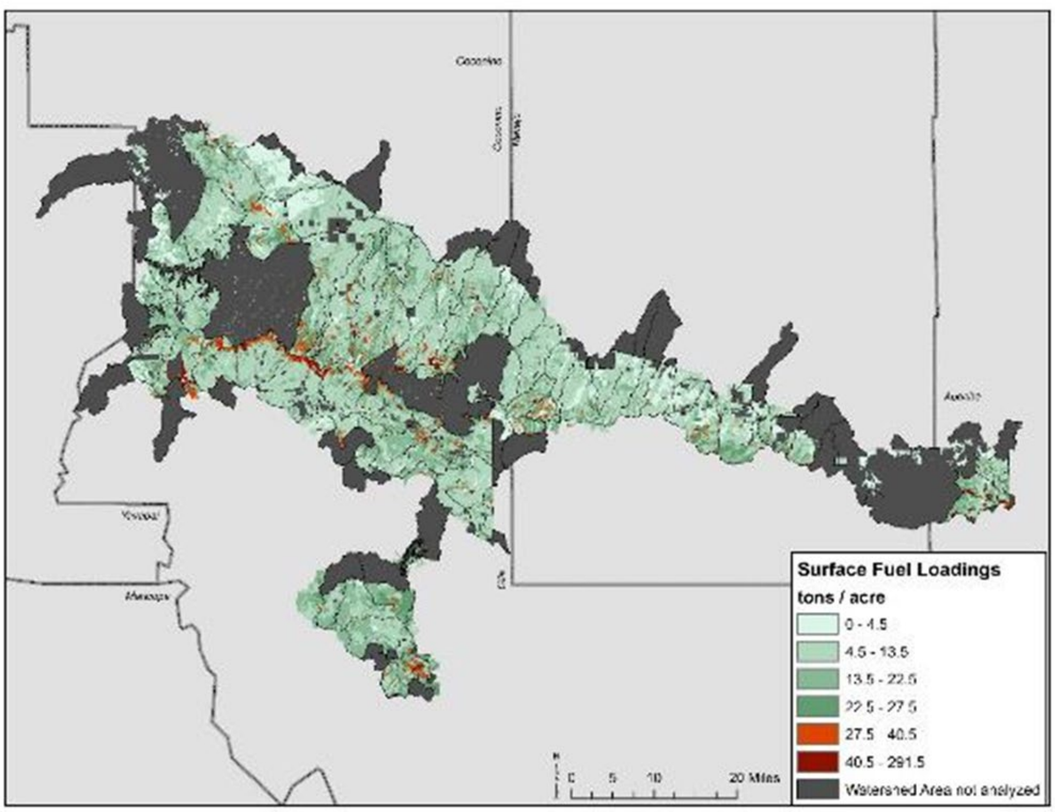


Figure 71. Total Surface Fuel Loadings for Alternative 3, under modeled weather conditions

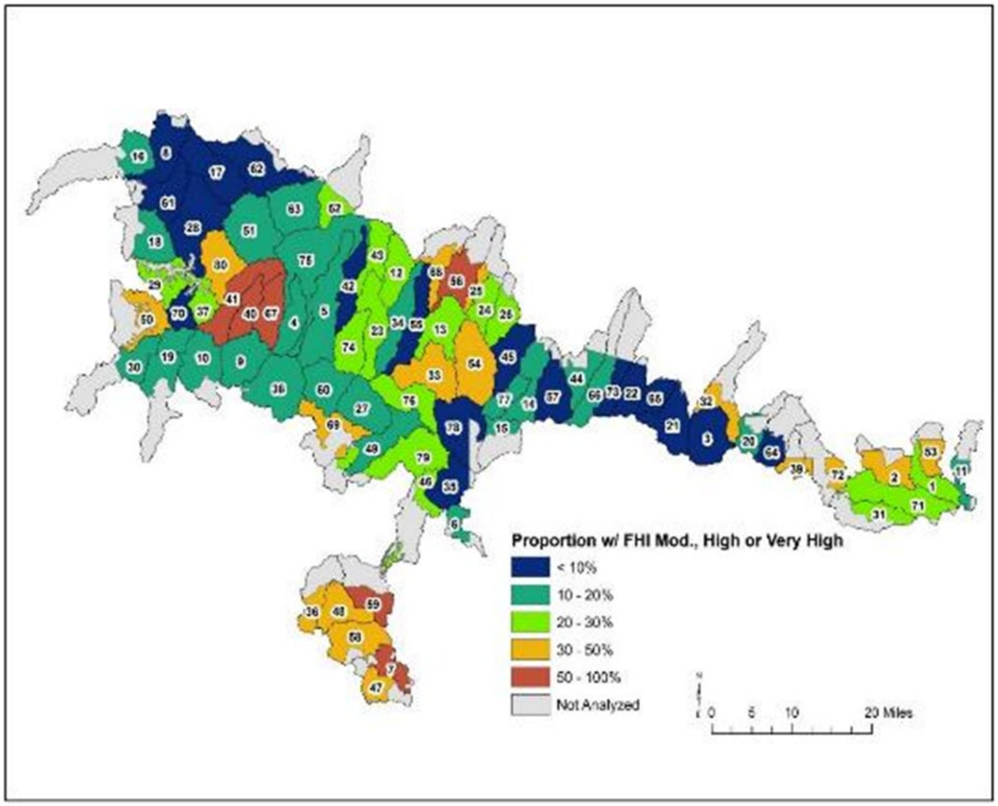


Figure 72. Proportion of each HUC6 watershed with Moderate, High, or Very High Fire Hazard Index for Alternative 2, under modeled weather conditions

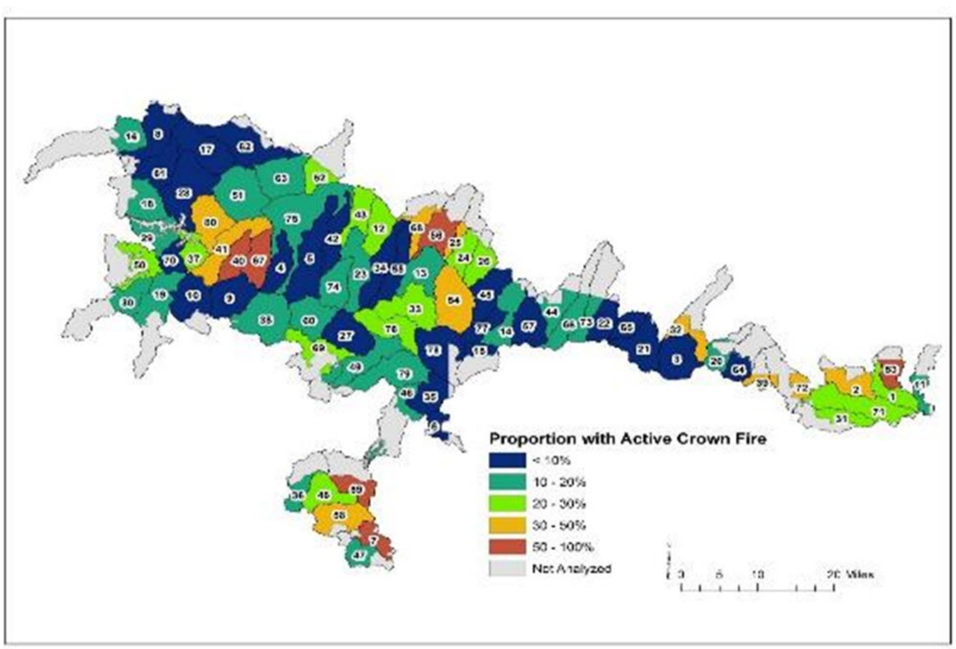


Figure 73. Proportion of each HUC6 watershed with Active Crown Fire for Alternative 3, under modeled weather conditions

Surface Fuel Loadings

Under the Alternative 3, surface fuel loading would initially increase with mechanical treatment, and would also increase where no treatments occur. As first and second entry prescribed burns are implemented, these fuel loadings would decrease in most areas except those proposed for MSO treatments, which are designed to maintain a higher level of fuel loading, especially Coarse Woody Debris (dead/down woody fuels greater than 3” in diameter).

Desired conditions for total surface fuel loadings are less than 27 tons/ac in Ponderosa Pine vegetation types and less than 30 tons/ac in Dry Mixed Conifer. Figure 71 highlights those areas where surface fuel loading is expected to exceed desired conditions under Alternative 3.

Effects on Values, Resources and Assets

Wildfire Management

Wildfire management environment would become safer and more effected as both CFA and FHI decrease. However in areas where no treatments are planned, CFA and FHI both increase. Even under extreme fire weather, suppression tactics would be more effective than current conditions. Decision space for managing unplanned ignitions would expand as Rim Country (and other projects) are implemented.

WUI

Under Alternative 3, WUI areas on Forest Service lands across the treatment area would be more fire adapted, however increasing smoke from prescribed fires would be present next to homes. CFA and FHI both decrease on Forest Service lands (Table 37). The potential for home and asset loss from crown fires, high intensity surface fires and ember lofting from fires on Forest Service land would decrease. The need for private and non-forest service land owners to manage fuels on their lands in order to compliment Rim Country initiatives will be imperative to fully mitigate risk and impacts from wildfires.

Table 37: Alternative 3 metrics for the Wildland Urban Interface

WUI CLASS	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
High Value Rec Sites	375	81%	8%	6%	5%	65%	11%
Comm Sites	2074	86%	8%	6%	1%	68%	11%
Non FS Lands	22638	87%	8%	4%	0%	63%	10%
Transmission Lines	4083	84%	10%	6%	1%	65%	15%
FS Buildings	1683	80%	8%	10%	3%	71%	14%

FS-Forest Service

Vegetation Cover Type

At the project scale, active crown fire and fire hazard index are reduced for all target vegetation cover types (Table 38). At the project area scale, ponderosa pine would not meet desired conditions for active crown fire (<10 percent), under Alternative 3 under the extreme conditions modeled, however it would move the cover type closer to desired conditions.

Table 38: Alternative 3 metrics by Vegetation Cover class

Vegetation Cover type	Total Acres	very Low - Low FHI	moderate FHI	high FHI	very high FHI	Fire type: Passive & Active Crown Fire	Fire type: Active Crown Fire
Ponderosa Pine	556284	75%	7%	16%	3%	75%	22%
PIPO Evergreen Oak	147989	36%	33%	26%	5%	62%	30%
Dry Mixed Conifer	49281	26%	17%	28%	29%	29%	54%
Wet Mixed Conifer	3130	29%	4%	26%	41%	30%	70%
Aspen	1438	95%	1%	3%	2%	4%	5%
Pinyon Juniper	135085	36%	33%	28%	3%	53%	67%
Madrean Pinyon Oak	23318	19%	33%	41%	7%	55%	80%
Grasslands	18851	98%	2%	0%	0%	3%	3%
Riparian Areas	14567	70%	11%	13%	6%	35%	19%

Large and old trees

Under Alternative 3, the potential for fire-related mortality of large and/or old trees would be reduced across the landscape where treatments are implemented in the same manner as Alternative 2. In areas where no treatments are applied, old trees would respond as in Alternative 1.

Emissions and Air Quality

This alternative would meet the purpose and need, and desired conditions for Air Quality. Effects to Air Quality from smoke emissions will be a mix of Alternative 1 and Alternative 2. 528,060 acres would be treated resulting in lower emissions from a post-treatment wildfire. And, 528,060 acres would increase in potential wildfire emissions due to increases in surface fuel loadings and crown fire potential.

The number of days (duration) of smoke impacts, as well as the intensity (concentration) of the impacts are of concern to the public. While the variability from year to year would be large, under Alternative 3, prescribed fire would need to be implemented on up to 52,806 acres annually to produce an average fire return interval of 10 years across 528,060 acres proposed for prescribed fire. Implementing prescribed fire as proposed in Alternative 3 would result in lower emissions than if the area burned in a wildfire because there would be less biomass to burn (Figure 68).

Under Alternatives 3, the number of acres available for prescribed fire would increase by 52,806 acres, this, in turn, would increase the flexibility for the forests in laying out burn units and managing prescribed fires. With potential for larger burn units, it would be possible to burn ‘hotter’, so that, although more acres may be burned at one time, the heat created by increased fire behavior is could provide more ‘lift’ for the smoke, increasing dispersal and minimizing smoke impacts.

Surface fuel loading would decrease where treatments are implemented, decreasing the volume of potential emissions from wildfires and future prescribed fires. However, there is no change in CWD fuel loading for Very Low (PAC Burn Only) treatments. In these areas, smoldering fuels would produce high levels of smoke, as well as a high likelihood of high severity fire effects.

The likelihood and degree of potential impacts from wildfire smoke would decrease as fuel loading decrease after prescribed burns. After implementation, Watersheds 75 (East Clear Creek-Clear Creek) and 79 (Haigler Creek) have the greatest potential to produce emissions because of surface fuel loading (Figure 43 of Fire Ecologist Specialist Report 2019). Under Alternative 3 all but 46 watersheds decrease in total surface fuel loadings. Five remain effectively the same (< 3 percent change), and 41 increase in fuel loadings (see Table 44 below). Watershed 1 (Upper Rocky Arroyo) and 133 (Decker Wash) increase the most (29 percent and 28 percent respectively).

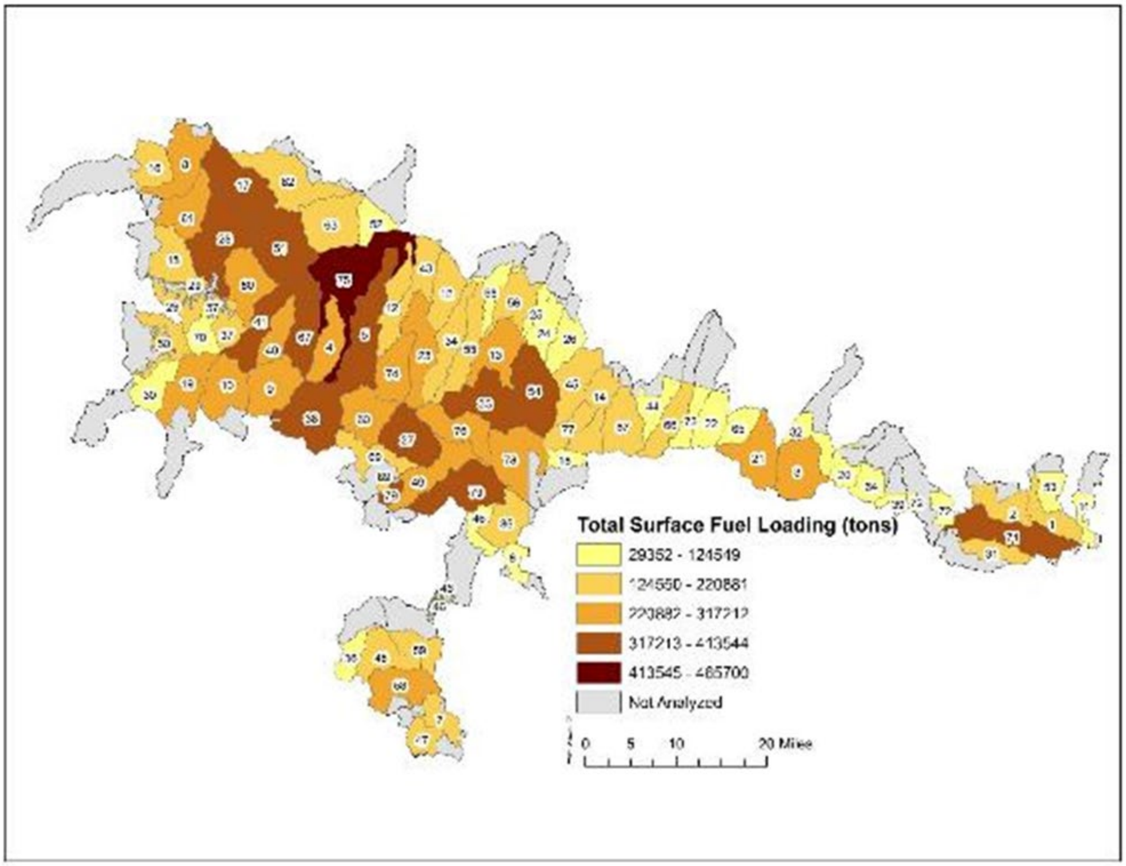


Figure 74. Total Surface Fuel loadings of each HUC-6 watershed for Alternative 3, as modeled using FVS

Comparison of Alternatives

This report analyzed the effectiveness of three alternatives for modifying composition, pattern, and structure as a means of restoring healthy ecological function to ponderosa pine, specifically in regards to fire ecology and air quality. All action alternatives are expected to reset the current trajectory of areas proposed for treatment towards greater sustainability and resilience. Aspen, grasslands, oak communities, and some pinyon/juniper communities associated with ponderosa pine are included. Restoring historic fire regimes plays both direct and indirect roles in achieving or maintaining desired conditions for these vegetation communities. All action alternatives move the Rim Country proposed treatment area toward desired conditions. Differences between them are discussed below, and summarized at the end of this section.

Fire Type

The change from existing conditions to post-treatment conditions in the action alternatives results primarily from: 1) mechanical treatments breaking up the vertical and horizontal continuity of canopy fuels; 2) mechanical treatments and prescribed fire raising canopy base heights; and 3).

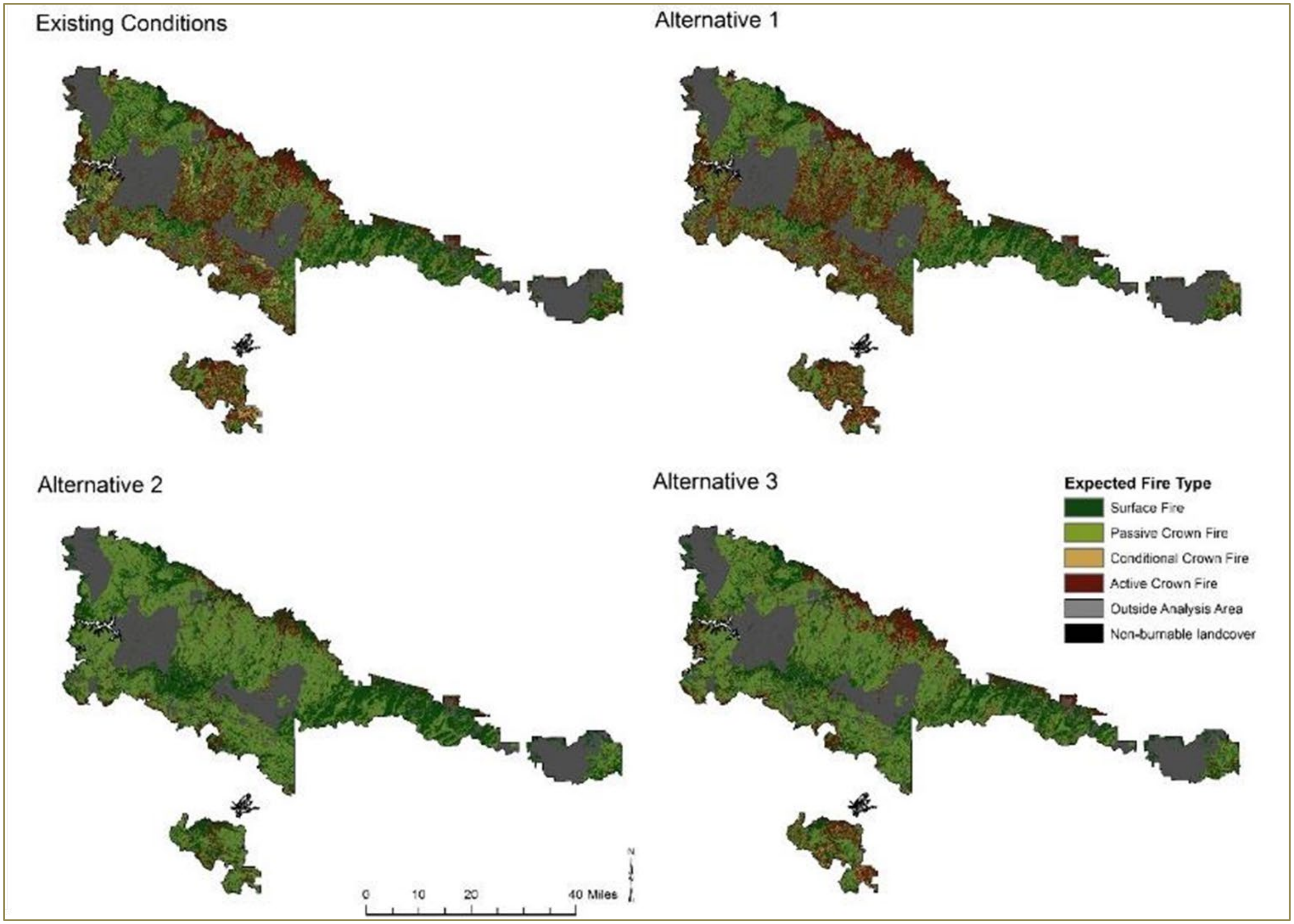


Figure 75. Comparison of fire type for each alternative

Table 39: Comparison of Alternatives Fire Type within the Wildland Urban Interface. The ↑ symbol indicates increases compared to existing conditions (EC), while the ↓symbol indicate decreases.

WUI CLASS	Total Acres	Passive & Active Crown Fire: Existing Conditions	Passive & Active Crown Fire: ALT1	Passive & Active Crown Fire: ALT2	Passive & Active Crown Fire: ALT3	Active Crown Fire: Existing Conditions	Active Crown Fire: ALT1	Active Crown Fire: ALT2	Active Crown Fire: ALT3
High Value Rec Sites	375	79%	↑83%	↓64%	↓65%	38%	↑40%	↓10%	↓11%
Communication Sites	2074	75%	↑79%	↓65%	↓68%	27%	↑28%	↓6%	↓11%
Non FS Lands	22638	68%	↑73%	↓57%	↓63%	28%	↑29%	↓6%	↓10%
Transmission Lines	4083	66%	↑74%	↓61%	↓65%	32%	↑33%	↓6%	↓15%
FS Buildings	1683	83%	↑85%	↓67%	↓71%	41%	↑43%	↓5%	↓14%

FS-Forest Service

Desired condition for ponderosa pine is to have potential for less than 20 percent crown fire.

Table 40: Comparison of Alternatives for Fire Type by vegetation cover class for extreme fire weather

Vegetation Cover Type	Total Acres	Passive & Active Crown Fire: Existing Conditions	Passive & Active Crown Fire: ALT1	Passive & Active Crown Fire: ALT2	Passive & Active Crown Fire: ALT3	Active Crown Fire: Existing Conditions	Active Crown Fire: ALT1	Active Crown Fire: ALT2	Active Crown Fire: ALT3
Ponderosa Pine	556284	72%	81%	75%	79%	21%	22%	1%	5%
Ponderosa Pine Evergreen Oak	147989	82%	85%	62%	72%	29%	30%	0%	9%
Dry Mixed Conifer	49281	75%	77%	29%	33%	50%	54%	11%	14%
Wet Mixed Conifer	3130	71%	74%	30%	30%	66%	70%	13%	14%
Aspen	1438	6%	6%	4%	4%	4%	5%	2%	2%
Pinyon Juniper	135085	71%	71%	53%	62%	65%	67%	25%	49%
Madrean Pinyon Oak	23318	85%	86%	55%	71%	79%	80%	41%	59%
Grasslands	18851	15%	16%	3%	5%	3%	3%	0%	5%
Riparian Areas	14567	44%	48%	35%	35%	18%	19%	2%	2%

Fire Hazard Index

Overall, fire hazard index ratings are expected to increase under the no action alternative (alternative 1) and would decrease under both alternatives 2 and 3 (Figure 76). The biggest decrease in FHI would occur under alternative 2 (Table 41).

Under alternative 1, the percentage of the total project area with moderate to very high fire hazard index (FHI) rating is expected to increase from 37 percent under existing conditions to 40 percent and an additional two subwatersheds would have greater than 50 percent moderate to very high ratings when compared to existing conditions. Alternative 2 would provide the biggest decrease in FHI, reducing the percent of the project area in moderate to very high down to 15 percent and reducing the number of subwatersheds as such to three. Alternative 3 also provides for a significant reduction in FHI, though not to the same degree as alternative 2.

An overall comparison of fire hazard index across alternatives is presented in Figure 76. Alternative 1 results in the largest percentage of the project area in the moderate, high and extreme FHI classes. Alternative 2 provides for the largest overall reduction in FHI for the project area as a whole, while Alternative 3 shows significant reductions in FHI ratings across much of the project area, though less so than Alternative 2.

To further understand the impacts of each proposed alternative based on fire hazard index, it is useful to examine the relative change in FHI rating classes within select areas of interest, especially within Wildland Urban Interface (WUI) classes. As shown in table 40, Alternative 1 results in a relative increase in the amount of acreage in the high and very high FHI classes across nearly all WUI Classes. Both Alternative 2 and Alternative 3 show a relative decline in the area of high and very high FHI classes, with a corresponding increase in the area rated as very low-low FHI. This illustrates the effectiveness of both alternatives in reducing the overall fire hazard index rating across all WUI classes. The differences between Alternative 2 and Alternative 3 are limited, reflecting the emphasis of treatment in and adjacent to the WUI areas in both action alternatives. Table 43 provides a further examination of the relative changes in FHI for each vegetation cover type across all alternatives.

Table 41: Comparison of alternatives for Fire Hazard Index ratings

Fire Hazard Index (FHI)	Existing Conditions	Alt 1	Alt 2	Alt 3
Percent of Project Area with Moderate to Very High FHI:	37%	40%	15%	22%
Number of Subwatersheds with >50% of their area in Moderate to Very High FHI:	23	25	3	6

A comparison of FHI by WUI Class and Vegetation Cover Type are displayed in Table 42 and Table 43 respectively.

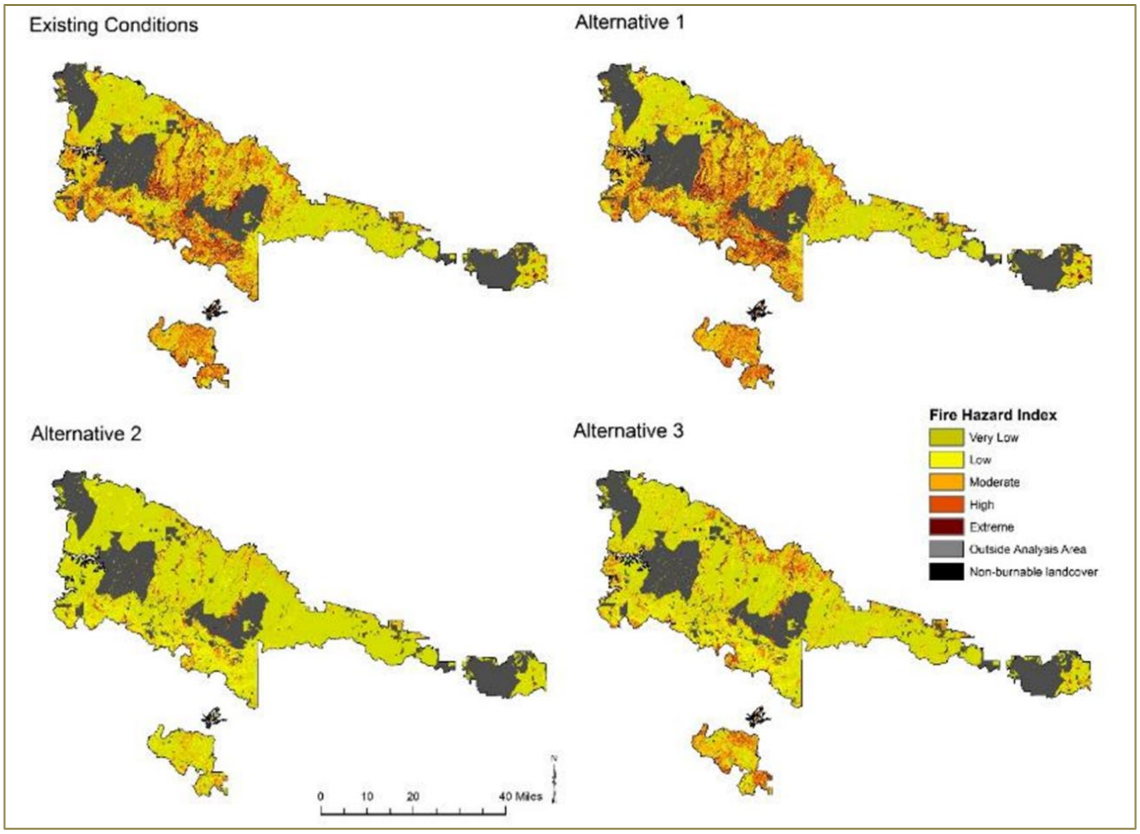


Figure 76. Fire hazard index

Table 42: Comparison of Alternatives by Fire Hazard Index for the Wildland Urban Interface Classes

WUI Class	Total Acres	Very Low-Low FHI: Existing Conditions	Very Low-Low FHI: ALT1	Very Low-Low FHI: ALT2	Very Low-Low FHI: ALT3	Moderate FHI: Existing Conditions	Moderate FHI: ALT1	Moderate FHI: ALT2	Moderate FHI: ALT3	High FHI: Existing Conditions	High FHI: ALT1	High FHI: ALT2	High FHI: ALT3	Very High FHI: Existing Conditions	Very High FHI: ALT1	Very High FHI: ALT2	Very High FHI: ALT3
High Value Rec Sites	375	49%	45%	83%	81%	16%	19%	6%	8%	18%	18%	6%	6%	16%	19%	5%	5%
Comm Sites	2074	66%	63%	92%	86%	15%	16%	6%	8%	17%	18%	2%	6%	2%	3%	0%	1%
NonFS Lands	22638	66%	63%	93%	87%	16%	17%	6%	8%	15%	18%	1%	4%	3%	3%	0%	0%
Transmission Lines	4083	64%	61%	93%	84%	18%	17%	6%	10%	15%	18%	1%	6%	3%	4%	0%	1%
FS Buildings	1683	51%	49%	89%	80%	14%	14%	6%	8%	27%	29%	4%	10%	8%	9%	1%	3%

FS-Forest Service

Table 43: Comparison of Alternatives by Fire Hazard Index for each Vegetation Cover Type

Vegetation Cover Type	Total Acres	Very Low - Low FHI: Existing Conditions	Very Low - Low FHI: ALT1	Very Low - Low FHI: ALT2	Very Low - Low FHI: ALT3	Moderate FHI: Existing Conditions	Moderate FHI: ALT1	Moderate FHI: ALT2	Moderate FHI: ALT3	High FHI: Existing Conditions	High FHI: ALT1	High FHI: ALT2	High FHI: ALT3	Very High FHI: Existing Conditions	Very High FHI: ALT1	Very High FHI: ALT2	Very High FHI: ALT3
Ponderosa Pine	556284	77%	75%	97%	93%	9%	7%	2%	3%	12%	16%	1%	3%	2%	3%	0%	0%
Ponderosa Pine Evergreen Oak	147989	41%	36%	95%	75%	31%	33%	4%	16%	24%	26%	1%	8%	4%	5%	0%	1%
Dry Mixed Conifer	49281	29%	26%	74%	70%	18%	17%	10%	12%	27%	28%	9%	11%	26%	29%	7%	8%
Wet Mixed Conifer	3130	32%	29%	83%	82%	5%	4%	4%	4%	25%	26%	7%	7%	38%	41%	6%	6%
Aspen	1438	95%	95%	98%	97%	1%	1%	1%	1%	3%	3%	1%	1%	2%	2%	0%	0%
Pinyon Juniper	135085	37%	36%	74%	53%	34%	33%	22%	27%	26%	28%	4%	19%	2%	3%	0%	1%
Madrean Pinyon Oak	23318	20%	19%	55%	37%	31%	33%	25%	30%	43%	41%	19%	29%	6%	7%	1%	4%
Grasslands	18851	98%	98%	100%	100%	2%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Riparian Areas	14567	74%	70%	92%	92%	11%	11%	5%	5%	11%	13%	2%	2%	5%	6%	1%	1%

Surface Fuel Loading

Total surface fuel loadings is expected to increase under alternative 1, compared with existing conditions. Both alternatives 2 and 3 would reduce total surface fuel loadings, with the biggest reductions occurring under alternative 2 (Figure 16). Table 44 shows the percent change in total surface loading for each subwatershed in the project area under each alternative.

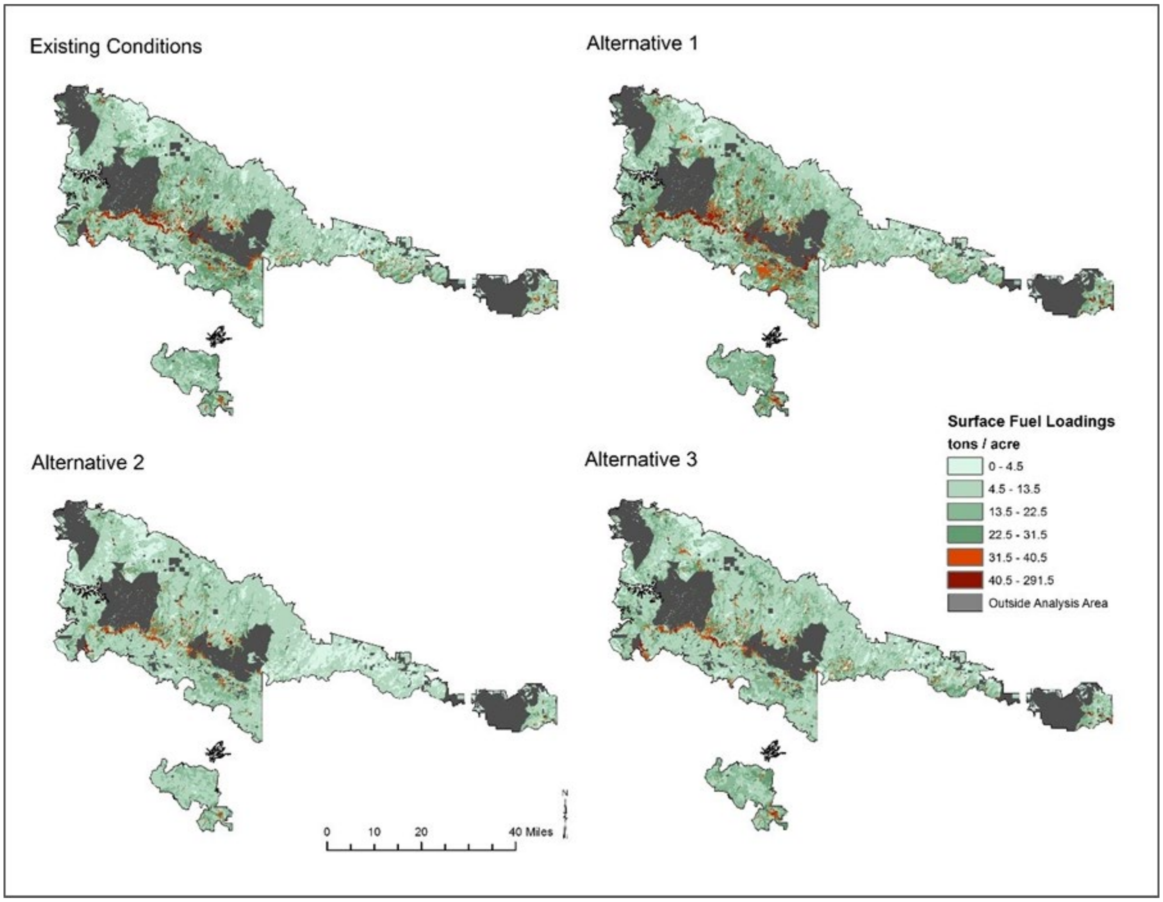


Figure 77. Comparison of Total Surface Fuel Loading

Table 44: Comparison of Percent Changes in Total Surface Fuel Loadings from existing conditions

Map Label	Watershed Name	Existing Total SFL	ALT 1 % Change	ALT 2 % Change	ALT 3 % Change
1	Upper Brown Creek	143,874	26%	-10%	10%
2	Upper Rocky Arroyo	117,828	30%	29%	29%
3	Mortensen Wash	238,345	9%	-55%	-7%
4	Barbershop Canyon	316,351	19%	-22%	-22%
5	Leonard Canyon	490,214	19%	-22%	-22%
6	Gentry Canyon	77,488	16%	-25%	-25%
7	Reynolds Creek	176,637	20%	-19%	7%
8	Double Cabin Park-Jacks Canyon	264,058	17%	7%	10%
9	East Verde River Headwaters	389,775	12%	-27%	-26%
10	Webber Creek	327,236	16%	-16%	-16%
11	Sepulveda Creek	72,897	23%	-23%	-1%
12	Cabin Draw	159,183	24%	-21%	0%
13	Upper Chevelon Canyon-Chevelon Canyon Lake	234,868	25%	-10%	2%
14	Bear Canyon-Black Canyon	185,764	16%	-46%	8%
15	Bull Flat Canyon	79,640	6%	-47%	5%
16	Red Tank Draw	194,843	14%	5%	5%
17	Upper Willow Valley	290,666	23%	-20%	10%
18	Home Tank Draw	140,654	15%	-22%	7%
19	Pine Creek	349,252	12%	-31%	-27%
20	Linden Draw	75,116	7%	-45%	-8%
21	West Fork Cottonwood Wash-Cottonwood Wash	229,322	9%	-53%	2%
22	Upper Day Wash	64,663	28%	-22%	19%
23	Upper Willow Creek	355,012	19%	-14%	-14%
24	Middle Wildcat Canyon	93,047	15%	-21%	9%
25	Lower Wildcat Canyon	28,219	18%	4%	18%
26	Upper Potato Wash	106,747	19%	-22%	-3%
27	Christopher Creek	444,690	11%	-26%	-26%
28	Lower Willow Valley	337,796	19%	-22%	2%
29	Upper West Clear Creek	148,312	19%	-22%	-12%
30	Hardscrabble Creek	148,864	13%	-30%	-25%
31	Billy Creek	118,406	22%	19%	22%
32	Dodson Wash	71,678	15%	-11%	11%
33	Long Tom Canyon-Chevelon Canyon	394,280	21%	2%	2%
34	Upper West Chevelon Canyon	271,066	20%	-24%	-24%
35	Parallel Canyon-Cherry Creek	237,399	16%	-33%	-33%
36	Rock Creek	105,061	21%	-21%	8%
37	Clover Creek	140,657	33%	15%	15%
38	Ellison Creek	397,878	17%	-15%	-4%

Map Label	Watershed Name	Existing Total SFL	ALT 1 % Change	ALT 2 % Change	ALT 3 % Change
39	Fools Hollow	49,749	19%	15%	16%
40	Miller Canyon	195,395	21%	19%	19%
41	East Clear Creek-Blue Ridge Reservoir	289,492	25%	23%	23%
42	Wilkins Canyon	210,859	24%	-27%	-23%
43	Lower Willow Creek	158,542	20%	-6%	-5%
44	Upper Pierce Wash	78,338	5%	-47%	5%
45	Upper Brookbank Canyon	182,964	23%	-26%	-12%
46	Gruwell Canyon-Cherry Creek	121,988	19%	-30%	-13%
47	Workman Creek	138,566	27%	-22%	-7%
48	Buzzard Roost Canyon	187,727	28%	-10%	10%
49	Gordon Canyon	381,345	14%	-26%	-25%
50	Upper Fossil Creek	173,917	20%	-23%	16%
51	Windmill Draw-Jacks Canyon	353,747	17%	-18%	5%
52	Hart Tank	45,265	23%	18%	18%
53	Ortega Draw	63,924	25%	18%	21%
54	Upper Wildcat Canyon	370,140	25%	5%	6%
55	Alder Canyon	214,676	23%	-23%	-19%
56	Durfee Draw-Chevelon Canyon	134,595	18%	0%	16%
57	Buckskin Wash	191,122	6%	-60%	-7%
58	Upper Salome Creek	214,917	33%	-17%	6%
59	Upper Spring Creek	179,642	22%	-27%	21%
60	Horton Creek-Tonto Creek	341,225	14%	-25%	-15%
61	Brady Canyon	222,194	17%	13%	15%
62	Tremaine Lake	129,905	28%	4%	26%
63	Dogie Tank-Jacks Canyon	142,974	20%	-6%	17%
64	Bagnal Draw-Show Low Creek	93,232	10%	-46%	-3%
65	Stinson Wash	64,844	14%	-32%	-8%
66	Upper Phoenix Park Wash	110,842	15%	-40%	15%
67	Bear Canyon	285,961	18%	17%	17%
68	Lower West Chevelon Canyon	65,172	20%	5%	19%
69	Bull Tank Canyon-Tonto Creek	164,608	22%	-24%	-12%
70	Toms Creek	125,511	29%	-17%	-17%
71	Porter Creek	319,069	27%	11%	24%
72	Show Low Lake-Show Low Creek	56,145	19%	12%	12%
73	Decker Wash	52,388	28%	-24%	28%
74	Gentry Canyon	327,002	19%	-10%	-10%
75	East Clear Creek-Clear Creek	499,780	20%	-12%	-7%
76	Woods Canyon and Willow Springs Canyon	241,500	22%	21%	21%
77	West Fork Black Canyon	122,169	16%	-49%	15%
78	Canyon Creek Headwaters	315,160	18%	-19%	-15%

Map Label	Watershed Name	Existing Total SFL	ALT 1 % Change	ALT 2 % Change	ALT 3 % Change
79	Haigler Creek	509,875	17%	-22%	-20%
80	Long Valley Draw	252,547	18%	10%	17%

Emissions and Air Quality

The amount of biomass consumed during a prescribed fire (and therefore the emissions produced) is more easily controlled than for wildfires burning on dry, hot, windy days. When comparing alternatives, all of the action alternatives propose prescribed fire at some level which could impact air quality in the surrounding communities but in a controllable manner. The post-treatment conditions from implementing these alternatives would reduce the amount of biomass available to burn during wildfire which would moderate fire behavior, fire effects, and reduce the emissions potential of wildfire occurring in those areas. Alternative 1 does not propose any prescribed burning, and would produce increasing amounts of biomass available to burn in the event of a wildfire. This would have direct and most likely uncontrollable impacts on recreation and surrounding communities from emissions, as well as longer lasting fire effects.

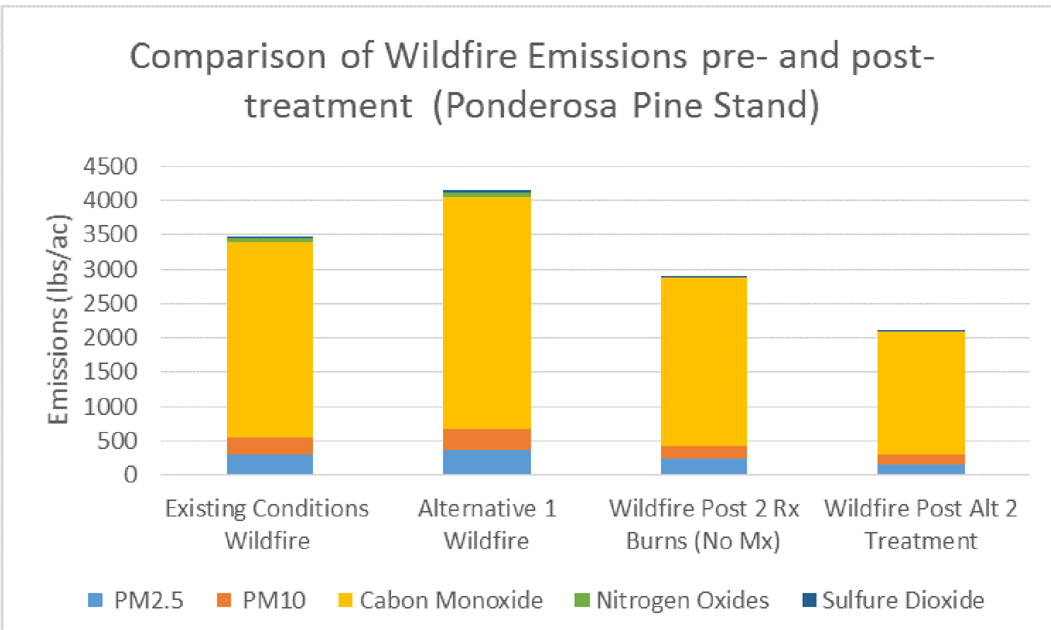


Figure 78. Comparison of Wildfire Emissions pre- and post-treatment in a Ponderosa Pine stand

Examining the cumulative effects from smoke on air quality differs from the evaluation of cumulative effects for many other resources because of the transient nature of air quality impacts. It is a relatively simple exercise to estimate the total tons per acres of emissions, but there is no calculation that correlates total annual emissions to total concentrations of emissions. As discussed earlier, air quality impacts are measured as concentrations of emissions, whether it's in µg/m3 for National Ambient Air Quality Standards (NAAQS), or in deciviews measuring visibility in Class I Areas. Cumulative effects are not the total emissions produced in a day or a year, but rather the concentration of all fire emissions in a given airshed at a given time. For NAAQS these concentrations have a varying time weighted period depending on the pollutant. For PM10 and PM2.5, they are measured as a 24 hour average, and as an annual arithmetic mean (Kleindienst 2012). The area of analysis discussed for air quality includes all three forests, the Verde River Airshed, the Lower Salt River Airshed, and the Little Colorado River Airshed (Figure 54).

The season for broadcast burning is about April through October, pile burning is most often done in the winter months, and wildfires generally occur from April through October. More acres are proposed to be burned in the implementation than are currently being burned annually on all forests, so there would be prescribed burning on more days each year. However, after the first entry burn, fuel loads would be significantly decreased, so potential tons/acre of emissions would be significantly lower. Additionally, because of the decrease in fuels, fire behavior potential would also be significantly lower, so there would be more potential to burn on days with better smoke dispersal (higher winds and more lift).

The action alternatives propose prescribed burning at different levels. There are too many variables affecting the concentration of smoke at specific locations for a given prescribed fire for a spatially explicit evaluation on the scale of this project a year (or more) in advance of implementing a burn. Burn Plans are tiered to the NEPA document for which they direct prescribed fire implementation, and include spatial modeling that identifies what effects are expected where, and helps determine conditions that would produce the desired results to minimize impacts from emissions. It is reasonable to assume there is a correlation between the amount of smoke produced in a fire, and the potential for that smoke to produce undesirable impacts.

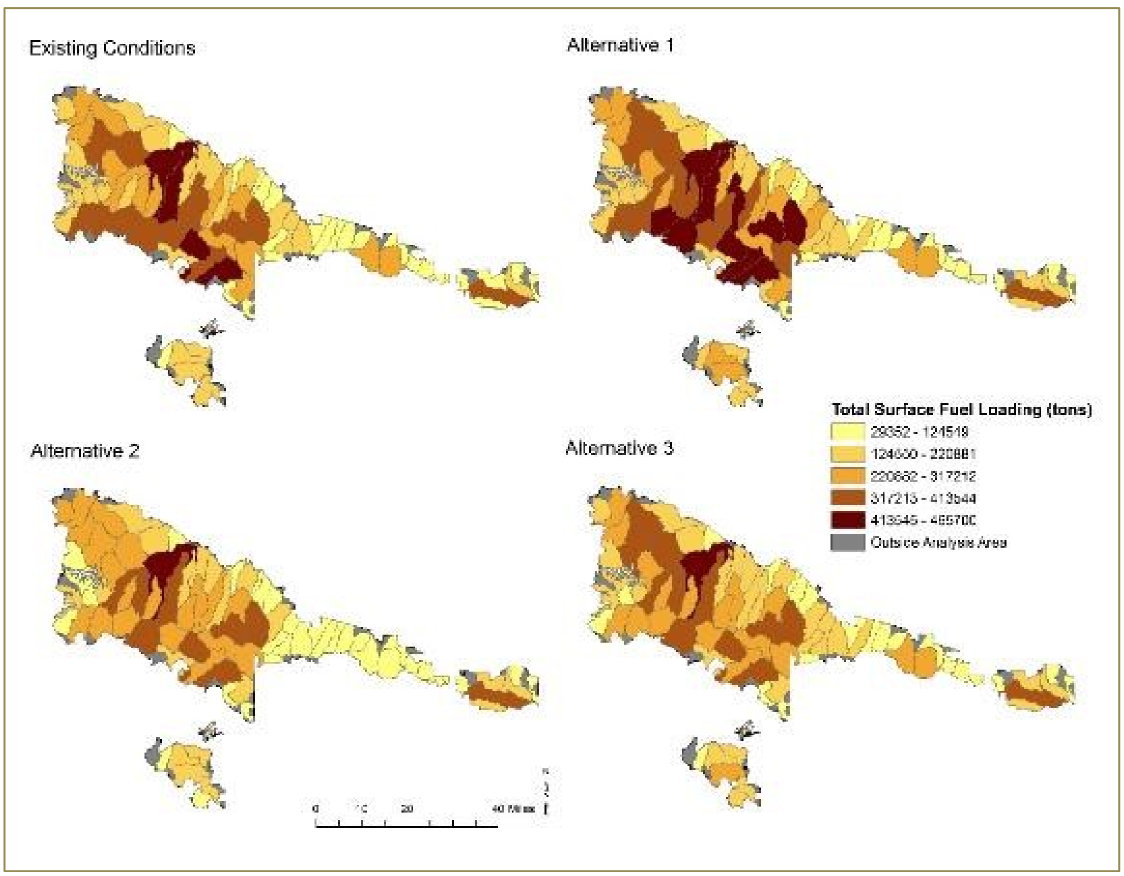


Figure 79. Surface fuel loading comparison

Cumulative Effects

Cumulative effects related to fire ecology and air quality are incremental impacts of an alternative when added to the effects of other past, present, and reasonably foreseeable future actions. These include the effects of wildfire and vegetation management activities (mechanical treatments, & prescribed fire) on fire behavior and associated fire effects, including air quality.

Geographic Scope - Cumulative effects of wildfires and other projects are considered for the approximately 1.24 million acre Rim Country project area.

Temporal Scope - This analysis primarily considered the past 10 years (2009-2018) of associated activities. This time period is based on recovery times and fuel accumulation rates associated with the ecological systems present in the Rim Country area. This analysis considered a 10 year time frame to reflect future and reasonably foreseeable activities at which time the majority of the actions proposed will have been completed.

Past Actions

Wildfire

Nearly all area of the cumulative effects analysis area has been influenced or altered by past modifications to natural fire regimes as a result of fire suppression and livestock grazing. The culmination of these impacts over more than a century has resulted in the contemporary conditions found throughout the Rim Country project area. While the primary focus of this cumulative effects analysis focusses on the previous 10 years of wildfires and activities, it is important to note the role that past management has had on influencing this landscape and creating undesirable and unnatural conditions.

From 2009 – 2018, a total of 81 large wildfires[6] burned within the project acre, representing a total of 217,780 acres burned (Figure 80). Many of the wildfires that burned within the project area in the last 10 years were managed primarily for beneficial resource objectives (as opposed to being managed primarily for suppression objectives). These accounted for 38 wildfires totaling 126,310 acres burned within the project area. Other fires may have had some resource benefit management objectives as well, however the information needed to assess this is not readily available. The fire severity of the 38 wildfires managed primarily for resource benefit was mostly low and moderate.

[6] The USFS and the National Interagency Fire Center define 'large fires' as fires of at least 300 acres in size for grass or shrub fuels, or at least 100 acres in size in timber fuels (USDA 2014a). This analysis includes all fires that occurred from 2009 through 2018 and were at least 100 acres in size.

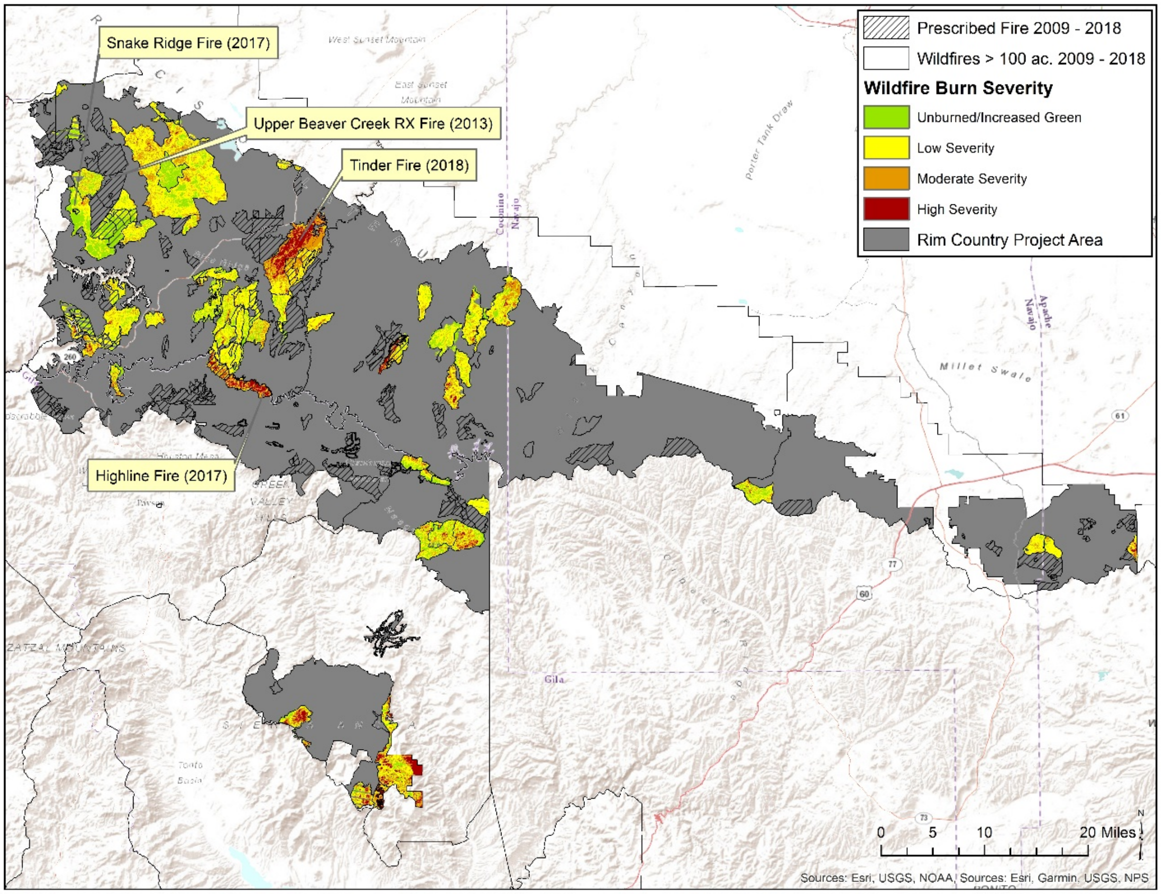


Figure 80: Recent Wildfire and Prescribed Fire (2009 – 2018) and the associated wildfire burn severity

However, high severity fire has continued to occur within the Rim Country area. In the past 10 years, approximately 12,193 acres burned at high severity within the project area. The Tinder fire (managed for suppression) burned with 27 percent (4,328 acres) high severity, and 33 homes were destroyed. The Highline fire (also managed for suppression) burned with 18 percent high severity. Post fire debris flows initiated in part from the Highline Fire claimed the lives of 10 people and caused significant damage to the watershed. These fires demonstrate some of the negative impacts associated with high severity fires.

Vegetation Management Activities

Within the cumulative effects analysis area, there were approximately 164,232 acres of mechanical thinning and approximately 259,661 acres of prescribed fire acres within the past 10 years (Table 45).

Table 45: Acres of past, present and reasonably foreseeable projects with cumulative effects for fire, fuels and air quality.

Treatment Type	Past Projects (approximate acres)	Current Projects (approximate acres)	Reasonably Foreseeable Projects (approximate acres)	Combined Past, Present and Reasonably Foreseeable Projects (approximate acres)
Mechanical Vegetation Management	164,232	417,551	124,434	*706,217*
Prescribed Fire	259,661	383,541	64,710	*707,912*
Other Activities*	51,072	40,379	93,147	*184,598*
Totals	**474,965**	**841,471**	**282,291**	***1,598,727***

*Other activities include but not limited to fuels chipping, range forage improvement or manipulation, range vegetation control, wildlife habitat improvement, tree encroachment control, tree release, fuels compaction, special products removal, insect control and prevention planting, fuel break creation, cultural site protection, scarification and seeding, pruning, and salvage.

These past activities have, and will continue to moderate potential wildfire effects for the cumulative effects analysis area. This was demonstrated by the Upper Beaver Creek prescribed fires completed in 2013. These treatments allowed for the 2017 Snake Ridge wildfire to be managed for beneficial resource objectives, and influenced the final fire perimeter. Objectives of these projects include fuels reduction, maintenance burning, recreating historic stand conditions in PJ (mixed severity), and reducing the risk of stand replacement fire and the rate of spread, intensity, and severity of wildfires that do occur.

In general, the past management actions have decreased the potential for active crown fire, crown fire initiation and high severity fire effects on the acres treated and/or burned by wildfire. Across the cumulative effects analysis area other projects have affected vegetation in similar ways to those described under this project's alternatives, though there are some variations in treatments, particularly for the older fuels treatments. Past mechanical and prescribed fire treatments have decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels. Prescribed fire and low severity wildfires further decreased the potential for crown fire, by removing additional ladder fuels, decreasing canopy bulk density, and raising canopy base height. Maintenance burning and wildfires decreased surface fuel loading in most areas burned, decreasing the potential intensity of subsequent fires in those locations.

Air Quality: Past treatments and wildfires have decreased the potential emissions by removing canopy fuels, mostly from thinning, but also some from wildfire and prescribed fire. Low to Moderate severity fire would have consumed surface fuels, further decreasing potential for emissions on about 205,587 acres. Where wildfires burned with high severity (~12,193 acres in and adjacent to the project area), fine canopy fuels (needles and small twigs) were consumed leaving tree stems and branches, some of which have fallen and are now Coarse Woody Debris which have the potential to smolder for days, or weeks.

Present and Reasonably Foreseeable Actions

Current, ongoing, and foreseeable projects within the Rim Country project area include 448,251 acres of prescribed fire and 541,985 acres of mechanical vegetation management (Table 19). Some of these projects are in the early stages of proposal development or are presently on hold, so their implementation is reasonably foreseeable but not assured. The acreages shown under mechanical vegetation management and fuels treatments are not all mutually exclusive. There are many acres on which proposed fuels treatments (mechanical and prescribed fire) overlap with proposed mechanical vegetation management treatments.

Alternative 1

Effects of the Alternative

Alternative 1 would continue to maintain 977,656 acres with increasing potential for high severity fire effects and behavior, though the effects would be mitigated to some degree by current and reasonably foreseeable projects, and any beneficial wildfires that may occur in the future. Alternative 1 would not contribute to improving the structure, composition, and patterns within the area proposed for treatment.

Effects of Other Actions

Fuel treatments have been, and continue to be implemented in WUI closest to major population centers, but much of the landscape is still vulnerable to undesirable fire behavior and effects, including changes in site productivity, loss of critical habitat, flooding, erosion, weed infestations, damaged infrastructure, and the longer term effects of having thousands of acres of dead trees nearby for decades.

Within the area considered for cumulative effects for fire ecology and air quality, other actions will contribute to some improvement in landscape conditions. However, these improvements would be much less than those predicted for the action alternatives. Improvements would be primarily localized, within individual project boundaries, and collectively do less to move the broader landscape towards desired conditions. Alternative 1 would lead to less spatial continuity between treatments when compared to the action alternatives. At the landscape scale, it would not put the ponderosa pine and associated vegetative systems on trajectories towards being resilient or sustainable.

Cumulative Effects

Under Alternative 1, the treatment area would continue develop unnatural densities and fuel loading, increasing the potential for undesirable fire behavior and effects when wildfires occur. When fires did occur, many would have potential for extreme fire behavior and could produce large areas of high severity fire effects. These impacts could extend well outside of the treatment area as fires that start within the proposed treatment area may pose difficulties for control and spread to adjacent lands. Many fires starting within the untreated project area would have potential to spread outside of the treatment area. Increased potential for extreme fire behavior would put lives, property, infrastructure, and natural resources at risk. Effects would also extend well beyond the perimeters of the fire, and would include such effects as flooding, debris flow, sedimentation, decreased water quality and quantity, decreased soil productivity, and other effects of fires burning out of their natural range of variation.

Fire Type

For those areas treated under the past, present and reasonably foreseeable actions, there would be a decrease in potential crown fire. However, the majority of the landscape would remain susceptible to crown fire and associated fire related impacts under Alternative 1.

Fire Hazard Index

Similar to fire type, reductions in fire hazard index are anticipated for areas treated under past, present and reasonably foreseeable actions. While beneficial, these reductions are not sufficient to mitigate the high fire hazard index ratings across the majority of the landscape.

Surface Fuels
Some reductions in surface fuels are anticipated, associated with the areas treated by past, present and reasonably foreseeable actions. However, for much of the cumulative effects analysis area, unnatural levels of surface fuels will continue to build up. When wildfires do occur in these areas of increased surface fuels, additional consumption and associated emissions are expected.

Air Quality & Smoke
Air quality would be unaffected by prescribed fire from the treatment area, however current and foreseeable activities will continue to produce smoke. Emissions from close to 450,000 acres of prescribed fire from current, ongoing, and reasonably foreseeable projects would be managed in compliance with regulations and requirements of the Arizona Department of Environmental Quality (ADEQ). Wildfires occurring in the untreated areas would produce more emissions in areas that were not treated than in areas that were treated, and could augment the effects of prescribed fires (from current and foreseeable projects) on air quality. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park, Sycamore Canyon Wilderness Area.

Alternative 2

Effects of the Alternative
As described in the direct and indirect effects section, treatments proposed in Alternative 2 would move considerable acres toward desired conditions for fire behavior and associated fire effects across the project area.

Effects of Other Actions
Fuel treatments have been, and continue to be implemented in the WUI, closest to major population centers.

Within the area considered for cumulative effects for fire ecology and air quality, other actions will contribute to improvements in landscape conditions. Improvements include localized reductions in crown fire potential, decreases in fire hazard index values, and reduced levels of surface fuels.

Cumulative Effects
When considered with past wildfires, and past, ongoing, and reasonably foreseeable management activities, this alternative would augment the effects of proposed treatments at multiple scales, creating mosaics of potential fire behavior and effects, dominated by low severity fire. The proposed treatments would fill in most of the acres between past, current, ongoing, and foreseeable management activities, creating a more cohesive, contiguous, restored landscape across the project area.

Where past, present and foreseeable wildfires and treatments occur close to treatments proposed in the action alternatives, they serve to augment the moderating effect that the change in fuel structure is predicted to have on wildfires moving though the area by decreasing the acres where high severity fire effects are likely to occur. These combined activities also serve to augment the potential size and locations of burn units for the action alternatives because the moderated fire behavior in burned and/or thinned areas allow prescribed fire to be implemented with broader burn windows and higher intensity fire (if desired) while still meeting control and resource objectives.

Fire Type
Alternative 2 reduces crown fire potential under extreme fire weather conditions from 31 percent under

current conditions to 12 percent within areas proposed for treatment. This reduction, combined with the past, ongoing, and reasonably foreseeable management activities would cumulatively reduce the overall landscape susceptibility to crown fire. When added to other treatments in the cumulative effects area alternative 2 provides for greater connectivity of treated landscapes resulting and the largest overall reduction in crown fire potential as contrasted with alternative 3. As a result, under moderate burning conditions, the majority of the landscape is projected to support surface fire. These cumulative effects provide the biggest improvement of all alternatives in overall firefighter and public safety while allowing fire to play a more natural role across the landscape, and provide opportunities to manage fires for resource benefits across a broader landscape.

Fire Hazard Index

This alternative provides for a significant reduction in moderate to extreme fire hazard index (FHI) ratings, reducing the total area in these categories to 15 percent of the project area from 37 percent. When combined with past, ongoing, and reasonably foreseeable management activities, this alternative provides for additional improvements in FHI over the full cumulative effects analysis area.

Surface Fuels

Cumulative effects on surface fuels under alternative 2 provide for the greatest overall reduction in surface fuels. Cumulatively, this alternative will lead to a reduction in unnatural levels of surface fuels that have built up over time. When wildfires do occur in these areas of reduced surface fuels, consumption and associated emissions are expected to be lower than they would have been without the combined treatments.

Air Quality & Smoke

The cumulative effects under Alternative 2 include the greatest number of acres being treated with prescribed fire across the cumulative effects area. Cumulatively, this alternative combined with current and reasonably foreseeable activities will result in an annual average of more than 140,000 acres of prescribed fire (though annual amounts may vary considerably). The overall impacts from this amount of prescribed fire is expected to be more than those associated with alternatives 1 and 3. All prescribed fires would be implemented in compliance with ADEQ regulations and requirements as well as forest plan direction to meet legal standards and provide for public safety.

Emissions from prescribed fires proposed in Alternatives 2 would utilize many of the same burn windows that the nearly 450,000 acres of current, ongoing, and reasonably foreseeable prescribed fire projects would use. However, the increased acres of prescribed fire would allow more flexibility for implementation, and may make it possible to burn more acres at once with the same impacts to air quality.

Areas with potential for air quality impacts include the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Petrified Forest National Park, Sierra Anches Wilderness Area and Mazatzal Wilderness Area. As more acres are treated, there would be broader burn windows, potentially resulting in more days of prescribed fire and days of air quality impacts when added to prescribed burning occurring in the cumulative effects boundary.

Alternative 3

Effects of the Alternative

As described in the direct and indirect effects section, treatments proposed in Alternative 3 would move considerable acres toward desired conditions for fire behavior and associated fire effects across the project area.

Effects of Other Actions

Fuel treatments have been, and continue to be implemented in the WUI, closest to major population centers. Within the area considered for cumulative effects for fire ecology and air quality, other actions will contribute to improvements in landscape conditions. Improvements include localized reductions in crown fire potential, decreases in fire hazard index values, and reduced levels of surface fuels.

Cumulative Effects

Fire Type

Alternative 3 reduces crown fire potential under extreme fire weather conditions from 31 percent under current conditions to 18 percent within areas proposed for treatment. This reduction, when combined with the past, ongoing, and reasonably foreseeable management activities will serve to reduce the overall landscape susceptibility to crown fire. Cumulatively alternative 3 when combined with prescribed fire from other projects provides for less connectivity of treated landscapes, though portions of areas not proposed for treatment remain susceptible to crown fire. As with Alternative 2, under moderate burning conditions, the majority of the landscape is projected to support surface fire. The cumulative effects will improve overall firefighter and public safety while allowing fire to play a more natural role across the landscape, and provide opportunities to manage fires for resource benefits across a broader landscape, though to a lesser degree than alternative 2.

Fire Hazard Index

This alternative provides for a significant reduction in moderate to extreme FHI ratings, reducing the total area in these categories to 22 percent of the project area from 37 percent. When combined with past, ongoing, and reasonably foreseeable management activities, this alternative provides for additional improvements in FHI over the cumulative effects analysis area.

Surface Fuels

Cumulative effects on surface fuels under alternative 3 provide for considerable reduction in surface fuels. Cumulatively, this alternative will lead to a reduction in unnatural levels of surface fuels that have built up over time. However, areas left untreated will continue to accumulate unnatural fuel loading, and when wildfires do occur in these areas, elevated consumption and associated emissions are expected.

Air Quality & Smoke

Cumulatively, alternative 3 combined with current and reasonably foreseeable activities will result in an annual average of more than 97,000 acres of prescribed fire (though annual amounts may vary considerably). The overall impacts from this amount of prescribed fire is expected to be nearly a third less than those associated with alternative 2, but more than alternative 1.

Additionally, the potential for higher overall emissions associated with wildfires burning in areas not identified for treatment under Alternative 3 will result in more emissions in these areas than alternative 2. All prescribed fires would be implemented in compliance with ADEQ regulations and requirements as well as forest plan direction to meet legal standards and provide for public safety. Emissions from prescribed fires proposed in Alternatives 3 would utilize many of the same burn windows that the nearly 450,000 acres of current, ongoing, and reasonably foreseeable prescribed fire projects would use over the next 10 years. However, the increased acres of prescribed fire would allow more flexibility for implementation, and may make it possible to burn more acres at once with the same impacts.

Areas with potential for impact include the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Petrified Forest National Park, Sierra Anches Wilderness Area and Mazatzal Wilderness Area. As more acres are treated, there would be broader burn windows, potentially resulting in more days of prescribed fire and days of air quality impacts when added to prescribed burning occurring in the cumulative effects boundary

Climate Change

All Alternatives

Climate change is expected to result in extreme weather conditions, with more extreme droughts and higher temperatures, making conditions for undesirable fire and insect outbreaks even more prevalent in the western United States. As a part of current, ongoing, and reasonably foreseeable management actions, there would be prescribed fire and mechanical thinning adjacent to, or within, the 4FRI Rim Country project area. Thinning, prescribed burning, or allowing wildfires that produce only low to moderate-severity effects reduces on-site carbon stocks and releases carbon into the atmosphere at a lower rate than high-severity fire.

Carbon sequestration is an important dynamic of climate change that has been and continues to be affected by current and past forest management. Fire suppression practices have changed the dynamics of fire in ponderosa pine forests across the southwest, resulting in greater fuel-loads and increased risk of uncharacteristic fire. Although current conditions, with dense forest stands can sequester more carbon than open forests, shrublands, or grasslands, it is not a stable state. These forests are prone to increasingly large, high severity wildfires, which release a pulse of carbon emissions, shifting carbon storage from live trees to standing dead trees and woody debris (North et al. 2009). Kolb et al. (2007) have shown that biomass and carbon may fail to recover; the Horseshoe Fire was still a net carbon source fifteen years after the fire. Savage and Mast (2005) showed that these conditions can persist for decades.

High severity fire in ponderosa pine forests releases large quantities of CO2 to the atmosphere. The emissions below are associated with ponderosa within an existing, healthy fire regime. Far more carbon is stored in the healthy ponderosa pine forest than the area recovering from a high severity fire.

Both thinning and prescribed burning would help to mitigate the negative effects of stand replacing fire in dry, dense forests, by consuming less biomass and releasing less carbon into the atmosphere (Finkral and Evans 2008, Wiedinmyer and Hurteau 2010). They found that while the treatment initially produced a 30 percent reduction in the carbon held in trees, it significantly reduced the threat of an active crown fire, which they predicted would kill all the trees and release 3.7 tons of carbon per acre in any untreated areas. Such findings are especially important when one considers that climate change is expected to cause conditions that support uncharacteristic fire and insect outbreaks to become even more prevalent in the western United States. Thinning, prescribed burning, or allowing wildfires that produce only low to moderate severity effects reduces on-site carbon stocks and releases carbon into the atmosphere at a lower rate than high severity fire.

Heritage Resources

A summary of the heritage resource analysis is presented here and the complete heritage specialist report (Hangan 2018) is incorporated by reference.

Affected Environment

Within the Rim Country project area, cultural resources range temporally from prehistoric times through the historic period and into modern times. Prehistoric sites can include rock art, cliff dwellings, pithouses, multiple room pueblos and artifact scatters. Historic resources may consist of logging railroad grades, trails and historic roads, cabins and homesteads, Forest Service administrative sites, Basque sheep camps, mining camps, Civilian Conservation Corps sites, and Native American shelters such as sweat lodges and brush shelters. Cultural resources also include Native American traditional use areas and places known as Traditional Cultural Properties. These hold a central and important place in Native American culture.

The existing condition for cultural resources is determined by the number of existing heritage inventories within the analysis area, in addition to the amount and/or types of resources, and cultural periods represented by those resources, that have been identified within the boundaries of the EIS. Table 46 was generated by the Apache-Sitgreaves and Coconino National Forests using their heritage GIS databases, while the Tonto used their hard copy heritage atlases.

Table 46. Cultural resource sites and surveys

Forest Name	Acres Previous Survey	Cultural Resources Recorded	National Register Listed Sites	NR eligible Sites	Unevaluated Sites	Site Previously Evaluated Ineligible
Apache-Sitgreaves	104,474	3,012	6	795	2,026	57
Coconino	97,900	946	2	148	774	22
Tonto	29,226	1100	2	388	621	91

Apache-Sitgreaves National Forests

The Rim Country EIS Area of Potential Effect includes 539,942 acres of the Apache-Sitgreaves National Forests, 401,911 acres on the Black Mesa Ranger District (65 percent of the district) and 138,031 acres on the Lakeside Ranger District (51 percent of the district). According to current geographic information systems (GIS) data, forest archaeologists have surveyed 90,929 acres, approximately 17percent of the 539,942 acres in the Rim Country project area.

Three thousand and twelve (3,012) cultural resources have been recorded, 1,694 on the Black Mesa Ranger District and 1,318 on the Lakeside Ranger District, of which six are listed on the National Register of Historic Places, 795 were determined eligible for inclusion on the National Register, 2,026 are unevaluated for eligibility, and 27 have been determined not eligible for inclusion on the National Register. Most of the sites recorded are prehistoric or protohistoric in nature (84 percent), followed by historic sites (12 percent), 74 sites of unknown affiliation (2½ percent), and multi-component sites with historic and prehistoric artifacts/features (1½ percent). Site types represent a full range of human occupation, from Paleoindian sites of the Pleistocene to a wide variety of historic period sites dating to 50 or more years ago.

Coconino National Forest

The Rim Country EIS Area of Potential Effect includes 398,860 acres of the Coconino National Forest, 389,482 acres on the Mogollon Rim Ranger District and 9,378 acres on the Red Rock Ranger District. Within this area, forest archaeologists have surveyed 97,900 acres, approximately 25 percent of the 398,860 acres in the Rim Country project area. Archaeologists have identified 946 cultural resources, of which two are listed on the National Register of Historic Places, 148 were determined eligible for inclusion on the National Register, 774 are unevaluated for eligibility, and 22 have been determined not eligible for inclusion on the National Register.

Most of the sites recorded on the Coconino are prehistoric in nature (78 percent), followed by historic sites (20 percent), multi-component sites with historic and prehistoric artifacts/features (16 percent), and four sites of unknown affiliation. The majority of the prehistoric sites are lithic scatters (47 percent) and scatters with lithic artifacts and ceramics (21 percent). Other prehistoric sites include sites with house features: field houses, pueblos, pithouses, cliff dwellings, or other house features (20 percent), caves/rockshelters/cavates (3 percent), agricultural fields (3 percent), and rock art sites (4 percent). The 189 historic sites include those associated with national forest management (21 percent), logging or sawmills (7 percent), ranching (47 percent), historic trails or wagon roads (6 percent), mining (3 percent), military (3 percent), historic burials (3 percent), and trash dumps that may be related to one or several of these historic activities (10 percent).

Tonto National Forest

The Rim Country EIS Area of Potential Effect includes 290,090 acres on the Payson and Pleasant Valley Ranger Districts of the Tonto National Forest. Within this area, forest archaeologists have surveyed 29,226 acres, approximately 10 percent of the 290,090 acres in the Rim Country project area. Archaeologists have identified 1100 cultural resources, of which two are listed on the National Register of Historic Places, 388 were determined eligible for inclusion on the National Register, 621 are unevaluated for eligibility, and 91 have been determined not eligible for Assumptions and Methodology

Assumptions and Methodology

The primary assumption for this effects analysis is that the removal of fuel from archaeological sites and improving or decommissioning roads is a benefit to cultural resources. These activities could protect cultural resources from the effects of extremely hot, highly destructive wildfires by removing fuel from around and off of archaeological sites. Improving or decommissioning roads could protect archaeological sites by removing roads that go through sensitive sites. Improving rough, impassible roads could reduce the threats to archaeological sites from off-road driving. This would also encourage drivers to remain on roads rather than drive cross-country to avoid bad spots in roads. However, the methods for accomplishing these tasks, such as mechanical thinning or ripping of roads, also has the potential to adversely affect cultural resources.

The secondary assumption is that cultural resources would be present at the proposed spring, riparian, or stream restoration locations. Cultural resources are frequently found in association with water sources such as springs, streams, and riparian areas. Water sources would have been exploited prehistorically and during historic periods. A reliable spring, for example, would likely have been developed to supply stock grazing, logging operations, or farming.

The final assumption is that all activities proposed with the Rim Country EIS would meet the criteria of a No Adverse Effect determination as defined in the Programmatic Agreement and/or 36 CFR 800.6 where appropriate.

In consultation with the AZ SHPO, the forests are going to rely on multiple guidance documents and strategies to assist in reaching a No Adverse Effect determination. The primary guidance would be Appendix J of the Programmatic Agreement. Appendix J of that agreement outlines the consultation protocols and strategies for implementing large-scale fuels reduction, vegetation treatment, and habitat improvement projects.

To supplement Appendix J, in consultation with the AZ SHPO and tribes, the Rim Country forests created a sample survey strategy specifically for vegetation projects that would involve mechanical treatments (Morgan et al 2017). Appendix J of the Programmatic Agreement provides guidance for mechanical treatment. However, it does not distinguish between the various types of mechanical treatment options, for example, feller-buncher versus agra-ax, nor does it take into account existing site inventory data or identified high and low site densities areas. A model was created using terrestrial ecological unit strata and known site densities within the project area. The model, amount of existing inventory within a task area and the type of proposed mechanical treatment would all be taken into account when determining the amount of inventory necessary and any standard mitigation measures that need to be implemented to meet the criteria of No Adverse Effect.

The Programmatic Agreement would guide the analysis for the remaining activities proposed in the Rim Country EIS. The one exception would be road improvement and decommissioning. Some Forest roads are known to cross archaeological sites and they often have exposed artifacts and cultural features in the road beds. Improving or decommissioning roads usually involves some level of mechanical work such as grading or ripping road beds. The forests, in consultation with the AZ SHPO and tribes, developed a road plating protocol. This protocol outlines procedures for "plating" or covering the portions of sites within road beds that have remaining features or intact cultural deposits. This would help to protect intact cultural remains in the roads from blading or other types of maintenance or decommissioning activities.

Phased Section 106 Compliance

Because of the size of the undertaking, implementation would be phased over several years. Appendix J, reviewed by the AZ, NM, TX and OK SHPOs, the ACHP, and tribes, allows for the phasing of the Section 106 compliance. Appendix J of the Programmatic Agreement and the Rim Country Sampling Strategy, developed in consultation with tribes and the AZ SHPO, describes the methods to be used to achieve a No Adverse Effect determination for the Rim County analysis as a whole, while providing a strategy for a phased Section 106 evaluation for individual task orders.

Individual task orders, or undertakings, would be inventoried when each specific project area is identified. A Section 106 report would be produced for each proposed individual undertaking, and all consultation with the AZ SHPO and appropriate tribes would be completed prior to implementing the task order.

Environmental Consequences

Alternative 1 – No Action

Under Alternative 1, existing fuels in and around archaeological sites would continue to increase. This could result in more frequent and intense wildfires which could result in site and artifact damage such as spalling of rock art and cracking of artifacts. Fire suppression actions, particularly bulldozer operations, could damage or completely destroy surface and subsurface (pit houses/kivas) archaeological sites, resulting in the loss of those resources and their research potential.

Soil erosion due to uncharacteristic wildfires could have both direct and indirect effects on heritage resources. Rain and snow melt could cause channels to form within denuded sites, or mud slides from nearby slopes could deposit soil and debris within site boundaries, leading to the loss of data potential and the characteristics that would make a heritage property eligible for the National Register of Historic Places.

Archaeological sites located within open grass lands would be affected by an increased number of trees growing inside the site boundaries. The trees and their root systems might displace surface and subsurface artifacts and features. Also the trees would increase the amount of fuel on the sites. This might result in effects from intense wildfires.

Forest system roads that cross archaeological sites would continue to affect the sites by degrading cultural deposits and features within road beds located inside site boundaries. Also, when roads are not well maintained, users may drive off existing roads to avoid "bad spots" and could affect cultural sites adjacent to the roads.

No action might also result in the reduction over time of pre-European settlement-adapted native plants, some of which have been collected since historic times by Native Americans for food and medicine. Additionally, springs, seeps, and riparian areas are important locations to Native Americans and other members of the public, and increasingly overstocked forests might have some effects on those historic water sources.

Effects Common to Both Action Alternatives

Each of the alternatives recommends a substantial amount of ground disturbance, particularly mechanical treatments as part of thinning trees, grassland restoration, blading in new temporary roads, maintaining existing roads, or decommissioning roads. Other activities such as stream and riparian restoration, and the installation of barriers around springs, aspen, and other native trees may also include-ground disturbing activities. Riparian areas and water sources like streams and springs tend to be locations where the presence of cultural resources can be reliably predicted. All of these activities have the potential to adversely affect cultural resources. Effects could include rutting, erosion, dislocation, or breakage of artifacts and features, and destruction of sites and site stratigraphy.

Prescribed burning also has the potential to affect sites. If the burning is low to moderate in heat intensity, and there is little fuel on the sites, most sites located inside the project area would be minimally affected, if at all, with the exception of sites that include wood elements or rock art. Sites within the project area with a significant amount of fuel in a prescribed burn area could be affected by heat damage in the same manner as a wildfire if the fuel is not removed prior to burning. Effects from heat damage would include breaking, pocking, and spalling of ground stone tools and architectural features. Excessive heat could alter obsidian hydration rinds, destroying their dating potential and the associated loss of scientific information. Effects on structural components such as rock walls or rock faces include discoloration, cracking, and spalling, making the rocks susceptible to accelerated deterioration. There is also the potential for effects from soil erosion due to the removal of vegetation. Rain and snow melt, for example, could cause channels to form within denuded sites. Mud slides from nearby slopes could deposit soil and debris inside site boundaries, leading to the loss of data potential and the characteristics that would make a heritage property eligible for the National Register of Historic Places. The majority of the effects listed above can be mitigated through project design, avoidance, removing fuel from sites prior to project implementation, and implementing site protection measures (see Appendix C).

Thinning and prescribed burning should reduce unnatural fuel loading around and inside the boundary of National Register listed or eligible heritage resources. Uncharacteristic fire behavior should also be reduced by these treatments, which would help to prevent extensive heat damage from future wildfires. There would be less need for fire suppression activities during a wildfire, and consequently less of a threat from ground-disturbing activities, such as bulldozer fire-line construction.

Initial reduction of heavy fuels may lead to an increase in site visibility, public visitation, and possible vandalism. Those issues are mitigated through management actions that include project-specific as well as long-term monitoring. Initial entry prescribed burns should be periodically revisited and burned to reduce natural fuel accumulations, and archaeological site monitoring is part of that process. Road decommissioning can also assist in limiting access to some archaeological sites, thus minimizing post-burn visibility and visitation issues at those sites.

The proposed temporary road construction, road maintenance, and road decommissioning do have the potential to affect cultural resources. The Programmatic Agreement includes mitigation measures that would help protect cultural resources affected by system roads identified for maintenance or decommission. The locations of temporary roads would be inventoried prior to implementation and any potential effects to sites would be mitigated through avoidance or project redesign. Decommissioning activities, if contained within the road beds and not inside site boundaries, should have no effects on cultural resources. In those cases where road maintenance or decommissioning might occur within National Register listed or eligible cultural resources, a site plating strategy should be used that has been developed in consultation with the AZ SHPO and tribes[7]. The protocol includes mitigation measures to protect any existing cultural deposits or features present within the road beds or along road cuts.

Restoration activities for grasslands, riparian areas, and streams do have the potential to effect cultural resources. Grasslands tend to contain low densities of archaeological sites. Some restoration activities, such as the use of an agra-ax to remove encroaching trees, though a mechanical treatment, are known to disturb little of the ground surface. Therefore grassland restoration activities are less likely to adversely affect cultural resources. Where sites are present, mitigation measures listed in the Programmatic Agreement and design features in Appendix C would be implemented.

Springs, streams, and riparian areas are known to be very sensitive for the presence of cultural sites and culturally important plants. Restoration activities that are highly ground-disturbing would affect cultural resources. The Programmatic Agreement lists mitigation measures that should be implemented to minimize effects on cultural sites.

Project implementation may affect some Native American uses as tribal members commonly access forest lands for ceremonial activities and to gather forest products. Access concerns can be addressed through on-going consultation between the Forest Service and Native American groups.

There is the possibility that cultural resources would be discovered during project implementation. These inadvertent discoveries would be handled, in consultation with AZ SHPO and tribes, following the guidance in Appendix J of the PA and 36 C.F.R 800.12., if appropriate.

Effects Unique to Each Action Alternative

The action alternatives propose essentially the same activities, ranging from various mechanical treatments, comprehensive restoration, and various types of road work. The major differences involve the amount of each activity being proposed. From a cultural resources stand point, there are no effects that are unique or different between the alternatives. Effects on cultural resources are highly dependent upon the proposed activity, its location, and the likelihood of the presence or absence of cultural resources in the proposed treatment area. Therefore, mechanically thinning *889,340 acres versus *483,160 acres only matters in that fewer acres proposed for mechanical treatment means less of a threat of effects on cultural resources from this activity. However, it also means less fuel removed, thus less protection to cultural resources from the effects of high intensity wildfires.

Effects from Rock Pit Use and Expansion

Approximately nine existing rock pits on the Coconino National Forest are being proposed for use within the Rim Country project area. On the Apache-Sitgreaves National Forests, 11 sites are proposed for use.

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7 The region is in the process of working on adding this strategy as a protocol to the R3 PA. Until that time, AZ SHPO agreed that this plating strategy can be used within the 4FRI Rim Country area.

The rock pits would be used as a source of gravel for various road maintenance activities. Their access roads might undergo some level of maintenance and the pits might be expanded in various directions to a maximum of 500 feet, where needed to increase their capacity to yield material. The rock pit locations on the Coconino were evaluated for Section 106 as part of the Rock Pits EA (USDA 2016). Unlike the pits on the Coconino, the rock pits on the Apache-Sitgreaves have not been evaluated for Section 106 compliance beyond their current operations. According to the forest's cultural resource database, Carr Lake, Brookbank, Borrow, and Cottonwoods Wash pits all have cultural resources that would need to be mitigated before and expansion of the pits.

Rock pit operations and expansions have the potential to affect cultural resource sites adjacent to the rock pits and their access road locations. Erosion by mass wastage, slope wash, and wind over many years can strip cultural deposits from archaeological sites, remove or displace artifacts, and undermine historical structures. Ground disturbances adjacent to cultural resource sites may accelerate erosion by damaging vegetation, loosening stable soil surfaces, or compacting soils, and thereby promote surface runoff. Vehicle tracks tend to channel surface runoff, causing down-cutting and increased soil erosion. These effects are expected to be avoided at cultural sites near rock pits through pit expansion design and avoidance measures such as erecting temporary fences around sites during periods of operation.

It is possible that increased truck traffic to and from proposed rock pits could result in indirect erosion effects on a small number of sites that occur adjacent to access roads. Keeping these roads well maintained would be expected to limit these effects.

The risk of unauthorized collection of artifacts would increase due to the presence of project personnel in areas where the locations of heritage resource sites are clearly marked. Unauthorized removal of materials from heritage resource sites could result in the loss of objects with cultural importance to Native American groups, or of artifacts needed to determine the age and nature of the occupation at prehistoric sites. This would be mitigated by requiring that sites identified near the pit operation areas are recorded in detail, then monitored after the operations are completed.

Effects from Use of In-woods Processing and Storage Sites

Twelve locations have been identified as potential processing and storage areas within the Rim Country project area on the Coconino and Tonto National Forests.

The storage and processing areas located on the Coconino National Forest are within the Cragin Watershed Protection project area. These areas were assessed as part of the Cragin heritage evaluation. Mitigation measures and design features for the Cragin Environmental Assessment parallel those listed in the Programmatic Agreement and Appendix C of this Rim Country EIS and would be implemented prior to project implementation. If the proposed processing and storage areas are selected for use, the Mogollon Rim Ranger District archaeologist would review the existing inventory for that location and would ensure that mitigation measures for the Cragin Project are implemented, if needed.

The potential locations on the Tonto National Forest would likely be utilized for task orders or contracts in those areas. The evaluation for all of the processing and storage locations would follow the processes outlined in the design features in Appendix C. Otherwise the guidance within the Programmatic Agreement would be used. Proposed mitigation measures would be implemented prior to the areas being used. With the implementation of standard mitigation measures and design features, there should be no adverse effects on cultural resources due to the use of these locations as storage and processing areas.

Effects from Forest Plan Amendment(s)

Three plan amendments were added to the Tonto National Forest Plan. They removed language restricting mechanical equipment on slopes of over 40 percent, amended Plan language and components to align with the Mexican Spotted Owl Recovery Plan, and redefined the treatment for ponderosa pine vegetation types. Of these three amendments, removing restrictions for mechanical equipment on slopes of less than 40 percent has the most potential to affect cultural resources and the methods for conducting Section 106 analysis.

Sensitive cultural resources such as rock art and rock shelters tend to be located on 40 percent or greater slopes of small hills, rock out-croppings and mountain slopes. However, because steeps slopes are typically not treated mechanically, Appendix J includes provisions that would allow for exempting slopes 40 percent or greater from intensive archaeological inventory. The Rim Country alternatives will include treatment of slopes up to 40 percent. This increases the likelihood of impacts to the types of cultural resources found in those locations. It also means that the archaeological analysis will need to include an intensive inventory of the steep slope treatment locations.

Cumulative Effects

The cumulative effects analysis area is the Area of Potential Effect for the Rim Country EIS.

Alternative 1 – No Action

If this proposed large scale, landscape level forest health project is not implemented, there would still be some serious cumulative effects on heritage resources. High intensity wildfires and the construction of fire breaks using bulldozers during a wildfire could severely damage sites. Wildfires could also sterilize the soil or completely remove ground fuels, making the sites vulnerable to soil erosion. Also, because sites are more visible after a fire, they are much more susceptible to vandalism. Soil erosion from dry channels that are within or adjacent to sites could continue to affect a site's cultural stratigraphy and displace much cultural material. Roads through sites would continue to degrade cultural deposits and features. Trees would continue to encroach into grasslands and displace artifacts and cultural deposits within sites.

Effects Common to Both Action Alternatives

Cumulative effects from mechanical treatments, temporary road construction, and other ground-disturbing activities, as well as effects caused by prescribed burning, would be mitigated using site protection measures identified in Appendix C, Appendix J of the Programmatic Agreement, the Rim Country Sample Survey Strategy, and the Site Plating Strategy. These include archaeological monitors during mechanical activities, keeping ground-disturbing activities out of sites by flagging and avoiding the sites, and post prescribed burn site monitoring to assess the effects of the low-intensity burns. Covering cultural deposits and features in road beds within cultural sites prior to maintenance activities or during decommissioning would protect buried cultural deposits and features. Also, well-maintained roads would encourage the public to remain on roads and deter cross-country travel which could damage sites located near roads. Because all ground-disturbing and prescribed fire undertakings go through the Section 106 review process, and identified potential effects would be mitigated, the overall cumulative effects from these undertakings should be minimal. Therefore, there should be few cumulative effects on cultural resources as a result of the activities proposed for the Rim Country Project.

There is the possibility of cumulative effects from archaeological site vandalism that results from increased visibility once the project is implemented. However, the management practice of implementing low to moderate-intensity prescribed fire typically does not sterilize soil or completely remove ground fuels, as does a high-intensity wildfire. Low-intensity fires also tend to leave some trees in place that would eventually cover the surface with a recurring needle cast. Sites are also periodically monitored both during project implementation, as well as for NHPA Section 110 purposes, by agency and volunteer personnel. Proposed road closures would also reduce public access to some of these areas.

The likelihood of erosion on cultural resources is also minimal. Reducing fuel loads and implementing low to moderate-intensity prescribed fires does not cause soil sterilization or hydrophobic soils like high-intensity wildfires. As noted previously, low-intensity prescribed fires leave some vegetation in place and re-vegetation occurs soon afterwards if soils are not sterilized. However, as implementation occurs, archaeologists would monitor for erosion concerns, examining sites in the project areas, especially focused on slopes, drainages, and other high probability areas where cultural resources maybe present.

The proposed restoration activities in grasslands, riparian, streams, and seeps would also have a very limited ability to cause cumulative effects. All of these activities can easily be modified to minimize effects on cultural resources through avoidance or prescription modification. In the case of grasslands, the physical removal of encroaching trees and other fuels would have the added benefit of protecting sites from the effects of wildfire.

Socio-Economics

A summary of the Socioeconomic Report is presented here. The complete specialist report (Jaworski 2019) is incorporated by reference. The analysis describes the current conditions and trends related to the social and economic environment of the planning area, including: population and demographic changes, potential environmental justice populations, and employment and income conditions.

Affected Environment

Population Growth

The planning area counties are home to approximately 530,000 people, which is approximately eight percent of Arizona's population (U.S. Census Bureau 2017). Table 47 displays annual population estimates for the planning area counties and the state.

Table 47. Population Estimates 2010 to 2016

Location	2010	2011	2012	2013	2014	2015	2016
Coconino County	134,624	134,186	135,999	136,641	137,695	139,076	140,908
Gila County	53,539	53,486	53,036	53,039	53,124	53,138	53,556
Navajo County	107,714	107,735	107,037	107,443	108,178	108,363	110,026
Yavapai County	211,139	211,138	212,350	215,027	218,405	221,584	225,562
Arizona	6,408,312	6,467,163	6,549,634	6,624,617	6,719,993	6,817,565	6,931,071

Source: U.S. Census Bureau, Population Estimates, 2017

Arizona was among the fastest growing states between 2010 and 2016, over which period Arizona grew 8.2 percent (U.S. Census Bureau 2017). The counties in the planning area grew more slowly over this period, ranging from 6.8 percent population growth in Yavapai County to no growth in Gila County (U.S. Census Bureau 2017).

Population growth in the planning area may interact with forest management activities. For example, population growth may increase the size of the wildland-urban interface. Wildland-urban interface growth can affect ecological integrity, wildfire suppression costs, and the number of people exposed to smoke emissions.

Wildfire Costs

In 2015 and 2016, federal wildland fire suppression cost approximately $2 billion annually, $1.7 billion of which was spent by the USFS (NIFC 2017). That is a nearly 300 percent increase in cost (inflation adjusted) since 1985 (NIFC 2017). Much of the cost increase has been attributed to the further development of the wildland-urban interface, climate change, and management of forests (suppression, prescribed burns, etc.). Past large wildfires in and around the Rim Country project area have cost tens of millions of dollars to fight. The 2005 Cave Creek Complex Fire alone cost the Forest Service approximately $18 million to fight. In 2016, the Forest Service spent $12 million on the Juniper and Fulton Fires (N. Hale, personal communication, June 7, 2017).

Between 1995 and 2015, the percentage of the Forest Service budget spent on fire expanded from 16 to 52 percent (USFS 2015). Furthermore, suppression costs account for only a fraction of the total cost of wildfires. Wildfires often entail costs associated with rehabilitation, lost property, decreased business revenue, and human health effects. The Western Forestry Leadership Coalition estimates that total wildfire-related expenses, when accounting for a variety of direct and indirect costs, range from two to thirty times the reported suppression expenditures (WFLC 2010).

The rising cost of federal wildland fire operations has caused a shift of agency expenditures from other mission critical activities (for example, restoration, research, and recreation) toward firefighting and fire management (USFS 2015). Reduced funding for recreation, vegetation and watershed management, wildlife and fisheries habitat management, and other non-fire activities limits the ability of the Forest Service to contribute to improvements in ecosystem services and quality of life in nearby communities (USFS 2015). For example, between fiscal years 2014 and 2015, the agency's fire suppression expenditures increased by $115 million while non-fire programs were reduced by the same amount (USFS 2015). Climate change and continued population growth in the wildland-urban interface are expected to contribute to rising fire suppression costs.

Beginning in fiscal year 2020 through fiscal year 2027, the Forest Service fire suppression spending from its regular budget would be capped at just over $1 billion and fire suppression costs in excess of this amount would be funded through an emergency wildland firefighting account rather than through borrowing from other Forest Service program areas (USDA 2018).

Forest Products Industry

Table 48 shows the number of employees in four forestry-related sectors in the project area. According to the IMPLAN data, the counties in the project area currently have few jobs in forestry-related sectors. Navajo County has the largest numbers of employees in commercial logging, biomass generation, and sawmills. Gila County has the fewest employees in these sectors. The four counties in the project area have approximately 30 percent of commercial logging and sawmill employees and seven percent of wood product manufacturing employees in the state. As of 2015, the only biomass power generation facility in the state was in Navajo County (IMPLAN 2015).

Table 48. Employment in Forestry-Related Sectors, 2015

Location	Commercial Logging	Biomass Power Generation	Sawmills	Wood Product Manufacturing
Coconino County	17.6	0.0	2.4	137.1
Gila County	8.5	0.0	0.0	60
Navajo County	42.0	0.5	39.8	146.6
Yavapai County	41.9	0.0	4.2	19.2
Arizona	379.7	0.5	162.5	5,539.8

Source: IMPLAN, 2015

In terms of employment, only Navajo County is more specialized in forestry-related sectors than the nation overall (Headwaters Economics 2017). These data indicate where existing capacity – in terms of infrastructure and skilled labor – to implement 4FRI activities may exist in the project area.

The vast majority (97 percent) of timber harvested in Arizona is processed in the state, though very little timber from other states flows into Arizona for processing (Sorenson et al. 2016). In 2012, there were 25 active wood product manufacturers, including sawmills, house log and viga manufacturers, bioenergy facilities, and other plants (Sorenson et al. 2016). These facilities are concentrated near the Rim Country project area. The number of primary wood processing facilities in Arizona increased by approximately 50 percent between 2007 and 2012 (Sorenson et al. 2016). Proximate wood processing facilities are essential for forest restoration activities, since transportation costs can erode the financial feasibility of removing small diameter and low value forest products.

4FRI Phase One Implementation

Implementation of phase one of 4FRI contributed jobs and labor income to the regional area. This is important because it sets the stage for future implementation activities under the Rim Country 4FRI. This section will demonstrate how the social and economic affected environment has changed since phase one was implemented in FY 2017.

Implementation activities for phase one were assessed using primary employment data gathered via surveys of wood contractors in the area. In FY 2017, the economic activities related to implementation of 4FRI phase one were 12,000 acres mechanically thinned and the removal of about 400,000 green tons of sawlogs and biomass for processing. These activities generated almost 1,000 full and part-time jobs and $50 million in labor income in FY 2017 in Apache, Coconino, Gila, Greenlee, and Navajo counties in northern Arizona (Hjerpe 2018).

While these economic contributions from phase one 4FRI activities are substantial, the growth in contributions has been limited and are less than original project objectives (Hjerpe 2018). Hjerpe (2018) also found that "the main barrier to ramping up 4FRI mechanical thinning accomplishments is the lack of profitability in thinning and processing small diameter ponderosa pine." Ways to boost the economic contributions from 4FRI activities include "to increase the scale of acres treated, which would result in greater thinning and wood utilization employment" and "to decrease the amount of contributions leaked from the region" (Hjerpe 2018). Contributions leave the region when there is inadequate infrastructure to process the harvested wood in the region. Any regional response to these barriers and solutions would affect how wood is processed and how the resulting economic contributions accrue to the region under this current Rim Country 4FRI.

Ecosystem Services

The economic value of Forest Service resources, uses, and management is not entirely captured in market transactions. Much of the value of national forests is "non-market" in nature – meaning that many of the benefits that forests provide to humans do not have a price. The lack of a price, however, should not be conflated with an absence of value. Indeed, non-market values from forests provide economic benefits to adjacent communities and forest visitors.

Ecosystem services are "components of nature, directly enjoyed, consumed, or used to yield human well-being" (Boyd and Banzhaf 2007). Healthy forests provide numerous ecosystem services, including clean water and air, biodiversity, forest products, and many other goods and services.

Wildfire has the potential to reduce ecosystem service values through: (1) destruction of wildlife habitat, (2) water quality and watershed impacts, (3) damage to cultural and archaeological sites, and (4) soil erosion and impacts to water quality (Morton et al. 2003). Furthermore, post-fire effects, such as flooding, can threaten life and property and further degrade ecosystem services.

Socioeconomic Vulnerability

A social vulnerability index for all counties in the Southwestern Region of the Forest Service reveals that Navajo County has among the lowest adaptive capacity of counties in the region. Households in Navajo County are likely to have fewer resources available to them. In contrast, Coconino and Yavapai counties have among the highest adaptive capacity of counties in the region. Households in these counties are likely to have many more resources available to them (Hand et al., forthcoming). Displacement due to wildfire, for instance, may be more difficult for households in Navajo County than households in Coconino and Yavapai counties. These findings reveal a great deal of socioeconomic diversity across the planning area.

Environmental Justice

In 1994, President Clinton issued Executive Order 12898. This order directs federal agencies to consider the human health and environmental conditions in minority and low-income communities. The purpose of Executive Order 12898 is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations (Executive Office of the President 1994).

Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The goal of environmental justice is for Federal agency decision-makers to identify impacts that are disproportionately high and adverse with respect to minority and low-income populations and identify alternatives that would avoid or mitigate those impacts.

Coconino, Gila, and Navajo counties have high concentrations of American Indian residents, due to the large share of tribal lands in these three counties. The majority of land in Navajo County is tribal land. Yavapai County also contains tribal lands, though the areas are quite small. [8] As a result, environmental justice issues are more likely to occur in Coconino, Gila, and Navajo counties than Yavapai County.

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8 Coconino County contains all or part of the Navajo Indian Reservation, Hualapai Indian Reservation, Hopi Indian Reservation, Havasupai Indian Reservation, and Kaibab Indian Reservation. Navajo County contains part of the Navajo Indian Reservation, Hopi Indian Reservation, and Fort Apache Indian Reservation. Gila County contains part of the Fort Apache Indian Reservation, the Tonto Apache Reservation, and the San Carlos Indian Reservation. Yavapai County contains all or part of the Yavapai-Prescott Indian Reservation, the Yavapai-Apache Nation Indian Reservation, the Hualapai Indian Reservation, and the Camp Verde Indian Reservation.

However, a finding of low racial or ethnic diversity does not eliminate the need to consider potential disproportionate impacts of Forest Service management actions. A county may have a low overall concentration of minority residents, but still have areas with a high concentration of minority residents who could be adversely affected by management actions.

Gila and Navajo counties have meaningfully greater[9] shares of people living in poverty than the state overall. More than one-fifth of Gila County residents and more than one-quarter of Navajo County residents live in poverty.

Based on the minority status and poverty data presented above, Coconino, Gila, and Navajo counties appear most at risk for environmental justice issues. The largest minority group in these counties – American Indians – also experience a very high poverty rate. Between one-third and one-half of American Indians in the planning area counties live in poverty (U.S. Census Bureau 2016a).

Numerous tribes were invited to consult on the 4FRI project. The process for tribal consultation is outlined in the EIS in Chapter 1 under Public Involvement. In addition, the tribal relations section in chapter 3 of the EIS and tribal relations specialist report provide more information and complete documentation of consultation.

The conditions described in this section underscore the importance of evaluating environmental justice consequences. The economic data suggest that Navajo County is both the most underserved county (in terms of economic opportunities) and also the most reliant on forest-related employment in the study area. Therefore, Navajo County may be particularly influenced by economic changes related to 4FRI. The potential for disproportionately high and adverse impacts on minority and low-income individuals due to Forest Service management actions are evaluated in the environmental consequences section of this document.

Assumptions and Methodology

This analysis addresses the implementation of Rim Country treatments on the Apache-Sitgreaves, Coconino, and Tonto National Forests. Unless specifically indicated otherwise, all estimates of economic and social consequences are based on only the implementation of 4FRI Rim Country.

Economic Impact Methodology

Economic impacts were modeled using IMPLAN Professional Version 3.1 with 2016 data. The IMPLAN model area includes Coconino, Gila, Navajo, and Yavapai Counties. Maricopa County is also included in the economic impact model due to the economic linkages between Maricopa County and the project area. The firms and employees that would support Rim Country activities are located in these counties (both primary and supplier firms).

Data on use levels under each alternative were collected from the forests' resource specialists. In most instances, the precise change is unknown. Therefore, the changes are based on the professional expertise of the forests' resource specialists. Regional economic impacts are estimated based on the assumption of full implementation of each alternative. The actual changes in the economy would depend on individuals taking advantage of the resource-related opportunities that would be supported by each alternative. If market conditions or trends in resource use were not conducive to developing some opportunities, the economic impact would be different from what is estimated in this analysis.

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9 In this case, meaningfully greater indicates that the 90% confidence interval of the county's poverty rate does not overlap with the 90% confidence interval of the state's poverty rate.

Economic Efficiency Methodology

Economic efficiency analysis follows Forest Service and Office of Management and Budget guidance. A four percent discount rate is commonly used for evaluations of long-term investments and operations in land and resource management by the Forest Service (FSM 1971.21). This discount rate is used in the calculation of net present value (NPV). Inflation can affect NPV; however, due to the uncertainty of future inflation, OMB Circular A-94 recommends avoiding assumptions about the inflation rate whenever possible. Thus, for the purposes of this analysis, inflation is left at zero. Data on program revenues and program expenditures were provided by the national forests' resource specialists and budget staff.

Assumptions

1. The IMPLAN model assumes a static economy – in other words, the industry composition and trade linkages in the economy today would be the same in the future.
2. The IMPLAN model does not impose supply constraints when estimating employment and labor income effects. It assumes that local industry would be able to harvest and process all of the forest product volume from the Rim Country project. If some of the forest product volume is harvested or processed by firms outside the model area, the employment and labor income effects would be lower than those estimated here.
3. The economic analysis assumes that all project activities are implemented over a 20-year period. If the implementation period is longer, the average annual number of jobs and amount of labor income would be lower than estimated in this report.
4. The economic analysis assumes that firms bid on 4FRI Rim Country contracts and that the activities are fully implemented. Full implementation relies on private sector interest in bidding on contracts. A slower pace and/or lower forest product volume removal would produce less economic activity than estimated in the analysis.
5. The economic analysis uses forest product distribution data from the 4FRI implementation team to classify forest product types in the economic modeling program. The economic analysis assumes the following distribution: 30 percent sawn products, 6 percent poles, 4 percent firewood, and 60 percent other forest products (including biomass).
6. The economic analysis assumes that forest products are harvested outside of protected activity centers (PACS) with mean slopes less than 40 percent.
7. The economic analysis assumes that the cost of prescribed fire treatment is $175 per acre and the cost of mechanical treatment is $400 per acre. The analysis also assumes that treatments are evenly distributed across 20 years.

Issues/Indicators/Analysis Topics

Economics is an issue for the Rim Country Project. Stakeholders are concerned that the lack of existing markets and the low value of material generated by proposed treatments may make project implementation economically infeasible. This report analyzes the economically feasibility of proposed activities across a range of alternatives.

Table 49 displays the resource indicators and measures used to evaluate the economic consequences of the Rim Country project.

Table 49. Resource indicators and measures for assessing effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?
Economic feasibility	Forest product volume removal	Forest Products (ccf)) harvested per year	Yes
Economic feasibility	Economic efficiency	Project benefits less project costs	Yes
Economic impact	Employment and labor income	Number of jobs and amount of labor income	Yes
Environmental justice	Effects to low-income and minority populations	Qualitative evaluation of disparate treatment and/or disparate effects	No

Environmental Consequences

Alternative 1 – No Action

Forest Products: Under Alternative 1, the three national forests would continue to provide forest products and support restoration activities. However, the scale of these activities would be substantially smaller than activities under the Rim Country Project. The provision of forest products unrelated to Rim Country treatments would be the same under all alternatives, and therefore are not described in detail in this EIS.

Economic Efficiency: Under Alternative 1, wildfire suppression costs would, on average, increase due to fuel buildup and the expanding wildland-urban interface. The per-acre administrative burden (cost of time and other resources) of planning, implementing, and monitoring forest restoration activities would be highest under Alternative 1. The Rim Country Project benefits from economies of scale – a single environmental compliance document addresses more than one million acres. Furthermore, the large project area reduces cost to government through increased private sector interest in engaging in harvesting and restoration activities on the forests. In contrast, restoration activities under Alternative 1 would occur piecemeal – requiring numerous environmental compliance documents and increased administrative costs.

Employment and Labor Income: The three national forests would continue to provide opportunities for forest product harvesting, livestock grazing, recreation, and other activities that support employment and labor income in communities in the project area. The extent of these contributions are not expected to differ from current conditions. Forestry-related sectors would remain a relatively minor part of the project area's economy.

Environmental Justice: The communities that surround the project area, particularly in Navajo County, have large minority populations, high poverty rates, and individuals vulnerable to smoke. Minority and low income residents may experience differential exposure to wildland fire, changes in employment opportunities, or changes in the provision of ecosystem services. None of the alternatives eliminates smoke – either from wildfire or prescribed burns. Alternative 1 would treat the fewest acres with prescribed fire; however, it would also do the least to restore fire-adapted forests. As a result, smoke from uncharacteristic wildfire is most likely under Alternative 1. Smoke emissions from prescribed burning would be lower under Alternative 1. Smoke emissions resulting from wildfires and prescribed burns may produce health and quality of life consequences. Smoke is most likely to affect vulnerable populations – children, the elderly, and individuals in poor health.

Alternative 1 would not affect the potential for wildland fire to threaten human safety and property in the project area. Low income individuals have fewer resources to engage in averting behavior (for example, leaving town during a wildfire to avoid smoke emissions). However, since approximately half of homes in the wildland-urban interface in the project area are second homes, the individuals with the highest exposure to wildfire risk are expected to be relatively affluent (Headwaters Economics 2017).

Alternative 1 would not affect employment or labor income in the project area. Therefore, no disproportionate or adverse effects related to changes in economic opportunities would occur as a result of this alternative.

The provision of ecosystem services may be affected by Alternative 1; however, these effects would not disproportionately affect low income and minority residents.

Table 50. Resource indicators and measures for Alternative 1

Resource Element	Resource Indicator	Measure	Alternative 1
Economic feasibility	Forest product volume removal	Forest Products (ccf) harvested	Forest products would continue to be harvested from all three national forests, consistent with current conditions
Economic feasibility	Economic efficiency	Project benefits less project costs	No direct project benefits or costs; no economies of scale in forest restoration activities
Economic impact	Employment and labor income	Number of jobs and amount of labor income	Three national forests would continue to support local employment and labor income associated with harvesting, grazing, and recreation at levels similar to current conditions
Environmental justice	Effects to low-income and minority populations	Qualitative evaluation	Smoke emissions from wildfire are most likely to adversely affect vulnerable populations, including children, the elderly, and individuals in poor health

Effects Common to All Action Alternatives

Environmental Justice: The employment and labor income associated with the Rim Country Project are expected to have a small, but positive, effect on employment and labor income in minority and low income communities.

Smoke emissions from both prescribed fire and wildfire can have health effects, particularly on the young, elderly, and individuals with existing health issues. Tribal elders may be more likely to experience acute health effects. Technological and cultural constraints to effective communication would make smoke effects more pronounced, as averting behavior is limited. However, burn plans written for implementation of the proposed prescribed fires would include modeling to determine the most appropriate conditions under which to burn in order to minimize smoke impacts.

Effects Unique to Each Action Alternative and Differences among Them

Forest Products: Alternative 2 would produce approximately 5.3 Million CCF of forest products over the life of the project. The economic analysis assumes that volume is harvested evenly over a 20-year period. Approximately 262,920 ccf would be harvested annually.

Alternative 3 would produce approximately 3.6 million ccf of forest products over the life of the project. The economic analysis assumes that volume is harvested evenly over a 20 year period. Approximately 178,530 ccf would be harvested annually.

Economic Efficiency: Under Alternatives 2 and 3, the per-acre administrative burden (cost of time and other resources) of planning, implementation, and monitoring forest restoration activities would be lower than for Alternative 1. The Rim Country project benefits from economies of scale – a single environmental compliance document addresses hundreds of thousands of acres across three forests. Alternative 2 would mechanically treat up to 889,334 acres of vegetation and treat up to 953,132 acres with prescribed fire. Alternative 3 would mechanically treat up to 483,158 acres of vegetation and treat up to 529,059 acres with prescribed fire.

The present net cost to taxpayers to conduct restoration treatments equivalent with those proposed under Alternative 2 would be approximately $370 million, and approximately $200 million under Alternative 3, over 20 years. The Rim Country Project would provide a stable supply of forest products to encourage private sector engagement in forest restoration activities, which would reduce the cost to taxpayers. Furthermore, the treatments would reduce the risk and hazard of uncharacteristic wildfire. The costs of a single large fire routinely amount to millions of dollars in direct suppression expenditures alone. The Forest Service, for instance, spent approximately $14.4 million responding to the 2010 Schultz Fire (Combrink et al. 2013). Furthermore, the total cost of the Schultz Fire and subsequent flooding – including decreased property values, loss of life, cleanup, evacuation, and habitat destruction – is estimated to be between $133 million and $147 million (Combrink et al. 2013). For the 2002 Rodeo-Chedeski Fire, estimated suppression costs ranged between $43 and 50 million. Other direct costs, including the loss of homes and property, totaled $122.5 million. Rehabilitation costs were projected over a three year period for a total cost of $139 million (WFLC 2010).

Compared to Alternative 2, Alternative 3 would treat fewer acres more intensively. More concentrated treatments could lower the operating costs associated with treatments. Fixed costs associated with site preparation would be lower, site infrastructure needs (for example, processing, roads) would be reduced, and costs associated with transporting forest products would be lower than under Alternative 2. Given the relatively low market value of most of the wood products to be removed from the project area, keeping operating costs low is critical to the financial feasibility of forest treatments.

Employment and Labor Income: The direct, indirect, and induced economic effects of forest product removal under Alternative 2 are estimated to support approximately 1,890 jobs and $78 million in labor income on an average annual basis over the life of the Rim Country Project.

Alternative 3 would produce somewhat lower wood product volume than Alternative 2. Therefore, Alternative 3 would support fewer jobs and less labor income than Alternative 2. The direct, indirect, and induced economic effects of forest product removal under Alternative 3 are estimated to support approximately 1,280 jobs and $53 million in labor income on an average annual basis over the life of the Rim Country Project.

Both Alternatives 2 and 3 may temporarily displace other forest users (for example, recreation visitors) due to treatment activities. Alternative 2 would lead to more displacement of forest visitors than

Alternative 3 due to the larger number of acres to be treated under Alternative 2. Displaced recreationists are expected to visit another site on one of the three forests to participate in another activity in the local area. Therefore, recreation visitor expenditures are not expected to change.

Likewise, forest restoration activities may affect ranchers who graze livestock in the project area. The brief duration and advance notice of disturbances due to Rim Country treatments would make it easier for ranchers to adapt to changes. As a result, no reductions in grazing-related employment are expected. However, minor reductions in rancher income are possible if ranchers purchase more expensive private forage or reduce their stocking levels. However, post-treatment soil and forage quality is expected to increase. Therefore, over the long-term, ranchers would benefit from Rim Country activities.

Table 51. Resource indicators and measures alternative comparison

Resource Element	Resource Indicator	Measure	Alternative 2	Alternative 3
Economic feasibility	Forest product volume removal	Forest products (ccf) harvested	Volume from trees < 5” = 278,440 CCF Volume from trees 5” - 12”= 2,303,480 CCF Volume from trees > 12”= 2,676,470 CCF	Volume from trees < 5” = 191,000 CCF Volume from trees 5” - 12”= 1,467,810 CCF Volume from trees > 12” = 1,911,750 CCF
Economic feasibility	Economic efficiency	Project benefits less project costs	$370 million present net cost; Avoided costs from forest restoration and reduced risk of high intensity wildfire	$200 million present net cost; Avoided costs from forest restoration and reduced risk of high intensity wildfire; more concentrated treatments (compared to alternative 2) would lower operating costs
Economic impact	Employment and labor income	Number of jobs and amount of labor income	1,890 jobs and $78 million in labor income	1,280 jobs and $53 million in labor income
Environmental justice	Effects to low-income and minority populations	Qualitative evaluation	Employment and labor income may have a small, but positive, effect on economic opportunities in low-income and minority communities; smoke emissions may have a disproportionate effect on low-income and minority communities	Same as alternative 2

Effects from Rock Pit Use and Expansion

The Rim Country Project would authorize the use and expansion of rock pits to supply material for road construction and improvement. Rock pits on the national forests provide a low cost source of material for road work. In particular, rock pits avoid the need to purchase and haul roadbed material from more distant sites. The 2016 Rock Pits Environmental Assessment for the Coconino and Kaibab National Forests found that haul costs were approximately four times higher for material purchased off-site than for on-forest rock pits. Rock pit use and expansion would increase the financial feasibility of road work needed to support Rim Country project activities.

Effects from Use of In-woods Processing and Storage Sites

The key barrier to the financial feasibility of forest restoration is that the costs of hauling raw material from the harvest site to mill locations may exceed the value of the timber harvested in the project area. To address this challenge, the Rim Country Project would authorize 13 in-woods sites (in addition to the eight sites analyzed in the Cragin Watershed Protection Project) for processing, sorting, storing, and the refinement of raw material. In-woods processing and storage sites would offset haul costs by increasing the value of material either by hauling dried material or secondary products.

In-woods processing and storage site selection criteria – including at least ¼ mile from hiking trails, campgrounds, group recreation sites, and private property – would reduce the potential for effects on forest visitors and nearby residents.

Cumulative Effects for all Alternatives

Past management activities, including mechanical vegetation treatments, fuels treatments, and prescribed fire, have affected economic activity in the communities in and around the project area. The socioeconomic consequences of these actions are captured in the baseline data presented in the affected environment section of this report. Therefore, these activities are not included in the cumulative effects analysis.

The temporal boundary is 20 years of implementation activities and the spatial boundary is the economic analysis project area (Coconino, Gila, Navajo, and Yavapai Counties).

Restoration activities would continue to occur in the region regardless of the Rim Country decision. Current and foreseeable activities include approximately 470,000 acres of mechanical vegetation treatments and approximately 650,000 acres of fuels treatments. The acreages of mechanical vegetation management and fuels are not all mutually exclusive. There are many acres on which proposed fuels treatments (mechanical and prescribed fire) overlap with proposed mechanical vegetation management treatments. Reasonably foreseeable actions on private, state, and other federally-managed lands include mechanical treatments, fuels treatments, and prescribed fire. These actions would occur regardless of the selected Rim Country alternative.

The effect of past, present, and reasonably foreseeable treatment activities in the project area would improve forest health relative to existing conditions even without the implementation of the Rim Country Project.

Forest Products: Forest products available for harvesting under the Rim Country Project would contribute to an increased supply of forest products available from national forests in the region. When harvest volumes are low, harvesting and processing industries are unlikely to locate in the region. However, the cumulative effects from both Alternative 2 and Alternative 3 would be to improve the financial viability of locating forest product industries - including logging firms, sawmills, and biomass facilities – in the project area. The no action alternative would have the least cumulative effects to forest products industries since no forest products would be harvested.

Economic Efficiency: Present net costs are greatest under alternative 2, so the cumulative effects (costs) of the Rim Country project, in addition to other projects, would be the greatest. The no action alternative does not have any costs of treatment for Rim Country, so cumulative costs would be the least.

Observational evidence and fire modeling indicates that large-scale fuel treatments are necessary to meaningfully reduce the risk of high intensity wildfire and produce fire suppression cost savings (Thompson et al. 2017). The proposed Rim Country treatments, in combination with the current and foreseeable mechanical and prescribed fire treatments, would conduct fuel treatments across a large landscape. The cumulative effects of Alternative 2 are most likely to reduce wildfire suppression costs in the project area.

Employment and Labor Income: The increase in jobs and labor income during implementation of the Rim Country project would be greater under alternative 2 than alternative 3 and the no action alternative, which would be additive to job contributions from other current and foreseeable projects in the area. Therefore, the cumulative economic impacts would be greatest under alternative 2.

The increased forest product supply from Rim Country and other current and foreseeable projects would contribute to the development of a local forest products industry. Cumulatively, the development of a local industry, as a result of Rim Country and other projects, would have several economic effects, including (1) lower costs of transporting wood products for secondary processing thereby increasing the financial viability of treatments, (2) increase the probability that employment and labor income associated with forest restoration activities would occur in the local area, and (3) contribute to the growth of supporting industries (for example, construction and retail trade).

As described in the Affected Environment section above, there has been limited growth of jobs and income from 4FRI phase one implementation activities. With more acres treated from the Rim Country 4FRI project, this would add to the wood utilization employment. Cumulative effects of increasing wood volume could increase the amount of economic contributions that stay in the region if the activity boosts the infrastructure and capacity to process the harvested wood in the region. For example, if the wood produced from both phases of 4FRI implementation creates enough demand (or the funding mechanism is collaboratively resolved) for a company to install a biomass facility, the jobs and income from restoration activities are more likely to stay in the region.

Environmental Justice: Ongoing and reasonably foreseeable prescribed fire treatments would contribute to smoke emissions, which may affect the health and quality of life of individuals who live near or visit the forests. Since the no action alternative would not prescribe additional treatments, it would not cause cumulative effects related to smoke emissions from prescribed fire. However, the risk of uncharacteristic wildfire and associated smoke emissions in the project area would be highest under this alternative.

The proposed treatments under Alternatives 2 and 3, combined with other ongoing and foreseeable treatments, could increase exposure to smoke emissions, which could cause cumulative effects to health and quality of life for individuals who are sensitive to smoke. However, the cumulative effect of these treatments would be to decrease the risk of uncharacteristic wildfire, which would decrease the probability of smoke emissions associated with these events. The no action alternative would have lower additive effects to smoke exposure but in the longer term would contribute to a greater risk of wildfire.

Forest Plan Amendment

Amending the forest plan is not expected to have any additional effects to social or economic resources, other than what is already analyzed. The harvest volumes and treatment acres (and associated costs) are not expected to differ than what is proposed and analyzed under alternative 2 and alternative 3. Costs of treatment may be higher on steeper slopes (due to Amendment 3. Mechanical treatments on steep slopes), however, this is uncertain and the best cost estimates are used in the analysis.

Lands and Minerals

Affected Environment

Lands

The acquisition and disposal of National Forest System lands are designed to consolidate interest and management of the federal estate to enhance public benefit, and to consolidate the management and ownership of federal, state, and private lands within the proclaimed forest boundary. The establishment of rights-of-way throughout the forest is needed to create easy accessibility to both public and private lands within the proclaimed boundary of the national forest.

Land subdivision and development is increasing the need for accurate and reliable surveys. Numerous conflicts between past surveys have occurred, leading to an unknown number of unauthorized occupancies and use violations on national forest lands. Identification of property boundaries is an increasing expense to resource programs, especially fuel treatments. Increasingly, additional expenditures would be necessary in order to fully utilize national forest resources and to prevent claims against the federal government. Although land acquisition eliminates the need for land line location in some areas, many miles of property boundary still need to be surveyed and posted.

Property boundary location involves all activities necessary to identify the boundaries of National Forest System lands, including the search for survey corners, surveying and marking of land lines, and maintenance of the same. Marking and posting boundaries identifies or locates National Forest System lands for public use and enjoyment and prevents and controls trespass upon the forests.

There are many private land inholdings within the Rim Country project area. To ensure any treatment is done on private land and to meet Forest Service policy, the boundary lines between Forest Service and private lands should be marked by a professionally-licensed land surveyor prior to implementation. This would also ensure the lines are adequately marked so the Forest Service can meet objectives stated in the Apache-Sitgreaves Forest Plan for Community-Forest Intermix and Wildland-Urban Interface, as well as similar direction in the other forests (Coconino and Tonto National Forests) within the Rim Country project area. Boundaries are considered marked to standard if they have been surveyed and posts set at approximately 250-foot intervals along the boundary line and have been set with boundary signs attached. Some historic boundary lines can be maintained, which entails ensuring posts and signs are in good condition and replacing any that are not. This can be accomplished with surveys that have been recently completed. Any posting older than 15 years may be questionable because of age. The current status of boundary lines in the project area is shown in Table 52 below.

Table 52. Miles of boundary lines within the project area

Forest	Total Miles	Marked	Unmarked	Marked over 15 years ago
Apache-Sitgreaves	374	231	143	182
Coconino	110	55	55	42
Tonto	132.5	125	7.5	75

Overall, it is important to provide ample time to existing land surveying staff to analyze implementation areas and access needs, and provide feedback on necessary time and funding to complete work.

In addition to marking and posting boundary lines before resource work is completed, there are also numerous pieces of direction in the forest plans on how land within the Wildland Urban Interface and Community-Forest Intermix should be treated. This direction calls for lower basal areas, treatment of slash, and retention of fire-resistant tree species. There is very little restriction on what kind of treatments are used, but forest plans do convey the message of minimized smoke effects, reduction of fuel load, and working with communities on defensible space.

The existing access routes through the project area may travel across both forest system and private lands. It is important for the ensure rights-of-way are properly obtained in order to protect existing or new roads crossing private property by describing type and duration of use. If a permanent easement for standard use can be obtained in an area that was not historically documented, this would be beneficial to both parties to guarantee the road's protection in the future.

Lands Special Uses

Lands special use authorizations include permits, term permits, leases, and easements that authorize occupancy and use of National Forest System lands. Authorized activities include uses such as utility corridors, roadways, communications sites, research projects, and many other uses. The terms of these authorizations vary based upon the type of use.

Table 53. Lands Special Use Authorizations within the Project Area

Permit Type	Total
Fish Hatchery	2
Fence	2
Cemetery/Church/Monument	3
Waste Disposal Site (solid/liquid)	2
Sewage Line	3
Weather Station	9
Observatory	1
Research/Non-Disturbing Use	8
Warehouse/Storage Yard	4
Processing Plant	1
Powerline	10
Easement	85
Road	21
Communication Site	42
Irrigation/Water Transmission/Conveyance	35
Dam/Reservoir/Well/Storage Tank	20
Wildlife Water Supply	10
Stream Gauge	2
Water Treatment Plant	1
TOTAL	**261**

As of August 29, 2017, there were 261 active lands special use permits within the project area. Of these, 219 (85 percent) are communication sites, water storage or conveyance, powerlines, roads/easements, or water or waste treatment facilities. These uses have direct effects on human populations and therefore carry greater risks from fire danger than other uses.

Recent years show an increasing demand for lands special uses. As communities in and around the forests increase in development, their need to utilize public lands in support of their infrastructure also increases. Proposals for power lines, rights-of-way, communication sites, water transmission lines, and roadways have increased steadily and would continue to do so in future years. Increased interest in renewable energy sources, such as wind and solar, has also contributed to the increased demand.

Solar energy potential is high and future development would be related to demand. There may be a need for additional energy corridors or developments (for example, electric transmission lines, pipelines, wind turbines) because of the expected demand for electricity to serve the growing populations of Arizona and the Southwest and to provide reliable and consistent services. As communities expand and as non-Forest Service lands surrounded by Forest Service lands are developed, there may be increased demand for energy development on Forest Service lands.

Minerals

Minerals of economic interest are classified as leasable, locatable, or salable. Coal, oil shale, oil and gas, phosphate, potash, sodium, geothermal resources, and all other minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, are referred to as leasable minerals. Common varieties of sand, stone, gravel, pumice, and clay that may be acquired under the Materials Act of 1947 are considered salable minerals. Any minerals that are not salable or leasable, such as gold, silver, copper, tungsten, and uranium, are referred to as locatable minerals. These mineral deposits include most metallic mineral deposits and certain nonmetallic and industrial minerals. Locatable minerals are subject to the Mining Act of 1872.

Apache-Sitgreaves

Mineral resource activity on the Apache-Sitgreaves National Forests has historically been low. Mineral activity is presently concentrated in a few scattered areas. Commodity use and production have shown declines from the past. However, these forest uses contribute to sustaining the lifestyles and traditions of local communities. The potential for locatable minerals on Apache-Sitgreaves National Forests lands may be much greater at depth than surface geology would otherwise suggest. The potential for leasable minerals on the Apache-Sitgreaves National Forests is low because of the existing geology. There are no known leases on the forests for the following leasable mineral resources: oil and gas, oil shale, coal or geothermal (BLM 2009/2013). Should valid leasable mineral proposals be submitted, the Forest Service would respond as a cooperating agency when requested by the BLM, which acts as the lead agency for subsurface mineral extraction. There are no current leases for oil and gas, geothermal, or coal on the Apache-Sitgreaves National Forests.

Coconino

The Coconino National Forest has very few locatable mineral resources, and no oil and gas leases or developments, but has potential geothermal resources (no current leases, no developments) associated with the San Francisco Volcanic Field. Locatable minerals with past or current production have included manganese, gypsum, flagstone and pumice. The forest has a small amount of common variety mineral materials production including cinders, crushed and pit run aggregate, rock and fill dirt, and landscape rock/decorative stone. Most of the use of mineral materials on the forest is by the Forest Service or authorized contractors or permittees for projects and by Coconino County under permits or other agreements. Aggregate production and salable minerals are anticipated to increase with future forest restoration activities. Some areas are withdrawn from locatable mineral entry.

Tonto

No leasable mineral authorizations or applications are currently located on the Tonto National Forest. The potential for development of leasable minerals in the planning area is low; the geologic depositional environment of the planning area is not conducive to hydrocarbon generation. The Tonto National Forest has a long history of mining across the national forest.

Although numerous prospects on the Payson Ranger District were identified from the Arizona Department of Mines and Mineral Resources database, most of the gold and silver deposits were found within veins found fairly close to the surface with visible mineralization. Most of the metals could be extracted with minimal milling effort, usually with a stamp mill. Most if not all of the mineralization occurred within “quartz stringers” of a granodiorite intrusion (Botsford 1933). Once these narrow dikes (bands) are mined out, only the “non-visible” or disseminated mineralization is left behind, which requires a much greater milling process and larger scale operation to be profitable.

Arizona is well known for its large porphyry copper deposits, which are low-grade disseminated type deposits that require mining by large-scale, low-per-ton cost methods. The copper minerals are distributed uniformly through large sections or blocks of the deposit, that must be mined by bulk methods, rather than selective or vein mining methods. These bulk mining methods consist of either open-pit or block caving mining methods. Gold and silver occur as secondary metals that are associated with porphyry-type deposits. Based on historic activity of this district, further exploration efforts may have merit. As a result, the favorability for mineral potential within the Green Valley Mining District and two other districts, the Polk and the Rye Creek, is determined to be moderate (USDI 1993). Although no exploration activity is currently taking place on the Payson Ranger District, the potential for such activities remains.

Assumptions and Methodology

Assumptions

The following assumptions were made for this analysis:

- Forest Plan direction would be followed when planning or implementing site-specific projects and activities resulting from this decision.
- Applicable laws, regulations, and policies would be followed when planning or implementing site-specific projects and activities resulting from this decision.
- With population growth in the communities within and surrounding the forest, as well as throughout the State of Arizona, there would be increased demand for uses such as alternative energy development, utility corridors, and transportation systems.
- Community and public needs for use of federal land for services and infrastructure, including roads and energy corridors, would continue.
- Proposals for lands special uses, mineral exploration, and energy development on the national forests would increase in the foreseeable future.

The primary assumption for the analysis of effects on lands, lands special uses, and minerals is that the number of acres treated under each alternative corresponds directly to a reduced risk of uncharacteristic wildfire behavior within the project area. This in turn corresponds to a reduced risk of damage to structures and facilities within the project area. Therefore, the greater the number of acres treated, the greater the reduction in uncharacteristic fire behavior, and therefore the greater positive effect to these resources. This correlation holds true regardless of the mix of treatment methods used (such as, mechanical thinning, prescribed burning).

Methodology

The Special Uses Database System (SUDS) was used to generate a list of all special use authorizations within the project area. This report was sorted by use type; recreation special uses were then removed from the analysis. The remaining lands special use authorizations were then sorted by status. They were considered as part of the existing condition if they had statuses of application accepted, pending signature, or issued.

Some inaccuracies are commonly known to exist in the SUDS. Permits are sometimes shown as "issued" even after they have expired, or sometimes are shown as expired when in fact they have been reissued and the activity continues. Where it was known or suspected that these permits were still in place and in the process of reissuance, they were considered in the analysis.

Mineral resources were identified using the specialist reports and supporting materials for the Forest Land and Resource Management Plan Revisions for each forest in the project area.

Issues/Indicators/Analysis Topics

None of the significant issues for Rim Country relate to the potential effects on lands, lands special uses, or minerals, and therefore they do not serve as indicators for analyzing the effects of the project on these resources. However, the project would have an indirect effect in the form of reduced risk of uncharacteristic fire behavior. Uncharacteristic fire behavior presents a threat to the facilities authorized by special use permits and to any structures that may lie on non-forest lands within the project area. Therefore, the indicator used for this analysis is the reduced risk of uncharacteristic fire behavior, as represented by the number of acres treated under each alternative.

Environmental Consequences

Alternative 1 – No Action

Under this alternative, no large-scale restoration activities would occur. Stand and vegetation structures would be improved only in accordance with each forest plan, and with the data available at the time of this report, this would be occur on only 140,324 acres. This would make the landscape in the project area less resilient to disturbance and would provide increased fuels for wildland fires and uncharacteristic fire behavior. Increased fire danger would impact lands special uses by threatening the structures they authorize in both the short term (10 years) and long term (20 years and more). Any structures associated with active minerals sites and those located on non-National Forest Service lands would be similarly threatened. Long-term effects could be the destruction of these facilities by fire, and possibly the closure of fire-damaged areas for rehabilitation. There may be short-term, temporary effects in the form of restricted access to sites during fire suppression activities or post-fire rehabilitation.

Many of these authorized land uses serve and support local communities. If infrastructure is damaged by wildfire, there could be a delay in providing utilities such as power, phone, and water. Emergency service providers could be delayed in providing for health and safety if communication equipment is damaged. Private property has the potential to be impacted as a result of wildfires in the area as fires may burn at a higher intensity and severity and would be more difficult to control. Existing land uses would continue to be managed under the current forest plan direction and under the terms of their authorizations and other laws, policies, and regulations such as power line clearance requirements and vegetation management along highway corridors for safety purposes and utility reliability.

Effects Common to All Action Alternatives

All action alternatives would improve forest health by restoring forest ecosystems toward their natural, pre-fire-suppression states. While they vary in specific approaches, the overall effect on lands, lands special uses, and minerals would be the same. Increased forest health would lower the risk of undesirable fire behavior, which would reduce the threat to the structures authorized for lands special uses and mineral projects and to those on private lands.

Effects Unique to Each Action Alternative and Differences among Them

For the purposes of this analysis, the only difference between action alternatives is the number of acres treated.

Table 54. Comparison of Alternatives by Number of Total Acres Treated

Alternative	Acres Treated Under This Project	Total Acres Treated in Project Boundary
1	0	140,324
2	889,340	1,039,654
3	483,160	615,254

Effects from Rock Pit Use and Expansion

The Rim Country Project would require the use of mineral materials for the surfacing of temporary roads and possible resurfacing/maintenance of roads after their use in the implementation of this project. The scope of work proposed in the action alternatives exceeds the mineral materials currently available in existing rock pits within or near the project area. Therefore, the use of one additional rock pit and the expansion of some existing rock pits are being analyzed in the Rim Country EIS.

On the Coconino National Forest, the development, expansion, and use of nine rock pits in the Rim Country project area were analyzed in the Rock Pits Environmental Assessment for the Coconino and Kaibab National Forests (June 2016). One additional rock pit, Park Knoll, is currently being developed by Coconino County under a special use permit; the Forest Service would have access to approximately 20,000 cubic yards of material from this pit.

On the Apache-Sitgreaves National Forest, two ranger districts are within the project area, the Lakeside and Black Mesa Ranger Districts. Surfacing material needs on the Lakeside Ranger District are met by a large county-operated rock pit under special use permit, as well as other commercial sources. On the Black Mesa Ranger District, 11 existing rock pits in the Rim Country project area could be expanded to provide future material for implementation of Rim Country. Each of these rock pits are considered for 30 percent expansion of their current footprint. The potential environmental effects from the anticipated expansion of these rock pits, as well as those from their use, are analyzed in the Rim Country EIS.

On the Tonto National Forest, all road surface material needs would be met by local commercial sources. Therefore, no effects from rock pit use on the Tonto are analyzed for Rim Country implementation. Figure 81 displays the locations of these rock pits in the Rim Country project area.

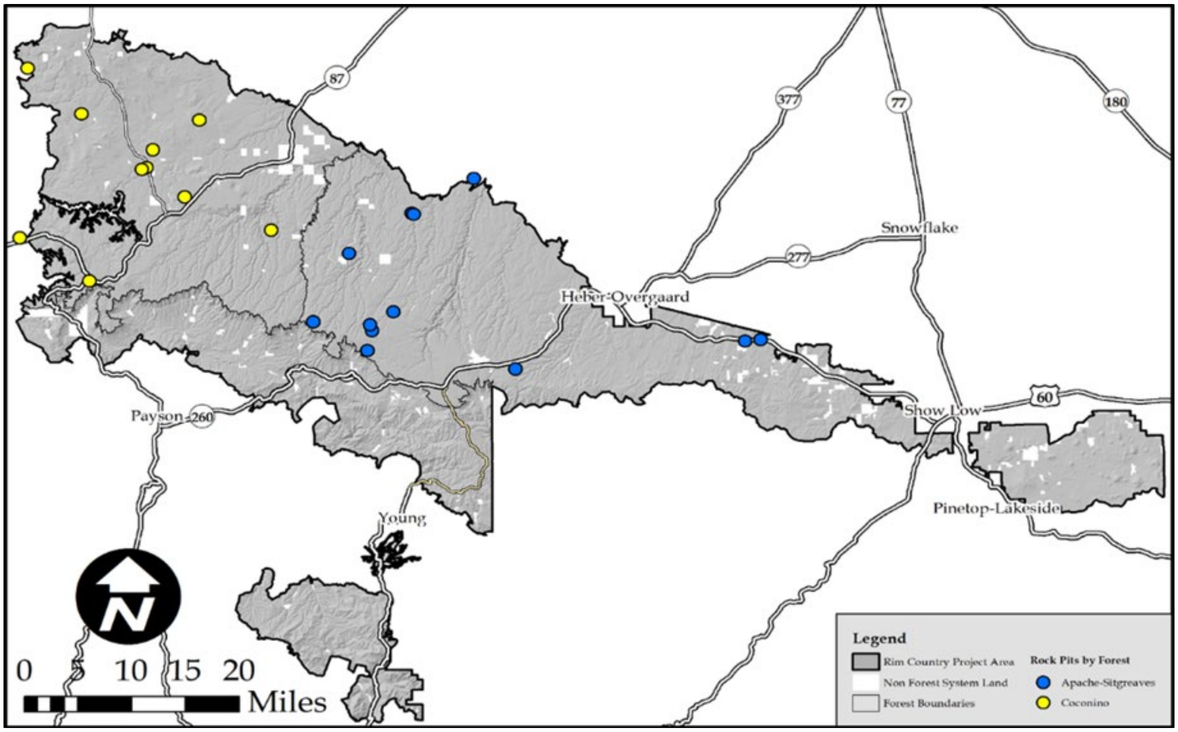

Figure 81. Rock pits in the Rim Country project area

Rock pit use and expansion would be the same under both action alternatives. There would be no effects on lands or lands special uses. The effect on minerals would be that, once used, these resources would no longer available for other future projects. The consumption of mineral resources for road surfacing needs for the Rim Country Project must be weighed against the cost of purchasing these materials from a commercial source in the future. As budgets continue to shrink, this would be an important consideration. The Coconino and Tonto National Forests receive very high levels of use, and road surfacing would continue to be an ongoing need.

Effects from Use of In-woods Processing and Storage Sites

The western parts of the project area are far from businesses that are able to process the wood products that would result from either of the action alternatives. To make the business opportunities more viable, the project identifies multiple on-forest sites that could potentially be used by contractors for processing wood products.

The closest mill to Rim Country is the Lumberjack Mill, approximately 13 miles from Heber, Arizona, just north of the eastern edge of the project area. The Lumberjack Mill is operated by Good Earth Power. The mill underwent an extensive upgrade in 2017 and is currently processing dry kilned and finished lumber. On the western side of Rim Country, the closest wood processing facility is Canyon Wood Supply, approximately 25 miles from the western boundary of the project area in Camp Verde, Arizona. Canyon Wood Supply processes ponderosa pine into bundled fuelwood for retail consumption.

Processing sites serve many purposes. Tasks accomplished at processing sites would include drying, debarking, chipping stems and bark, cutting logs, manufacturing and sorting logs to size, scaling and weighing logs, and creating poles from suitable sized logs. Equipment commonly used at processing sites would include circular or band saws, various sizes and types of front-end loaders, log loaders, and several types of chippers. Equipment may include timber processors, planers and mechanized cut to length systems, associated conveyers, and log sorting bunks for accumulation and storage of logs. Electric motors and gas or diesel generators would also be used to provide power.

Eight processing sites were proposed and analyzed for environmental effects in the Cragin Watershed Protection Project (CWPP). These sites are carried forward for potential use in implementing the Rim Country Project. In addition, 13 in-woods processing sites are being proposed and the environmental effects from their use analyzed in the Rim Country EIS. For both projects, processing site location and siting considerations include: flat uplands less than five percent slope; more than 200 feet from perennial, intermittent, and ephemeral stream channels; more than 300 feet from meadows, springs, and karst features; more than ¼ mile from MSO PACs and outside of NOGO PFAs; more than ¼ mile from system hiking trails, campgrounds, and group event recreation sites; more than ¼ mile from private lands, residences, or offices; and adjacent to roads that are open year-round for product removal. Processing sites were located to provide a buffer of 100 to 300 feet from forest roads and state highways to provide for visual screening from Concern Level 1 and 2 travelways.

These 20 in-woods processing and storage sites may be used for implementation of the Rim Country Project over its implementation period of 20 years, or until implementation is completed. Continuous-use processing sites are those where use is expected to be continuous on a regular basis for 10-20 years. These sites are typically the larger 10 to 21 acre areas located close to major highways. Sites originally developed and operated for continuous use would frequently change to intermittent use or occasional use following initial harvest activities in the area. Intermittent use processing sites are those where use is expected to be shorter term and used for one or multiple contract periods, lasting from three to 10 years.

Processing sites may be authorized under timber contract or under special use authorizations. Special use authorizations for processing sites would comply with appropriate policies related to cost recovery and land use fees and other special use regulations (36 CFR 251). A performance bond would be used to insure that all obligations are fulfilled by the contractor or permittee and would be used if needed to cleanup and rehabilitate the processing sites.

Processing site locations and use are the same under both action alternatives. There would be no effects on minerals. There would only be effects on lands or lands special uses if the sites were located too closely to these resources. It is possible that sites in close proximity to special uses such as utility corridors or water lines could have an adverse effect these facilities, if they interfere with operations. Such effects could be mitigated by ensuring placement of processing sites away from special use facilities

Residents living within the project area boundaries could be impacted by the increased noise, traffic, and emissions produced by active operations at processing sites. These effects would be greater the closer processing sites are to any private lands or special use facilities with residents. These effects can be mitigated by advance communications with any residents and notifying them of potential active operation timeframes.

Cumulative Effects

The cumulative effects analysis area for lands, lands special uses, and minerals is the Rim Country project area.

Alternative 1 – No Action

Vegetation treatments would reduce the risk of uncharacteristic fire behavior on approximately 140,000 acres within the project area. Restoration activities would occur on a project-by-project basis, rather than as a part of a landscape-scale effort. The threat of uncharacteristic fire behavior to lands, lands special uses, and mineral site structures would be reduced somewhat within the project area, but not as much as under the Action Alternatives.

Alternative 2

Under this alternative, approximately 953,130 acres would receive vegetation treatments and restoration activities. This is a 60 percent increase over the no action alternative. Alternative 2 would treat the greatest number of acres and therefore contribute the most toward the reduction of fire risk to lands, lands special uses, and mineral site structures. Fire damage to the facilities or structures in these areas would mean destruction of private property and damage to utility corridors for electricity and water. This would have a significant impact to communities relying on these utilities.

Alternative 3

Under Alternative 3, approximately 529,060 acres would receive vegetation treatments and restoration activities. This represents 44 percent fewer acres than Alternative 2, but a 44 percent increase over alternative 1. The threat of fire to lands, lands special uses, and mineral site structures would be greater than under Alternative 1 but less than under Alternative 2. Therefore, the risk of damage to or destruction of utility corridors and private property are also greater than Alternative 1 and less than Alternative 2. This alternative provides the greatest reduction in fire risk to these resources and therefore the greatest positive effects to the people owning these structures and the communities relying on these utilities.

Tribal Relations

Affected Environment

All of the lands in the 4FRI Rim Country project area are the ancestral homelands of American Indian tribes. The archaeological resources in the project area demonstrate a high level of traditional uses which continue today (see the Cultural Resources section for more details concerning archaeological resources). In lands occupied by their ancestors, tribal members continue traditions of hunting, collecting medicinal plants, and conducting traditional ceremonies. This includes American Indian traditional use areas and places known as Traditional Cultural Properties (TCPs). TCPs are places traditionally used by cultural groups over generations. These TCPs hold a central and important place in American Indian culture. Through years of tribal consultation the forests have learned that many natural springs, prominent bodies of water, mountains, subsistence areas, prayer areas, shrines, clan origin locations, holy places, trails and shelters (Sweat lodges and brush shelters) are considered TCPs by numerous tribes.

Tribal members make pilgrimages to the Rim Country forests for ceremonial activities throughout the year. Springs in the project area and throughout the forest are valued as TCPs and sacred sites. Many plants gathered for ceremonial use are collected on or near TCPs.

Tribal Consultation

The Forest Service and Tribes have legislative authority to partner under law, including but not limited to the Indian Financing Act of 1974, the Cooperative Funds and Deposits Act of 1975, the Forest and Rangeland Renewable Resources Research Act of 1978, the Federal Technology Transfer Act of 1986, the Department of Interior, Environment and Related Agencies Appropriations Act of 1992, the Tribal Forest Protection Act of 2004 (TFPA), the Culture and Heritage Cooperative Authority of 2008 (CHCA), and the Wyden Amendment (Public Law 109-54, Section 434). These authorities provide opportunities to exchange technical expertise, funding, goods, and services to the mutual benefit of both parties. An effective government-to-government relationship would provide for the identification of common goals and partnership opportunities. For additional guidance, see FSM 1563 (2015 draft).

Assumptions and Methodology

Assumptions made are as follows: no activities would adversely affect archaeological sites or traditional cultural properties; the removal of excess fuels is a benefit to cultural resources, traditional cultural properties, traditional use forest products, and adjacent tribal lands; low heat prescription wildfires can result in the regeneration of medicinal plants; mechanical thinning of specific species can protect other plant species of cultural importance (such as Emory oak groves); restoration activities would benefit natural springs which are of universal importance to Indian tribes; Indian tribes would be consulted at critical points before project activities.

Issues/Indicators/Analysis Topics

Traditional Collecting Areas - Dense tree growth and heavy ground fuels can have a negative effect on certain plant species; thinning the forest may provide a better habitat for these plants to thrive. Fire can also enhance certain plant species such as wild tobacco. Restoration activities could positively affect the sustainability and availability of traditionally important plant species and natural springs.

Smoke Impacts - Increases in prescribed fire in all alternatives (no action, Alternative 2, and Alternative 3) create the potential for increased smoke impacts. Most of the smoke from prescribed fires on the Coconino and Tonto National Forests would carry from the southwest to the northeast, potentially affecting the Havasupai Reservation and western portions of the Navajo Nation Reservation. Many people living in these areas are seniors with health conditions and are sensitive to smoke. The effects of limited communications (they cannot get on a website to check out where we're burning, etc.), language barriers, and cultural differences make it difficult to get information to them and receive information in return about smoke impacts. There is a general lack of smoke monitoring data on the reservations. Therefore, those living on these reservations may be disproportionately affected by smoke from burning by the various agencies (especially from multiple fires on multiple jurisdictions). Coconino County has a significantly higher poverty rate than the other counties and the states of Arizona and Utah. The incidence of poverty in Coconino County is not evenly distributed among racial and ethnic groups. Approximately 50 percent of American Indian residents in Coconino County live in poverty. The high proportion of American Indian residents in the county therefore increases the poverty rate relative to other study area counties and the state (Eichman and Jaworski 2011).

Environmental Consequences

Alternative 1 – No Action

Direct effects as a result of the no action alternative would result in the loss of native plant species, an increase in springs drying up, and a greater threat of devastating wild fires. Also, with continued drying trends across the southwest, the forests would issue forest closures and fire restrictions thus effecting traditional uses and ceremonies.

TCPs are at risk to catastrophic fire because it can destroy the setting of the TCP. Springs and plant collection areas are at risk to catastrophic fire because of excessive runoff from monsoon rain washing in ash and debris in a fire-devastated landscape. Overstocked stands are reducing the sunlight available for cultural and medicinal plants and catastrophic fire could destroy seed and habitat for native plants. A lack of low-intensity fire is reducing regeneration of plants collected by native people.

Soil erosion due to uncharacteristic wildfires could have both direct and indirect effects on traditional collecting areas. Rain and snow melt could cause channels to form, or mud slides from nearby slopes could deposit soil and debris over traditional areas, leading to the loss of biological communities for both plant and animal species used by the tribes.

The no action alternative may result in the possible reduction over time of pre-settlement adapted native plants, some of which have been collected since historical times by American Indians for food and medicine. Additionally, springs and seeps are important locations to American Indians and other members of the public; increasingly overstocked forests might affect those historic water sources.

Effects Common to Both Action Alternatives

The ground-disturbing activities associated with these two alternatives (2 and 3) are not significant enough to analyze separately.

Alternatives 2 and 3 would increase the amount of ground-disturbing activities, including mechanical treatments, prescribed burning, temporary road construction, skidding, stream restoration, and fence construction. When considered together with the past, present, and reasonably foreseeable future actions, these activities have the potential to affect cultural resources such as traditional collecting, gathering, ceremonial use areas, and TCPs. All undertakings that have the potential to affect cultural resources would go through tribal consultation. In addition, protection measures such as the possibility of tribal monitors during mechanical activities, keeping ground-disturbing activities out of sensitive areas by flagging and avoiding the sensitive areas, and post-prescribed burn monitoring to assess the effects of the low-intensity burns, would help to minimize the effects. The potential cumulative effects on cultural resources and TCPs such as springs from increased ground-disturbing activities and prescribed burning in these alternatives are therefore not considered to be adverse.

Cumulative Effects to Both Action alternatives

The cumulative effects on TCPs, and gathering and ceremonial areas resulting from any potential increase in erosion would also be minimal. Reducing fuel loads and implementing low to moderate-intensity prescribed fires do not cause soil sterilization or hydrophobic soils as high intensity wildfires do. Low-intensity prescribed fires leave some vegetation in place and re-vegetation occurs soon afterwards if soils are not sterilized. However, as implementation occurs, monitors would check for erosion concerns by examining culturally sensitive locations like TCPs and ceremonial sites in the implementation areas, including focusing on slopes, drainages, and other areas with a high probability of cultural resources. The cumulative effects on cultural resources caused by an increase in erosion are not considered to be adverse. An increase in these types of activities would not result in an adverse effect on cultural resources as long as tribal consultation is conducted prior to project implementation, protection measures are imposed, and post-project implementation monitoring is conducted when appropriate.

Range

A summary of the range specialist report is presented here and the complete report is incorporated by reference (Hughes 2018). Refer to the Range Report for additional information on methodology, the grazing history of the project area, and supporting information. This analysis incorporates questions designed to evaluate movement toward desired conditions and concerns brought up by the public during scoping: (1) How would project activities affect livestock grazing management in the project area? (2) How would project activities affect livestock forage in the project area? (3) Would livestock grazing affect the restoration of understory species?

Affected Environment

The affected environment for the range analysis is the Rim Country project area, approximately 1,240,000 acres. Only allotments within the project area are considered. Within the project area, approximately 1,129,490 acres are within grazing allotments and 109,170 acres are not grazed by livestock. The majority of the understory vegetation within the grazing area is dominated by Arizona fescue, mountain muhly, pine dropseed, blue grama, and squirreltail grasses.

Within the project area there are 70 livestock grazing allotments, with 69 active allotments and one vacant. Of these 70 allotments, 68 permit cattle grazing and two permit sheep grazing (one being a sheep driveway). The amount of each allotment lying within the project area varies from less than 1 percent to 100 percent.

Assumptions and Methodology

Annual planning occurs prior to the livestock grazing season. During this planning the livestock numbers and the grazing season are developed based on several factors including the previous year's management plans and outcomes, current year's predictions, and current resource conditions. During the grazing season, changes may be needed to the rotation or numbers, due to unexpected changes in conditions, such as those caused by drought or fire. This is a piece of the adaptive management cycle. Annual monitoring typically includes an assessment of current conditions, a measure of livestock usage and actual use. Long-term monitoring usually consists of condition and trend monitoring every five to fifteen years measuring plant canopy cover, plant frequency, species composition, and/or ground cover.

Design features, best management practices, mitigation and conservation measures have been developed to be used during implementation to protect range resources as well as other resources from grazing effects.

Environmental Consequences

Alternative 1

Direct and Indirect Effects

In Alternative 1, there would be no management activities occurring within the project area as a result of the Rim Country Project. Because no activities would occur, tree densities and canopy cover would remain high and understory plant cover would stay the same. Over time, tree densities and canopy cover would continue to increase, under which understory vegetative cover and production would decline. Understory species would also be reduced because of the buildup of pine needles and the lack of nutrient cycling.

The reduction in understory vegetation over time would reduce the amount of forage available to livestock. Over time, livestock numbers may need to be reduced. This reduction in forage and decrease in livestock numbers has been recorded throughout the project area. There is no reason to believe that this trend would not continue under Alternative 1.

Under Alternative 1, additional prescribed fire would not occur in the project area. Without these acres of prescribed burning, no pasture rest periods would be necessary after burning.

Since no treatments are planned in Alternative 1, grazing management would continue as has generally been planned and actually carried out in the past. However, this alternative would not adequately reduce the increased risk of uncharacteristic wildfire.

Uncharacteristic wildfires can burn with high severity and burn through multiple pastures, burning fences and other structural range improvements. Uncharacteristic wildfire would have an adverse effect on livestock grazing management and forage until the area recovers and structural improvements are replaced.

Effects Common to Both Action Alternatives

The environmental consequences for Alternatives 2 and 3 are based upon the application of design features and other resource protection measures, and are based upon the environmental consequences in the silviculture, fire and air quality, and wildlife sections.

Tree thinning and prescribed burning would increase understory vegetation. Understory species and composition would change primarily by increasing shade-intolerant understory species and decreasing shade-tolerant species. Understory species would also be increased because of the reduction of pine needles and the increase in nutrient cycling provided by burning. All these factors would improve forage production for livestock within the areas treated.

Both Alternatives 2 and 3 would directly decrease tree density by mechanical tree thinning and prescribed burning. An increase in the groupy/clumpy arrangement would substantially increase herbaceous species production by creating openings between these groups. The indirect effect of cutting trees in a groupy/clumpy arrangement would increase herbaceous vegetation because of the overall increase in sunlight reaching the soil. The increase in forage would have short-term (within three years) and long-term 10-year beneficial effects on livestock grazing.

In research near the project area, herbaceous production dropped from greater than 650 pounds per acre to 100 pounds per acre when basal area increased above 50 square feet/acre (Pearson and Jameson 1967). In another study, grasses increased by more than 470 percent cover in high-intensity harvest units compared to a 53 percent increase in pre-treatment control units (Stoddard et al. 2011). Griffis et al. (2001) also found that the abundance of native grasses increased significantly along with treatment intensity throughout thinned and burned stands.

The increase in forage within treatment areas would improve allotment conditions and allow for more flexibility in grazing management systems. Livestock distribution would improve because forage is more available in uplands. An increase in pasture graze periods would allow for additional pasture rest or deferment in other pastures within an individual allotment.

Prescribed burning would have an adverse effect on livestock grazing by removing forage available to livestock. This effect would be short term until the forage plants regrow, typically within one year. This effect would be offset by the long-term increase in forage after burning. The prescribed burning would be phased throughout the project area to minimize effects on individual allotments. Most allotments in the project area have the ability to rest a pasture for one year after a burn with little effect on overall allotment grazing management. However, livestock numbers or season of use might have to be adjusted in some allotments because of the combined effects from prescribed burns and other factors like wildfire and drought. If the burned areas do not recover within a year, then livestock would likely continue to run in the same pastures, reducing the amount of rotational grazing on an allotment. Adaptive management would continue to be used to adjust livestock management to meet annual forage production, with or without the burns.

Adjustments in grazing of livestock after prescribed fires are a mitigation to reduce effects on forage species. These mitigations have shown to maintain static understory conditions in grazed areas. Adjustments needed, such as rest or deferment are difficult to determine because each pasture’s response to ground-disturbing treatments (including mechanical thinning and prescribed fire) is unique. Climatic conditions, soils, vegetation, the severity of fire effects, burn amount, intensity of vegetation treatments, and pasture management may vary greatly from year to year or from pasture to pasture.

The removal of trees during mechanical thinning operations would have little effect on livestock grazing. Mitigations would be implemented to maintain structural range improvements and keep livestock within designated pastures during these operations. Pastures may be deferred during operations to minimize equipment and livestock conflicts, but it is not mandatory. Mechanical thinning has been conducted throughout the project area for many years with few effects on livestock grazing operations, although post-treatment inspections may result in changes to annual pasture rotations (such as deferment).

Mechanical and fire treatments (Intermediate Thin, Stand Improvement, and Uneven-aged) would leave tree groups with differing sizes of interspaces between the tree groups. Treatments in the 40 to 55 percent and the 55 to 70 percent interspace ranges would result in an increase in herbaceous cover and production, and the treatments in 10 to 25 percent, 10 to 40 percent, and 25 to 40 percent interspace ranges would still result in an increase in herbaceous cover and production, but less of an increase than the higher interspace treatments.

Single-tree selection treatments leave fewer tree groups and more randomly spaced trees. They are designed to increase or maintain age class diversity and reduce understory brush and shrub response, creating small openings less than or equal to 1/4 acre in size. This type of treatment would result in an increase in herbaceous cover and production in the openings created. Aspen restoration treatments, mechanical and prescribed fire facilitative operations, and savanna, grassland, and meadow restoration treatments would result in an increase in herbaceous cover and production. Severe disturbance area treatments, have an objective of restoring forest cover, which if it involves tree planting, would reduce herbaceous cover and production slowly over time.

Spring exclosure areas would not be available for livestock grazing and would have an adverse effect on available forage within a pasture. However, these exclosures would not be large enough and would not amass in any particular pasture to reduce pasture stocking rates. In addition, by the time these exclosures would be completed, it is anticipated the increase in pasture forage by the tree thinning and burning would help to offset the forage lost within the exclosures. Spring projects would not have a measureable impact on the capacity of allotment or grazing management.

Stream and riparian area restoration would have a long-term benefit to livestock grazing management by increasing forage, by improving bank stability, and by decreasing the amount of sediment to downstream stock tanks. Excluding livestock from these restoration areas would be short term.

Aspen exclosure areas would not be available for livestock grazing and would have an adverse impact on available forage within a pasture. However, the majority of these exclosures would not be large enough or amassed in any particular pasture to reduce pasture stocking rates. Aspen projects would not have a measureable impact on the capacity of an allotment or grazing management.

Road decommissioning would have a beneficial effect on livestock grazing by growing additional forage in the old road bed. Constructing temporary roads would have a temporary adverse effect to livestock grazing when the forage on the road was disturbed. No road project would have a measureable impact on the capacity of allotments or grazing management.

Effects from Use of In-woods Processing and Storage Sites

The development and use of the proposed processing areas would make any potential forage unavailable to livestock grazing for approximately 20 years from their initial development. These processing sites would reduce the amount of forage available in these areas which could last up to 20 years. This effect would be small compared to the size of the allotment, and would likely have no noticeable effect on livestock management.

Alternative 2

This alternative has the largest amount of acres proposed for treatments, leading to the biggest increase in forage production. This alternative also proposes the most acres of severe disturbance area treatments, which could include treatment options such as tree planting. These areas are generally within previously burned areas, such as the Rodeo-Chediski fire area. If the tree planting treatment is chosen, a decrease in production would occur overtime, in these areas.

This alternative contains the largest amount of acres proposed for mechanical treatment and prescribed fire. Therefor this alternative would have the most livestock management adjustments, such as pasture rest or deferment, following treatments.

Alternative 3

This alternative would also have an increase in forage production resulting from the proposed treatments. Due to less proposed acres of treatment, the overall forage production would be less than with alternative two. This alternative also proposes less acres of severe disturbance area treatments than is proposed in alternative two, which could include treatment options including tree planting. These areas are generally within previously burned areas, such as the Rodeo-Chediski fire area. If the tree planting treatment is chosen, a decrease in production would occur overtime, in these areas.

This alternative contains has acres proposed for mechanical treatment and prescribed fire. Therefor this alternative would have the fewer adjustments needed, such as pasture rest or deferment, following treatments than with alternative two.

Cumulative Effects

The area considered for cumulative effects analysis includes 100 percent of the acres within allotments that occur within the project area. This is a logical boundary because changes to grazing management in one pasture of an allotment affect the management in the entire allotment.

The time frame for these combined effects is 23 years, 20 years for project implementation and three years following implementation for the forage to respond to treatments. Changes in condition of the vegetation depend on the presence or absence of favorable growing conditions. If growing conditions are favorable, plant height and canopy cover would completely recover from the effects of the proposed forest management activities within one to two years. If growing conditions are not favorable, plant recovery may occur more slowly (up to two or more years). Vegetation recovery from the other activities and natural events may take this long depending on annual weather conditions particularly annual precipitation.

Continuation of current management, absent the proposed treatments in the Rim Country project area, would result in further reductions in forage production over time with the increase in tree density. Past restoration projects within and close to the project area have increased forage and understory vegetation. Forest Service policy and forest plan direction is to manage for uneven-aged stands and allow fire to return to its nature role in ecosystems. Current grazing management uses adaptive management to meet objectives established in existing allotment management plans. Past vegetation and prescribed fire projects have resulted in the current resource conditions.

The cumulative effects on livestock grazing management and livestock forage from Alternative 1 would be no change in the short term, but would result in a long-term decrease in forage with the increase in tree density. The 4FRI Rim Country project area would not be treated with the additional activities proposed. When other current and foreseeable projects are considered, 282,291 acres would be treated (168,416 acres of mechanical thinning and 113,875 acres of burning), which would increase forage production. Livestock grazing management decisions such as if pastures would be rested or deferred would be determined through inspections. With fewer treatment acres, there would be fewer adjustments on pasture rotations.

The treatments proposed in Alternatives 2 and 3 would overlap with the other current and reasonably foreseeable projects in the project area. Any overlap, when added to forage production improvements from other projects, the understory species in Rim Country would result in a positive cumulative increase in production, more in alternative 2 than in alternative 3. Livestock grazing management decisions such as pasture rest or deferred rotations would increase with the acres of treatments in both action alternatives, more in alternative 2 than alternative 3, and would be determined through inspections.

Transportation

A summary of the transportation report is presented here. The specialist report (Rich 2018) is incorporated by reference.

Affected Environment

Forest system roads within the analysis area are managed in accordance with current management objectives that are based on a variety of needs for access and use of forest resources. The system of roads ranges from primitive, unsurfaced roads (maintained for resource protection and not user comfort), aggregate surfaced roads (maintained for varying degrees of user comfort), and double-lane asphalt-surfaced state highways. These roads form a transportation system that provides access to the area for a variety of uses, including vegetation treatments, fuel treatments, fire suppression, and recreation. The majority of these system roads were planned and constructed during past commercial timber harvest activities and are not accessible year-round by all types of vehicles. These roads were designed for primary use by a standard log truck. In addition to passenger vehicles and high clearance vehicles, many of these roads are used by off-highway vehicles, hikers, mountain bikers, and horseback riders.

Some roads within the project area are poorly located. They may be overly steep and difficult to drain, located in drainages, too close to streams, or a number of other situations. Many of these roads are difficult to maintain and are causing soil and water resource damage.

The number of miles of county, state, and federal highways within the project area and that provide access to the project area and link it with potential wood processing facilities is not estimated. Since the location of potential future processing facilities is unknown it is not possible to designate all public roads which may or may not be used for accessing the area.

Current National Forest System Roads within Rim Country

Currently there are approximately 5,682 miles of Forest Service roads within the project area on Forest Service lands. Table 55 displays the miles of road by operational maintenance level.

Table 55. Summary of existing road mileage

Maintenance Level	A-S	Coconino	Tonto	Total
1- Basic Custodial Care (closed)	1,747	189	140	2,076
2 - High Clearance	856	1,417	591	2,864
3 - Suitable for Passenger Vehicles	347	240	82	669
4 - Moderate Degree of User Comfort	22	11	38	71
5 - High Degree of User Comfort	0	0	2	2
Total System Roads	**2,972**	**1,857**	**853**	**5,682**

Assumptions and Methodology

The Rim Country project area consists of 1.24 million acres on the Apache-Sitgreaves, Coconino, and Tonto National Forests. Within this area, several other environmental analyses have been conducted in recent years. These previous analyses affect the type of transportation analysis conducted in this document.

Two environmental assessments, totaling 61,101 acres, were recently analyzed for transportation needs for mechanical thinning and also for road decommissioning. No additional transportation analysis was conducted in these areas within the Rim Country EIS project area. These projects are:

- Larson- 29,921 acres- Apache-Sitgreaves National Forests
- Upper Rocky Arroyo- 31,180 acres- Apache-Sitgreaves National Forests

Six other environmental assessments totaling 192,187 acres, analyzed only for transportation needs for timber harvesting and did not analyze for any road decommissioning. These projects are:

- Upper Beaver Creek- 48,245 acres- Coconino National Forest
- Clints Well- 16,825acres- Coconino National Forest
- CC Cragin- 63,867 acres- Coconino National Forest
- Rim Lakes- 33,746 acres- Apache-Sitgreaves National Forests
- Show Low South- 4,624 acres- Apache-Sitgreaves National Forests
- Timber Mesa-Vernon- 24,880 acres- Apache-Sitgreaves National Forests

On the Coconino National Forest, 212,720 acres are identified for mechanical treatment as part of the Rim Country EIS. On the Apache-Sitgreaves National Forests, 243,995 acres are identified for mechanical treatments. On these two forests, all mechanical treatments are assumed to require adequate road access to facilitate the removal of forest product resulting from forest restoration work.

On the Tonto National Forest, 210,251 acres have been identified for mechanical treatment as part of Rim Country; however, many of these acres are dominated by chaparral, juniper, or other vegetation with less ponderosa pine present. While these areas may be mechanically treated, it is unlikely that mechanical thinning would be carried out on all of these acres due to the small amount of merchantable material present.

Areas not proposed for mechanical treatments with wood products removal would not need the same level of access as those areas where forest products would be utilized. A minimum of 100 square feet of basal area per acre of ponderosa pine was used to determine which acres would likely need adequate road access to remove forest products. Based on this analysis, 80,561 acres on the Tonto were analyzed for temporary road construction needs. The remaining 129,690 acres on the Tonto were not analyzed for temporary road construction needs, as removal of forest products is considered to be unlikely.

As a result of the previous analyses in the 4FRI footprint, and the basal area threshold of 100 square feet per acre on the Tonto National Forest, temporary road needs are only analyzed for 243,995 acres of the Apache-Sitgreaves National Forests, 212,720 acres of the Coconino National Forest, and 80,561 acres of the Tonto National Forest, for a total of 537,276 acres within the Rim Country project area.

Road decommissioning is analyzed for 1,080,341 acres within the Rim Country EIS project area. This represents the entire project area outside of the Larson and Upper Rocky Arroyo analysis areas, which have already been analyzed for road decommissioning.

Issues/Indicators/Analysis Topics

The following significant issue was identified for the Rim Country Project:

> The miles of temporary roads in the proposed action may negatively affect watershed and stream conditions, and wildlife habitat and connectivity. Commenters asked that the Forest Service limit road networks to those roads needed for access and management. Commenters requested an alternative that dramatically reduces temporary road mileage.

Indicators/Measures:

Indicators would include the range of temporary roads that may be needed in each of the alternatives, measured by the approximate number of miles of temporary roads proposed in each alternative.

Environmental Consequences

Alternative 1 – No Action

Use of Existing Roads

Under Alternative 1, no new restoration activities would take place and no additional use of existing roads would occur. Current rates of public and administrative use would continue.

Road Maintenance

Under Alternative 1, maintenance to provide public and administrative access would continue, contingent upon funding. No increase in road maintenance to accommodate restoration activities would occur.

Road Decommissioning

Under Alternative 1, no road decommissioning would occur within the project area unless it is analyzed under separate NEPA analysis.

Temporary Roads

Under Alternative 1, no new temporary roads would be constructed, unless constructed under separate NEPA analysis

Rock Pit Use and Expansion

Under Alternative 1, there would be no expansion of existing pits. Current use of existing and new pits analyzed under separate NEPA would continue.

Use of In-woods Processing and Storage Sites

Under Alternative 1, no in-woods processing and storage sites would be created or used; therefore there would be no effects resulting from them.

Effects Common to Both Action Alternatives

An adequate transportation system to provide access for restoration work and for removal of forest products generated from restoration activities is critical for accessing stands identified for mechanical treatment. Listed in the following paragraphs are practices that are common to all action alternatives.

Use of Existing System Roads

It is assumed that nearly all of the existing roads within the Rim Country analysis area may be used to provide access for a variety of restoration activities, including hauling of forest products resulting from mechanical treatments. Nearly all of the forest system roads within the project area are ML 1, 2, or 3 roads. This analysis addresses temporarily opening existing closed roads (ML 1) to utilize them for the time period they are needed to provide access for restoration work. These roads would be closed upon completion of work in the area they access and returned to a closed status (ML 1).

The preferred alternative in the Tonto Travel Management EIS proposes that 354 miles of ML 2 roads be converted to motorized trails. These roads have received minimal maintenance over the years and their current condition is not anticipated to improve (narrowing, roughening up, or otherwise modifying the road as it’s redefined to a motorized trail). Full size vehicles would be authorized to use these routes under Tonto Travel Management and they would be managed as motorized trails. It’s anticipated that pre-haul maintenance is all that would be needed in the future to prepare the motorized trails for use to access mechanical treatment areas.

Roads used for hauling of forest products under this analysis would be maintained or improved in order to meet road management standards under National Best Management Practices for Water Quality Management on National Forest System lands.

Road Maintenance

Road maintenance is defined as, “The upkeep of the entire transportation facility including surface and shoulders, parking and side areas, structures, and such traffic-control devices as are necessary for its safe and efficient utilization. This work includes brushing of roadside vegetation, falling danger trees, road blading, cleaning ditches, cleaning culvert inlets and outlets, etc.” (36 CFR 212.1)

Road maintenance on roads that receive substantial use by the public are maintained by the Forest Service on a regular basis as funding allows. When there is a substantial increase in use of a road by a Forest Service contractor for uses such as hauling, this contractor is usually required to perform maintenance both during and after their use of the road commensurate with their use. This maintenance is often blading and reshaping of the road surface. Road maintenance on roads that are closed to the public would be performed by the logging contractor.

Roads used for hauling of forest products under Rim Country would generally be maintained by contactors. This maintenance would likely be done while the road is being used and at the completion of hauling. All maintenance performed by contractors would be in accordance with Forest Service maintenance standards.

Road Decommissioning

Road decommissioning is defined as: "Activities that result in the stabilization and restoration of unneeded roads to a more natural state." (36 CFR 212.1, FSM 7705 – Transportation System) The Forest Service Manual (7712.11- Exhibit 01) identifies five levels of treatments for road decommissioning which can achieve the intent of the definition. These include:

- Block entrance
- Revegetation and water barring
- Remove fills and culverts
- Establish drainage ways and remove unstable road shoulders
- Full decommissioning, recontouring and restoring natural slopes

These five treatments provide a wide range of options to stabilize and restore unneeded roads. In some cases restoration may be achieved by blocking the entrance. In other situations, the more extensive activities listed above may be called for.

This analysis does not identify specific road segments for decommissioning. Rather it would provide the NEPA decision to decommission roads and road segments at the time that task orders or other projects are implemented. Roads would be evaluated for decommissioning at that time.

Roads may be decommissioned for a variety of reasons, including but not limited to roads that are:

- No longer needed for future management
- To protect cultural resources
- Causing soil or water resource damage
- Not useable without significant investment beyond current and future funding levels
- An ongoing road maintenance challenge
- An unauthorized road (an unauthorized roads is defined as road that is not a forest road or a temporary road and that is not included in a forest transportation atlas).
- Other unique situations

Under this alternative both National Forest Systems roads and unauthorized roads could be decommissioned. When a system road is decommissioned it is also removed from the National Forest Road System. Transportation Analysis Process (TAP) reports for the Coconino, Apache-Sitgreaves, and Tonto National Forests and site-specific on-the-ground evaluations would be considered in selecting roads for decommissioning.

On the Tonto National Forest, decommissioning of system roads is being analyzed as part of the Tonto Travel Management EIS and roads for decommissioning are identified. Roads identified for decommissioning under the Tonto Travel Management EIS could be physically decommissioned as part of restoration work undertaken to implement the Rim Country EIS.

Unauthorized roads within the project area on all forests could be decommissioned under this decision. Roads currently designated as open on a forest's Motor Vehicle Use Map would not be decommissioned or closed under the action alternatives. Unless already identified for decommissioning under the Tonto Travel Management, roads on all three Rim Country forests that are needed to provide reasonable skidding distances for future harvesting would not be decommissioned. Also, roads that are needed to provide access to leases and other special uses on National Forest System lands would not be decommissioned unless other suitable access is provided. If these roads are needed for future management, but are a problem for soil and water resources, they would instead be relocated.

Road Relocation

Road relocation is defined as moving an existing road from its current location and re-locating it to a new location. Unfortunately many roads within the project area are poorly located and were never properly designed. As a result these roads are in need of relocation. Roads that could be considered for relocation include those that are:

- Too steep, resulting in significant erosion
- Below the level of the surrounding land and are difficult to drain.
- Are too close to a seasonal or perennial waterbody and contributing sediment to the waterbody
- Other unique situations
- Any combination of the reasons listed above

When roads are relocated, their former location would be decommissioned. This would result in little if any net gain or loss in road mileage in most cases. Road relocation of a system road is not considered construction of a new permanent road. It is considered a relocation of an existing road.

This analysis does not identify specific road segments for relocation. Rather it provides the basis to relocate roads and road segments at the time that task orders or other projects are implemented. Roads would be evaluated for relocation at that time.

Temporary Roads

The Collaborative Forest Landscape Restoration Act (CFLRA), does not allow for the construction of new permanent roads in CFLR projects. Any new road constructed under CFLRA must be a temporary road and cannot be added to the national forest road system. All new road construction in this project is considered temporary.

A temporary road is defined as: "A road or trail necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road, or trail and that is not included in the transportation atlas." (36 CFR 212.1)

In order to provide adequate access to the project area for timber removal, temporary roads would need to be constructed in some locations, and are intended to provide short-term access to a specific area for wood products removal and/or follow up treatments, such as prescribed burning. Temporary roads are often used to provide economically feasible skidding distances in harvest operations. Following completion of work in the area they serve, temporary roads would be decommissioned and made impassable to vehicles. Decommissioning would be accomplished with one or more of the five levels of treatments described above.

Temporary roads might be either new construction or utilize existing road prisms of unauthorized roads. Temporary road mileage for each action alternation is listed under that alternative.

Rock Pit Use and Expansion

Rock pit use and expansion could require a limited amount of temporary road. This mileage is included in the estimated temporary road mileage under each action alternative.

Use of In-woods Processing and Storage Sites

In-woods processing and storage sites could require a limited amount of temporary road. This mileage is included in the estimated temporary road mileage under each action alternative.

Effects Unique to Each Action Alternative

Alternative 2 – Modified Proposed Action

Temporary Roads

Under this alternative up to 330 miles of temporary road could be created and utilized to facilitate mechanical treatments. These temporary roads might be new construction or utilize existing unauthorized roads. Temporary roads would be decommissioned when thinning and related restoration work is completed in the areas they access.

Alternative 3 – Focused Restoration

Temporary Roads

Under this alternative up to 170 miles of temporary road could be created and utilized to facilitate mechanical treatments. These temporary roads might be new construction or utilize existing road prisms of non-systems roads already present. Temporary roads would be decommissioned when thinning and related restoration work is completed in the areas they access.

Cumulative Effects

The spatial boundary for this cumulative effects analysis is the Rim Country Project Area. The time frame for the analysis begins in 2010, and was selected because it captures all the decisions that include the applicable transportation system activities in the cumulative effects spatial boundary. . The timeframe extends to twenty years into the future because that is what is reasonably foreseeable for implementation of the Rim Country Project.

Construction of temporary roads would expand the existing transportation system within the project area to provide adequate access to all stands in need of mechanical treatment. Construction of temporary roads would allow nearly all stands to be harvested with a maximum skidding distances of 1,250 feet or less. Temporary roads may also be used for access for prescribe fire and other restoration activities. Following completion of activities in an area temporary roads would be decommissioned.

Alternative 1 – No Action

Under Alternative 1, there are no proposed activities so there would be no cumulative effects in the project area from; use of existing roads, road maintenance, road decommissioning, temporary roads, rock pit use and expansion, and use of in-woods processing and storage sites.

Cumulative Effects Common to Both Action Alternatives

Use of Existing Roads

Under both action alternatives use of existing roads would be in addition to current use by the public, contractors, and permittees on national forest system lands.

Road Maintenance

Under both action alternatives road maintenance performed would be in addition to road maintenance performed currently under a forest regular program of road maintenance

Road Decommissioning

Under both action alternatives up to 200 miles of system road on the Coconino and Apache-Sitgreaves National Forests could be decommissioned. The Tonto National Forest Travel Management EIS has identified approximately 290 miles of road within the Rim Country project area for decommissioning. In addition to system road decommissioning, up to 800 miles of unauthorized roads on all three forests could be decommissioned under these alternatives. In addition to these road mileages the Larson and Upper Rocky Arroyo environmental assessments on the Apache-Sitgreaves National Forests identified 18 miles of system road 57 miles of unauthorized road for decommissioning.

Road Relocation

Under both action alternatives any roads relocated under this alternative would be in addition to roads relocated on other projects within the Rim Country project area.

Overall, the cumulative effect to the transportation system in the project area from the action alternatives would result in a more sustainable road system that would provide access for the Rim Country Project Area.

Alternative 2-Modified Proposed Action

Temporary Roads

There are approximately 50 miles of temporary road that have been analyzed under separate project within the project area and are in various stages of implementation. When these are added to the 330 miles proposed in alternative 2 the total mileage of temporary roads is 380 miles within Rim Country analysis area, which is more than under alternative 3. Cumulatively these temporary roads would serve as access to their respective treatment areas for the duration of the projects they are constructed for. The

Alternative 3- Focused Alternative

Temporary Roads

There are approximately 50 miles of temporary road that have been analyzed under separate projects within the project area and are in various stages of implementation. When these are added to the 170 miles under proposed in alternative 3 the total mileage of temporary roads is 220 miles within the Rim Country analysis area, which is less than under alternative 2. Cumulatively these temporary roads would serve as access to their respective treatment areas for the duration of the projects they are constructed for.