United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

**November
2013**

Vegetation and Fire Specialist Report

Forest Plan Revision DEIS

Submitted by: __/s/_____

Shawn A. Martin
Certified Silviculturist
Coconino National Forest

__/s/_____

Victor Morfin
Forest Fuels Management Specialist
Coconino National Forest

__/s/_____

Wesley Hall
Forest Fire Management Specialist
Coconino National Forest

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Preface

The information in this specialist report reflects analysis that was completed prior to and in conjunction with the completion of the Draft Environmental Impact Statement (DEIS) for the revision of the 1987 Coconino National Forest Land Management Plan (the Plan). The primary purpose of specialist reports associated with the DEIS is to provide detailed information to assist in the preparation of the DEIS. As the DEIS was prepared, review-driven edits to the broader DEIS resulted in modifications to some of the information contained in some of the specialist reports. As a result, some reports no longer contain information and analysis that was updated through an interdisciplinary review process and is included in the DEIS in its entirety. This is a complete specialist report which includes all the information that was summarized in the DEIS and other supplemental information. Efforts have been made to ensure that the retained information in the specialist reports is consistent with the DEIS. If inconsistencies exist between specialist reports and the DEIS, the DEIS should be regarded as the most current, accurate source of analysis.

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Introduction

This specialist report evaluates and discloses the potential environmental consequences on the Vegetation and Fire resource that may result with the adoption of a revised land management plan. It examines, in detail, four different Alternatives for revising the 1987 Coconino National Forest Land Management Plan (1987 Plan).

Healthy, resilient landscapes have greater capacity to survive natural disturbances and large scale threats to ecological sustainability, especially under changing and uncertain future environmental conditions, such as those driven by climate change and increasing human uses (Fule 2008).

Fire is a critical evolutionary force that has helped shape the vegetation of the Coconino National Forest (Coconino NF). The resiliency of much of the forest is dependent upon fire as a frequent disturbance process; the structure and function of vegetation are closely intertwined with the role of fire. Hence, they are examined together in this report.

Relevant Laws, Regulations, and Policy that Apply

All Alternatives are designed to guide the Coconino NF's management activities in meeting all applicable Federal and State laws, regulations, and policies.

The authority for restoring National Forest System lands derives from many laws enacted by Congress that define the purpose of national forests and grasslands. These are cited throughout the Forest Service Manual and Handbooks. FSM 1010 lists the most necessary laws and provides guidance on where to obtain copies. Forest Service Manual 2020 – Ecological Restoration and Resilience, summarizes the principal laws and statutes governing the management and restoration of National Forest System lands. See also Appendix A.

Laws include:

- Organic Administration Act of 1897 (16 U.S.C. 475, 551)
- Weeks Law of 1911, as amended (16 U.S.C. 515, 552)
- Knutsen-Vandenberg Act of 1930 (16 U.S.C. at 576b)
- Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act of 1949 (16 U.S.C. 581j and 581j(note))
- Granger-Thye Act of 1950 (16 U.S.C. at 580g-h)
- Surfaces Resources Act of 1955 (30 U.S.C. 611-614)
- Sikes Act (Fish and Wildlife Conservation) of September 15, 1960 (16 U.S.C. at 670g)
- Multiple-Use Sustained Yield Act of 1960 (MUSYA) (16 U.S.C. 528-531)
- Wilderness Act of 1964 (16 U.S.C. §§ 1131 et seq.)
- Wild and Scenic Rivers Act (82 Stat. 906, as amended, 16 U.S.C. 1271 (note), 1271-1287)
- National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321 et seq.)
- Endangered Species Act of 1973 (P.L. 93-205, 87 Stat. 884; 16 U.S.C. 1531-1544, as amended)

- Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 1600-1614, 472a)
- Clean Water Act of 1977 (33 U.S.C. 1251, 1254, 1323, 1324, 1329, 1342, 1344; 91 Stat. 1566)
- Clean Air Act, as amended 1977 and 1990 (42 U.S.C. 7401, 7418, 7470, 7472, 7474, 7475, 7491, 7506, 7602)
- North American Wetland Conservation Act of 1989 (16 U.S.C. 4401 (note), 4401-4413, 16 U.S.C. 669b (note))
- 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)

Principal Executive Orders relevant to ecological restoration are listed below and in Appendix A:

- Executive Order 11514: Protection and enhancement of environmental quality (35 FR 4247, March 7, 1970).
- Executive Order 11644: Use of off-road vehicles on the public lands (37 FR 2877, February 9, 1972).
- Executive Order 11988: Floodplain management (42 FR 26951, May 25, 1977).
- Executive Order 11990: Protection of wetlands (42 FR 26961, May 25, 1977).
- Executive Order 13112; Invasive Species (64 FR 6183, February 8, 1999).
- Forest Service Manual (FSM):
    - Chapters 5100-5190
    - 2020

Federal Wildland Fire Policy

In addition, there are numerous guides (Appendix A) that have been developed to provide guidance for successful planning and implementation of fire management operations.

The “Federal Wildland Fire Policy” is the principle document guiding fire management on Federal lands. The Policy was developed in 1995, and was further evaluated, and updated in 2001, 2003 and 2009. The 2009 Implementation Guide provides the terminology related to fire used in this report. Wildland fire is a term describing any non-structure fire that occurs in the wildland fire. Wildland fires are categorized in two distinct types:

- Wildfires are unplanned ignitions, including escaped prescribed fires that are declared wildfires. Wildfires may be ignited by natural causes, namely lightning, or human caused. Under the current Implementation Guide, initial action on human-caused wildfires would be to suppress the fire at the lowest cost with the fewest negative consequences with respect to firefighter and public safety.
- Prescribed fires are planned management ignitions.

The Implementation Guide states that fire, as a critical natural process, would be integrated into the land management plan. It also states that wildland fire . . . "would be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role as a disturbance factor in the ecosystem." (USDA and USDOI 2009)

Methodology and Analysis Process

The vegetation analysis modeled the potential vegetation conditions resulting from natural disturbances and succession in conjunction with proposed management (human disturbances) for each of the Alternatives. The evaluation focused on ecosystem functions associated with the Priority Needs for Change in the Analysis of the Management Situation (USDA Forest Service 2010) and served as the basis for several other resource assessments including species habitats, soil and watershed condition, air quality, and social and economic uses. A number of sources were used to display current conditions. Various models were used to predict trends in vegetation and disturbances in response to natural and anthropogenic forces by Alternative. Alternatives were evaluated by their progress toward priority needs for change and associated desired conditions.

Vegetation Modeling

State-and-Transitions Models (STMs) played a prominent role in the plan revision process in the Southwestern Region. The State-and-Transitions model used for plan revision analysis was the Vegetation Dynamic Development Tool or VDDT. In the first phase of the process, the VDDT was used in the ESR to estimate condition and trends of some of the PNVTs and to identify ecological needs for change. Following this, priority needs for change to be addressed in plan revision were identified in the Analysis of the Management Situation. In the analysis for the draft environmental impact statement, outputs from the VDDT models were used to compare the conditions and trends of PNVTs by Alternative. VDDT models are further described below.

Several sources were utilized to determine existing conditions. The primary sources for existing vegetation conditions included:

- Information about the frequency of stand-replacing fire on the Coconino NF and other national forests located along the Mogollon Rim in northern Arizona.
- A classification of PNVTs developed and based primarily upon the map units from the Terrestrial Ecosystem Survey. This classification was used to compare existing vegetation to characteristic vegetation[1]. Descriptions of PNVTs with characteristic vegetation composition and structure for the Coconino NF were displayed in a spreadsheet.
- A mid-scale vegetation inventory. This inventory, completed in 2008 for the Coconino and Kaibab National Forests, provided geospatial polygons of life form characteristics (e.g., tree, shrub, and grass-forb), size class (for trees), and canopy cover class. The Southwestern Regional Office performed an accuracy assessment of the mid-scale vegetation inventory for the Coconino and Kaibab National Forests, and estimated the average accuracy (weighted by area) at 61percent for species dominance (68 percent for

[1] Characteristic vegetation is the vegetation composition and structure that would exist in a natural disturbance regime, and considered to be ecologiclly sustainable, and more resilient to climate change.

"tree classes"), 59 percent for canopy cover class, and 42 percent for size class (USDA Forest Service, 2008a). This data is a mid-scale product meant to represent general landscape vegetation patterns that are being evaluated with base scale plots (i.e., comparing mid-scale data points to Forest Inventory and Analysis data points), and it is not appropriate for site-specific analyses (Beyerhelm and Mellin, 2011). However, this data is appropriate for use in landscape-scale projects such as plan revision.

- Forest Inventory and Analysis (FIA) plot data. The FIA plot data was used to: estimate relative proportions of even- and uneven-aged structural conditions on the Forest, estimate proportions of various vegetation types within Piñon-Juniper systems, estimate the amount (percentage) of ponderosa pine-Gambel oak vegetation on the Forest, estimate the quantity of snags in ponderosa pine, and calibrate the VDDT model used in predicting vegetative trends (USDA Forest Service 2011a).

Various models were then used to predict trends in vegetation and disturbances in response to natural and human forces by Alternative. VDDT was the primary model used to evaluate trends. VDDT is a Windows-based computer tool which provides a modeling framework for examining the role of various disturbance agents (e.g. fires, insects, pathogens) and management actions in vegetation change. The interaction of these disturbances is complex, and the combined effects are difficult to predict over long periods. VDDT provides a way to compare Alternatives by testing the sensitivity of the ecosystem to a multitude of activities and agents of disturbance. Using the VDDT model, a vegetation type is assigned various states—some are seral states found within the historic range of variability and others are uncharacteristic states not present in the historic range of variability. Inputs to the VDDT model are agents of disturbance, such as number of acres mechanically treated to restore vegetation stand structure or acres that are burned by fire under low, moderate, or high fire weather conditions. Outputs to the VDDT model are the transition of the vegetation, by percent, from one state to another. For example, an input of high severity fire would move a percentage of dense states to more open states. Conceptual diagrams projecting transitions in vegetation states (i.e., composition and structure) can be found in figures 2 and 3. State descriptions are listed in Table 1 below.

Table 1. VDDT state descriptions for Ponderosa Pine and Mixed Conifer states

State	Description
A	Grass, forb, shrubland; <10% canopy cover
B	Seeding/sapling, open; <10% canopy cover
C	Small trees, open; 10-30% canopy cover; 5-10" diameter class
D	Medium trees, open, single story; 10-30% canopy cover; 10-20" diameter class
E	Very large trees, open, single story; 10-30% canopy cover; 20+" diameter class
F	Seeding/sapling, closed; >30% canopy closure; 0-5" diameter class
G	Small trees, closed; >30% canopy closure; 5-10" diameter class

State	Description
H	Medium trees, closed, single-story; >30% canopy closure; 10-20” diameter class
I	Very large trees, closed, single-story; >30% canopy closure; 20+” diameter class
J	Medium trees, open, multi-story; 10-30% canopy closure; 10-20” diameter class
K	Very large trees, open, multi-story; 10-30% canopy closure; 20+” diameter class
L	Medium trees, closed, multi-story; >30% canopy closure; 10-20” diameter class
M	Very large trees, closed, multi-story; >30% canopy closure; 20+” diameter class
N	Uncharacteristic state ; <10% canopy cover

Projecting transitions in vegetation states (i.e., composition and structure) over time facilitates the evaluation of each Alternative considered. The vegetation states, and transitions from one state to another, can be visualized in a conceptual diagram. Figure 1 below illustrates the conceptual diagram for the successional pathways of the Ponderosa Pine Bunchgrass PNVT state-and-transition model. Boxes represent model states and arrows represent transitions due to natural growth and other natural and human factors such as management activities, fires, insects, and disease.

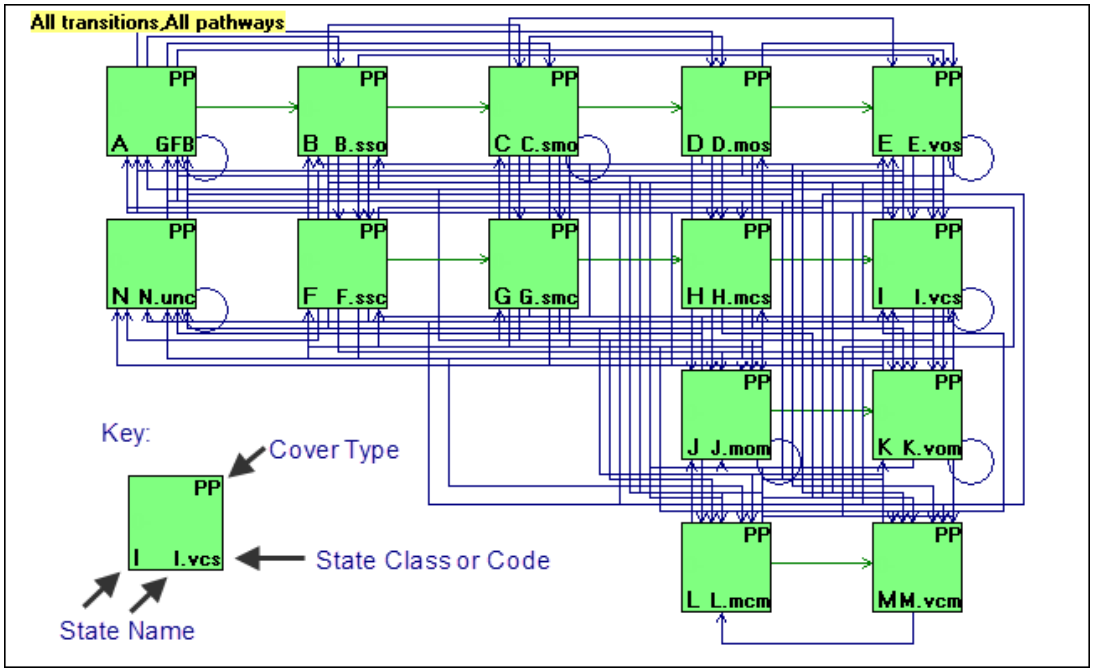

Figure 1. VDDT conceptual diagram for projecting transitions in vegetation states

Figure 2 is a conceptual diagram for the historic state and transition model of the Semi-Desert Grassland Mixed Native Vegetation PNVT. Frequency of transitions are noted when this

information is supported by published sources, where no information exists on the frequency of transitions the arrow is blank. Dashed outlines represent states which have crossed an ecological threshold. An example of ecological threshold is the box labeled ‘eroded condition’ in Figure 2 below.

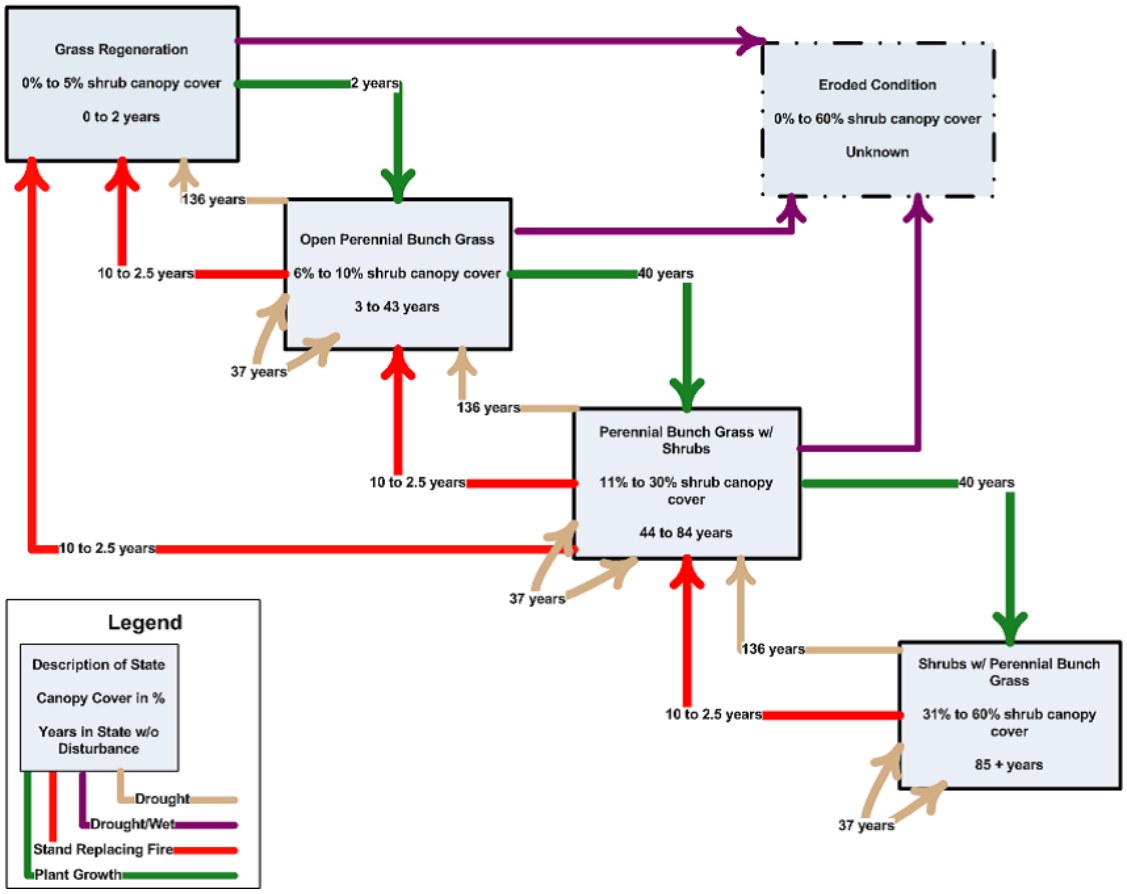

Figure 2. Conceptual historic state and transition model of the Semi-Desert Grassland Mixed Native Vegetation Type

VDDT models for ponderosa pine, mixed conifer, and Piñon-Juniper vegetation types (among others) were developed by the Forest Service at the regional level to be used specifically to compare Alternatives for land management plans in the Southwestern Region. The actual data, databases, and spreadsheets that were used in this process are contained in the forest plan revision project record.

The Forest Vegetation Simulator (FVS) was used to calibrate STMs in Arizona and New Mexico. A standard set of silvicultural and fire transitions were evaluated using FVS simulations of Forest Inventory and Analysis plot data that have been grouped up by each Vegetation Dynamic Development Tool (VDDT) model state within each Potential Natural Vegetation Type (PNVT). For example, if a stand that is in the medium-sized, closed canopy, single story state were treated with group selection and free thinning followed by low severity Rx fire, it may go from 100% in the closed canopy, single story state to 20% grass/forb/shrub; 5% very large, open, single story; 50% medium, open, single story; and 25% remaining in the original closed canopy, single story state. A range of outputs from FVS (e.g., natural growth in the absence of disturbance, the

probabilities of transitions to destination states resulting from natural and human events, harvest volumes, and vegetation characteristics such as carbon values) were captured and linked to transitions through the modeling framework. These outputs were used to evaluate the effects of vegetation management activities in the plan revision process (USDA Forest Service Region 3 White Paper, 2011b)

The Forest began with the models for Ponderosa Pine Bunchgrass (PPG) and Mixed Conifer with Frequent Fire (i.e. Mixed Conifer Dry or MCD) models. The PPG model was similar enough to the Ponderosa Pine Gambel-Oak (PPO) model that the two were evaluated together as Ponderosa Pine Forest (PPF). A spreadsheet displaying a crosswalk of the PNVTs and VDDT models is contained in the project record and it allows for user input of the percentage of PPG and PPO. Using FIA data collected across the Forest over the past 10 years, it was estimated that PPO accounts for approximately 40 percent of the combined PPF type. The VDDT model provided a base comparison for the relative progress the plan Alternatives are predicted to make toward desired conditions based on plan objectives. Much of the modeling response in VDDT was calibrated using FIA data inputs and results from FVS runs. In contrast to VDDT models, FVS can be more sensitive to management, because it models the fate of individual trees over time rather than finite states of stand averages.

Each ecosystem has a standard set of vegetation states. Each vegetation state has a typical set of vegetation characteristics whose attributes can be defined by the FIA inventory plots that reside within the state (Miles et al., 2001). A standard set of potential natural and human events can occur within each state. These states and the effects of each event can be modeled with FVS simulations using the FIA plot data (Dixon, 2002). Reports generated from FVS outputs can provide a variety of information by quantifying the following information by VDDT model state:

- The vegetation characteristics of each vegetation state. The probabilities of transitions to destination states resulting from:
    - natural growth in the absence of disturbance,
    - management activities, and
    - wildfire.
- The wood volumes and other outcomes resulting from each type of disturbance.

In the analysis process, the vegetation characteristics existing at any point in time for each modeled PNVT are described by specific combinations of size, cover, and dominance type that are characteristic for each PNVT. For example, the combinations used to describe the vegetation states in the Ponderosa Pine Grassland ecosystem are illustrated in table 2 (Weisz et al., 2011)[2].

[2] A more detailed explanation can be found in the manuscript *Calibrating State and Transition Models with FVS: A Case Study* (Weisz et al., 2011).

Table 2. Stratification of Ponderosa Pine and Mixed Conifer with Frequent Fire states A through N

Canopy Layering	Canopy Cover[1]	GFB-SHR	Tree DBH			
			0-5"	5-10"	10-20"	20"+
Single	Open	A or N[2]	B	C	D	E
Single	Closed		F	G	H	I
Multi	Open				J[3]	K[3]
Multi	Closed				L	M

[1] Except for states A and N, "open" states have 10 to 30 percent canopy cover and "closed" states have greater than 30 percent canopy cover. States A and N have less than 10 percent canopy cover.

[2] States A and N are grass, forbs, brush and shrub states. A is the characteristic state which existed in reference conditions. N is the uncharacteristic state resulting when stand-replacing fire occurs in closed canopy states.

[3] The desired condition is an open multi-layered (> 5 age classes) state with average diameter varying by site productivity, state J occurring on less productive sites and state K on-sites with greater productivity.

The Forest Vegetation Simulator (FVS) (v2.02) along with the Fire and Fuels Extension (FFE) were used to simulate the effects of using fire as a restoration tool on various stand conditions. Only one fire cycle per stand was modeled, but each fire was modeled at low, moderate and high intensities. The comparative stand conditions from pre-modeled fire to post-modeled fire were then used as input to the Vegetation Dynamics Development Tool (VDDT). VDDT was used to model vegetation succession over the life of the forest plan and into the future, under the various proposed management Alternatives. The current plan describes goshawk habitat in terms of Vegetation Structural Stage or VSS classes. Appendix B provide crosswalks between the state names used in the DEIS analysis and the more descriptive, qualitative state descriptors used in the analysis of Alternatives along with proportions of each stated under reference (desired) conditions. Appendix C provides a crosswalk between VDDT model states, VSS class, and descriptions of northern goshawk habitat from Reynolds and others (Reynolds et al., 1992).

Environmental conditions used to simulate the low, moderate, and high fire conditions are based on historic weather data from the Alpine Remote Automated Weather Station (RAWS) (Appendix D). The Alpine RAWS has complete and accurate weather data. The data were sorted using Fire Family Plus (v4.1) to produce a Percentile Weather Report. This percentile report was used to determine the 15th, 75th and 90th percentile weather for the past twenty years (1990 to 2009). Weather data were used for a period from April 1- October 15 each year, representing a typical fire season period. The 15th percentile represents natural fire season conditions for a low intensity fire and the 75th percentile represents moderate and the 90th percentile the high intensity fire conditions.

These percentiles of environmental conditions were used to represent both natural fire conditions such as wildfires that may be managed to move vegetative conditions toward desired conditions, as well as burning prescriptions that may be used for management ignited prescribed fires. These environmental conditions approximate natural conditions under which a natural fire may burn and

would be a good starting point for development of a management burning prescription. Winds generated from the report were unusually low, so 10, 15 and 20 mph winds were substituted for low, moderate, and high 20' winds. The percentile weather report does not produce an air temperature, so based on analysis of the weather data and professional judgment 60, 75, and 90 degrees were used respectively. Duff moisture is also not produced by the percentile weather report. These were derived using FVS, FFE defaults for duff moisture under moist 125%, dry 50%, and very dry 15% conditions (USDA Forest Service 2008 p. 43). Varying duff moisture had little effect in the model on fire effects on stand conditions. These conditions were used across all vegetation types to provide consistency. A cooler and moister condition at higher elevation vegetation types compared to hotter and dryer lower elevation vegetation types was not significant in model outcome.

Ponderosa Pine, Mixed Conifer with Frequent Fire, Piñon-Juniper with Grass, Semi-Desert Grassland, Great Basin Grassland, Montane/Subalpine Grassland were the only PNVTs modeled.

Modeled outputs from the Vegetation Dynamics Development Tool (VDDT) would be compared to existing and desired conditions. Evaluation criteria for whether an Alternative is addressing the need for change, in (Ponderosa Pine or Mixed Conifer with Frequent Fire) communities are:

- Frequency of States[3] B and F combined. States B and F represent seedlings and saplings (0-5" DBH). State B is open canopy (10-30% cover) and State F represents closed canopy (30% plus). These are both single-storied states. These represent conditions indicative of occasional even-aged stand dynamics and the development of closed mature forest habitat.
- Frequency of States C and G. State C represents small (5-10" DBH), open canopy stands and Sate G represents small closed canopy stands. These represent conditions indicative of occasional even-aged stand dynamics and the development of closed mature forest habitat.
- Frequency of States D, E, J and K combined. States J and K represent uneven-aged (multi-storied) conditions and dynamics with medium (10-20" DBH) and very large (20"+ DBH) open forests. States D and E represent even-aged (single storied) conditions and dynamics with medium and very large open forests.
- This is based on reference conditions, and the predominance of uneven-aged dynamics and open forest condition. Stands on low-productivity sites are more likely to occur as state J, versus high-productivity sites where State K is more likely. Desired conditions are to have area primarily represented by J and K.
- Frequency of States H, L, I, and M combined. States L and M represent uneven-aged conditions and dynamics with medium and very large closed multiple storied canopies. States H and I represent medium and very large closed single storied canopies.
- These conditions are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2009), particularly on north facing slopes and canyons. Stands on low-productivity sites are more likely to occur as state H/L, versus high-productivity sites where State I/M are more likely.

[3] A Description of Transitional States can be found in appendix C.

Evaluation criteria for whether an Alternative is addressing the need for change, in Piñon-Juniper Grassland are:

- Frequency of State A. States A represents grass, forb, and brush/shrub.
- Frequency of States B, E, and C combined.
    - State B is seedlings and saplings, single-storied, with open canopy.
    - State C is small trees, single-storied, with open canopy.
    - State E is very large trees, single-storied, with open canopy.
- Frequency of State D. State D represents grass, medium sized trees, single-storied, with open canopy.
- Frequency of State F. State F represents seedlings and saplings, single-storied, with closed canopy.
- Frequency of State G. State G represents small trees, single storied, with closed canopy.

Each modeled vegetation type would also be compared over time in terms of departure from reference conditions. All criteria are evaluated at the current, 15-year, and 50-year time-marks. Table 3 lists the quantitative objectives developed for certain PNVTs. Acres listed are for each 10-year period following plan approval and assume treatments would be prioritized to move identified forest priority sixth code watersheds toward satisfactory conditions.

Table 3. Treatment objectives alternatives B, C, and D

PNVT	Objective
Ponderosa Pine	Silviculturally treat (primarily using group selection or free thinning) 50,000 to 260,500 acres.
Ponderosa Pine	Utilize prescribed fire to underburn 150,000 (low severity) to 300,000 acres (low severity).
Ponderosa Pine	Using naturally ignited fires (lightning-caused), treat 135,000 acres with low severity fire.
Mixed Conifer w/ Frequent Fire	Silviculturally treat (primarily using group selection or free thinning) 300 acres.
Mixed Conifer w/ Frequent Fire	Utilize prescribed fire to underburn 8,000 acres (low severity burn only).
Mixed Conifer w/ Frequent Fire	Using naturally ignited fires (lightning-caused), treat 7,500 acres with low severity fire.
Piñon-Juniper Grassland	Silviculturally treat (primarily using group selection or free thinning) 1,000 to 10,000 acres.

PNVT	Objective
Piñon-Juniper Grassland	Using naturally ignited fires (lightning-caused), treat 3,750 acres with low to mixed severity fire.
Piñon-Juniper Evergreen Shrub	Using naturally ignited fires (lightning-caused), treat 3,750 acres with low to mixed severity fire.
Montane/Subalpine Grasslands	Restore/enhance between 7,600 and 11,400 acres.
Great Basin Grasslands	Restore/enhance between 10,800 and 12,400 acres.
Semi-Desert Grasslands	Restore/enhance 3,500 acres.
Riparian Forest Types	Restore at least 200 – 500 acres of non-functional and functional-at-risk riparian areas.
All Forest Types	Achieve 1,000 acres of aspen and maple restoration and maintenance.

There are no objectives in any of the developed Alternatives for the remaining vegetation types, recognizing the limited capacity for treatment during the planning period. This does not prevent treatments from being planned and implemented in these vegetation types as funding and personnel become available. Since there are no objectives developed for these vegetation types, no meaningful comparison of Alternatives is possible using vegetation modeling. However, these PNVTs will be evaluated qualitatively based on desired conditions, plan guidelines, and other plan components. Appendix E shows a crosswalk between VDDT states and qualitative state descriptions for a variety of PNVTs.

Fire Departure and Trend

Fire Regime Condition Class (FRCC) was used in the Ecological Sustainability Report to characterize fire departure and to quantify how departed vegetative structure is from historical conditions in relation to the role fire historically played in that system (Hann and Bunnell 2001, Hardy et al. 2001, Hann et al. 2004). Vegetation condition class, analysis of changes in fire return intervals, and analysis of fire severity replaced FRCC in this analysis because the earlier version of FRCC did not adequately quantify key fire regime attributes or address the ecological role of fire [4]. For this analysis VCC/FRCC 1 is represented by vegetation departure ratings 0 to 33, VCC/FRCC 2 is 34 to 66, and VCC/FRCC 3 is 67 to 100. The departure ratings are from

[4] VCC was originally referred to as FRCC by LANDFIRE and in the ESR (USDA Forest Service 2009). However, LANDFIRE changed the designation from FRCC to VCC because the classification methods within the LANDFIRE database did not include the two primary fire regime factors (departure from historic frequency and severity) that are required to calculate FRCC as defined by Hann and Bunnell (2001).

LANDFIRE. The methods to predict fire departure and trend are summarized in Appendix C of the DEIS.

Fire return interval and fire severity: In order to address the importance of the fire process on fire dependent PNVTs, we compared historic to current fire return intervals and severity to quantify the differences in fire disturbance patterns and how that relates to ecosystem process and function (Allen 1996) using fire regimes.

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993, Brown 1995). Coarse-scale definitions for natural fire regimes have been developed by Hardy et al. (2001) and Schmidt et al. (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). The five natural fire regimes are classified based on average number of years between fires (fire frequency) combined with the severity (amount of replacement) of the fire on the dominant overstory vegetation. These five regimes are:

- **I** – 0-35 year frequency and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced);
- **II** – 0-35 year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);
- **III** – 35-100+ year frequency and mixed severity (less than 75% of the dominant overstory vegetation replaced);
- **IV** – 35-100+ year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);
- **V** – 200+ year frequency and high (stand replacement) severity.

All fire regimes are represented across the Forest as noted in Table 21 of the ESR (USDA Forest Service 2009).

Vegetation condition class: The different classes describe the degree of departure from the historical fire regime (as defined by the intensity and frequency of historic fires) and summarize changes in forest composition, structure, fire frequency and intensity, fuel composition, fire mosaic, and the extent and timing/seasonality of future fires.[5] What was referred to as Fire Regime Condition Class (FRCC) in 2009 is now more accurately called vegetation condition class (VCC).

Vegetation condition class (VCC) is classified in the LANDFIRE database and represents the vegetation element in FRCC. VCC has three condition classes: low (VCC I), moderate (VCC II), and high (VCC III) which represent departure from natural vegetative condition (LANDFIRE 2013). A limiting factor is that trends cannot be predicted with VCC.

For frequent-fire systems, vegetation in VCC I is more resistant and less likely to lose key ecosystem components (e.g., native species, large trees, soil) after a disturbance. Fire behavior

[5] The forest desired conditions are similar but not equal to historical conditions for Ponderosa Pine, Mixed Conifer with Frequent Fire, and Mixed Conifer with Aspen, given management considerations for Mexican spotted owls and northern goshawks. This is important because FRCC describes how departed a system is from historical conditions, not from desired conditions.

and other associated disturbances are similar to those that occurred prior to fire exclusion. For example, Ponderosa Pine in VCC I would have a vegetative structure similar to historic conditions when fires were generally high frequency low intensity surface fires and vegetation consisted of all-aged open stands and clumps of trees. This is considered to be within the historic range of variability.

Vegetation in VCC II and VCC III is moderately to highly altered, or departed, from historic conditions e.g. denser, less open, fewer age classes, and fewer clumps. Two outcomes are possible when a vegetation type is highly departed in terms of FRCC/VCC. The first is that intensity, severity and extent of fires can alter because of changes in vegetation conditions and the second is that a PNVT is no longer able to carry characteristic fire across the landscape. An example of the latter is the Piñon-Juniper with Grass PNVT. In this PNVT, fire exclusion has resulted in missed fire return intervals which in turn facilitated tree establishment. Canopy closure increased as tree density increased which reduced the abundance and vigor of understory vegetation. Consequently, surface fire can no longer be carried by the understory facilitating the establishment of more trees and closed conditions. Changes like this would be most pronounced in frequent fire PNVTs where disruption of fire return intervals has resulted in higher departures. Within reference conditions, fire would be self-regulating and would maintain fire intensity and severity more consistently. As a result, the risk of uncharacteristic fires increases, or the ability to carry fire would be reduced. In vegetation types where the disruption of fire disturbance is closer to reference conditions, the environmental consequences of fire exclusion are not as great and, therefore, are not as likely to produce uncharacteristic fires.

This vegetation would be outside the range of historic variability, would be less resistant to disturbances and more likely to lose key ecosystem components following a disturbance. Fuels may be more contiguous and present in high amounts increasing the likelihood of uncharacteristic fires. In VCC II and VCC III, fires may be larger and more severe compared to historic conditions.

Vegetation Condition Class (VCC) (LANDFIRE 2013) and analysis of fire severity was also used to examine fire departure in each PNVT. The dominant VCC class was used to describe each PNVT. For example, a PNVT may be classified as 50 percent VCC II (moderate departure), 25 percent VCC I (low departure), and 25 percent VCC III (high departure). VCC II would be the dominant condition class even though portions of the PNVT may be highly departed and portions of the PNVT may be at reference condition (VCC I).

For the Ponderosa Pine PNVT, trend was determined as follows. The method for determining a predicted fire return interval was completed by taking the forestwide acreage of a PNVT and dividing it by the annual fire treatment acreage (provided by plan objectives in each Alternative). This value was then evaluated to see where it fell relative to the PNVT's HFRI. For example, there are about 800, 000 acres of Ponderosa Pine forestwide. Therefore, forestwide fire treatment level of 100,000 acres per year of Ponderosa Pine would result in an 8 year fire return interval and a commensurate trend toward reference conditions. A forestwide fire treatment level of 52,000 acres per year for Ponderosa Pine would be at the upper end of the natural fire return interval (about 15 years) and would result in a static trend. The above method for determining trend was only applied to Ponderosa Pine and Mixed Conifer Frequent Fire PNVTs, and it was not applied to the other fire adapted PNVTs due to the lack of fire treatment forestwide historically and the lack of prescribed burning related plan objectives under any Alternative. In these other PNVTs, the current fire return interval from the Ecological Sustainability Report was compared to the HFRI for each PNVT. If the current fire return interval was similar to the HFRI,

then the trend was static. If there was a large difference between the current fire return interval and the HFRI, the trend would be away from desired conditions. Where current fire return interval values were unavailable in the Ecological Sustainability Report, estimates were made.

Predicting the condition of a PNVT was made by using the current vegetation departure summary rating and percentage of PNVT in each of the three FRCC classes and evaluating the effect of the predicted trend. Then the condition and trend for fire departure was made based on the anticipated fire treatment (based on plan objectives for each Alternative). The current condition reflects vegetation composition and structure, but the predicted fire departures were derived solely on the anticipated fire frequency relative to the historic/reference fire frequency. For example, Great Basin Grassland PNVT currently has a low vegetative departure and is trending away from reference conditions. This PNVT is in VCC III (highly departed), and its fire severity is highly departed and trending away from reference conditions. VCC trend and fire severity correlate with the vegetative trend because vegetative structure correlates with fire severity and fire behavior.

Assumptions

- There are minor, acceptable inconsistencies between the number of acres on the Forest between the Coconino NF administrative boundary and the PNVT GIS data layer.
- Ponderosa Pine PNVT was not broken out into a subsection of Gambel-oak. In the calculations of desired conditions using the PNVT to VDDT crosswalk, FIA data was used to calculate that ponderosa pine-Gambel oak accounts for approximately 40 percent of the Ponderosa Pine PNVT on the Forest.
- Desired conditions for Ponderosa Pine Forest and Mixed Conifer with Frequent Fire are most heavily represented by the combination of transitional states D, E, J, and K, with the majority being in states J and K. The important distinction is that states J and K are both multi-storied (i.e., uneven-aged) and have at least three age classes represented, including adequate openings for planned regeneration immediately after treatment. Although a state is described as “medium” or “very large” trees, it is inferred that trees of other sizes/ages are included. For example, state J is dominated by trees of 10 to 20 inch diameter at breast height (DBH), but it would also include a more or less balanced representation of seedlings/saplings, small trees, and very large trees (DBH of 20 inches or higher) as well because it represents a multi-storied, uneven-aged state. Similarly, state I contains primarily very large trees and is described as single-storied (i.e., even-aged) with closed canopy, but it may also contain up to one other distinct size/age class and scattered single trees of different sizes.
- The occurrence interval of 35 years for mixed severity fire was used for modeling Great Basin Grassland and Montane Sub-Alpine Grassland PNVTs. This was assumed to be a conservative approach figuring that 35 years is on the long end of the fire return interval. Mechanical clearing was then added at the low and high objectives for these PNVTs. Tree encroachment as a consequence of missed fire return intervals has resulted in departure from historical open states. We assumed that mixed severity fire would be the initial type of fire because of the tree encroachment and that a 35 year fire return interval would be appropriate because these frequent fire systems have not experienced frequent fire.
- Modeling for Alternative A (the 1987 Plan) assumes that uneven-aged silvicultural systems (e.g., group selection) would be the predominant system(s) used; thus, the VDDT projects the modeled PNVTs to improve over current conditions with Alternative A.

- Alternatives were modeled out 15 years and 50 years. The 15 year time period is designed to represent the life of the revised forest plan, and the 50 year time period is designed to demonstrate longer term trends. As with any predictive model, it should be assumed that accuracy may decline the farther out in time that a given simulation is projected because of the chaotic nature of the system(s) being modeled.
- The Federal Fire Policy Implementation Guidance continues to provide clear direction regarding the use of wildland fire (USDA and USDOI, 2009).
- Acres treated, from both mechanical and fire treatments, that improve (or reduce) the VCC rating are considered effective because they alter forest structure (e.g., tree density, crown base heights, and fuel load and arrangement) enough to make these acres fire-resilient for 5 to 10 years.
- A set acreage would be burned each year and varies by Alternative. The actual acres burned may fluctuate yearly due to the number, timing, and location of wildfire starts; NEPA analysis completed; availability of fire resources; weather conditions; fuel conditions; and smoke management and socio-political factors (e.g., burn bans or fire restrictions). Unpredictable factors such as nationally significant fire management failures (e.g. the Cerro Grande prescribed burn of 2000 that escaped) or changes in Federal fire policy may also influence actual acres burned. The number of acres burned is dependent on many variables, few of which are within the Forest's direct control.
- Plan objectives are achievable considering budgets, market conditions, project planning timelines, and external factors (e.g., weather conditions and fuel conditions) over the next 10 years and there are no major changes in policy or other factors.
- Ninety-five percent of annual prescribed fire treatments are in the Ponderosa Pine PNVT, and five percent are in the Mixed Conifer with Frequent Fire PNVT.
- The maximum number of acres burned using prescribed fire is about 30,000 acres per year and would only be possible under the Four-Forest Restoration initiative or another large scale project.
- Wildfires managed for resource benefits would be utilized aggressively, under the assumption that on average 15,000 acres are burned each year (range of 5,000 to 50,000 acres) in the following PNVTs: 90 percent in Ponderosa Pine, 5 percent in Mixed Conifer with Frequent Fire, 2.5 percent in Piñon-Juniper Grasslands, and 2.5 percent in Piñon-Juniper Evergreen Shrub. Ponderosa Pine, Mixed Conifer with Frequent Fire, and Piñon-Juniper Grasslands would be managed under low severity fire; while Piñon-Juniper Evergreen Shrub would be managed under mixed severity fire. These acreage assumptions are based on past and predicted opportunities and consider fuel conditions, smoke management factors, firefighting capability, leadership and resource availability, and fire policy.
- Low severity fires refer to an area where a relatively uniform fuel type results in 0 to 25 percent top-kill of vegetation when burned, and mixed severity fires refer to an area

where a relatively uniform fuel type results in 25 to 75% top-kill of vegetation when burned[6].

- Based on FIA plots, we assumed that 60% of the Ponderosa Pine PNVT was the ponderosa pine/bunchgrass subtype and 40% was the ponderosa pine /Gambel oak subtype.
- In the wilderness, two types of fire management may be used: those that are ignited by lightning and allowed to burn, and those ignited by qualifies Forest Service officers under prescribed conditions. FSH 2324.22
- All fire management activities within wilderness would be conducted with overall wilderness objectives as priority FSH 2324.23
- Motorized equipment usage during a wildfire in the wilderness would follow Forest Service policy for approvals FSH 2326.
- Mechanical treatment limitations are imposed by fluctuating and uncertain annual funding, the lack of a current market for small diameter trees and biomass to offset cost of treatments, and length of time required to accomplish and approve planning for treatments due to appeals and litigation.
- The predicted annual acreage of wildfires managed for resource objectives is dependent on many factors beyond the control of managers such as other management direction, the agency's National Fire Policy, or environmental conditions. Thus, actual fire treatment could be less than predicted. Fewer acres of treatment using unplanned ignitions would contribute to trends away from reference conditions.
- There is a range of plan objectives for prescribed fire treatments in Ponderosa Pine in Alternatives B, C, and D (150,000 to 300,000 acres during 10 years following plan approval). The high end of fire treatment was modeled using VDDT. This is more acres than that completed in an average year. It was assumed that the low end of fire treatment objectives would not result in a trend towards desired conditions because too few acres would be treated to be meaningful at the landscape level.

Items Addressed in this Analysis

The items addressed in this analysis fall under two main themes that have been identified as needs for change: Maintenance and Improvement of Ecosystem Health and Community Forest Interaction. The specific issues addressed in this analysis are listed below, as are the indicators used to compare Alternatives.

Issue: Some potential natural vegetation types (PNVTs) are departed from reference conditions and either static or trending away from reference conditions, reducing ecosystem function and resilience to disturbance in terms of vegetation and fire regime condition class.

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[6] Low severity fires cause less than 25 percent average replacement of dominant overstory above ground biomass within a typical fire perimeter; while mixed severity fire causes between 25 and 75 percent. See LANDFIRE website: http://www.landfire.gov/NationalProductDescriptions14.php

Indicator/Evaluation Criteria: Environmental consequences of plan language on improving trends and ecosystem function by PNVT and Alternative. Level of departure from reference conditions. Change in Vegetation Condition Class (VCC), vegetation departure rating, and predicted departure for fire return interval (also called fire departure).

Issue: Old growth forest and large, pre-settlement trees are under-represented on the landscape and may not be adequately protected.

Indicator/Evaluation Criterion: Environmental consequences of plan language on old growth/large tree protection. Area represented by medium and large tree states.

Issue: Current plan language is outdated and does not reflect current science. Not all vegetation types on the forest have desired conditions.

Indicator/Evaluation Criterion: Environmental consequences of plan components relative to composition, structure, and function of vegetation types.

Issue: Uncharacteristic wildfire is a threat to communities and ecosystem health. Smoke from fires may significantly affect nearby communities with respect to human health and impacts to local tourism.

Indicator/Evaluation Criterion: Expected smoke impacts to nearby communities from fire management activities on the Forest. The number of burn days and acreage burned/day are used to evaluate impacts. Regulatory authorities relating to air quality are clarified.

Summary of Alternatives

A summary of Alternatives, including the key differences among Alternatives, is outlined in the Draft Environmental Impact Statement.

Four Alternatives are analyzed in detail in this Specialist Report: Alternatives A through D. Alternative A is the current 1987 Coconino National Forest Plan (Forest Service, as amended, 1987), and Alternative B is modified draft plan, drafted over the past several months and refined with several tranches of internal and informal public feedback. Alternative C considers increases in the amount of wilderness and special areas, as well as increased opportunities for quiet semi-primitive recreation and retains most of the old growth language, while Alternative D considers slightly fewer restrictions than Alternatives B and C on human access and use of the Forest and its resources.

- Alternative A is the 1987 plan
- Alternative B is the proposed draft plan
- Alternative C
- Alternative D

PNVT Departures

Introduction

The Coconino National Forest has a high diversity of vegetative communities (also called vegetation types or potential natural vegetation types (PNVTs)) due to its wide range of

elevations, complex topography, and presence of perennial water. Vegetative communities at the lowest elevations are more typical of Sonoran deserts while the highest elevation vegetative community, alpine tundra, is the only one in Arizona. In between, there are extensive areas of Piñon-Juniper, ponderosa pine, and mixed conifer forests interspersed with grasslands and scattered pockets of aspen at higher elevations. Riparian vegetation lines stream courses of perennial and intermittent water (USDA Forest Service 2009). Ponderosa pine and Piñon-Juniper vegetation communities dominate the forested landscape, covering approximately 76 percent of the forest.

The PNVTs on the forest were initially evaluated for vegetative departures from reference conditions using methods described in the Ecological Sustainability Report (USDA Forest Service 2009). Subsequently, PNVT spatial distribution was further refined and adjusted based on new information, current science, local knowledge, and field verification. Table 4 provides the amount of the various PNVTs on the forest and reflects acreage changes as a result of these updates. Mixed Conifer was divided into two types based on the presence of quaking aspen and differences in the fire regimes (Mixed Conifer with Aspen and Mixed Conifer with Frequent Fire). Piñon-Juniper Woodland was divided into two types based on differences in fire regimes (Piñon-Juniper with Grass and Piñon-Juniper Woodland (persistent)). The acres of Desert Communities and Semi-Desert Grassland were refined to more accurately reflect arid desert soil types and rare desert plant indicator species. Crosswalks for PNVTs were updated by the Southwestern Regional Office in November 2011 (USDA 2011c). Forest Inventory Analysis (FIA) data was incorporated to split out size class distributions and create more “storiedness” to distinguish between single storied (even-aged) and multi-storied (uneven-aged) stands (USDA 2011a). Finally, updated riparian mapping resulted in refinement of riparian acres and the addition of a new riparian forest PNVT, Gallery Coniferous Forest. Riparian PNVTs are discussed under Riparian Resources in the DEIS.

Table 4. Updates to PNVTs and amounts on the forest

Previous PNVT Description	Initial PNVT Acres	Initial % of Forest	Current PNVT Description	Current PNVT Acres	Current % of Forest
Desert Communities	6,339	0.3%	Desert Communities	63,548	3.5%
Interior Chaparral	50,687	2.8%	Interior Chaparral	50,471	2.7%
Cottonwood Willow Riparian Forest	2,017	0.1%	Cottonwood Willow Riparian Forest	2,507	0.1%
Mixed Broadleaf Deciduous Forest	2,562	0.1%	Mixed Broadleaf Deciduous Forest	3,612	0.2%
Montane Willow Riparian	557	<0.1%	Montane Willow Riparian	3,829	0.2%

Previous PNVT Description	Initial PNVT Acres	Initial % of Forest	Current PNVT Description	Current PNVT Acres	Current % of Forest
Not Previously Included			Gallery Coniferous Riparian Forest	200	<0.1%
Wetland Cienega	1,140	0.1%	Wetland/Cienega	9,879	0.5%
Semi-Desert Grasslands	147,573	8.0%	Semi-Desert Grasslands	89,683	4.9%
Great Basin Grasslands	94,277	5.1%	Great Basin Grasslands	92,913	5.1%
Montane/Subalpine Grasslands	24,199	1.3%	Montane/Subalpine Grasslands	23,429	1.3%
Piñon Juniper Woodland	301,675	16.4%	Piñon Juniper with Grass	261,432	14.2%
			Piñon Juniper Persistent	75,393	4.1%
Piñon Juniper Evergreen Shrub	300,154	16.3	Piñon Juniper Evergreen Shrub	263,835	14.4%
Ponderosa Pine	807,424	43.8%	Ponderosa Pine	791,897	43.1%
Dry Mixed Conifer	79,060	4.3%	Mixed Conifer w/Frequent Fire (Dry)	49,619	2.7%
Not Previously Included			Mixed Conifer w/Aspen (Wet)	37,083	2.0%
Spruce Fir	13,942	0.8%	Spruce Fir	13,946	0.8%
Alpine Tundra	941	0.1%	Alpine Tundra	939	0.1%

Table 5 provides a breakout of the distribution of PNVTs by Ranger District. Acreage and percent are expressed by Forest and Ranger District (Flagstaff- FRD, Mogollon Rim- MRRD, and Red Rock - RRRD).

Table 5. Potential Natural Vegetation Types by district

PNVT	Forest Acres	% of Forest	FRD Acres	% of FRD	MRRD Acres	% of MRRD	RRRD Acres	% of RRRD
Ponderosa Pine	791,897	43.1%	448,941	53.1%	324,998	64.4%	17,959	3.7%
Piñon-Juniper Evergreen Shrub	263,835	14.4%	12,721	1.5%	19,649	3.9%	231,466	47.5%
Piñon-Juniper Grassland	261,432	14.2%	18,187	2.2%	62,373	12.4%	0	0.0%
Great Basin Grasslands	92,913	5.1%	62,490	7.4%	30,423	6.0%	0	0.0%
Semi-Desert Grasslands	89,683	4.9%	0	0.0%	0	0.0%	89,683	18.4%
Piñon-Juniper Woodland (Persistent)	75,393	4.1%	29,255	3.5%	12,956	2.6%	33,182	6.8%
Desert Communities	63,548	3.5%	0	0.0%	0	0.0%	63,548	13.0%
Interior Chaparral	50,471	2.7%	5,511	0.7%	0	0.0%	44,959	9.2%
Mixed Conifer with Frequent Fire	49,619	2.7%	8,368	1.0%	41,224	8.2%	28	0.0%
Mixed Conifer with Aspen	37,083	2.0%	34,172	4.0%	2,910	0.6%	0	0.0%
Montane/ Subalpine Grassland	23,429	1.3%	18,187	2.2%	4,865	1.0%	377	0.1%
Spruce Fir	13,946	0.8%	13,946	1.7%	0	0.0%	0	0.0%
Wetland or Cienega	9,879	0.5%	8,058	1.0%	1,764	0.3%	56	0.0%

PNVT	Forest Acres	% of Forest	FRD Acres	% of FRD	MRRD Acres	% of MRRD	RRRD Acres	% of RRRD
Montane Willow Riparian	3,829	0.2%	700	0.1%	2,688	0.5%	442	0.1%
Mixed Broadleaf Deciduous Riparian	3,612	0.2%	21	0.0%	176	0.0%	3,415	0.7%
Water	3,176	0.2%	2,287	0.3%	744	0.1%	145	0.0%
Cottonwood Willow Riparian	2,507	0.1%	0	0%	0	0.0%	2,507	0.5%
Alpine or Tundra	939	0.1%	939	0.1%	0	0.0%	0	0.0%
Gallery Coniferous Riparian	200	0.0%	19	0.0%	182	0.0%	0	0.0%
Urban or Agricultural	100	0.0%	100	0.0%	0	0.0%	0	0.0%
Total Acres:	**1,837,491**		**844,774**		**504,951**		**487,766**	

Since more than two-thirds of the Coconino NF had a fire return interval of less than 35 years, the majority of the Forest evolved with and is dependent on frequent fire to maintain growth, structure, function and health. In particular, the Ponderosa Pine, Mixed Conifer with Frequent Fire and the Piñon-Juniper with Grass PNVTs require fire. Without fire, many natural processes cannot continue at a productive and efficient level, resulting in ecosystems that are degraded and not sustainable. This fire regime disruption occurred due to three main factors: excessive domestic livestock overgrazing, selective timber harvesting, and fire suppression (Covington and Moore 1994a). There is no substitute for wildland fire, it is an ecological imperative.

Affected Environment

Forestwide Vegetation and Fire

The current conditions of the PNVTs are summarized in two tables that show different aspects of non-riparian PNVTs on the forest. Riparian resources are addressed in the DEIS and the Riparian Specialist Report (USDA Forest Service 2013). Table 6 summarizes current vegetation departure and trends from reference condition, historical fire severity, and changes in fire return intervals by

PNVT. It also identifies primary threats to the PNVTs and departure characteristics. Vegetation departures are focused on differences in vegetative states as they relate to ecosystem composition and structure. Historic and current fire return intervals show differences in disturbance patterns and relate to ecosystem process and function. Vegetation departure can reflect the disparity between current and reference condition, or can be modeled into the future show changes in departure over time depending on types and amount of treatments.

Departure values represent the difference between current and reference conditions for individual characteristics. For these PNVTs, characteristics that were evaluated were: structure (vegetation states) of the dominant life forms (e.g., grass, shrub, and tree) and cover. Vegetation departure was assessed as Low (0–33%), Moderate (34–66%), or High (>66%). Primary reasons for departures include fire suppression and livestock grazing, lack of characteristic fire, and invasive exotic plants. . While weeds are generally localized, present at low densities, or low-priority species in most PNVTs, some PNVTs face increased threats by exotic, invasive species because they can alter fire regimes, increase erosion, and compete with native plants.

Table 6. Summary of vegetation and fire changes, PNVT threats, and departure characteristics

PNVT	Acres on the Forest (% of Forest)	Current Vegetation Departure/(% Departure)/ Future Trend)	Historic Fire Return Interval (HFRI) and Severity***	Current Fire Return Interval	PNVT Threats[7]	Primary Departure Characteristics
Desert Communities	63,548 (3.5%)	High (77%)/ Unknown	Not fire adapted	Unknown	Invasive exotic plants; Road construction and maintenance	Increased late seral herbs and shrubs with >15% cover and invasion of exotic plant species
Semi-Desert Grassland	89,683 (4.9%)	High (100%)/ Away	0 to 35 years Low Severity	500+ years	Fire exclusion/ uncharacteristic fire	Lack of characteristic fire disturbance, significant shift to shrubs and trees, increased closed shrub states, and invasion of exotic plant species
Great Basin Grassland	92,913 (5.1%)	Low (10%)/ Away	0 to 35 years Low Severity	500+ years	Fire Exclusion;	Lack of characteristic fire disturbance, significant shift to shrubs and trees, increased closed shrub states and invasion of exotic plant species

[7] Within Forest Service control. See climate change section for analysis of potential climate change effects. Other PNVT threats not within FS control include excessive wildlife herbivory, drought, and fragmentation on lands off-forest. These other threats are considered in cumulative effects.

PNVT	Acres on the Forest (% of Forest)	Current Vegetation Departure/(% Departure)/ Future Trend)	Historic Fire Return Interval (HFRI) and Severity***	Current Fire Return Interval	PNVT Threats[7]	Primary Departure Characteristics
Montane/ Subalpine Grassland	23,429 (0.8%)	Low (32%)/ Away	0 to 35 years Low Severity	500+ years	Fire exclusion/ uncharacteristic fire	Lack of characteristic fire disturbance, tree encroachment, increased closed shrub states, invasive plants
Interior Chaparral	50,471 (2.7%)	Low (26%)/ Static	Primarily 200+ years High Severity; some 0 to 35 years High Severity	384 years	Fire exclusion	Lack of characteristic fire disturbance
Piñon-Juniper with Grass*	261,432 (14.2%)	Moderate (55%)/ Away	0-35 years Low Severity to Mixed Severity	**	Fire exclusion/ uncharacteristic fire	Increased tree density, and reduced understory species cover and diversity
Piñon-Juniper Evergreen Shrub	263,835 (14.4%)	Moderate (50%)/ Away	35-200+ years Mixed Severity	500+ years	Fire exclusion/ uncharacteristic fire	Increased tree density, and reduced understory species cover and diversity
Piñon-Juniper Woodland (Persistent)*	75,393 (4.1%)	Low (25%)/ Static	35-200+ years High Severity	192 years	Fire exclusion/ uncharacteristic fire	Increased tree density & significant shift to small and medium sized trees, and reduced understory species cover and diversity

PNVT	Acres on the Forest (% of Forest)	Current Vegetation Departure/(% Departure)/ Future Trend)	Historic Fire Return Interval (HFRI) and Severity***	Current Fire Return Interval	PNVT Threats[7]	Primary Departure Characteristics
Ponderosa Pine	791,897 (43.1%)	High (79%)/ Away	0-35 years Low Severity	344 years	Fire exclusion/ uncharacteristic wildfire; invasive exotic wildlife, insects, and disease	Increased tree density & significant shift to closed medium aged forest; reduced understory species cover and diversity; increased risk of uncharacteristic, high severity fire; and invasion of exotic plant species
Mixed Conifer with Frequent Fire*	49,619 (2.7%)	Moderate (64%)/ Away	0-35 years Low Severity	130 years	Fire exclusion/ uncharacteristic wildfire; invasive exotic wildlife, insects, and disease	Increased tree density & significant shift to closed medium aged forest with shifts in species composition to more shade tolerant species reduced understory species cover and diversity, increased risk of uncharacteristic, high severity fire
Mixed Conifer with Aspen*	37,083 (2.0%)	Moderate (62%)/ Away	35-200 year Mixed Severity	**	Fire exclusion/ uncharacteristic wildfire; invasive exotic wildlife, insects,	Increased tree density and shifts in species composition to more shade tolerant species, increased fuel loading and continuity

PNVT	Acres on the Forest (% of Forest)	Current Vegetation Departure/(% Departure)/ Future Trend)	Historic Fire Return Interval (HFRI) and Severity***	Current Fire Return Interval	PNVT Threats[7]	Primary Departure Characteristics
					and disease	
Spruce Fir	13,946 (0.8%)	Moderate (49%)/ Static to Away	200+ years High Severity	500+ years	Fire exclusion/ uncharacteristic wildfire; invasive exotic wildlife, insects, and disease	Increased tree density and shifts in species composition to more shade tolerant species, increased fuel loading and continuity,
Alpine Tundra	939 (0.1%)	Low (32%)/ Unknown	N/A	N/A	None within Forest Service control.	None within FS control.

*Piñon-Juniper Woodland and Piñon-Juniper with Grass were lumped together in the analysis in the Ecological Sustainability Report , as were the two mixed conifer types.

** Not available in the Ecological Sustainability Report.

***Severity: Low severity fires kill/topkill 25% or less of the dominant overstory and are primarily surface fires. Less than 75% of the dominant overstory is replaced in mixed severity fires which are a combination of crown and surface fire. High severity fires replace more than 75% of the dominant overstory as a crown fire. Also called stand replacement fire.

Eleven of eighteen vegetation communities (86 percent of the Forest) analyzed are moderately to highly departed from reference conditions. Consequently, they are increasingly subject to uncharacteristic disturbances, such as stand replacing fire especially in low severity-high frequency fire regime types. In addition, mixed fire regime types are now more prone to uncharacteristic large patches being created from by fire due to increased smaller tree density, increased canopy bulk density, increased canopy cover, and increased fuel loadings.

The composition and structure of these types is departed from reference conditions and all except for Interior Chaparral PNVT are trending away under current management. Together, these vegetation types account for 60% of the Forest. Over the anticipated 10 -15 year lifespan of the revised forest plan, the Forest has a limited capacity to significantly alter trends in all vegetation types and move them towards desired conditions. Limitations are imposed by budget, market conditions, competing resource objectives, weather, fuel conditions, fire management resource availability, and planning timelines.

Fire was a natural disturbance that maintained reference conditions in the following 11 fire-adapted PNVTs: Semi-Desert Grassland, Great Basin Grassland, Montane/Subalpine Grassland, Interior Chaparral, Piñon-Juniper with Grass, Piñon-Juniper Evergreen Shrub, Piñon-Juniper Woodland (Persistent), Ponderosa Pine, Mixed Conifer with Frequent Fire, Mixed Conifer with Aspen, and Spruce Fir. The other PNVTs (including Riparian Forest Types and Wetland and Cienegas) experienced fire infrequently and had different primary natural disturbances such as flooding or climate variability.

Table 7 shows the estimated vegetation condition class for each PNVT. Vegetation condition class describes vegetation structure in terms of its contribution to fire severity and intensity and its ability to carry characteristic fire. Because it is derived from relatively coarse data, it only represents the disparity between current and reference conditions. The percentage values do not include the categories of Barren, Agricultural, Urban, or Water and are based off of LANDFIRE data 1.0.0 (National). The values were generated without alteration of base fuel models in LANDFIRE and therefore the values are subject to minor inconsistencies. Approximately 90 percent of the forest is moderately to highly departed from historic conditions and classified as VCC II and III. Only about 10 percent of the entire forest is dominated by VCC I (low departure). Based on these values, each PNVT was assigned a dominant VCC as shown in table 8.

Table 7. Current overall VCC by PNVT

PNVT	VCC I (%)	VCC II (%)	VCC III (%)
Ponderosa Pine	1.92	24.56	72.57
Mixed Conifer with Frequent Fire	0.23	23.21	76.38
Mixed Conifer with Aspen	0.02	5.41	94.18
Spruce Fire Forest	0.00	0.40	99.55
Alpine Tundra	0.00	0.97	96.39
Piñon Juniper Woodland (Persistent)	8.98	58.85	31.13

PNVT	VCC I (%)	VCC II (%)	VCC III (%)
Piñon Juniper Evergreen Shrub	10.32	78.29	10.85
Piñon Juniper Grassland	10.37	55.22	33.74
Interior Chaparral	18.26	72.27	9.34
Montane/Subalpine Grassland	14.59	48.32	36.21
Great Basin Grassland	14.22	43.89	40.86
Semi-desert Grassland	36.71	61.69	0.00
Desert Communities	74.45	21.81	0.00
Montane Willow Riparian Forest	7.69	50.46	51.45
Cottonwood Willow Riparian Forest	42.33	50.61	0.00
Gallery Coniferous Riparian Forest	15.80	54.06	30.14
Mixed Broadleaf Deciduous Riparian Forest	13.14	85.57	0.21
Wetland or Cienega	40.49	12.58	46.93
Water	14.47	16.77	22.06
Urban or Agricultural	0.67	23.66	56.03
Total Forestwide	**10.28**	**41.87**	**46.64**

Table 8. Dominant Vegetation Condition Class by PNVT

PNVT	Dominant Vegetation Condition Class
Desert Communities	VCC I/ Not fire adapted
Semi-Desert Grassland	VCC II
Great Basin Grassland	VCC III
Montane/Subalpine Grassland	VCC III
Interior Chaparral	VCC I & II
Piñon-Juniper with Grass	VCC III

PNVT	Dominant Vegetation Condition Class
Piñon-Juniper Woodland (Persistent)	VCC II
Ponderosa Pine	VCC III
Mixed Conifer with Frequent Fire	VCC III
Mixed Conifer with Aspen	VCC III
Spruce Fire Forest	VCC II
Alpine Tundra	VCC III/Not fire adapted

Historically, over two-thirds of the Coconino National Forest had a fire return interval of less than 35 years (USDA Forest Service 2009), and years of fire suppression and excessive livestock grazing have resulted in missed fire return intervals. Semi-Desert Grassland, Great Basin Grassland, Montane/Subalpine Grassland, Piñon-Juniper with Grass, Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs evolved with and are dependent on frequent fire to maintain their growth, structure, function, and health. Without fire, the accumulation of debris on the forest floor increases fire intensity and severity and results in uncharacteristic fire that kills more vegetation and damages soil. Uncharacteristic fire also poses a greater threat to values at risk,[8] such as infrastructure, and public and firefighter safety (Moore et al., 1999). Fires that occur in departed ecosystems can result in rapid spread, high fire intensity, and high fire severity to levels at which managers cannot safely control (Moore et al. 1999). Fire exclusion causes missed fire return intervals and leads to dramatic changes in ecosystem structure and function and increased potential for uncharacteristic fire behavior. Historic and current fire return intervals are compared in table 9.

Table 9. Historic and Current Fire return Intervals by PNVT

Vegetation Type (PNVT)	Historic Fire Return Interval (years)	Current Fire Return Interval (years)
Semi-desert Grassland	0-35	500+
Great Basin Grassland	0-35	500+
Montane/Subalpine Grassland	0-35	500+
Interior Chaparral	35-200	384

[8] Values at risk encompass a wide range of ecological and social values that could be negatively impacted by wildfire, including wildlife habitat, soils, watershed, riparian and water resources, heritage resources, and recreation amenities.

Vegetation Type (PNVT)	Historic Fire Return Interval (years)	Current Fire Return Interval (years)
Piñon Juniper with Grass	0-35	*
Piñon Juniper Evergreen Shrub	35-200	500+
Piñon Juniper Woodland (Persistent)	35-200+	192
Ponderosa Pine	0-35	344
Mixed Conifer with Frequent Fire	0-35	130
Mixed Conifer with Aspen	35-200	*
Spruce Fir Forest	200+	500+

Alpine Tundra, Desert Communities, Cottonwood Willow Riparian Forest, Gallery Coniferous Riparian Forest, Mixed Broadleaf Deciduous Forest, Urban/Agricultural, Water and Wetland/Cienega PNVT's have historic and current fire return intervals that are similar to adjacent vegetation types.

*Values based on the ESR (USDA Forest Service 2009)

Table 10 shows the number of burned acres by PNVT on the forest. The column titled Wildfires show the ten year average annual number of acres. The column titled Wildfires that meet Resource Objectives show the three year average of annual acres burned and the column titled Planned Ignition shows the two year average of annual acres burned by prescribed fire.

Table 10. Acres burned by PNVT

Vegetation Type (PNVT)	Wildfires Acres)	Wildfires that meet Resource Objective (Acres)	Number of Fires	Planned Ignition (Prescribed Fire) Acres	Total Acres Burned
Desert Communities	1.7	0	49	0	16.5
Semi-desert Grassland	42.5	0	81	0	425.1
Great Basin Grassland	65.0	128.4	88	1281.8	3598.5
Montane/Subalpine Grassland	83.2	114.5	175	592.5	2767.4
Interior Chaparral	150.2	0	50	17.2	1536.7

Vegetation Type (PNVT)	Wildfires Acres)	Wildfires that meet Resource Objective (Acres)	Number of Fires	Planned Ignition (Prescribed Fire) Acres	Total Acres Burned
Piñon Juniper with Grass	2389.1	71.0	287	130.6	25862.9
Piñon Juniper Evergreen Shrub	273.6	155.3	179	202.2	3606.6
Piñon Juniper Woodland (Persistent)	79.4	0.7	95	0	808.5
Ponderosa Pine	2675.9	8618.4	2,693	16267.4	103444.9
Mixed Conifer with Frequent Fire	189.3	768.6	155	537.0	5273.3
Mixed Conifer with Aspen	592.4	8.6	220	44.1	6078.6
Spruce Fire Forest	114.1	0	36	0	1140.9
Alpine Tundra	0	0	0	0	0
Cottonwood Willow Riparian Forest	0.1	0	6	0	1.3
Mixed Broadleaf Deciduous Riparian Forest	7.1	0	5	0	71.2
Montane Willow Riparian Forest	7.1	84.5	29	17.6	375.1
Gallery Coniferous Riparian Forest	0.4	0	1	0	4.2
Wetland or Cienega	0.5	0.3	13	18.1	46.6

Potential Natural Vegetation Types (PNVTs)

The current vegetative conditions and trends for each of the PNVTs are described below. More information on current condition and trends in these and other vegetation types can be found in the Coconino National Forest Ecological Sustainability Report (USDA Forest Service 2009).

Desert Communities

On the Coconino National Forest, the Desert Communities PNVT occurs in the Verde Valley where the Upper Sonoran Desert PNVT merges with the forest. It ranges in elevation from 2,700 to 4,000 feet and covers approximately 63,548 acres (3.5 percent of the forest). It generally occurs in creosote-dominated, alluvial position and on old stream terraces adjacent to the Cottonwood Willow Riparian Forest PNVT. Vegetation includes: desert scrub, grasses, and some succulents; however, some areas may be barren with abundant sand, rock, gravel, scree, or talus. The dominant species are creosote bush and mesquite, but other species may include: cat claw acacia, saltbush, desert broom, desert willow, Apache plume, hedgehog cacti, cholla, and tabosa grass. Desert Communities supports a unique community of endemic plants adapted to its calcium-rich soils; it also supports a plant, Arizona cliffrose, which is federally listed as endangered and only occurs in a very restricted portion of this PNVT. Climate is the primary natural disturbance, and extreme climate variability (namely from temperature and precipitation) can cause temporary and localized shifts in vegetative composition.

According to reference conditions, Desert Communities was less fragmented and its vegetative structure was mostly open with sparse vegetation, as only 20 percent of the area contained dense vegetation of shrubs and understory species. Current conditions for this PNVT are highly departed with an unknown trend from reference conditions due to increased fragmentation from urbanization and increased density in vegetation structure. In addition, it contains a few invasive exotic plant species which, although they are at low densities, they are widely dispersed across the area. The opportunity for their spread and colonization across new sites is high due to the presence of high-use roads such as State Highways 89A and 179, which have numerous weed infestations. The increased abundance and distribution of invasive exotic annual grasses is likely to result in an increase in the frequency and severity of wildfires.

Interior Chaparral

On the Coconino National Forest, the Interior Chaparral PNVT occurs at lower elevations, mostly in the Verde River basin, between the Semi-Desert Grassland and Piñon-Juniper Evergreen Shrub PNVTs. Its elevation ranges from 3,750 to7,300 feet, and it covers approximately 50,471 acres (approximately 3 percent of the forest). Its location varies from widely scattered pockets within grasslands and woodlands to more extensive areas on steep slopes. Vegetation includes: turbinella oak, mountain mahogany, manzanita, desert ceanothus, silk tassel, Stansbury cliffrose, and sumac. Interior Chaparral is characterized by high severity fire that occurs every 35 to 200+ years, however some high severity fire may occur every 0 to 35 years.

According to reference conditions, Interior Chaparral is composed of 93 percent dense shrubs with a closed canopy and no understory, 5 percent grass and open shrubs, and 2 percent grass and forb regeneration. Current conditions are similar (low departure) with a static trend to reference conditions in the PNVT's extent, structure, and composition. Current predicted fire departure is moderate and trending away from reference conditions. A few invasive exotic plant species are present in this PNVT; however, because their populations are few in number and acreage, this PNVT is rated low for departure from reference conditions with respect to weeds. The projected trend for vegetation structure and composition is static, but the trend for invasive exotic species is away from desired conditions because of the anticipated spread of non-native grasses from adjacent PNVTs.

Semi-Desert Grassland

On the Coconino National Forest, the Semi-Desert Grassland PNVT occurs in the Verde Valley, and it is bounded by the Desert Communities PNVT at lower elevations and Piñon-Juniper Woodland or Interior Chaparral PNVTs at upper elevations. Its elevation range is approximately 3,000 to 4,500 feet, and it covers approximately 89,683 acres (approximately 5 percent of the forest). It contains numerous roads and private land parcels, and it adjoins the communities of Camp Verde, Cornville, and Cottonwood. Current vegetation is dominated by perennial bunchgrasses; shrubs such as crucifixion thorn, velvet mesquite, cat claw mimosa, agaves, and turbinella oak; forbs which may include various buckwheat species; and trees such as Utah juniper and red berried juniper. Wildfire is a natural disturbance within this PNVT, and Semi-Desert Grassland is characterized by low-severity fire that occurs every 0 to 35 years.

According to reference conditions, the Semi-Desert Grassland PNVT was less fragmented than present (due to less human development), and the vegetative structure of the grasslands was more open with fewer trees and shrubs. Frequent low-intensity fires were the principal driving force that formed and maintained the open structure of Semi-Desert Grassland. Current vegetative conditions are highly departed and trending away from reference conditions. This PNVTs current predicted fire departure is high and trending away. Semi-Desert Grassland's extent on the Forest has substantially decreased (namely due to increased private development), and fire frequency has decreased. Increased interface with developed private land increases the difficulty in maintaining frequent low-intensity fire in this PNVT. The departures in composition and structure that resulted from fire exclusion include alterations in many other subcomponents such as structural stage, stand age, canopy closure, and mosaic pattern, fuel composition, and fire frequency, severity, and pattern. The departed attributes do not allow for the natural fire disturbance cycle and thereby alter future fire disturbance processes. Lack of fire in this PNVT would likely result in a trend away from reference conditions relative to fire return interval and a continued shift to shrub- and tree-dominated grasslands into the future. Due in large part to fire exclusion, about 30 percent of the Semi-Desert Grassland on the south end of the forest have become so shrub and tree invaded that they have likely undergone a vegetation type conversion with little potential to be restored to open native grassland condition (USDA Forest Service 2009). A few, widely distributed invasive exotic plant species are present, including red brome.

Great Basin Grassland

On the Coconino National Forest, the Great Basin Grassland PNVT occurs at elevations between 4,800 and 7,500 feet and covers approximately 92,913 acres (approximately 5 percent of the forest). Great Basin Grassland is more arid than Montane/Subalpine Grassland, and typical locations include Anderson Mesa and near Wupatki National Monument. Dominant species in this PNVT are mostly grasses such as: Western wheatgrass, spike muhly, black grama, Indian ricegrass, threeawn, blue grama, fescue, James' galleta, and Sandberg bluegrass. Shrubs, and to a lesser extent, trees are also present and may include: sagebrush, salt brush, Mormon tea, snakeweed, winterfat, rabbitbrush, sparse one-seeded juniper, and Colorado piñon pine. Natural disturbances are: weather, natural soil movement (e.g., natural shrink-swell and surface cracking), and wildfire. Great Basin Grassland is characterized by low-severity fire that occurs every 0 to 35 years.

According to reference conditions, nearly three-fourths of the Great Basin Grassland PNVT was in open, mid-development grasses and forbs with about one-fifth of it in late development shrubs and trees with open canopy. Fire entered this grassland type from adjacent fire-adapted PNVTs.

Current conditions are similar to reference conditions; however, some shrub and tree invasion is occurring along the edge of grasslands, and there has been a shift from small to large tree sizes. Although this PNVT contains only a few invasive exotic species, some plants (camelthorn and diffuse knapweed) are ranked high for invasiveness. In addition, cheat grass is widely dispersed at low densities and could cause major changes in ecosystem integrity if not controlled. The departures in composition and structure that resulted from fire exclusion include alterations in many other subcomponents such as structural stage, stand age, canopy closure, and mosaic pattern, fuel composition, and fire frequency, severity, and pattern. Great Basin Grassland have a low vegetative departure, and modeling indicates that it is trending away from desired conditions. Current predicted fire departure is high and trending away.

Montane/Subalpine Grassland

On the Coconino National Forest, the Montane/Subalpine Grassland PNVT occurs at elevations between 6,550 to 9,200 feet, with some small, unmapped patches existing at higher elevations. This PNVT covers approximately 23,429 acres (approximately 0.8 percent of the forest), and consists of two sub-types: montane grasslands and subalpine grasslands. Montane grasslands occur above the Mogollon Rim and extend upward to about 7,800 feet in elevation and include locations such as Kendrick Peak, Antelope Park, and Mule Park. Species in this sub-type include: muttongrass, mountain muhly, spike muhly, Arizona fescue, blue grama, red threeawn, squirreltail, yarrow, and pine dropseed. Subalpine Grassland typically occurs above 7,800 feet in areas such as Freidlein Prairie on the San Francisco Peaks. Species in this sub-type include: pine dropseed, nodding brome, various sedges, Arizona fescue, mountain junegrass, mountain muhly, muttongrass, and squirreltail. In both sub-types, trees may also be present in trace amounts within the grasslands and along their periphery. The primary natural disturbance is wildfire which reduces the number of tree seedlings and saplings that establish in grasslands, especially on the perimeter. Montane/Subalpine Grassland PNVT has a 0- to 35-year fire frequency and fires of low severity (surface fires most common) to mixed severity (i.e., less than 75 percent of the dominant overstory vegetation replaced).

According to reference conditions, Montane/Subalpine Grassland was less fragmented before changes occurred in land ownership to private property owners and State and other Federal agencies. Its vegetative structure was more open or dominated by grass species; and it did not contain any invasive exotic species. This open structure was formed and maintained primarily by frequent low-intensity fire entering from adjacent fire-adapted PNVTs. Due to fire exclusion in adjacent fire-adapted PNVTs, by default fire has been excluded from this PNVT. Consequently, vegetation structure is trending away from reference conditions and is approaching moderate departure. The departures in composition and structure that resulted from fire exclusion include tree encroachment and alterations in the pattern and diversity of understory species resulting from fire intrusions. The presence of a few invasive exotic species that are ranked high for invasiveness, such as leafy spurge, also represent a departure from reference conditions.

Piñon-Juniper with Grass

On the Coconino National Forest, the Piñon-Juniper with Grass PNVT occurs at elevations between 5,000 and 8,300 feet and covers approximately 261,432 acres (14.2 percent of the forest). This woodland PNVT is distributed in upland and valley settings or where local conditions are inherently favorable for grasses, and it is often found on moderately deep soils and gentle topography. Tree species includes: piñon pine and Utah and one-seed juniper (which are

most common) and alligator juniper at higher elevations. Its understory consists of annual and perennial grasses (with forbs) including: blue grama, needle and thread grass, and western wheatgrass. Shrubs may be present, but they are a minor component (Romme et al 2009). Piñon-Juniper with Grass is characterized by low severity to mixed severity fire that occurs every 0 to 35 years.

According to reference conditions, Piñon-Juniper with Grass was generally uneven aged and open in appearance. Trees occurred as individuals, but occasionally in smaller groups, and they ranged from young to old. Shrubs were scattered, and a dense, nearly continuous herbaceous understory included: native grasses, forbs, and annuals. Romme et al. (2009) estimated that probable fire behavior would be moderate surface fire spread, limited torching, and low tree mortality (in mostly smaller stems) in this PNVT when conditions are typical of the 80th percentile fire weather following a single ignition event in piñon and juniper vegetation with significant grass cover and sparse tree density. Under extreme fire weather conditions, there would be probable extensive surface fire spread and torching, and moderate mortality across all sized trees.

Current vegetative conditions are moderately departed from reference conditions and trending away Within this PNVT, there are currently more trees per acre and greater cover than under reference conditions due to fire exclusion and weather patterns which have favored tree germination and establishment. As a result, understory abundance and diversity has decreased. In severe cases of tree encroachment, former grasslands and savannas have undergone a vegetation type conversion, including a change in fire regime, to juniper or Piñon-Juniper woodlands. The expansion of piñon and/or juniper into previously non-wooded areas is resulting in a more homogenous landscape that, in some areas, is suppressing understory herbaceous growth and consequently the potential for surface fires. The pronounced departures in composition and structure that resulted from fire exclusion include alterations in many other sub-components such as: structural stage; stand age; canopy closure; mosaic pattern; fuel composition; and fire frequency, severity, and pattern. The departed attributes do not allow for the natural fire disturbance cycle and, thereby, alter future fire disturbance processes. Areas that have been affected by drought and the *Ips* bark beetle infestation over the past decade, however, are expected to trend toward reference conditions.

Piñon-Juniper Evergreen Shrub

Piñon-Juniper Evergreen Shrub occurs at elevations between 4,000 and 6,900 feet and covers approximately 263,835 acres (approximately 14 percent of the forest). It usually occupies hills, plains, mountains, and escarpments below the Mogollon Rim. This PNVT is dominated by open to closed shrub canopy of evergreen oaks, such as turbinella oak, and some tree forms of Emory and Arizona white oak and Stansbury cliffrose. Co-dominant species include single-needle piñon pine and Utah juniper, and some areas contain alligator juniper and Arizona cypress. A grassy understory may be present in areas with decreased tree cover, and herbaceous ground cover is dominated by warm season grasses including blue and sideoats grama and needle and thread grass. Piñon-Juniper Evergreen Shrub is characterized by mixed severity fire that occurs every 35-200+ years.

According to reference conditions, Piñon-Juniper Evergreen Shrub was dominated by shrubs and medium to very large open, grown trees, and invasive exotic species were not present. Current conditions are moderately departed and trending away from reference conditions as this PNVT is now less extensive and mid-scale vegetation analysis indicates a shift to more closed tree canopies and a loss of herbaceous understory. There are a few invasive exotic species within

Piñon-Juniper Evergreen Shrub, but their populations are few in number and acreage. This PNVTs current predicted fire departure is high and trending away from reference conditions.

Piñon-Juniper Woodland (Persistent)

On the Coconino National Forest, Piñon-Juniper Woodland (also called Persistent Piñon-Juniper) occurs at elevations between 3,000 and 7,500 feet and covers approximately 75,393 acres (approximately 4 percent of the forest). It is located mainly in the north and east portions of the forest on the lower slopes of mountains and upland rolling hills. This PNVT ranges from sparse stands of scattered, small trees growing on poor substrates to relatively dense stands of large trees on more productive sites. However, tree density and cover may fluctuate in response to disturbance and climatic variability. Tree species includes: piñon pine and Utah and one-seed juniper (which are most common) and alligator juniper at higher elevations. Shrubs may include: Stansbury cliffrose, Gambel oak, saltbush, big sagebrush, and limited areas of turbinella oak and manzanita. Understory species is mostly comprised of annual and perennial grasses including: blue grama, needle and thread grass, and western wheatgrass. Natural disturbances in persistent Piñon-Juniper Woodland include endemic levels of insects and disease and wildfire.

According to reference conditions, Piñon-Juniper Woodland was mostly open with a mosaic of small, medium, and large trees overtopping an herbaceous understory. Piñon-Juniper woodland is characterized by high severity fire that occurs 35 to 200+ years. Fires were more frequent and generally did not “thin from below” (i.e., they did not kill predominantly small trees) but rather tended to kill all or most of the trees, regardless of size, within the places that burned. In addition, invasive exotic species were not present. Historical fire rotations (i.e., the time required for the cumulative area burned to equal the size of the entire area of interest) varied from place to place. Overall, current vegetative conditions have a low departure with a static trend from reference conditions. This PNVTs current predicted fire departure is low and trending away from reference conditions. Areas that are overstocked with trees are expected to trend away, and the remaining areas are expected to have a static trend.

Currently, there is an overall shift toward small and medium sized trees with loss of herbaceous understory and large trees with open canopy, mainly because of a history of fire suppression activities. Tree density and canopy coverage have increased in many or most persistent woodlands during the 20th century (Romme et al 2007). Piñon *Ips* bark beetle infestations, since 2002-03, have resulted in the mortality of piñon in most of the affected area over the past 20 years. This resulted in more open canopies, and increased solar radiation and herbaceous understory production. Since 1996, piñon mortality averaged more than 55% across the Forest, but has been the most severe at low elevations, in stands with high stand density, in the larger size classes, and in trees with severe Piñon dwarf mistletoe infection. Overstocked stands are susceptible to insect attacks during drought periods. Small piñons would help maintain the tree‘s presence in the future. The increase in dead fuels, however, increases the potential for high severity fires.

Romme et al (2007) concluded with high confidence that spreading, low-intensity surface fires had a very limited role in molding stand structure and dynamics of persistent piñon-juniper woodlands in the historical landscape, that they tended to kill all or most of the trees within the places that burned regardless of tree size, and that historical fire rotations (i.e., the time required for the cumulative area burned to equal the size of the entire area of interest) varied from place to place in persistent piñon-juniper woodlands, but generally were very long (e.g., two to six centuries). Huffman et al. (2008) estimated a fire rotation of 340 years at a site in northern

Arizona, but this site represented an ecotone between Piñon–Juniper Woodland and Ponderosa Pine forest.

Romme et al (2009) also note that in many piñon and juniper woodlands, and particularly this PNVT, stand dynamics are driven more by climatic fluctuation, insects, and disease than by fire. Although increases in piñon and juniper density have received much attention in many areas, loss of piñon and juniper (especially from marginal sites) has also occurred recently and in the past. For example, the widespread and severe piñon mortality event that occurred locally in 2002–2004 as a result of drought, high temperatures, and bark beetle outbreaks. The 150,000 acres that were affected by drought and Piñon *Ips* bark beetle infestations is expected to move towards reference conditions with respect to insect and disease (USDA Forest Service 2009). This primarily because a majority of the most susceptible trees were successfully attacked and killed during that outbreak, leaving younger stands with a smaller average diameter. These types of events would tend move this PNVT away from reference conditions because stands would be less structurally diverse, particularly in the large, older trees.

Recent, large, severe (stand-replacing) fires in piñon and juniper woodlands are, for the most part, similar to fires that occurred historically (Romme et al 2009). This statement is best supported by empirical research in persistent woodlands, where some large, severe, pre-1900 fires have been documented. However, it is unclear whether the very large size of some recent, stand-replacing fires is exceptional (because of changing climate or fuels conditions) or represents a kind of infrequent, but nevertheless natural, event in this PNVT.

Ponderosa Pine

Ponderosa Pine is the largest PNVT on the forest. It occurs from 5,300 to 8,200 feet in elevation and covers approximately 791,897 acres (or approximately 48 percent) of the Forest. In addition to the dominant overstory species (ponderosa pine), other trees include: Gambel oak; Douglas-fir; piñon pine; Utah, Rocky Mountain and alligator juniper; and aspen in small, localized areas. Snags (dead standing trees) are also present. Understory vegetation includes a mixture of shrubs and grasses including: manzanita, Fendler's ceanothus, Arizona fescue, mountain muhly, screw leaf muhly, and blue grama. In some areas, ponderosa pine occurs as savannah with extensive grasslands interspersed between widely spaced clumps or individual trees (USDA Forest Service 2009). Ponderosa pine is the host to several different bark beetles, defoliators, and dwarf mistletoe.

According to reference conditions, ponderosa pine primarily occurred as open, all-aged forests, with a widespread herbaceous understory, and its composition and structure was maintained by frequent, low-intensity fires and endemic levels of insects and disease. Ponderosa pine is characterized by low severity fire that occurs every 0 to 35 years. Historic logging practices (e.g., railroad logging on the north side of the forest) originating in the 1880s focused on even-aged silvicultural systems, particularly clearcutting. Logging companies purchased timber rights from the transcontinental railroads which had been granted "checkerboarded" or alternating, sections of land from the Federal Government. Many of these sections in the north were clearcut prior to the establishment of the Coconino National Forest in 1908 (USDI 1995). However, the railroad line only penetrated as far south as Allen Lake, into the northern edge of what is now known as the Mogollon Rim Ranger District.

Early reports indicate that bark beetle activity was less frequent, extensive, and damaging in the southwest than other western regions (USDA Forest Service 2009). This includes periodic

outbreaks, especially with droughts, or in the absence of controlling disturbance agents. There were widespread bark beetle outbreaks on the Forest in the mid-1920s, late 1930s, mid-1960s, late 1970s through the early 1980s, and late 1990‘s through the mid-2000s (Lynch et al. 2007). Dwarf mistletoe abundance is probably greater today than in the 1800s, mostly because there are more trees now, especially in the ponderosa pine type (USDA Forest Service 2010).

Prior to 1930, early cutting had an even-aged management strategy that was mainly a seed-tree system with an emphasis on high-grading. The first cutting treatments retained more large trees on the southern portion of the forest, and the first entry occurred several decades later on the southern portion compared to the northern portion. The forest did a lot of tree pruning to accelerate the higher-grade lumber from logs during the period of the mid-1940s through the mid-1950s. This practice was discontinued due to higher labor costs and lumber markets not yielding the select grade lumber to justify the investment costs of pruning. During the 1950s up until the early 1990s, there was little emphasis on density management except for pre-commercial thinning. The primary emphasis was on selective cutting (sanitation, salvage, removing poor-risk trees, improvement, mature tree harvest, and free selection). The Colorado Plateau Pulpwood contract (1959-1989) focused on thinning trees, generally 6 to 13 inches d.b.h. which had the result of an all-aged appearance since spacing was the objective. Reforestation (which also increased an even-aged appearance) was accelerated in the mid-1960s, peaked in the early 1980’s and tapered off to sporadic plantings by the early 1990s. From the mid-1970s to early 1990s, the primary emphasis shifted to density management, specifically regulated even-aged management using a shelterwood management system. In the early 1990’s, little thinning was done due to a lack of Knutsen-Vanderberg dollars or project dollars and the loss of the timber industry. A 1996 forest plan amendment shifted emphasis once again, this time to primarily uneven-aged selection management systems targeting forest structure and tree density. In addition, in the middle to late 1990’s, efforts like the Greater Flagstaff Forests Partnership changed the focus to commercial thinning and breaking up the even-aged stands. In the early 2000’s, the National Fire Plan also shifted the focus to treatments in the wildland-urban interface (personal communication Greco 2013).

Current vegetative conditions within Ponderosa Pine are highly departed and trending away from reference conditions. The current predicted fire departure is high and trending slowly toward for fire return interval. Ponderosa Pine differs from reference conditions in that the amount of cover is higher, trees are denser and more continuous, fuel loads are higher, and more even aged stands of trees exist due to the exclusion of fire. Open canopy stands are extremely deficit. Stands growing under these conditions are less resilient and sustainable over time, because they are under greater competitive stress and are more susceptible to threats including: uncharacteristic wildfire; invasive, exotic species; and widespread infestations of disease. Another consequence of fire exclusion and the interruption of the frequent fire regime is the decline in understory species diversity and abundance which exists because tree density is higher and less sunlight reaches the forest floor. Secondary threats include uncharacteristically intense wildfire and increased susceptibility to insect and disease from increased plant competition for water during times of drought.

Mixed Conifer with Frequent Fire

On the Coconino National Forest, Mixed Conifer with Frequent Fire PNVT (also called Dry Mixed Conifer) occurs at elevations ranging from 7,000 to 8,900 feet and covers approximately 49,619 acres (2.7 percent of the forest). It is located between lower elevation Ponderosa Pine and

Mixed Conifer with Aspen PNVTs and the higher elevation Spruce Fir PNVT. This PNVT is dominated by mainly shade-intolerant trees such as ponderosa pine, southwestern white pine, limber pine, quaking aspen, and Gambel oak, and there is a lesser presence of shade-tolerant species such as white fir and blue spruce. Additionally, shade tolerant species, such as Douglas-fir, are common; aspen may occur as individual trees or small groups; and maple is generally found in wetter sites, canyons, and draws. An understory of various grasses, forbs, and shrubs is also present. The primary natural disturbances in this PNVT are wildfire and endemic levels of insects and disease. The normal fire regime is generally considered to be the similar to Ponderosa Pine with fire return internals of less than 35 years. Like Ponderosa Pine, this PNVT co-evolved with fire; therefore, fire was the driving force that formed and maintained the openness of stands and appropriate conditions for the maintenance of early succession species and made them less susceptible to insect and disease.

According to reference conditions, Mixed Conifer with Frequent Fire was a mostly open landscape and was dominated by largely mature and old trees; however, all age classes of trees were present. A widespread herbaceous understory was also present. Current conditions are moderately departed and trending away from reference conditions because of the lack of fire. Current fire frequency is far below reference conditions As a result of fire exclusion, shade-tolerant species, such as white fir, are increasing in the understory. Consequently, tree density is high in most places, and conditions for early succession species are not being maintained or created. Current fire frequency is much lower than historic however the current predicted fire departure is high but is trending toward reference at a very slow rate.

Douglas-fir dwarf mistletoe is thought to be currently more widespread and continuous in distribution than in reference conditions due to the exclusion of fire and the increased amount of dense multi-layered stands (USDA Forest Service 2009). Based on present understanding of mistletoe ecology, increases in host abundance over the past 150 years, decreases in fire frequency, and evidence of previous forest conditions and fire regimes, it can be inferred that southwestern dwarf mistletoe abundance (severity and distribution) was likely lower historically and current conditions are likely similar to those described by Hessburg and Beatty (1985). Hessburg and Beatty estimated that 32 percent of the commercial acres of ponderosa pine on the Coconino National Forest were infected with dwarf mistletoe, an increase from 30 percent found in a similar survey 30 years earlier (Lynch et al. 2007). Compared to reference conditions, this level of insect and disease is outside the historic range of variability, and the possible introduction of white pine blister rust, which was recently discovered for the first time in eastern Arizona, could further elevate mortality levels. White pine blister rust is one of the most damaging tree diseases in North America, affecting trees of all sizes, but has not been detected yet on the Coconino. Mixed Conifer with Frequent Fire has few weed species (USDA Forest Service 2009).

Mixed Conifer with Aspen

On the Coconino National Forest, the Mixed Conifer with Aspen PNVT (also called Wet Mixed Conifer) occurs at elevations between 8,000 and 10,400 feet and covers approximately 37,083 acres (2 percent of the forest). It occurs on mountain slopes such as the San Francisco Peaks and may also occur in canyons and north-facing slopes such as on Hutch Mountain and Mormon Mountain. This PNVTs current vegetative departure is moderate and trending away from reference conditions. The predicted fire departure from historic fire return intervals is high and trending away. Aspen populations are declining in these PNVTs due to insect defoliators, drought and heavy ungulate browsing. Dominant and co-dominant species include: Douglas-fir, New

Mexico locust, southwestern white pine and limber pine, and late seral species such as maple, white fir and blue spruce. Ponderosa pine may be present in minor proportions. The absence of significant quantities of Engelmann spruce and/or corkbark fir distinguishes Mixed Conifer with Aspen from the Spruce Fir PNVT. Its understory contains a wide variety of shrubs, grasses, and forbs, and it generally has more sedges, mosses, and liverworts than Mixed Conifer with Frequent Fire and more leaf litter because there are more deciduous species. Disturbances typically occur at two temporal and spatial scales: large-scale infrequent disturbances (mostly mixed-severity fires at 35- to 200-year frequency) and small-scale, frequent disturbances (e.g., fire, insect, disease, wind).

Current conditions are moderately departed and trending away from reference conditions. Nearly 80 percent of this PNVT is denser, with higher canopy closure, indicating that a greater percentage of this PNVT is in a late successional state than in reference conditions. Consequently, shade tolerant species are more prevalent and early successional, more fire tolerant species are declining. As a result, the risk of uncharacteristic fire that is larger in extent and possibly more severe is higher than reference conditions. Mortality due to insect and disease is likely to continue because of the high proportion of dense stands, lack of fire, and the possible introduction of white pine blister rust, which was recently discovered for the first time in eastern Arizona. White pine blister rust is one of the most damaging tree diseases in North America, affecting trees of all sizes, but has not been detected on the Coconino.

Spruce Fir Forest

On the Coconino National Forest, the Spruce Fir PNVT occurs at elevations between 8,400 and 12,000 feet and covers approximately 13,946 acres (less than 1 percent of the forest). It is within the Kachina Peaks Wilderness and represents some of the coldest, wettest, and highest elevation sites on the forest. Spruce Fir is often dominated by Engelmann spruce but contains other species depending on elevation. The understory commonly includes: currants, maples, honeysuckle, common juniper, alpine clover, and sedges. Disturbances in Spruce Fir typically occur at two temporal and spatial scales: large-scale infrequent disturbances (mostly fire) and small-scale frequent disturbances (e.g., fire, insect, disease, wind). This PNVT is characterized by infrequent, high-severity fire (fire return interval of over 200 years). Other major disturbances were wind or snow-related.

According to reference conditions, structure and composition of the Spruce Fir forest type was governed by complex interactions between multiple disturbance agents. Spruce beetle outbreaks cause extensive tree mortality and modify stand structure by reducing the average tree diameter, height, and stand density while dramatically increasing fuel loading. Insect and disease populations will often remain endemic for hundreds of years as the younger forests mature. Spruce Fir forests characteristically experienced infrequent, high severity fires, typically following epidemic beetle infestations in susceptible, mature forests. Invasive exotic species were not present.

Vegetative structure is moderately departed and its trend is static to trending away from reference conditions. Current predicted fire departure for Spruce Fir is high with a static trend. There is a surplus of younger age classes and fewer old age classes due to extensive wildfires that occurred in the early 1900s. Because the majority (80%) of this PNVT is located in designated wilderness and has been subject to little management, except for fire suppression, the majority of the PNVT is late seral or is trending towards developing old growth. Although approximately 340 acres are

affected by the spruce beetle, this acreage is considered to be within historic levels (Lynch et al 2007). Two invasive exotic species (Dalmatian toadflax and houndstongue) are present in Spruce Fir, but their populations are few in number and acreage and they have a low ranking for invasiveness, and therefore, are not considered a threat to this PNVT.

Alpine Tundra

On the Coconino National Forest, about 939 acres of the Alpine Tundra PNVT occur in the Kachina Peaks Wilderness (approximately one-tenth percent of the forest), beginning around 10,600 feet in elevation and continuing to the top of Humphrey's Peak, the highest point in Arizona. It is the only area of Alpine Tundra in Arizona, and it is one of the southernmost extents of this PNVT in the United States. Alpine Tundra consists of three main habitat associations: boulder fields, talus slopes, and meadow-like areas. It is typically barren with sparse vegetation including: grasses, forbs, lichens, and low shrubs. Dwarf, wind twisted trees are present near the tree line where trees transition to Alpine Tundra vegetation. One of the plants it supports, San Francisco Peaks ragwort, is federally listed as threatened. Alpine Tundra is not a fire-adapted PNVT; instead, its natural disturbance processes are related to episodic weather events including: extreme temperatures, solar radiation, winds, avalanches, and moisture. While wildfires and invasive exotic species have had little effect on this PNVT, off-trail recreation can trample plants and damage habitat, especially outside of winter.

Current conditions in Alpine Tundra are similar to (low departure) and trending away from reference conditions, probably because this PNVT is located within an existing wilderness area and current management has sought to reduce recreation impacts (the primary human disturbance in this PNVT) by restricting off-trail use. Invasive exotic species are currently absent from this PNVT, namely because of its remoteness from roads, lack of management activities, and extreme environmental conditions. Over time, this PNVT may move away from reference conditions as localized warmer and drier climate conditions persist. These conditions could produce pronounced changes in the PNVT's composition and structure by increasing plant mortality, plant stress, and shifts toward meadow species rather than talus slope species.

Sub-PNVT Tree Features

Aspen

Aspen occurs in multiple PNVTs across the forest on cool, wet sites. It is an important component of Mixed Conifer vegetation types and a minor component of Ponderosa Pine and Spruce Fir vegetation types. Aspen communities in the southwest have been declining for decades. This decline is attributable to altered fire regimes and heavy browsing by ungulates combined with fires, insect defoliators, drought and the inability of aspen regeneration to survive browsing has resulted in conversion of aspen to coniferous forest (USDA Forest Service 2009). Aspen mortality has been greatest in the low-elevation range.

During the past 5 to 10 years, more than half of aspen sites below 7,500 feet elevation have experienced high rates of mortality (Fairweather et al. 2007). Drought conditions are expected to exacerbate this decline as stressed trees become more susceptible to damaging agents and mortality. Aspen at higher elevations would become increasingly susceptible and higher rates of mortality should be expected. As overstory aspen weaken and die and competition from conifers increase, successful sprouting (suckering) is expected to decline. Combined with heavy browse pressure from ungulates, drought, frost, and insect defoliation can prevent aspen regeneration,

from reaching maturity, except within fenced areas. Extensive mortality of the established aspen component combined with an almost complete regeneration failure at lower elevations (less than 8,500 feet), indicates that future persistence of aspen on the Coconino National Forest is not assured, except in relict locations at lower elevations (Lynch et al. 2007; Fairweather et al. 2007). Fairweather et al. (2007) found that since 2000, affected sites at less than 7,500 feet in elevation experienced, on average, greater than 95 percent mortality by the summer of 2007; sites located at elevations of 7,500 to 8,500 feet had 61 percent rate of mortality; and 16 percent mortality was observed at sites higher than 8,500 feet in elevation.

Maple

In Arizona, bigtooth maple occurs as a shade-tolerant, seral understory tree or shrub in Douglas-fir, white fir, and subalpine fir (*Abies lasiocarpa*) habitat types (DeVelice and Ludwig 1983, as cited in Tollefson 2006). On the Coconino National Forest, this species is most prominent in the Mogollon Rim Botanical Area, a 339-acre white fir/bigtooth maple community, and represents a unique vegetation type found in Arizona only at a few locations along the Mogollon Rim. Bigtooth maple is a deciduous, small tree or shrub of variable size, and its form is dependent upon the moisture regime. In canyon bottoms and along streams it grows as a tree with single or multiple trunks reaching 50 feet (15 m) tall and 1 foot (30 cm) in diameter, while on dry canyon slopes it grows as a shrub with 2 or more stems reaching 26 feet (8 m) tall. It occupies cool, shaded draws and intermittent stream drainages in the high mountains and plateaus of central and southern Arizona and southern New Mexico (Little 1950 and; Bassett et al. 1987, as cited in Tollefson 2006). It is currently more abundant in the bottom than in the top of snow-melt drainages on the Mogollon Rim in central Arizona (Martin 2001, as cited in Tollefson 2006).

In Arizona and New Mexico, the white fir/bigtooth maple habitat type typically occurs along stream courses. These riparian areas are considered high quality fish and wildlife habitat (Fitzhugh et al. 1987, as cited in Tollefson 2006). Bigtooth maple is a dominant species in broadleaf riparian woodlands in Arizona which are used by a variety of wildlife species (Brown et al. 1977, as cited in Tollefson 2006). In central and southern Arizona and southern New Mexico, the dense cover in white fir-bigtooth maple forests serves as excellent black bear habitat (Bassett et al. 1987, as cited in Tollefson 2006). Although white fir-bigtooth maple forest occurred on only 1 percent of a study area on the Mogollon Plateau, Arizona, it accounted for 12 percent of black bear use.

Gambel Oak

Gambel oak occurs with Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs in Arizona, growing primarily as an understory or mid-story tree. Most fire-history studies have discovered that surface fires burned ponderosa pine-Gambel oak forests on average at least once every 13 years or less before policies of fire exclusion beginning in the late 1800s (Abella and Fulé 2008a). Similar to pure ponderosa pine forests, fire exclusion, wood harvesting, livestock grazing, and other factors have altered forests with Gambel oak since Euro-American settlement in the late 1800s. Published research suggests that densities of small-diameter oaks have sharply increased in the past 140 years in ponderosa pine-Gambel oak forests (Abella and Fulé 2008b). Less clear, however, is whether large-diameter oaks have dwindled because of fuelwood harvest or other factors (Mast 2003). Empirical evidence suggests that increasing densities of conifer species are shading out Gambel oak, contributing to its decline. Diameter distributions at Camp Navajo, Arizona, in 1883 and in 1994 to 1995, suggest that densities of oaks greater than 10

inches in diameter have actually increased slightly since 1883 (Abella and Fulé 2008b). Overall, the number of small-diameter oaks on the landscape is higher than under reference conditions.

Alligator Juniper

Alligator juniper and blue spruce are additional tree species that are highlighted in the current forest plan. Alligator juniper occurs within several PNVTs, including Ponderosa Pine, Piñon-Juniper with Grass, Piñon-Juniper with Evergreen Oak, and Mixed Conifer with Frequent Fire; often occurring in transition zones. Species dominance among junipers appears to be related to elevation and precipitation patterns. In southern Arizona and southwestern New Mexico, where annual precipitation comes primarily during the summer monsoon, alligator juniper dominates in mesic (moist) sites often at higher elevations. Due to its ability to resprout after fire, alligator juniper may achieve dominance on a post-fire site more rapidly, and where it occurs, more frequent fires would be required to suppress small trees and maintain a savanna structure (Miller and Rose 1999). Both piñon and alligator juniper in north-central Arizona fall below the historical range for mean tree height and mean tree diameter. The smaller mean tree sizes potentially indicate sites that are more heavily dominated by young trees than occurred historically (Gori and Bate 2007).

Aerial photographs from 1935 and 1991 were used in an analysis of vegetation change in southwestern New Mexico. Dramatic changes occurred on gently sloping mesas where relatively dense stands of alligator juniper replaced former grasslands and juniper savannahs. During the 56-year period, grasslands and juniper savannas decreased from a combined 15 percent of the study area to less than 2 percent (Miller and Rose 1999). Similar encroachment by alligator juniper is occurring in grassland vegetation types on the Coconino.

Blue Spruce

In its southern range (southwestern Colorado, Arizona, and New Mexico), blue spruce is part of the widespread mixed conifer forest as a component of several diverse habitat types often occurring in stream bottoms and meadow borders across the forest.

In general, blue spruce dominates habitats that are too warm for Engelmann spruce and subalpine fir and that are wetter than those typically occupied by ponderosa pine. Shrub associates include Gambel oak, as well as alders and willows on the moister sites. Over the bulk of its range, blue spruce is most frequently associated with Douglas-fir and ponderosa pine, and with white fir on mesic sites in the central Rocky Mountains. Blue spruce is seldom found in large numbers, but on streamside sites it is often the only coniferous species present. Blue spruce is classed as intermediate in terms of shade tolerance. On cool sites, a dense or moderately dense canopy favors regeneration of subalpine fir, blue spruce, white fir, and Engelmann spruce, to the exclusion of Douglas-fir. On warm sites, an open canopy favors ponderosa pine, whereas a moderate canopy favors Douglas-fir (Fechner 1990). Spruce aphid is an exotic insect that established on the San Francisco Peaks about 1999. This insect feeds on tree sap through needle stomata and damages Engelmann spruce and Colorado blue spruce of all size classes. Blue spruce, however, is less susceptible to spruce aphid than is Engelmann spruce, so in some areas it would replace Engelmann spruce if heavy aphid mortality occurred (Lynch et al. 2007).

Environmental Consequences

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there can be no direct effects. However, there may be implications, or long-term environmental consequences, of managing the forests under this programmatic framework.

All Vegetation and Fire

Table 11 summarizes condition and trend for fire by PNVT and by Alternative. Table 12 summarizes vegetation departure rating and trend by PNVT and Alternative.

Table 11. Summary of VCC, Vegetation, Fire Return Interval, and Fire Severity Trends by PNVT*

PNVT	Existing VCC	Vegetation trend		Predicted Departure and Trend for Fire Return Interval	Predicted Departure and Trend for Fire Severity	
		Alt A	Alts B, C, D	All Alternatives	Alt A	Alts B, C, D
Desert Communities	VCC I	Not fire adapted	No change	Not fire adapted		
Semi-Desert Grassland	VCC II	Static	Toward	High/Away	Moderate/Static	Moderate/Toward
Great Basin Grassland	VCC III	Away	Static	High/Away	High/Away	High/Static
Montane/Subalpine Grassland	VCC III	Away	Toward	Moderate/Away	High/Away	High/Toward
Interior Chaparral	VCC I & II	Away	Away	Moderate/Away	Low to Moderate/Away	Low to Moderate/Away
Piñon-Juniper with Grass	VCC II & III	Toward	Toward	High/Away	Moderate to High/Toward	Moderate to High/Toward
Piñon-Juniper Evergreen Shrub	VCC II	Away	Away	High/Away	Moderate/Away	Moderate/Away

PNVT	Existing VCC	Vegetation trend		Predicted Departure and Trend for Fire Return Interval	Predicted Departure and Trend for Fire Severity	
		Alt A	Alts B, C, D	All Alternatives	Alt A	Alts B, C, D
Piñon-Juniper Woodland	VCC II	Static	Static	Low/Away	Moderate/Static	Moderate/Static
Ponderosa Pine	VCC III	Toward	Toward	High/slowly Toward	High/Toward	High/ Toward**
Mixed Conifer with Frequent Fire	VCC III	Toward	Toward	High/Slowly Toward	High/Toward	High/Toward
Mixed Conifer with Aspen	VCC III	Away	Static	High/Away	High/Away	High/Static
Spruce Fir	VCC II	Away	Away	High/Static	Moderate/Away	Moderate/Away
Alpine Tundra	VCC III	Not fire adapted				

*Trends for fire return interval and fire severity are the same for 15 and 50 years. Vegetative departure trends were used because VCC cannot be projected.

** Implementation of the higher end of plan objectives would result in trend toward desired conditions. Implementation of the lower end of plan objectives would result in trend away from desired conditions.

Table 12. Vegetation departure rating and trend by alternative

PNVT	Vegetation Departure Rating[1] and Trend							
	Alternative A		Alternative B		Alternative C		Alternative D	
	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year
Cottonwood Willow Riparian Forest (2,505 acres)	Not fire adapted	Not fire adapted	Not fire adapted	Not fire adapted	Not fire adapted	Not fire adapted	Not fire adapted	Not fire adapted
Gallery Coniferous Riparian Forest (200 acres)	*	*	*	*	*	*	*	*
Desert Communities (63,548 acres)	High/ Away	High/ Away	High/ Away	High/ Away	High/ Away	High/ Away	High/ Away	High/ Away
Semidesert Grassland (89,683 acres)	High/ Static	High/ Static	High (94)/ Toward	High (85)/ Toward	High (94)/ Toward	High (85)/ Toward	High (94)/ Toward	High (85)/ Toward
Great Basin Grassland (92,913 acres)	Low/ Away	Moderate/ Away	Low (12)/ Static	Low (11)/ Static	Low (12)/ Static	Low (11)/ Static	Low (12)/ Static	Low (11) Static
Montane Subalpine Grassland (23,429 acres)	Low/ Away	Low/ Away	Low (14)/ Toward	Low (4)/ Toward	Low (14)/ Toward	Low (4)/ Toward	Low (14)/ Toward	Low (4)/ Toward
Interior Chaparral (50,471 acres)	Low/ Away	Moderate/ Away	Low/ Away	Moderate/ Away	Low/ Away	Moderate/ Away	Low/ Away	Moderate/ Away

PNVT	Vegetation Departure Rating[1] and Trend							
	Alternative A		Alternative B		Alternative C		Alternative D	
	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year
Piñon-Juniper with Grass (261,432 acres)	Moderate (42)/ Toward	Moderate (48)/ Away	Moderate (41)/ Toward	Moderate (43)/ Static-Away	Moderate (41)/ Toward	Moderate (43)/ Away	Moderate (41)/ Toward	Moderate (43)/ Static-Away
Piñon-Juniper Evergreen Shrub (263,835 acres)	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away
Piñon-Juniper Woodland (Persistent) (75,393 acres)	Low/ Static	Low/ Static	Low/ Static	Low/ Static	Low/ Static	Low/ Static	Low/ Static	Low/ Static
Ponderosa Pine (791,897 acres)	Moderate (58)/ Toward	Moderate (58)/ Static	Moderate (51)/ Toward	Moderate (51)/ Static	Moderate (51)/ Toward	Moderate (51)/ Static	Moderate (51)/ Toward	Moderate (51)/ Static
Mixed Conifer with Frequent Fire (49,619 acres)	Moderate (39)/ Toward	Moderate (39)/ Static	Moderate (34)/ Toward	Low (30)/ Toward	Moderate (34)/ Toward	Low (30)/ Toward	Moderate (34)/ Toward	Low (30)/ Toward
Mixed Conifer with Aspen (37,083 acres)	Moderate/ Away	High/ Static	Moderate/ Static	Moderate/ Static	Moderate/ Static	High/ Static	Moderate/ Static	Moderate/ Static
Spruce Fir[2] (13,946 acres)	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away

PNVT	Vegetation Departure Rating[1] and Trend							
	Alternative A		Alternative B		Alternative C		Alternative D	
	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year	15 Year	50 Year
Alpine Tundra (939 acres)	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away	Moderate/ Away

Common to All Alternatives

Trends for vegetation as it relates to fire and fire severity would remain static in all Alternatives for Piñon-Juniper Woodland PNVT. A static trend means that the PNVT is neither moving towards nor away from the ecological systems' characteristic fire regime and current departures would be maintained.

Overall, trends for vegetation as it relates to fire and fire severity would improve in all Alternatives in Piñon-Juniper with Grass, Ponderosa Pine, and Mixed Conifer with Frequent Fire PNVTs. A trend towards desired conditions means the ecological system is moving towards characteristic fire, including a reduction in severity and a reduction in the risk of uncharacteristic fire.

The trends for Interior Chaparral, Piñon-Juniper Evergreen Shrub, and Spruce Fir PNVTs are trending away from desired conditions for fire severity and vegetation as it relates to fire. These would not change by Alternative. Piñon-Juniper Evergreen Shrub PNVT is adapted to mixed severity fire in which 25 to 75 percent of the dominant overstory is replaced. Consequently the away trend would result in a higher proportion of the PNVT burning at the higher end of the range for mixed severity fire. Interior Chaparral and Spruce Fir PNVTs are adapted to high severity fires in which over 75 percent overstory replacement is within the natural range of variability. Similarly, the away trends would result in a higher proportion of Interior Chaparral and Spruce Fir PNVTs burning at high severity compared to characteristic fire regimes.

Alternative A

Alternative A would result in fewer acres treated and higher fire intensities (relative to Alternatives B, C and D) mainly due to constraints on unplanned wildfires to meet resource objectives and a lack of emphasis on fire restoration.

Compared to Alternatives B, C, and D, Alternative A results in a trend toward less acreage treated and higher departures mainly due to constraints on unplanned wildfires to meet resource objectives and a lack of emphasis on fire restoration.

The 1987 Forest Plan includes the following forest-wide direction for management of timber, fuels, and protection from fire:

- Manage the timber resource to provide a sustained-yield of forest products through integrated stand management. On forested lands identified as suitable for commercial timber production, design timber management activities to integrate considerations for economics, water quality, soils, wildlife habitat, recreation opportunities, visual quality, and other values. Develop and implement a sustained-yield program for firewood and other miscellaneous forest products including posts, poles, Christmas trees, and wildings.
- Emphasize uneven-aged management for timber cutting areas. When stands are managed under even-aged systems, the shelterwood method is the preferred method. Manage resources to prevent a build-up of insects and diseases to prevent or reduce serious, long lasting hazards through integrated pest management (IPM).
- Use fire as a resource management tool where it can effectively accomplish resource management objectives. Use fire prevention and control to protect life, property, and resources.

- Establish and maintain stand diversity through Integrated Stand Management (ISM) to provide suitable habitat for wildlife in lands suitable for timber production, while maintaining or enhancing timber resource production and timber age class distribution (regulation).
- Strive to create or sustain as much old-growth compositional, structural, and functional flow as possible over time at multiple-area scales. Seek to develop or retain old-growth function on at least 20 percent of the naturally forested area by forest type in any landscape.
- Limit the treatment of natural fuels to areas where fuel buildups are a threat to life, property, adjacent to old-growth areas, or specifically identified high resource values.
- Prescriptions for the use of prescribed fire for any purpose include measures to minimize smoke production when projects would impact smoke sensitive areas.
- Monitor and document the effects on smoke sensitive areas of smoke from prescribed burning during the burning season. The purpose is to prevent smoke intrusions. Adjust the burning program as needed based upon the monitoring.

The following tables are based on silviculturally treating 10,000 acres and prescribe burning 15,000 acres annually. This was the amount used for calculations within the Ecological Sustainability Report and was determined based upon the average historic level of treated acres, primarily in the Ponderosa pine and Mixed Conifer with Frequent Fire vegetation types, over most of the life of the current Forest Plan (1987-2007). Modeled silvicultural treatments were free thinning in the small diameter tree states, and group selection in the medium and large diameter tree states. Ponderosa pine and, Mixed Conifer with Frequent Fire were modeled in three different ways; 1) the entire PNVT combining both suitable[9] and non-suitable lands[10]; 2) suitable lands alone, and; 3) non-suitable lands alone. This breakout was done to provide more insight into how the two levels of management (suitable and non-suitable) combine to move toward desired conditions across the landscape. The majority of lands trending toward desired conditions come from suitable timberlands that are managed for timber production. The body of this report contains the results from modeling treatment on both suitable and unsuitable timberlands. More detailed descriptions of the effects from Alternative A to suitable timberlands only and non-suitable timberlands only can be found in the Appendix H. Timber management may occur on non-suitable lands, but is driven by other resource objectives, such as wildlife habitat. The only unsuitable lands modeled for this report were Mexican spotted owl protected activity centers (PAC), which were thinned from below up to 9" DBH to reduce wildfire risk. In addition, Piñon-Juniper Grasslands were modeled because it is the most departed of the three Piñon-Juniper types on the Forest and presents the greatest opportunity for management.

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[9] Lands designated as suitable for timber production provide the base for calculating the Long Term Sustainable Yield (LTSY) of the Forest. The timber production objective is defined as growing, tending, harvesting, and regenerating crops of trees on a regulated basis to produce logs or other products for industrial or consumer use [1982 rule provisions section 219.16]

[10] Lands Not-Suitable for Timber Production = Non Forested + Withdrawn + Irreversible Resource Damage + Adequate Restocking not Assured + Lands Not Appropriate for Timber Production.

Desired conditions within the Ponderosa Pine and Mixed Conifer with Frequent Fire types are primarily represented by the combination of States D, E, J, and K, with the majority being in States J (trees 10-20" DBH with open, multi-storied canopy) and K (trees 20"+ DBH with open, multi-storied canopy). The important distinction is that States J and K are both multi-storied (uneven-aged) and have at least three age classes represented, including adequate openings for planned regeneration immediately after treatment. Although a state is described as "medium" or "very large" trees, it is inferred that trees of other sizes/ages are included. For example, State J is dominated by 10-20 inch DBH trees, but would also include a more or less balanced representation of seedlings/saplings, small trees, and some very large trees as well because it represents a multi-storied, uneven-aged state. Similarly, State I contains primarily very large trees and is described as single-storied (even-aged) with closed canopy, but may also contain up to one other distinct size/age class and scattered single trees of different sizes.

Alternative B

Direction in the proposed revised plan related to all vegetation types is listed below.

Desired Conditions for All Vegetation Types: Landscape Scale (10,000 acres or greater)

- Each PNVT contains a mosaic of vegetative conditions, densities, and structures. This mosaic occurs at a variety of scales across landscapes and watersheds. The distribution of physical and biological conditions is appropriate to the natural disturbance regimes affecting the area.
- Vegetative conditions are resilient to the frequency, extent, and severity of disturbances, such as fire in fire-adapted systems and flooding in riparian systems, and climate variability. Coconino NF landscapes are functioning ecosystems that retain their components, processes, and functions. Natural and human disturbances provide desired overall plant density, structure, species composition, coarse woody debris, and nutrient cycling. Desired disturbance regimes are restored where practical, including fire
- Native plant communities dominate the landscape while invasive exotic species are non-existent or in low abundance and do not occur at levels that disrupt ecological functioning. Establishment of invasive exotic plant species new to the Coconino NF is prevented. Existing invasive exotic plant species are prioritized for eradication, containment, or control.
- Vegetative and stream connectivity provides for upland and aquatic species movements and genetic exchange consistent with landforms and topography.
- Vegetation conditions allow for transition zones or ecotones between riparian areas, forests, woodlands, shrublands, and grasslands. Transition zones shift in time and space due to factors affecting site conditions (e.g. fire, climate).
- Native insect and disease populations are generally at endemic levels with occasional outbreaks. A variety of vegetation structures usually restrict the scale of localized insect and disease outbreaks.
- Vegetation provides sustainable amounts of products, such as wood fiber or forage. Herbivory (the act of feeding on plants) aids in sustaining or improving native vegetation cover and composition. Livestock grazing and wood fiber harvest activities contribute to aspects of the social, economic, and cultural structure and stability of rural communities.

- Ecosystem contributions (e.g., nutrient cycling, water infiltration, wildlife habitat, etc.) are sustained as vegetation on the Forest adapts to a changing climate.
- Plants known to be used by tribes that traditionally use the Forest are thriving.
- Rare and culturally important plant species are valued. Their habitat is enhanced and protected.

Guidelines for All Vegetation Types

- Forest and woodland vegetation within the wildland-urban interface may be composed of conditions at the lower end of desired conditions for the respective vegetation type such as younger age classes, and the lower end of coarse woody debris and snags in order to reduce fire risk in wildland-urban interface areas.

Management Approaches for Forest Products

- When forest products are available as a result of forest management activities, work with agencies, private organizations, and individuals to promote forest product use.
- Encourage use of forest products in lieu of onsite burning or chipping where ecologically feasible.
- Ensure the continued sustainability of special forest products through observation of commercial sales and personal-use permit harvest levels.
- Recognize the rights of members of tribes to collect forest materials for traditional, ceremonial, and subsistence purposes.
- Provide training to Forest employees about the trust responsibilities Federal agencies have for tribes, and the specific ways in which the Coconino NF honors and implements those responsibilities.
- Encourage tribal members to engage in traditional activities relating to forest botanical products, such as the collection of medicinal plants, wild plant foods, basketry materials, and fuel wood for traditional and cultural purposes.

Alternatives B, C, and D

Fire return intervals would not improve in those PNVTs with away or static trends for this characteristic. This is due to a lack of plan objectives for prescribed fire. These would include all grassland and Piñon-Juniper PNVTs as well as Mixed Conifer with Aspen, and Spruce Fir. Conditions could improve with unplanned natural ignitions that meet resource objectives; however, location and extent of these cannot be predicted.

Alternatives B and D should provide the most acreage treated and a resultant lower departure. Figure 3 illustrates VCC trends and PNVT departure by Alternative.

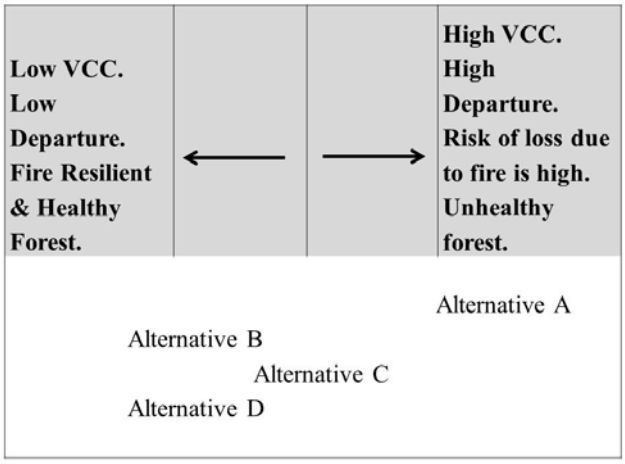

Figure 3. PNVT departure and ecosystem health by alternative

For other PNVTs (Fire Regimes II-V) the relationship between fire frequency and fire behavior remains but is not as pronounced. For example, Interior Chaparral would have increased fire behavior (intensity and severity) with increased time between fire events. However, this PNVT does not need frequent fire to maintain its structure and function to the extent of ponderosa pine.

For PNVTs not fire adapted, the above interactions do not apply.

Recreation Opportunity Spectrum

Alternatives B, C, and D generally allow for more treatment acres; however, this trend could be the opposite in key areas on the far southeast end of the Forest on the Mogollon R.D. This is because these Alternatives would re-designate large areas as Semi-Primitive Non Motorized ROS class. This designation has the potential to limit mechanical and fire treatment opportunities due to restricted access, potentially increasing departure.

Alternative C

Recommended Wilderness

Alternative C would lead to less acreage treated (relative to Alternatives B and D) due to the added constraints of Special Areas and wilderness designation. Wilderness designation constraints to fire treatment are increased logistical complexity (access limitations) and a reduction in fire management tools (chainsaws, engines, bulldozers, aviation resources, etc.). Special Area designation (Research Natural Areas, Botanical Areas, etc.) do not explicitly prohibit fire treatment. However, these designations result in increased complexity due to added coordination requirements and competing resource objectives. For example, RNAs have ongoing research projects that often have specific requirements (such as no fire, spring fire, fall fire, etc.) that can make fire treatment difficult or impractical. In addition, making necessary contacts to coordinate the use of wildfire to meet resource objectives in emergency timeframes is often impractical. Further, Alternative C would likely reduce mechanical treatment opportunities; therefore, potentially limit fire treatment due to stand conditions being dense and more volatile.

Although this Alternative proposes 10 more wilderness areas, and withdrawal of over 76,000 additional acres, the affect to suitable timberlands is relatively minor. Approximately 93% of acres affected by this change are within vegetation types that are designated as incapable of

producing industrial wood. Another 5% are designated as Critical Wildlife Habitat, and just slightly more than 1% (1,015 acres) is designated as suitable. The difference is not large enough to impact modeling results. It is assumed that designation of the WHMAs would not have a major effect on vegetation management. The largest potential impacts would primarily affect PNVTs not modeled, so predicted effects will be addressed qualitatively. The acreage affected in modeled PNVTs was small enough (<1%) that they did not significantly change modeled outputs. Table 13 lists the PNVTs that are included within the additional proposed wilderness and are greater than 1% of the area proposed.

Table 13. PNVTs within proposed wilderness (alternative C)

PNVT	Acres	%
Piñon-Juniper Evergreen Shrub	50,635	56.8%
Piñon-Juniper Persistent	13,665	15.3%
Semi-desert Grassland	12,186	13.7%
Ponderosa Pine	4,225	4.7%
Piñon-Juniper Grassland	3,648	4.1%
Great Basin Grassland	2,327	2.6%
Interior Chaparral	1,707	1.9%
Desert Communities	1,016	1.1%

Only PNVTs listed in the table above would be analyzed with this Alternative. It is expected that the environmental consequences of Alternative C would be the same as Alternative B for all other PNVTs

Ponderosa Pine

Fire Departure and Trend: Regardless of the Alternative, the Ponderosa Pine PNVT requires frequent fire to maintain its composition, structure, and overall health. Fire historically occurred about every 2 to 12 years in Ponderosa Pine. Forestwide fire treatment levels between 52,000 and 100,000 acres per year in the ponderosa pine would be required to be within the range of its natural fire return interval. Attaining a low fire departure including the desired fire return interval is unrealistic given current budgets and air quality concerns. In addition, there are relatively few acres of ponderosa pine that have the structure and composition that allows treatment with fire only. Many acres need mechanical treatment prior to burning to minimize fire severity and excessive damage to vegetation and soil. However, all Alternatives have objectives that would slowly improve vegetative structure and composition of the PNVT and reduce the risk of uncharacteristic fire. Over the life of the plan, vegetation treatments would allow natural fire regimes to be reintroduced to new areas on the landscape over the life of the plan.

Common to All Alternatives

As shown in table 14, all Alternatives would improve PNVT departure over the current condition; however, Alternatives B, C, and D would move closer to desired conditions (lower departure) than Alternative A.

In some areas, there would be an increased risk of uncharacteristic fire because of denser stand conditions. Aspen and other early seral species could continue to decline where late seral species or closed canopy conditions are emphasized. Areas outside of protected activity centers and areas outside recovery nesting and roosting habitat for Mexican spotted owls in the Ponderosa Pine-Gambel Oak subtype would generally be managed for large trees, large hardwoods, large snags, and large downed woody debris.

Fire treatment objectives would slowly move this PNVT toward the historic fire return interval. This would result in more areas where open conditions are maintained, nutrient cycling occurs, and age class diversity is promoted.

Table 14. Comparison of Ponderosa Pine PNVT states among desired distribution, existing distribution, and each alternative

Ponderosa Pine VDDT Model State	Desired Distribution	Existing Distribution	Alt. A		Alts. B, C, D	
			15 Year	50 Year	15 Year	50 Year
Grass, Forb, Brush/Shrub[1]	0.0%	0.8%	2.5%	2.3%	2.1%	2.0%
Seedling/Sapling, Even-aged, Open and Closed[2]	1.4%	0.0%	11.9%	11.9%	12.4%	12.0%
Small Trees, Open, Even-aged[3]	1.4%	19.3%	4.7%	4.7%	5.4%	5.5%
Very Large and Medium Trees, Open, Even-aged[4]	88.0% more than half multistoried	6.4%	10.4%	10.4%	8.7%	9.0%
Very Large and Medium Trees, Open, Uneven-aged[5]		4.2%	18.8%	18.8%	26.1%	25.9%
Small Trees, Closed, Even-aged[6]	1.4%	0.0%	17.3%	17.3%	13.8%	13.9%
Very Large and Medium Trees, Closed, Even-aged[7]	7.8%[10]	45.1%	8.6%	8.9%	9.0%	9.2%

Ponderosa Pine VDDT Model State	Desired Distribution	Existing Distribution	Alt. A		Alts. B, C, D	
			15 Year	50 Year	15 Year	50 Year
Very Large Trees and Medium Trees, Closed, Uneven-aged[8]		24.2%	24.0%	24.1%	19.8%	19.7%
Total PNVT Departure[9]		79%	58%	58%	51%	51%

[1] Includes Grass, Forb, Brush/Shrub resulting from uncharacteristic fire (delayed recovery time (State N))

[2] In the VDDT modeling described in appendix C, this row represents states B and F

[3] In the VDDT modeling described in appendix C, this row represents state C

[4] In the VDDT modeling described in appendix C, this row represents states D and E.

[5] In the VDDT modeling described in appendix C, this row represents states J and K.

[6] In the VDDT modeling described in appendix C, this row represents states G

[7] In the VDDT modeling described in appendix C, this row represents states H and I.

[8] In the VDDT modeling described in appendix C, this row represents states L and M.

[9] Departure from reference conditions = high (over 66 percent), moderate (34 to 66 percent), and low (0 to 33 percent).

[10] Desired distribution does not include Mexican spotted owl protected activity centers, which would be managed under the Mexican spotted owl recovery plan.

Alternative A

Table 15 and table 16 are based upon the objective of silviculturally treating 10,000 acres (includes Mixed Conifer with Frequent Fire because grouped together under MA 3) and prescribed burning 15,000 acres annually. Overall departure from desired conditions within this PNVT is decreased after 15 years, moving from high to moderate, but still remaining on the high side of moderate. The level of departure continues to improve, dropping further into the moderate range after 50 years. The huge disparity between closed and open canopy conditions has been reduced to almost equal after 50 years, and the amount of area with uneven-aged structure starts to occupy a majority within medium and very large trees. Alternative A would put this PNVT on a trend toward desired conditions by improving stand structure, opening up the canopy, and reducing the overall departure, but the amount of mechanically acres treated (10,000) is not enough to attain low departure over the time period modeled. This PNVT is currently highly departed, but would become moderately departed under this Alternative after both 15 and 50 years. The trend is currently away from desired conditions, but would begin to move towards desired conditions after 15 years and remain on that positive trend over 50 years. Understory vegetation diversity and distribution are expected to increase, but primarily where open stand conditions are created.

Table 15. Alternative A departure in suitable and unsuitable timberlands over time in Ponderosa Pine PNVT

Alternative A Suitability	Initial Departure	Post Treatment Departure[1]	
		15 Yr	50Yr
Suitable Timber	84%	52%	51%
Unsuitable Timber	75%	67%	67%
Combined	80%	59%	59%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Approximately 1/3 of the PNVT occurs within non-suitable timberlands which are less likely to be included with mechanical treatments unless there is pressing ecological need or larger areas of suitable timberlands are included to increase economic feasibility. Appendix F compares suitable and non-suitable modeled outputs in more detail. The greatest movement toward desired conditions and reduction of departure is achieved through treatments on suitable timberlands. Mechanically treating 10,000 acres per year equates to almost a 50-year return interval. This is approximately twice the amount of time typically prescribed, using silvicultural techniques, to move toward desired uneven-aged conditions. The result of a 50-year return interval created by mechanically treating only 10,000 acres is relatively slow movement toward desired conditions and slower rate of reduction in the level of departure.

Table 16. VDDT modeled output for Ponderosa Pine Forest PNVT (suitable and non-suitable timberlands combined)

State	Description	Desired %[1]	Current %	Year 15 %	Year 50 %
A	A – Grass, Forb, Brush/Shrub	0.0			
N	N – Grass, Forb, Brush/Shrub		0.5	1.8	1.8
	Resulting from Uncharacteristic		0.5	2.5	2.3
	Fire (delayed recovery time)				
Sub-total (A&N):			1.0	4.3	4.1
B	B – Seedling, Sapling, Open, SS_2	1.4	0.0	2.3	2.3
F	F – Seedling, Sapling, Closed, SS		0.0	9.6	9.6
Sub-total (B&F):			0.0	11.9	11.9
C	Small Trees, Open, SS	1.4	19.8	4.7	4.7
D	D – Medium Trees, Open, SS	88.0	5.81.0	2.1	2.1

State	Description	Desired %[1]	Current %	Year 15 %	Year 50 %
E	E – Very Large Trees, Open, SS	Primarily in J&K	3.4	8.3	8.3
J	J – Medium Trees, Open, MS[3]		1.0	6.9	6.6
K	K – Very Large Trees, Open, MS			11.9	12.2
Sub-total (D,E,J,K):			11.2	29.2	29.2
G	G - Small Trees, Closed, SS	1.4	0.0	17.3	17.3
H	H – Medium Trees, Closed, SS	7.8	39.3	5.2	5.4
L	L – Medium Trees, Closed, MS		21.2	16.2	16.2
I	I – Very Large Trees, Closed, SS		5.1	3.4	3.5
M	M –Very Large Trees, Closed, MS		2.5	7.8	7.9
Sub-total (H,L,I,M):			68.1	52.7	37.0
Level of Departure[4]:		0%	80%	59%	59%

[1] Desired % comes from PNVT Crosswalk spreadsheet using 40% PIPO-Gambel Oak and 60% PIPO Bunchgrass.

[2] SS = Single story (Even-aged).

[3] MS = Multiple Story (Uneven-aged).

[4] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Grass, Forb, Brush/Shrub (States A and N) are projected to increase, thereby moving away from the desired condition after the first 15 years, and then moving back towards after 50 years. The combination of these states represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. It is important to note that the percentage of desired regeneration openings is built into the various multistoried (uneven-aged) states and is not reflected in States A and N. Thus, the additional openings predicted in State N are not only larger than desired but in addition to the desired amount of openings already factored into the multistoried states. The continued increase in the grass, forb, and brush/shrub states is attributed to larger than desired openings being created, primarily as a result of wildfires and the resulting longer time period required to naturally move back into a forested state.

Seedlings and Saplings growing in open canopy conditions (States B and F) are projected to increase, meeting and then exceeding the desired condition of area occupied after 15 years. The trend is predicted to continue over the next 50 years. This increase in seedlings and saplings (primarily closed canopy) is attributed to the amount of acres being treated not keeping up with tree growth. Due to competitive interaction, seedlings and saplings start to stagnate and move mostly from State B (open) to State F (closed), unable to progress into larger tree stages.

Small, open canopy trees (State C) are projected to make substantial movement toward the desired condition after 15 years, decreasing from 20% to 5%. This trend would remain static, still not reaching the desired condition after 50 years. Some movement of small trees into this age/size

class would continue to occur as closed canopies are thinned, but slow growth rates and increasing closed conditions, combined with too few annual acres treated, diminish the positive trend over time. Understory vegetation composition and distribution should increase at a comparative rate as the amount of area occupied by open canopy conditions increases.

Medium and very large trees growing in open canopy conditions (States D, E, J, and K), which make up the vast majority of the desired distribution, are projected to increase toward the desired condition after 15 years, and continue on a positive trend over 50 years, but still remain well short of the desired area occupied by medium and very large trees growing under open conditions. Closed canopy conditions would still dominate and contribute to reduced growth rates of trees, and overall maintenance of even-aged structure and less than desired understory species abundance and diversity. Treatments do not occur at a large enough level to increase the area occupied by trees in this state by a large amount. However the percentage of area occupied by multistoried (uneven-aged) stands within these states is placed on a positive trajectory, increasing from 4% to 19% after 50 years. The most noticeable responses from understory vegetation are expected to occur within these states as canopy densities are reduced and openings are created, allowing for plant reestablishment.

Small, closed canopy trees (State G) are projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. After 50 years, the trend remains static. Canopy closure continues to increase, slowing tree growth and movement into the next size classes. The amount of acres treated is insufficient to create open canopies and reverse the trend. Existing understory vegetation in this state is likely to decline as the trend away from the desired condition is projected to persist over the next 50 years.

Medium and very large trees growing in closed canopy conditions (States H, L, I, and M) trend toward desired conditions after 15 years as more medium and large sized, closed canopy stands are moved into open canopy states and uneven-aged structure. After 50 years, the trend remains static, but the level of departure is still well away from desired conditions. While substantial progression toward the desired condition is projected, understory vegetation response is expected to remain static under the closed canopy conditions, with improvement primarily occurring where openings are created.

Under Alternative A, this PNVT occurs in 29 different management areas across the forest, with 56% covered by MA 3 – Ponderosa Pine and Mixed Conifer <40% Slope, and only about 6% in wilderness or slopes over 40%. Each Management Area provides different direction that is designed to address particular attributes or concerns that are prominent within each MA. This focus on management of geographic areas rather than on existing and desired conditions of PNVTs can be cumbersome, particularly when spread across dozens of MAs. While existing Forest Plan language does not necessarily prevent attainment of desired conditions in the ponderosa pine vegetation type, the somewhat narrow focus on commodity production, dwarf mistletoe eradication, and fire suppression may hinder the process.

Alternative A provides mostly general desired conditions in regard to the composition, structure and function of Ponderosa Pine compared to Alternatives B, C, and D. These other Alternatives describe desired conditions at multiple scales including a range of tree density (in terms of basal area), a range of the percentage of area in openings, size and number of trees per group, endemic levels of disturbances such as insects, disease, fire, and weather as part of the desired conditions while direction under Alternative A seeks to minimize most natural disturbances (i.e. - cuts are

designed to eliminate or reduce dwarf mistletoe infections to manageable levels). Standards and Guidelines for MSO habitat provide more specific direction including:

- Allow no timber harvest except for fuelwood and fire risk abatement in established protected activity centers (PAC). Harvest conifers less than 9 inches in diameter only within those protected activity centers treated to abate fire risk.
- In pine-oak forests, retain existing large oaks and promote growth of additional large oaks.
- Use light prescribed burns in non-selected protected activity centers on a case-by-case basis. Burning should avoid a 100 acre "no treatment" area around the activity center.
- Attempt to mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes, into management prescriptions.
- The minimum mixed conifer restricted (replacement threshold) area includes 10% at 150 basal area and should be managed to have nest/roost characteristics such as a minimum of twenty 18+ DBH trees/acre and at least 15 percent of the distribution in the following size classes: 12-18”, 18-24”, and 24”+ DBH.
- Remaining acres of restricted habitat may be managed to provide for a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.
- Emphasize uneven-aged management systems. However, both even-aged and uneven-aged systems may be used where appropriate to provide variation in existing stand structure and species diversity.

The specific direction listed above pertaining to protected and restricted habitat is associated with the Mexican spotted owl Recovery Plan (1995) which has since been revised (USDI Fish and Wildlife Service 2012). Direction for the remaining acres of restricted habitat (i.e. - pine-oak outside protected, restricted, and replacement threshold habitat) is to be managed to “retain existing large oaks and promote growth of additional large oaks” and “provide for a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species”. Beyond emphasizing large oak and uneven-aged management, the direction becomes vaguer. Because of this, past treatments prescribed under the existing Forest Plan may have been too conservative to maintain diversity. Treatments have tended to leave higher stocking densities that more closely resembled threshold habitat and actually discriminated against the promotion of additional large oaks. Additional direction for MSO restricted habitat states that except where otherwise noted, implement forest plan old-growth standards and guidelines to maintain and promote development of owl habitat.

Under the current Forest Plan, most forest types that are not classed as restricted habitat under MSO or management-limited by other specified requirements are managed for northern goshawks which provides guidance for structural diversity. Forest plan direction for the northern goshawk states: Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer and Spruce Fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape. Additional management direction for ponderosa pine outside of Post fledging Family Areas (PFA) states that Canopy Cover for mid-aged forest (VSS 4) should average 40+%, mature forest (VSS 5) should average 40+%, and old forest (VSS 6) should average 40+%. Opening size is up to 4 acres with a

maximum width of up to 200 feet. One group of reserve trees, 3-5 trees per group, will be left if the opening is greater than an acre in size. Leave at least 2 snags per acre, 3 downed logs per acre, and 5-7 tons of woody debris per acre. In order to achieve desired conditions of up to 4 acre sized openings, the required maintenance of one group of 3-5 leave trees where openings exceed one acre may actually work against that desired condition by maintaining a seed source that would serve to accelerate the restocking of desired openings.

More specific guidance provides for satisfactory stocking ranges from 120 to 325 trees per acre depending on site class and management objectives. The Ecological Restoration Institute compiled data summaries in a Fact Sheet (2011) following an intensive literature review of historical structural characteristics in forests across the southern Colorado Plateau, using information derived from either early historical inventories or forest reconstruction studies conducted between 1909 and 1952. These data indicate that the historic range of variation for ponderosa pine forests on basalt soils on the Coconino National Forest can be described as averaging between 15-43 trees per acre, and that presettlement mixed conifer forests on basalt soils had an average range between 21-65 trees per acre on sites on the Coconino National Forest. Variable densities occurred across the Colorado Plateau depending on forest type, location, soil parent material, and elevation. This fact sheet provides only overstory structural reference conditions using 4, 6, or 9” minimum tree DBH depending on the inventory, but even when smaller diameter trees are factored in, the low end of the satisfactory stocking range provided in the existing Plan may be higher than desired.

The current forest plan guides that management will generally use uneven-aged systems (goshawk guidelines) but when stands are managed under even-aged systems, the shelterwood method is the preferred method using the standard ponderosa pine mixed conifer silvicultural prescription, cutting pine to approximately 30 growing stock level (GSL) and mixed conifer to approximately 60 GSL using one to four commercial (intermediate) cuts and making a cut when the available average cut volume/acre is at least 160 cubic feet/acre for the sale area. Although economic feasibility must be considered for all proposed treatments, this guidance seems to emphasize commodity production over habitat improvement.

Additional direction for basal area (BA) and GSL density is provided for wildlife hiding and thermal cover required on 30% of each 10 K block, but it is designed for even-aged ponderosa pine and mixed conifer. The BA/GSL The presence of non-commercial species, such as Gambel oak, New Mexico locust, juniper, aspen, and bigtooth maple, or topographic features such as drainages or other terrain breaks, rocky outcrops, or large surface boulders, will normally result in less BA/GSL of commercial species to meet cover requirements. The Forest Plan definition of GSL is: The stand density level, usually expressed as a number of trees per acre or basal area per acre in square feet, using trees 10” + DBH to calculate BA, needed to maintain optimum tree growth through the life of a stand. It is often difficult to determine whether GSL refers to basal area or trees per acre, particularly in smaller size classes. This guidance is another example of where perhaps a lack of clarity has led to conservative treatments that may not have led to achievement of overall desired conditions.

Departure from reference conditions is predicted to drop from high to moderate over the short term (15 years), and is predicted to level off and begin to exhibit a static trend over the long term (50 years).

Based on the projected distribution of states following treatment, the following shows the estimated number of snags by size class after 15 and 50 years.

Table 17. Predicted snag density by size class in Ponderosa Pine under alternative A

	8-12 " d.b.h.	12-18" d.b.h.	18"+ d.b.h.
Existing	2.8	1.2	1.3
15 years	3.1	1.8	1.4
50 years	2.8	1.6	1.4

Alternative B

This PNVT occurs in 12 different proposed Management Areas (MA) under Alternative B, with 77% within the following three; Ponderosa Pine Belt (49%), Long Valley (22%), and Anderson Mesa (7%). These MAs do not list any additional management direction for vegetation beyond that listed for all vegetation types above. Alternative B is somewhat less restrictive than Alternative A in terms of vegetation management within this PNVT than the 1987 Plan, but mostly in terms of a larger acres treated objective. The proposed treatment of additional acres provides for closer achievement of desired conditions than Alternative A, primarily in more area converted from even to uneven-aged structure, and additional dense, closed canopy converted to open canopy conditions. These conditions would allow for increased growth and vigor, and make stands more resilient to uncharacteristic disturbances.

Alternative B includes mechanical and prescribed fire objectives for the Ponderosa Pine PNVT that are different or were not included in Alternative A:

- Thin (group selection or free thinning) 5,000 to 26,050 acres/year
- Max acres (26,050) = 23,806 acres treated in suitable & 2,244 acres in unsuitable
- Use naturally ignited fires (lightning-caused) to treat 13,500 acres/year with low severity fire
- Use prescribed fire to underburn 15,000 to 30,000 acres/year (low severity)

Alternative B Guidelines for Ponderosa Pine include:

- To retain structural diversity, existing old-growth forest should be protected from uncharacteristic disturbances. Methods of protecting existing old-growth may include thinning and use of wildland fire (including planned and unplanned ignitions) in adjacent areas, especially those areas that are situated upwind or are topographically lower.
- To promote structural diversity, the development of old-growth conditions should be encouraged in areas where old-growth is lacking. Vegetation treatments should be designed such that replacement structural stages and age classes are proportionally present to assure continuous representation of old growth characteristics across the landscape over time.
- To provide necessary habitat component, snags and downed logs should be emphasized along edges of openings and within groups/clumps to provide habitat and roost sites for wildlife species, such as small mammals, cavity nesting birds, and tree-dwelling bats.

- Management activities that result in accumulations of green slash should be timed to minimize potential impacts from the *Ips* beetle. Accumulating green slash before overwintering beetles emerge should be avoided, generally April-June.
- Existing large Gambel oak trees and snags should be retained and the development of additional large trees and snags enhanced.

To promote future old-growth forest, the development of old-growth conditions should be encouraged in areas where old-growth is lacking. Vegetation treatments should be designed such that replacement structural stages and age classes are proportionally present to assure continuous representation of old growth characteristics across the landscape over time.

Every effort should be made to retain old trees to promote a balanced, uneven-aged forest condition that maintains or contributes to the restoration of pre-settlement old growth conditions characteristic of the forest type. This should be achieved by retaining pre-settlement trees, often the largest and tallest trees on site. In rare circumstances, however, trees may be removed to minimize negative resource impacts from management activities relative to other options (e.g., removal of an old tree to widen an existing road may have less environmental impact than building a new road elsewhere). Hazard trees11 may also be removed regardless of age and size per agency protocols to prevent personal injury and property damage. For ponderosa pine, pre-settlement trees may be determined by the following characteristics described by Thomson (1940) as age class 3 (intermediate to mature) and age class 4 (mature to over-mature):

- **Age** – approximately 150 years and older.
- **Bark** – ranging from reddish brown, shading to black in the top with moderately large plates between the fissures to reddish brown to yellow, with very wide, long and smooth plates.
- **Branching** – ranging from upturned in upper third of the crown, horizontal in the middle third and drooping in the lower third of the crown to mostly large, drooping, gnarled or crooked. Branch whorls range from incomplete and indistinct except at the top to completely indistinct and incomplete.

The following tables are based on mechanically treating between 5,000 and 26,050 acres annually. This range was calculated based upon the average number of acres mechanically treated on the forest over the past decade, and the estimated annual amount of acres that could be treated under the Four Forest Restoration Initiative (4FRI). As with Alternative A, Ponderosa Pine and, Mixed Conifer with Frequent Fire were modeled in three different ways; 1) the entire PNVT combining both suitable and non-suitable lands; 2) suitable lands alone, and; 3) non-suitable lands alone to provide additional insight into how the two levels of management combine to move toward desired conditions across the landscape. The majority of lands trending toward desired conditions come from suitable timberlands that are managed for timber production. More detailed descriptions of the effects from Alternative B in suitable and non-suitable timberlands can be found in Appendix E. Timber management may occur on non-suitable lands, but is driven by

[11] A tree hazard refers to any potential tree failure due to a structural defect that may result in property damage or personal injury. USDA Forest Service. 1981. Tree Hazards: Recognition and Reduction in Recreation Sites. Forest Pest Management. Denver, CO. Accessed online at: http://na.fs.fed.us/spfo/pubs/hazardtrees/treehazards/thazards.pdf

other resource objectives, such as wildlife habitat. The only unsuitable lands modeled for this report were Mexican spotted owl protected activity centers (PAC), which were thinned from below up to 9" DBH to reduce wildfire risk. In addition, Piñon-Juniper with Grass PNVT was modeled because it is the most departed of the three Piñon-Juniper types on the Forest and presents the greatest opportunity for management.

Desired conditions within the Ponderosa Pine and Mixed Conifer with Frequent Fire types are represented by the combination of States D, E, J, and K, with the majority being in States J and K. The important distinction is that States J and K are both multi-storied (uneven-aged) and have at least three age classes represented, including adequate openings for planned regeneration immediately after treatment. Although a state is described as "medium" or "very large" trees, it is inferred that trees of other sizes/ages are included. For example, State J is dominated by 10-20 inch DBH trees, but would also include a more or less balanced representation of seedlings/saplings, small trees, and some very large trees as well because it represents a multi-storied, uneven-aged state. Similarly, State I contains primarily very large trees and is described as single-storied (even-aged), but may also contain up to one other distinct size/age class and scattered single trees of different sizes.

Movement toward desired conditions is a function of acres treated. The more acres treated the greater movement toward desired conditions (Table 18). Detailed results by state from the low range of treatment (5,000 acres) are not displayed here. When the upper end of the acre range

is treated (26,050), the overall departure from desired conditions is decreased more than Alternative A after 15 years, moving from high to moderate. When the low end of the range is treated, the level of departure remains high and Alternative A moves closer to desired conditions. If only 5,000 acres are treated, it takes more than 15 years to move from high to moderate departure. Alternative B is only an improvement over Alternative A when the maximum number of acres is treated. However, the amount of mechanically treated acres (26,050) is still not enough to achieve low departure over the time period modeled. After a significant initial gain, the rate of change levels off dramatically between 15 and 50 years.

Table 18. Effects of different mechanical treated acre objectives on the level of departure (suitable versus unsuitable)

Suitability	Initial Departure	5,000 Acres		10,000 Acres		26,050 Acres	
		Post treatment Departure Levels					
		15 Yr	50 Yr	15 Yr	50 Yr	15 Yr	50 Yr
Alternative A – Suitable Timber	83%			58%	50%		
Alternative A – Unsuitable Timber	74%			72%	68%		
Alternative A – Combined	79%			64%	57%		

Suitability	Initial Departure	5,000 Acres		10,000 Acres		26,050 Acres	
		Post treatment Departure Levels					
		15 Yr	50 Yr	15 Yr	50 Yr	15 Yr	50 Yr
Alternatives B, C, & D – Suitable Timber	83%	66%	56%			43%	39%
Alternatives B, C, & D – Unsuitable Timber	74%	72%	68%			71%	67%
Alternatives B, C, & D – Combined	79%	68%	61%			54%	50%

Understory vegetation diversity and distribution are expected to increase with the amount of acres treated, but primarily where open stand conditions are created. When the maximum acres are treated, open canopy conditions in medium and very large trees has been reduced to almost equal after 50 years, and the amount of area with uneven-aged structure starts to occupy a majority within medium and very large trees.

Approximately 1/3 of the PNVT occurs within non-suitable timberlands which are less likely to be included with mechanical treatments unless large areas of suitable timberlands are also included. Alternative B contains the same amount of suitable timber acres as Alternative A, but more acres would be treated under Alternative B, which reduces the level of departure for unsuitable timberlands down to the moderate range. The largest impact is seen in suitable timberlands where the level of departure is almost decreased to “low” after 50 years, a 17% reduction over suitable timberlands in Alternative A. Impressive positive trends toward desired conditions are seen in States D, E, J and K, which are dominated by medium and very large trees with open canopies and multi-storied (uneven-aged) structure. In addition, closed canopy states for medium and very large trees (H, L, I, M) are also set on a positive trend, with most moving to states J and K or D and E. Non-suitable timberlands also experience positive trends in these states, but not as pronounced due to reduced timber management options as a result of differing management objectives. Appendix G compares suitable and non-suitable modeled outputs in more detail.

Mechanically treating 26,050 acres per year equates to a 20-year return interval. This is approximately the amount of time typically prescribed, using silvicultural techniques, to move toward desired uneven-aged conditions. The result of a 20-year return interval created by mechanically treating 26,000 acres is moderate movement toward desired (reference) conditions and increased rate of reduction in the level of departure compared to Alternative A.

Table 19. VDDT modeled output for Ponderosa Pine Forest PNVT (suitable and non-suitable timberlands combined) for alternative B

State	Description	Desired %[1]	Current %	Year 15 %	Year 50 %
A N	A – Grass, Forb, Brush/Shrub N – Grass, Forb, Brush/Shrub Resulting from Uncharacteristic Fire (delayed recovery time).	0.0	0.4 0.4	1.0 1.4	1.7 2.0
Sub-total (A&N):			0.8	2.4	3.7
B F	B – Seedling, Sapling, Open, SS[2] F – Seedling, Sapling, Closed, SS	1.4	0.0 0.0	2.0 5.6	2.9 9.2
Sub-total (B&F):			0.0	7.6	12.1
C	Small Trees, Open, SS	1. 4	19.3	5.3	4.8
D E J K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS[3] K – Very Large Trees, Open, MS	88. 0 Primarily J & K	5.4 1.0 3.2 1.0	4.6 3.2 13.1 11.7	3.0 7.1 9.2 17.0
Sub-total (D,E,J,K):			10.6	32.6	36.3
G	G - Small Trees, Closed, SS	1. 4	0.0	9.9	13.2
H L I M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	7.8	39.9 21.6 5.2 2.6	16.9 17.4 4.4 3.7	6.9 14.5 2.8 5.8
Sub-total (H,L,I,M):			69.3	42.4	30.0
Level of Departure[4]:		0%	79%	54%	49%

1 Desired % comes from PNVT Crosswalk spreadsheet using 40% PIPO-Gambel Oak and 60% PIPO Bunchgrass.

2 SS = Single story (Even-aged).

3 MS = Multiple Story (Uneven-aged).

4 Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Grasses, forbs, brush/shrub (States A and N) are projected to move away from the desired condition after the first 15 years and continue to move away after 50 years. This state represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. It is also important to note that the percentage of desired regeneration openings is built into the multistoried (uneven-aged) states and is not reflected in these states. The continued increase in the grass, forb, and brush/shrub state is attributed to larger than desired openings being created, primarily as a result of wildfires and the resulting longer time period required to move back into a forested state. After 50 years, Alternative B (high range) has a slightly lower percentage of State N than Alternative A because the more acres treated translates into less uncharacteristic fires. There is little difference between suitable and non-suitable timberlands except that the non-suitable timberlands start out more highly departed.

Seedlings and saplings with open canopy (States B) and closed canopy conditions (State F) are projected to meet and then exceed the desired condition after 15 years. The trend is predicted to continue over the next 50 years. This increase in seedlings and saplings (primarily closed canopy) is attributed to the amount of acres being treated not keeping up with tree growth. Despite treating more than two and a half times as many acres as with Alternative A, less than 1% more area ends up in the seedling and sapling states. Slightly less area is projected to be in closed canopy conditions after 50 years than Alternative A. Due to competitive interaction, seedlings and saplings start to stagnate and move mostly from State B to F or progress primarily into the closed small tree stage (State G). Alternative B remains higher than desired (reference) conditions for seedlings and saplings, but is a slight improvement over Alternative A.

Small trees with open canopy conditions (State C) are projected to make substantial movement toward the desired condition after 15 years, reducing from 19% to about 5%. This trend is projected to continue, but at a much slower rate, still not reaching the desired condition after 50 years. Increased movement of small trees into this state would continue to occur as closed canopies are thinned either mechanically or with fire. In fact, State C increases slightly over Alternative A (i.e. – slower movement toward the desired condition for this state) as a result of more thinning in the small, closed canopy trees (State G).

States D, E, J, and K, which make up the vast majority of the desired distribution, are projected to increase toward the desired condition after 15 years, and continue on a positive trend over 50 years, but still remain well short of the desired area occupied by medium and very large trees growing under open conditions. Closed canopy conditions would still dominate this PNVT over the landscape and contribute to reduced growth rates of trees, and overall maintenance of even-aged structure. However, there is more movement toward the desired conditions represented by this combination of states in the first 15 years with Alternative B than in 50 years with Alternative A. Treatments still do not occur at a large enough level to increase the area occupied by trees in these states by the desired amount over the long term.

Small trees with closed canopy (State G) are projected to increase, reaching and then exceeding the desired condition after 15 years. As with Alternative A, this is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. After 50 years, the trend continues and moves farther away. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to create open canopies that allow for more rapid and desired growth into larger tree stages and reverse the trend. However, because of more acres being treated under Alternative B, there is less area occupied after both 15 and 50 years.

States H, L, I, and M, which are indicative of mature closed forest habitat and occasional even-aged dynamics that may represent Northern goshawk nesting habitat trends toward desired conditions after 15 years at a faster rate than Alternative A, as more medium and large sized, closed canopy stands are moved into open canopy states and uneven-aged structure. After 50 years the trend continues, falling from almost 70% down to 30% of area occupied, but the level of departure is still well away from desired conditions. Once again, more acres treated moves closer to desired conditions, but not enough to achieve a low departure level.

Overall departure from desired conditions within this PNVT is decreased after 15 years, moving from high to moderate and dropping an additional 10% beyond that predicted for Alternative A. The level of departure continues to improve, dropping further into the moderate range after 50 years. The huge disparity between closed and open canopy conditions has become balanced after 50 years, and the amount of area with uneven-aged structure starts to occupy a large majority within medium and very large trees. Alternative B would put this PNVT on a trend toward desired conditions by improving stand structure, opening up the canopy, and reducing the overall departure.

This PNVT is currently highly departed, but would become moderately departed under this Alternative after 15 and remain moderate after 50 years. The trend is currently away from desired conditions, but would begin to move back towards after 15 years and remain on that positive trend over 50 years, but the amount of acres treated is still not enough to attain low departure over the time periods modeled.

Based on the projected distribution of states following treatment, the following shows the estimated number of snags by size class after 15 and 50 years.

Table 20. Predicted snag density by size class in Ponderosa Pine under alternative B

	8-12 " d.b.h.	12-18" d.b.h.	18"+ d.b.h.
Existing	2.8	1.2	1.3
15 years	2.9	1.7	1.4
50 years	2.7	1.5	1.4

Understory vegetation is expected to respond favorably to treatment under Alternative B. The amount of open canopy in the PNVT moves from 30% to approximately 44% after 50 years, which will favor increased grass, forb, and shrub production. The Ponderosa Pine PNVT becomes more structurally diverse, moving from less than 1/3 uneven-aged to more than 40% after 50 years.

Alternatives B, C, and D

Plan objectives for prescribed burning in Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs would move fire return intervals towards desired conditions at a faster rate than in Alternative A. This is a net improvement in ecosystem processes and functions relating to fire as a natural disturbance such as understory productivity, nutrient cycling, and maintenance of open conditions. In the short term, maintenance of open conditions would slow encroachment of trees.

In the long run, fire intervals that are closer to desired conditions would also promote age diversity and subdominant species such as aspen and Gambel oak.

Alternative C

Approximately 4,225 acres of ponderosa pine are proposed for wilderness under this Alternative, most of which is already non-suitable timberlands. Alternative C is somewhat more restrictive than Alternative B in terms of vegetation management within this PNVT because of the reduced acres available for mechanical treatment. Approximately 668 acres would be removed from the suitable timber base (0.1%), but this withdrawal is not considered large enough to affect overall management or modeling results. The proposed treatment of fewer acres still provides for equal achievement of desired conditions as Alternative B. Modeling results from Alternative B were assumed to apply to this Alternative. These conditions would allow for increased growth and vigor, and make stands more resilient to uncharacteristic disturbances.

Movement toward desired conditions is a function of acres treated. The more acres treated the greater movement toward desired conditions (Table 21). Detailed results by state from the low range of treatment (5,000 acres) are not displayed here, but effects to departure levels are shown below. When the upper end of the acre range is treated (26,050), the overall departure from desired conditions is decreased more than Alternative A after 15 years, moving from high to moderate. When the low end of the range is treated, the level of departure remains high and Alternative A moves closer to desired conditions. If only 5,000 acres are treated, it takes more than 15 years to move from high to moderate departure. Alternative C is only an improvement over Alternative A when the maximum number of acres is treated, and is the same as Alternative B.

Table 21. Effects of different mechanical treated acre objectives on the level of departure (suitable versus unsuitable)

Suitability	Initial Departure	5,000 Acres		10,000 Acres		26,050 Acres	
		Post treatment Departure Levels					
		15 Yr	50 Yr	15 Yr	50 Yr	15 Yr	50 Yr
Alternative A – Suitable Timber	83%			58%	50%		
Alternative A – Unsuitable Timber	74%			72%	68%		
Alternative A – Combined	79%			64%	57%		
Alternatives B, C, & D – Suitable Timber	83%	66%	56%			43%	39%
Alternatives B, C, & D – Unsuitable Timber	74%	72%	68%			71%	67%
Alternatives B, C, & D – Combined	79%	68%	61%			54%	50%

Understory vegetation diversity and distribution are expected to increase with the amount of acres treated, but primarily where open stand conditions are created. When the maximum acres are treated, open canopy conditions in medium and very large trees has been reduced to almost equal after 50 years, and the amount of area with uneven-aged structure starts to occupy a majority within medium and very large trees.

Alternative C contains the same amount of suitable timber acres as Alternative B. The largest impact is seen in suitable timberlands where the level of departure is almost decreased to “low” after 50 years, a 17% reduction over suitable timberlands in Alternative A. Impressive positive trends toward desired conditions are seen in States D, E, J and K, which are dominated by medium and very large trees with open canopies and multi-storied (uneven-aged) structure. In addition, closed canopy states for medium and very large trees (H, L, I, M) are also set on a positive trend, with most moving to states J and K or D and E. Non-suitable timberlands also experience positive trends in these states, but not as pronounced due to reduced timber management options as a result of differing management objectives.

The result of treating 26,050 acres is moderate movement toward desired (reference) conditions and increased rate of reduction in the level of departure compared to Alternative A. Alternative C has the same effect as Alternative B. The proposed treatment of additional acres provides for closer achievement of desired conditions than Alternative A, primarily in more area converted from even to uneven-aged structure, and additional dense, closed canopy converted to open

canopy conditions. These conditions would allow for increased growth and vigor, and make stands more resilient to uncharacteristic disturbances.

This PNVT would move from high to moderate departure after 15 years and remain moderate after 50 years. The trend is currently away from desired conditions, but would begin to move back towards after 15 years and remain on that positive trend over 50 years, but the amount of acres treated is still not enough to attain low departure over the time periods modeled.

Alternative D

Alternative D analyzed the same range of acres treated as Alternatives B and C. The differences between this Alternative and Alternative B would have no effect on the Ponderosa Pine PNVT therefore the consequences are similar. Since Alternatives B and D are very similar in terms of fire treatment, the resulting consequences on fire regimes and predicted trends for fire severity are similar.

Mixed Conifer with Frequent Fire

Alternative A

Table 22 is based upon the objective of silviculturally treating 287 acres (approximately 10% of the suitable acres in this PNVT) and prescribed burning 800 acres annually. The overall departure from desired conditions within the Mixed Conifer with Frequent Fire PNVT is decreased with Alternative A after 15 years, but still remains moderately departed under this Alternative. Reversing the trend at this time is critical because the current departure is listed at 64%, only percentage points from High. The positive trend remains static over 50 years, and the PNVT remains moderately departed. This Alternative moves toward desired conditions by reducing the overall departure, but the amount of acres treated is not enough to make a significant short term impact. Seedlings, saplings, and small trees would continue on a negative trajectory while movement of medium and larger sized trees would slowly progress toward desired conditions. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

The largest impact is seen in suitable timberlands, where a significant positive trend (41% reduction) toward desired conditions is seen in States H, L, I and M, which are dominated by medium and very large trees with closed canopies and multi-storied (uneven-aged) structure. This Alternative would move toward more open canopy and uneven-aged conditions. In addition, open canopy states for medium and very large trees are also set on a positive trend, projected to be increased by 12%, with most moving to states J and K. Non-suitable timberlands also experience positive trends in these states, but like ponderosa pine, are not as pronounced due to reduced timber management options as a result of differing management objectives.

Understory vegetation diversity and distribution are expected to increase, but primarily where open stand conditions are created. This Alternative would improve ecosystem function and resilience to disturbance in the Mixed Conifer with Frequent Fire PNVT by moving toward more open, uneven-aged conditions, but the amount of acres treated is not enough to reduce the level of departure below moderate.

Table 22. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable and non-suitable timberlands combined

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Grass, Forb, Brush/Shrub	9.0	0.2	0.5	0.4
B	B – Seedling, Sapling, Open, SS_1		0.0	0.2	0.2
F	F – Seedling, Sapling, Closed, SS		0.0	14.8	14.9
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.2	1.9	1.7
Sub-total (A,B,F,N):			0.4	17.4	17.2
C	C - Small Trees, Open, SS	3.0	1.0	0.4	0.4
D	D – Medium Trees, Open, SS	60.0	2.0	1.2	1.2
E	E – Very Large Trees, Open, SS		0.0	0.9	0.9
J	J – Medium Trees, Open, MS_2		4.5	4.2	4.2
K	K – Very Large Trees, Open, MS		0.5	17.5	17.4
Sub-total (D,E,J,K):			7.0	23.8	23.7
G	G - Small Trees, Closed, SS	3.0	9.9	8.9	9.3
H	H – Medium Trees, Closed, SS	25.0	21.5	7.6	7.5
L	L – Medium Trees, Closed, MS		49.6	20.8	20.8
I	I – Very Large Trees, Closed, SS		3.0	4.5	4.4
M	M –Very Large Trees, Closed, MS		7.5	16.7	16.3
Sub-total (H,L,I,M):			81.6	49.6	49.0
Level of $Departure_3$:		0%	64%	39%	39%

[1] SS = Single story (Even-aged).

[2] MS = Multiple Story (Uneven-aged).

[3] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Grass, Forb, Brush/Shrub/Seedlings/Saplings (States A, B, F, and N) are indicative of early stand development and of even-aged stand dynamics and the development of MSO Habitat. This grouping of states is projected to move toward and then exceed the desired area occupied after 15 years. The trend away from the desired condition is projected to slightly decline between year 15

and year 50. This is attributed to seedlings and saplings moving from open to closed canopy conditions delaying transition into the small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state. Although not as pronounced as the Ponderosa Pine PNVT, the additional openings predicted in these states are not only larger than desired but in excess of the desired amount of openings already factored into the multistoried states. State F (closed canopy seedlings and saplings) is predicted to contribute much more to the departure away from the desired condition than the other states within this group, exceeding the desired amount of area occupied within 15 years all on its own. This is partially attributed to the small amount of available acres that can be treated, since much of the PNVT is located on steep slopes, inaccessible terrain, or in areas with habitat management restrictions that reduce feasibility of treatment.

Small, open canopy trees (State C) are projected to trend away from desired conditions after 15 years as canopies close and increasing competition reduces growth. Small open trees are transitioning to the small closed canopy tree state and not being replaced rapidly enough by seedlings and saplings which are slow to advance because of slow growth due to competition. When transition of seedlings and saplings into the small trees states does occur, it is primarily under closed canopy conditions. The trend is projected to become static, but still departed, after 50 years. Understory vegetation composition and distribution should decrease comparatively with the amount of area occupied.

Medium and very large trees growing in open canopy conditions (States D, E, J, and K), which combine for the largest portion of desired conditions in this PNVT, are projected to be placed on a favorable trend after 15 years by more than tripling their occupied area. The trend is expected to remain static through year 50. This is attributed to treatments beginning to create more open canopy conditions and providing for greater movement of the small tree states upward, while creating more uneven-aged stand conditions. However, tree growth within these states begins to exceed the amount of acres treated as evidence by the slower movement toward the desired condition between year 15 and 50. Noticeable responses from understory vegetation are expected to occur within these states as canopy densities are reduced and openings are created. The trend toward desired conditions is primarily achieved by treatments in suitable timberlands (Appendix H).

Small, closed canopy trees (State G) initially moves toward the desired condition after 15 years, then starts to slightly trend away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. The trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees in this slower growing closed canopy state, and treated acres are unable to keep pace with growth. Understory vegetation may be initially stimulated during the first 15 years, but any gains that were realized during this period are likely to decline or remain static as the trend begins to move away from the desired condition again by year 50.

Medium and very large trees growing in closed canopy conditions (States H, L, I, and M), which represent conditions indicative of MSO habitat and occasional even-aged dynamics that occurred in the reference condition, particularly on north-facing slopes and canyons. This grouping of states combine for the second largest portion of desired conditions, and are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands. While substantial progression toward the desired condition is projected, understory

vegetation response is expected to remain static under the closed canopy conditions, with improvement primarily occurring where openings are created.

The overall trend for the Mixed Conifer with Frequent Fire PNVT under this Alternative reduces departure from reference conditions, but still remains moderately departed after 15 years. The trend becomes static and remains moderately departed after 50 years. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees, both closed and open canopy, would progress toward desired conditions, but canopy cover would remain predominantly closed across the landscape inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

This PNVT is overlapped by 12 current management areas, with 63% in MA 3, and approximately 14% in wilderness and slopes over 40%. A large portion of this PNVT occurs in non-suitable timberlands, primarily MSO PACs that restrict management opportunities to thinning trees up to 9” d.b.h. with timing restrictions. All mixed conifer is considered to be MSO restricted or protected habitat. Treatments within PACs have largely been avoided due to the high cost and low return from mechanical treatments. This PNVT is currently at the high end of moderate departure, and is expected to decrease toward desired conditions, but still remain moderately departed under Alternative A. The current trend is moving away, but treatments under this Alternative would move toward desired conditions after 15 years then stabilize and remain on a static trend over 50 years. Projected treatments make an initial impact, but the amount of acres treated is not sufficient to maintain a positive trend toward reference conditions over the long term.

Because this PNVT is lumped with Ponderosa Pine under MA3 and 4, Alternative A still provides only general desired conditions in regard to the composition, structure and function of Mixed Conifer with Frequent Fire outside of protected and restricted MSO habitat compared to Alternatives B, C, and D. Direction for mixed conifer, both with frequent fire and with aspen, is that it is to be delineated as protected or restricted MSO habitat. Direction relating to these delineations is described above in Ponderosa Pine PNVT section.

Other analyzed Alternatives describe regionally consistent desired conditions at multiple scales including percent of area in openings, size of tree groups, number of trees per group, endemic levels of disturbances such as insects, disease, fire, and weather as part of the desired conditions. Beyond the specific direction pertaining to protected and restricted habitat, additional guidance from Alternative A for the remaining acres of restricted habitat to be managed to “provide for a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species” is ambiguous. Because of this ambiguity, past treatments prescribed under the existing Forest Plan may not have been aggressive enough to provide for adequate diversity. Treatments tended to leave higher stocking densities that more closely resembled threshold habitat and favored late seral species.

Management direction for areas outside of PFAs guide that canopy cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 40+%, mature forest (VSS 5) should average 50+%, and old forest (VSS 6) should average 60+%. Maximum opening size is up to 4 acres with a maximum width of up to 200 feet. Retain one group of reserve trees per acre of 3-5 trees per group for openings greater than 1 acre in size. In order to achieve desired conditions of 10-50% openings, maintenance of one group of 3-5 leave trees when openings exceed one acre may work against that desired condition, particularly in lower productivity sites.

Additional direction for MSO restricted habitat states that except where otherwise noted, implement forest plan old-growth standards and guidelines to maintain and promote development of owl habitat. Because of this, acres of existing old growth mixed conifer should increase as developing old growth matures.

Based on the projected distribution of states following treatment, the following shows the estimated number of snags by size class after 15 and 50 years.

Table 23. Predicted snag density by size class in Mixed Conifer with Frequent Fire under alternative A

	8-12 " d.b.h.	12-18" d.b.h.	18"+ d.b.h.
Existing	8.0	4.5	3.3
15 years	9.1	5.1	6.8
50 years	8.8	4.6	6.4

In the existing Forest Plan a ponderosa pine/mixed conifer snag is defined as a tree greater than 12 inches DBH and 15 feet tall, and at a minimum are maintained at an average of 200 snags per 100 acres. Snag requirements for old growth mixed conifer are a minimum of 2.5 trees per acre that are 20 feet tall and 14" DBH (low site) or 25 feet tall and 16" DBH (high site). Under Alternative A, the numbers of snags are expected to remain static or increase.

Issues with achieving desired conditions within the Mixed Conifer with Frequent Fire PNVT are largely the same as with ponderosa pine. The existing forest plan is more product than ecosystem driven, and desired conditions are often too general, which may lead to more conservative approaches to treatment, particularly in this PNVT. The number of acres treated would not be sufficient to maintain a long term trend toward desired conditions. However, on-the-ground conditions are still expected to be slightly improved as a result of activities that implement the current plan direction in Alternative A.

Alternative B

The overall departure from reference conditions within the Mixed Conifer with Frequent Fire PNVT is decreased from moderate to low with Alternative B after 15 years. Reversing the trend at this time is critical because the current departure is estimated at 64%, only percentage points from High. The positive trend continues, although at a much slower pace over 50 years, as the PNVT remains at a low level of departure. This Alternative moves toward desired conditions by reducing the overall departure, but the amount of acres treated is not enough to make a significant short term impact. The long term trend would continue to move toward desired conditions but at a relatively slow pace. Seedlings, saplings, and small trees would continue on a negative trajectory while movement of medium and larger sized trees would slowly progress toward desired conditions. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

The largest impact is seen in suitable timberlands, where a significant positive trend (39% reduction) toward desired conditions is seen in States H, L, I and M, which are dominated by medium and very large trees with closed canopies and multi-storied (uneven-aged) structure. This

Alternative would move toward more open canopy and uneven-aged conditions. In addition, open canopy states for medium and very large trees are also set on a positive trend, with most moving to states J and K. Non-suitable timberlands also experience positive trends in these states, but like ponderosa pine, are not as pronounced due to reduced timber management options as a result of differing management objectives (Appendix I).

This Alternative would improve ecosystem function and resilience to disturbance in the Mixed Conifer with Frequent Fire PNVT by moving toward more open, uneven-aged conditions.

Alternative B includes mechanical and prescribed fire objectives for the Mixed Conifer with Frequent Fire PNVT that are different or were not included in the 1987 Forest Plan:

- Use prescribed fire to burn 800 acres (low severity only)
- Use naturally ignited fires (lightning-caused) to treat 750 acres/year with low severity fire

Guidelines for Mixed Conifer with Frequent Fire include:

- To retain structural diversity, existing and developing old-growth forest should be protected from uncharacteristic disturbances. Methods of protecting existing old-growth may include thinning and use of wildland fire (including planned and unplanned ignitions) in adjacent areas, especially those areas that are situated upwind or are topographically lower.
- To promote structural diversity, the development of old-growth conditions should be encouraged in areas where old-growth is lacking. Vegetation treatments should be designed such that replacement structural stages and age classes are proportionally present to assure continuous representation of old growth characteristics across the landscape over time.
- Primary caches (i.e., seed storage sites) for red squirrels should be protected from loss due to management activities so they have sufficient food to last through the winter.

This PNVT is overlapped by 7 proposed Management Areas, with 84% in Upper Clear Creek (44%) and Long Valley (40%). Treatments have largely been avoided due to the high cost and low return from mechanical treatments, but have included when it is been feasible. These MAs do not list any additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. Alternative B is somewhat less restrictive than Alternative A in terms of vegetation management within this PNVT than the 1987 Plan, but mostly in terms of a larger acres treated objective. The proposed treatment of additional acres provides for closer achievement of desired conditions than Alternative A, primarily in more area converted from closed canopy to open canopy conditions. These conditions would allow for increased growth and vigor, and make stands more resilient to uncharacteristic disturbances such as insects, disease, and drought. Understory vegetation is predicted to improve in both distribution and species diversity as canopy cover is reduced.

Table 24. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable and non-suitable timberlands combined for alternative B

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Grass, Forb, Brush/Shrub	9.0	0.2	0.4	0.5
B	B – Seedling, Sapling, Open, SS_1		0.0	0.3	0.5
F	F – Seedling, Sapling, Closed, SS		0.0	11.6	19.9
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.2	1. 2	1. 7
Sub-total (A,B,F,N):			0.4	13.5	22.6
C	C - Small Trees, Open, SS	3.0	1.0	0. 3	0. 5
D	D – Medium Trees, Open, SS	60.0	2.0	1.8	0.7
E	E – Very Large Trees, Open, SS		0.0	0. 8	1. 3
J	J – Medium Trees, Open, MS_2		4.4	9.9	4. 1
K	K – Very Large Trees, Open, MS		0.6	17.3	27. 1
Sub-total (D,E,J,K):			7.0	29.8	33.2
G	G - Small Trees, Closed, SS	3.0	9.7	7.2	9.3
H	H – Medium Trees, Closed, SS	25.0	21.6	9.5	3.5
L	L – Medium Trees, Closed, MS		49.8	24.7	11.9
I	I – Very Large Trees, Closed, SS		3.0	4.1	3.7
M	M –Very Large Trees, Closed, MS		7.6	10.8	15.3
Sub-total (H,L,I,M):			82.0	49. 1	34. 4
Level of Departure$_3$:		0%	64%	33%	29%

1 SS = Single story (Even-aged).

2 MS = Multiple Story (Uneven-aged).

3 Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

States A, B, F, and N move toward and exceed the desired area occupied after 15 years. The trend away from desired conditions is projected to continue through year 50 as seedlings and saplings with closed canopy (State F) increase. This is attributed to seedlings and saplings moving from

open to closed canopy conditions delaying transition into the small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state. Although Alternative B moves this PNVT down from near high to low departure, the growth and level of treatment in the seedlings and saplings is still not sufficient to reverse the trend in these states.

State C is projected to trend away from desired conditions after 15 years as canopies close and competition increases. Small open trees are transitioning to the small closed canopy tree state and not being replaced fast enough by open seedlings and saplings. When transition of seedlings and saplings into the small tree states does occur it is primarily as closed canopy. The trend is projected to become static or slightly toward desired conditions but still departed after 50 years.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired conditions, are projected to be placed on a very favorable trend after 15 years, with the area occupied by very large, open trees predicted to quadruple, and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands. This trend toward desired conditions is primarily achieved by treatments in suitable timberlands.

State G moves initially moves toward the desired condition after 15 years, then starts trending away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. The trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees and treated acres are unable to keep pace with growth of small trees.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired conditions, are projected to be placed on a very favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands.

Based on the projected distribution of states after treatment, the following shows the estimated number of snags by size class after 15 and 50 years.

Table 25. Predicted snag density by size class in Mixed Conifer with Frequent Fire under alternative B

	8-12 “ d.b.h.	12-18” d.b.h.	18”+ d.b.h.
Existing	8.0	4.5	3.3
15 years	8.9	5.2	7.1
50 years	8.6	4.9	7.0

The overall trend for the Mixed Conifer with Frequent Fire PNVT under Alternative B reduces the departure from moderate to low after 15 years. This is the only PNVT that actually moves into the low range of departure. Alternative B moves this PNVT closer to desired conditions than Alternative A. The positive trend continues over the long term, remaining within low departure, but becoming more static after 50 years. Seedlings, saplings, and small trees would continue on a

negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Alternatives B, C, and D

Plan objectives for prescribed burning in Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs would move fire return intervals towards desired conditions at a faster rate than in Alternative A. This is a net improvement in ecosystem processes and functions relating to fire as a natural disturbance such as understory productivity, nutrient cycling, and maintenance of open conditions. In the short term, maintenance of open conditions would slow encroachment of trees. In the long run, fire intervals that are closer to desired conditions would also promote age diversity and subdominant species such as aspen and Gambel oak.

Piñon-Juniper with Grass

Alternative A

All Piñon-Juniper MAs in the 1987 Plan emphasize prescribed fire using planned and unplanned ignitions to accomplish resource objectives, except no provision for unplanned ignitions in areas included in urban interface, which have a suppression objective of 10 acres.

Summary: Overall departure from reference conditions within this PNVT is decreased after 15 years, but begins to increase again after 50 years. The level of departure improves, approaching low after 15 years, and then the trend reverses but still remains in the moderate range after 50 years. The short term improvement initially realized begins to reverse and resume a negative trend over the long term. This Alternative moves toward desired conditions by moving all open canopied states closer to reference conditions, but seedlings, saplings and small tree trees in closed canopy conditions continue to trend away. Alternative A reduces the overall departure, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions over the long term.

The following table is based upon silviculturally treating 100 acres and managing naturally ignited fires (lightning) to prescribe burn 375 acres annually. This amount was determined based upon recent average historic levels of treatment in this vegetation type (10 years), which have been limited due to budgetary constraints and the low value and lack of a market for piñon pine and juniper products. The desired conditions are for approximately half of the trees in the Piñon-Juniper grassland type to be medium sized trees growing in open canopy conditions. This is due, in large part, to the slower growth rates of piñon pines and juniper and because trees greater than 20” diameter at root collar (DRC) are relatively rare across the landscape. However, it is desirable to have some very large trees as reflected by State E.

Understory vegetation will likely increase in both distribution and diversity in the medium-open tree state (State D) coinciding with the increase in area occupied. However, the projected increase in the closed canopy states would essentially serve to offset that gain. The grass, forb, brush/shrub state will continue to decline as seedlings and saplings reestablish and encroach into these openings. While initial movement toward desired conditions is achieved in the short term, over

time acres treated at this level would not be able keep up with canopy closure and seedling/sapling establishment.

Table 26. VDDT modeled output for Piñon-Juniper Grassland PNVT

State	Description[1]	Desired %	Current %	Year 15 %	Year 50 %
A	Grass, Forb, Brush/Shrub	5.0	23.0	12.9	3.6
B	B – Seedling, Sapling, Open	25.0	16.0	9.1	3.5
C	C – Small Trees, Open		26.0	10.7	4.8
E	E – Very Large Trees, Open		17.0	11.0	4.5
Sub-total (B,C,E):			59.0	30.8	12.8
D	D – Medium Trees, Open	50.0	2.0	12.7	19.7
F	F – Seedling, Sapling, Closed	10.0	13.0	29.0	24.5
G	G – Small Trees, Closed	10.0	3.0	14.7	39.4
Level of Departure[2]:		0%	55%	37%	43%

[1] The combination of States B,C&E are uneven-aged. All other states are single storied (even-aged).

[2] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Grass, forb, brush/shrub (State A) is projected to move toward the desired condition after the first 15 years and then drop below after 50 years. This continued decline in the grass, forb, and brush/shrub state is attributed to tree growth and establishment exceeding the amount of acres treated and maintained as openings.

Seedlings/saplings, small, and very large trees - open (States B, C, and E) are projected to approach the desired condition after 15 years and then drop below after 50 years. This decline is attributed to the amount of area moving from open to closed canopy states within these size classes, as evidenced by the sharp increase in States F and G. Growth declines as canopy cover and competition increases. Understory vegetation is expected to decrease in distribution and diversity as crown cover increases. Less sunlight will reach the forest floor, and availability of water and nutrients to understory plants will decline as tree cover increase. Treatments at this level, while realizing initial gains the first 15 years, are simply unable to maintain the desired open conditions.

Medium trees – open (State D), where the largest percentage of area is desired, is projected to make substantial movement toward the desired condition after 15 years. This trend would continue through year 50, but at a much slower rate. Some movement of small trees into this size

class would continue to occur, but slow growth rates and increasing closed conditions, combined with few annual acres treated, diminish the positive trend. Understory vegetation should experience a corresponding increase in both distribution and diversity.

Seedlings/saplings – closed (State F) is projected to increase, moving from slightly above the desired condition, to more than double the area currently occupied after 15 years. This negative trend is attributed to trees moving in from States B and C as canopies close. The trend begins to reverse back toward the desired condition after 50 years as trees grow into the next size class. Closed canopy conditions contribute to competition and slower growth rates of trees within this state, slowing movement into the next size class. Treatments do not occur at a level to reduce the area occupied by trees in this state by a significant amount. Understory vegetation is expected to decline as tree canopy closes limiting the amount resources available (sunlight, water, nutrients).

Small trees – closed (State G) is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. After 50 years, the trend accelerates and moves farther away from the desired condition. Canopy closure continues to increase, slowing tree growth and movement into the next size class. Understory vegetation would suffer as the amount of area with closed canopy increases, shading out those species. The amount of acres treated is insufficient to maintain area occupied at or near current levels or reverse the projected trend of continued expansion.

Overall departure from desired conditions within this PNVT is projected to decrease after 15 years, but begin to increase again after 50 years. The level of departure approaches low, but still remains in the moderate range after 50 years. The short term improvement realized initially begins to reverse and resume a negative trend over the long term. This Alternative moves toward desired conditions by reducing the overall departure, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions beyond much more than 15 years. This PNVT is currently moderately departed, and would approach low departure after 15 years. The positive trend would be short-lived and become static or trending away by year 50. Overall within this PNVT, understory species abundance and diversity is expected to decline or remain static over the short term (15 years) as areas with closed canopy increase at a greater rate than open canopy conditions. Over the long term (50 years), this trend is expected to continue to decline.

Piñon-juniper woodlands, a key Southwestern vegetation type, are clearly water-limited systems, and Piñon-juniper ecotones are sensitive to feedbacks from environmental fluctuations and existing canopy structure that may provide trees a buffer against drought. However, severe multi-year droughts periodically cause dieback of Piñon pines, which may overwhelm local buffering (USDA Forest Service 2010). The current dieback is historically unprecedented in its combination of fire suppression, low precipitation, and high temperatures. Increased drought stress via warmer climate is the predisposing factor, and Piñon pine mortality and fuel accumulations are inciting factors. Ecosystem change may arise from large-scale severe fires that lead to colonization of invasive species, which further compromises the ability of Piñon pines to re-establish (USDA 2010). Both localized and widespread mortality events have occurred over time in the Piñon-Juniper Woodlands on the Forest, typically being piñon *Ips* outbreaks associated with periods of drought, such as occurred in the mid-1990s and 2001-2003 (Lynch et al 2007). These outbreaks may actually serve to decrease tree densities that have encroached into the Piñon-Juniper with Grass; however, trees targeted by the beetle are likely to be larger piñon pines that are desired within this PNVT. Negron and Wilson (2003) found that high stand density levels

of piñon make stands more susceptible to piñon Ips infestations and that the proportion of killed trees increased with increasing size classes. Continued infestations could favor the seedling, sapling and small tree states, which would tend move this PNVT away from desired conditions.

Romme et al (2009) state with high confidence that tree density and canopy coverage have increased substantially during the past 150 years in many piñon and juniper woodlands but have not changed or have declined in others, with former grasslands and shrublands in some regions being converted to savanna or woodland as trees have expanded into previously non-wooded sites. This statement holds true within piñon-juniper savannahs and adjacent grasslands on the Coconino where tree encroachment has occurred as a result of fire regime disruption.

Current Plan direction (MA 7) limits mechanical treatment of Piñon-Juniper woodlands to slopes of 15% or less only, and generally only provides for old growth on slopes above 15%. The emphasis is primarily placed upon extraction of firewood and miscellaneous convertible forest products rather than restoration of desired, or reference, conditions. This management approach limits treatments on steeper slopes designed to adjust composition and structure, and improve ecosystem function and resilience to disturbance. The amount of old growth within this PNVT should remain static or improve under Alternative A, but mechanical treatments on slopes over 15% that could set stands on a faster trajectory toward old growth conditions would not occur.

This PNVT is overlapped by 20 current management areas under the existing Forest plan, with 54% in MA 7 – Piñon-Juniper Woodland, Less than 40% Slope, and approximately 12% in Transition Grassland and Sparse Piñon-Juniper above the Mogollon Rim (MA 10). Current Forest plan direction guidance provides for shelterwood, clear-cutting and uneven-aged silvicultural systems, and to manage for at least 30 percent cover in MA 7 – Piñon-Juniper Woodland, less than 40% slope. The silvicultural systems recommended provide enough flexibility to move towards desired conditions. However, the direction to manage for at least 30% cover in piñon-juniper grasslands would leave to much canopy cover across the landscape to return to the desired grassland state of this PNVT. Compared to Alternatives B, C, and D this PNVT would be managed more as a true woodland with a predominantly closed canopy that would restrict restoration of the grassland component.

Forest Inventory Analysis data for Piñon-Juniper grassland shows the following averages of snags/acre:

Table 27. Predicted snag density by size class in Piñon-Juniper with Grass PNVT under alternative A

	8-12 “ d.b.h.	12-18” d.b.h.	18”+ d.b.h.
Existing	5.0	3.8	1.8

In the existing Forest Plan, a Piñon-Juniper snag is defined as being at least 9” DRC and at least 10 feet high, and managed for at least an average of 1.0 snag per acre on 40 percent of the Piñon-juniper woodland acres in each 10K Block. Snag requirements for old growth Piñon-Juniper are a minimum of 0.5 trees per acre that are 8 feet tall and 9” DBH (low site) or an average of 1 snag/acre that is 10 feet tall and 10” DBH (high site). Under Alternative A, the numbers of snags are expected to remain static or increase.

Regionally consistent desired conditions, including that 1) trees occur as individuals, but occasionally in smaller groups, and range from young to old; 2) scattered shrubs and a dense

herbaceous understory including native grasses, forbs and annuals are present to support frequent surface fires; 3) the composition, structure, and function of vegetative conditions are resilient to the frequency, extent and severity of disturbances (e.g. insects, diseases, and fire) and climate variability; and fires are typically low-severity (Fire Regime I) would be very difficult, if not impossible to achieve under Alternative A.

On-the-ground conditions are expected to be maintained or slightly improved over the short term (15 years) as a result of activities that implement the current plan direction in Alternative A. While the long term (50 year) trend in departure is predicted to be an improvement over current conditions, it begins to move away from desired conditions because too few acres would be treated.

Alternative B

This PNVT is overlapped by 7 proposed Management Areas, with the majority in Anderson Mesa (50%) and Volcanic Woodlands (38%). These MAs do not list any additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above, except Volcanic Woodlands which directs coordination with the Flagstaff Area Monuments to provide for compatible management of scenic resources within the area that is geologically related to Sunset Crater. Treatments have largely been avoided due to the high costs, but some habitat improvement projects have taken place. Alternative B is somewhat less restrictive than Alternative A in terms of vegetation management within this PNVT and it has a larger (and stated) proposed treatment objective. This objective results in a lower level of departure than Alternative A.

Alternative B would provide specific guidance for managing this PNVT, including desired conditions, objectives, and guidelines. The larger proposed treatment objective under Alternative B would lead to greater progress toward desired conditions than Alternative A. Alternative B is somewhat less restrictive than Alternative A in terms of vegetation management by focusing more on the desired conditions rather than prescribing how to achieve them. Desired conditions for the PNVT state that: (1) trees occur as individuals, but occasionally in smaller groups and range from young to old; (2) scattered shrubs and a dense herbaceous understory including native grasses, forbs, and annuals are present to support frequent surface fires; (3) the composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g., insects, diseases, and fire) and climate variability; and fires are typically low severity (Fire Regime I). These desired conditions would provide the potential for improvement in condition class (a decrease in departure) for this PNVT.

Overall departure within this PNVT improves after 15 years, but begins to trend away from desired conditions after 50 years. This Alternative moves toward desired conditions by moving all sizes of trees growing in open canopied conditions closer to desired conditions, but seedlings, saplings and small tree trees in closed canopy conditions continue to trend away. Alternative B reduces the overall departure more than Alternative A, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions over the long term.

Under Alternative B, the numbers of snags are correspondingly expected to remain static or increase. Table 28 illustrates the estimated averages of snags per acre for Piñon-Juniper with Grass.

Table 28. Piñon-Juniper with Grass estimated average of snags per acre

	8” to 12” d.r.c.	12” to 18” d.r.c.	18”+ d.r.c.
Snags per acre	5.0	3.8	1.8

Table 29 is based upon mechanically treating 1,000 acres annually. This amount was determined based upon the upper end of average historic levels of treatment in this vegetation type, which have been limited due to budgetary constraints and the low value and lack of a market for piñon pine and juniper products. The desired conditions are for approximately half of the trees in the Piñon-Juniper grassland type to be medium sized trees growing in open canopy conditions. This is due, in large part, to the slower growth rates of piñon pines and juniper and because trees greater than 20” diameter at root collar (DRC) are relatively rare across the landscape. However, it is desirable to have some very large trees as reflected by State E.

Alternative B includes mechanical and prescribed fire objectives for the Piñon-Juniper Grassland PNVT that are different or were not included in the 1987 Forest Plan:

- Treat 375 acres/year with low to mixed severity naturally ignited wildfire.
- Mechanically treat 100-1,000 acres/year

Guidelines in the proposed revised plan for Piñon-Juniper Grassland include:

- On grassland soil types, previous vegetation treatments (pushes) of Piñon-Juniper grasslands, juniper grasslands, or Piñon-Juniper Evergreen Shrub should continue to be treated to maintain seral grasslands.
- Grassland soil inclusions (also called mollisol soils) with tree encroachment within the Piñon-Juniper types should be restored to grassland desired conditions because….need intent.
- On non-grassland soil types, pushes in Piñon-Juniper grasslands, juniper grasslands, or Piñon-Juniper Evergreen Shrub should trend toward desired condition for the particular woodland type.
- In areas where there is little understory and treatments are proposed, slash treatments (e.g., lop and scatter and mastication) should be used that improve herbaceous vegetation growth, soil and watershed condition, and soil productivity. The intent is to thin to encourage response by herbaceous vegetation and allow smaller debris to decompose in place on the ground.
- If available and needed to support restoration, seeding with native species appropriate for the ecological unit (or similar in elevation, soil type, and eco regions) should be used to promote natural species composition.
- Vegetation conditions within the wildland-urban interface may be composed of younger and more widely-spaced shrub patches and tree groups so fires can be suppressed more easily when needed.

Table 29. VDDT modeled output for Piñon-Juniper with Grass PNVT

State	Description[1]	Desired %	Current %	Year 15 %	Year 50 %
A	Grass, Forb, Brush/Shrub	5	23.0	13.6	3.8
B	B – Seedling, Sapling, Open		16.0	9.1	4.1
C	C – Small Trees, Open	25	26.0	11.0	4.6
E	E – Very Large Trees, Open		17.0	10.7	4.2
Sub-total (B,C,E):			59.0	30.8	12.9
D	D – Medium Trees, Open	50	2.0	13.8	24.7
F	F – Seedling, Sapling, Closed	10	13.0	27.3	23.0
G	G – Small Trees, Closed	10	3.0	14.7	35.8
Level of Departure[2]:		0%	55%	36%	38%

[1] The combination of States B,C&E are uneven-aged. All other states are single storied (even-aged).

[2] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

State A is projected to move toward the desired condition after the first 15 years and then drop below after 50 years. This continued decline in the grass, forb, and brush/shrub state is attributed to tree growth and establishment exceeding the amount of acres treated.

States B, C, and E are projected to approach the desired condition after 15 years and then drop below after 50 years. This decline is attributed to the amount of area moving from open to closed canopy conditions within these size classes. Growth declines as canopy cover and competition increases. Treatments at this level are unable to maintain the desired open conditions.

State D, where the largest percentage of area is desired, is projected to make substantial movement toward the desired condition after 15 years. This trend would continue through year 50, but at a much slower rate. Some movement of small trees into this size class would continue to occur, but slow growth rates and increasing closed conditions, combined with few annual acres treated, diminish the positive trend.

State F is projected to increase, moving from slightly above the desired condition, to more than double the area currently occupied after 15 years. This negative trend is attributed to trees moving in from State B as canopies close. The trend begins to reverse back toward the desired condition after 50 years as trees grow into the next size class. Closed canopy conditions contribute to slow growth rates of trees within this state, slowing movement into the next size class. Treatments do not occur at a level to reduce the area occupied by trees in this state by a significant amount.

State G is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. After 50 years, the trend accelerates and

moves farther away. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to reverse the trend.

Overall departure from desired conditions within this PNVT is decreased after 15 years, but begins to increase again after 50 years. The level of departure approaches low, but still remains in the moderate range after 50 years. The short term improvement realized initially begins to reverse and resume a negative trend over the long term. This Alternative moves toward desired conditions by reducing the overall departure, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions beyond much more than 15 years. This PNVT is currently moderately departed, and would approach low departure after 15 years. The positive trend would be short-lived and become static or trending away by year 50.

Alternative B would reduce the overall vegetative departure from desired conditions more than Alternative A, but the amount of acres treated would still not be enough to maintain or continue to move toward desired conditions over the long term. Similar to Alternative A, the lack of fire treatment in this frequent fire PNVT would still result in a trend away from desired conditions with respect to fire return intervals. However, this Alternative would provide for increased growth and vigor and make treated stands more resilient to uncharacteristic disturbances.

Recommended Wilderness

Recommended wilderness in Alternative B would have little effect to departure on Piñon-Juniper with Grass or risk of uncharacteristic fire at the PNVT level primarily due to the small extent of the PNVT in recommended wilderness. The effect would be localized. A total of 3,648 acres of Piñon-Juniper with Grass PNVT (1 percent of the PNVT) occurs within Strawberry Crater recommended wilderness. It is unlikely that wilderness recommendation would influence wildfire management strategies. Consequently, there would be a lower risk of uncharacteristic fire and uncharacteristic fire severity along with an increased likelihood of restoring the natural fire regime in these localized areas. In the area recommended for wilderness, vegetation treatments would be more expensive to carry out and possibly less likely to occur because of the need to mitigate the effects from the use of mechanized and motorized equipment post-treatment and limitations on expanding the footprint of motorized vehicle use. As a result, tree encroachment would likely continue. These areas would not able to carry fire because of lack of understory and naturally occurring cinder soils.

Alternative C

Plan components for Piñon-Juniper with Grass in Alternative C would result in the same general management and acres of treatment as Alternatives B because the difference in plan components would not impact this PNVT.

Recommended wilderness

Recommended wilderness in Alternative C would have little effect to departure on Piñon-Juniper with Grass or risk of uncharacteristic fire at the PNVT level primarily due to the small extent of the PNVT in recommended wilderness. The effect would be the same as Alternative B.

Overall departure from reference conditions within this PNVT is decreased after 15 years, but begins to slightly increase again after 50 years. The level of departure approaches low, but still remains in the moderate range after 50 years. The short term improvement initially realized begins to reverse and resume a static-negative trend over the long term. This Alternative moves toward desired conditions by moving all tree sizes growing in open canopied conditions closer to

reference conditions, but seedlings, saplings and small tree trees in closed canopy conditions continue to trend away. Alternative C reduces the overall departure more than Alternative A, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions over the long term.

Overall departure from desired conditions within this PNVT is decreased after 15 years, but begins to increase again after 50 years. The level of departure approaches low, but still remains in the moderate range after 50 years. The short term improvement realized initially begins to reverse and resume a negative trend over the long term. This Alternative moves toward desired conditions by reducing the overall departure, but the amount of acres treated is not enough to maintain or continue to move toward desired conditions beyond much more than 15 years. This PNVT is currently moderately departed, and would approach low departure after 15 years. The positive trend would be short-lived and become static or trending away by year 50.

This PNVT is overlapped by 7 proposed Management Areas, with 88% in Anderson Mesa (50%) and Volcanic Woodlands (38%). These MAs do not list any additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above, except Volcanic Woodlands which directs coordination with the Flagstaff Area Monuments to provide for compatible management of scenic resources within the area that is geologically related to Sunset Crater.

Alternative C is somewhat less restrictive than Alternative A in terms of vegetation management within this PNVT, but mostly in terms of a larger acres treated objective. The proposed treatment of additional acres provides for closer achievement of desired conditions than Alternative A, primarily in more area converted from closed canopy to open canopy conditions and conversion to more uneven-aged structure. These conditions would allow for increased growth and vigor, and make stands more resilient to uncharacteristic disturbances.

Alternative D

Plan components for Piñon-Juniper with Grass in Alternative D would result in the same general management and acres of treatment as Alternatives B and C because the difference in plan components would not impact this PNVT.

Other PNVTs

The other 15 Potential Natural Vegetation Types were described in the Affected Environment Section of this Report in terms of Departure from Conditions and Projected Future Trend Under Current Management. More detailed information can be found in the Ecological Sustainability Report (USDA Forest Service 2009) and Assessment of the Management Situation (USDA Forest Service 2010). The 1987 Forest Plan includes management direction arranged by Management Areas (MA) rather than by PNVT. Because of this, there may be a wide range in direction for any given PNVT depending on how many different MAs it overlaps. A full description of MAs can be found in the 1987 Forest Plan.

Most of the following PNVTs have received little, if any mechanical or prescribed fire treatments over the life of the current plan. Fire has primarily been managed with a suppression objective of 100-1,000 acres. Because many of these vegetation types have unknown trends, have received such little past management and cover such a wide range of MAs and Forest Plan direction, it is assumed that there would be little to no change over current management levels under Alternative A. However, where permitted, and based upon uncertain budgets and outside funding

opportunities, it can be assumed that any prescribed management activities would be designed to move them toward desired conditions.

Desert Communities

Alternative A

This PNVT is within 10 different MAs under the 1987 Plan, but 87% is included within MA 11 - Verde Valley. Prescribed fire using planned and unplanned ignitions is used to accomplish resource objectives except no provision for unplanned ignitions in areas included in urban interface. Suppression objective is to minimize cost and provide for personnel safety except suppression objective is 10 acres or less in areas mapped as the urban interface. In areas outside the urban interface, the suppression objective is to hold fires to 1,000 acres or less. Other than the suppression objectives, fire management direction does not hinder actions that would move toward desired conditions, and the suppression objectives can vary depending on conditions and resources at risk. However, there is no specific direction for other types of treatment and fire is not a key ecological process. The major constraint would likely continue to be a lack of funding to accomplish mechanical treatments in this PNVT. Beyond using planned and unplanned ignitions to accomplish resource objectives, the existing Forest Plan provides little to no direction on desired conditions for this PNVT.

According to mid-scale data, it is currently 100% late seral herb and shrubs types. Current condition mainly consists of closed canopy late seral herbaceous vegetation and shrubs. Open canopy late seral shrubs are lacking from the landscape according to LANDFIRE. Extent and continuity of the Desert Communities PNVT has decreased relative to reference conditions because of activities on the multiple ownerships on which it lies, mainly State and private. A shift in understory species composition towards nonnative species is likely due to the proximity and rapid growth of the Verde Valley communities. An increase in the frequency and severity of wildfires is a logical consequence of increased abundance and distribution of nonnative annual grasses (USDA Forest Service 2009).

Projected increases in the frequency and intensity of drought will cause major changes in vegetation cover. Higher temperatures and decreased soil moisture will likely reduce the stability of soil aggregates. Loss of vegetative cover and reduced soil aggregate stability, coupled with increases in precipitation intensity, will dramatically increase potential erosion rates. The greater temperatures and higher rates of evapo-transpiration predicted to co-occur with drought portend increased mortality for the dominant woody vegetation, and open the door for establishment of nonnative annual grasses adapted to “escape” drought conditions (Archer & Predick 2008).

Desert Communities are currently highly departed with an unknown trend toward desired conditions. Under Alternative A, management is not expected to increase substantially over current levels, but the high departure should also make this PNVT a higher consideration for management depending on available resources. Sustained management at historic levels could lead to a continued increase in canopy cover, altered vegetative structure and composition, and fires burning at a severity, frequency or scale outside historic range of variability (USDA Forest Service 2009). Under Alternative A, this PNVT is expected to remain highly departed with a probable trend away from desired conditions.

Alternative B

This PNVT is within 3 proposed MAs, but 97% is included within Verde Valley. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. The following is provided for Desert Communities:

- Excessive ground disturbance should be avoided to limit accelerated erosion and to minimize bringing more calcareous soil to the surface. Bringing calcareous soil to the surface would limit soil plant nutrient availability.

According to mid-scale data, it is currently 100% late seral herb and shrubs types. Current condition mainly consists of closed canopy late seral herbaceous vegetation and shrubs. Open canopy late seral shrubs are lacking from the landscape according to LANDFIRE. Extent and continuity of the Desert Communities PNVT has decreased relative to reference conditions because of activities on the multiple ownerships on which it lies, mainly State and private. A shift in understory species composition towards nonnative species is likely due to the proximity and rapid growth of the Verde Valley communities. An increase in the frequency and severity of wildfires is a logical consequence of increased abundance and distribution of nonnative annual grasses (USDA Forest Service 2009).

Projected increases in the frequency and intensity of drought will cause major changes in vegetation cover. Higher temperatures and decreased soil moisture will likely reduce the stability of soil aggregates. Loss of vegetative cover and reduced soil aggregate stability, coupled with increases in precipitation intensity, will dramatically increase potential erosion rates. The greater temperatures and higher rates of evapo-transpiration predicted to co-occur with drought portend increased mortality for the dominant woody vegetation, and open the door for establishment of nonnative annual grasses adapted to “escape” drought conditions (Archer and Predict 2008).

Desert Communities are currently highly departed with an unknown trend. Under Alternative B, management is not expected to increase substantially over current levels, but the high departure should also make this PNVT a higher consideration for management depending on available resources. Sustained management at historic levels could lead to a continued increase in canopy cover, altered vegetative structure and composition, and fires burning at a severity, frequency or scale outside historic range of variability (USDA Forest Service 2009). Under Alternative B, this PNVT is expected to remain highly departed with a probable trend away from desired conditions.

Alternative C

This PNVT is within 3 proposed MAs, but 97% is included within Verde Valley. Approximately 1,016 acres are proposed for wilderness under this Alternative, which amounts to about 1 % of this PNVT. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. The following is provided for Desert Communities:

- Excessive ground disturbance should be avoided to limit accelerated erosion and to minimize bringing more calcareous soil to the surface. Bringing calcareous soil to the surface would limit soil plant nutrient availability.

According to mid-scale data, it is currently 100% late seral herb and shrubs types. Current condition mainly consists of closed canopy late seral herbaceous vegetation and shrubs. Open canopy late seral shrubs are lacking from the landscape according to LANDFIRE. Extent and continuity of the Desert Communities PNVT has decreased relative to reference conditions

because of activities on the multiple ownerships on which it lies, mainly State and private. A shift in understory species composition towards nonnative species is likely due to the proximity and rapid growth of the Verde Valley communities. An increase in the frequency and severity of wildfires is a logical consequence of increased abundance and distribution of nonnative annual grasses (USDA Forest Service 2009).

Projected increases in the frequency and intensity of drought will cause major changes in vegetation cover. Higher temperatures and decreased soil moisture will likely reduce the stability of soil aggregates. Loss of vegetative cover and reduced soil aggregate stability, coupled with increases in precipitation intensity, will dramatically increase potential erosion rates. The greater temperatures and higher rates of evapo-transpiration predicted to co-occur with drought portend increased mortality for the dominant woody vegetation, and open the door for establishment of nonnative annual grasses adapted to "escape" drought conditions (Archer & Predick 2008).

Desert Communities are currently highly departed with an unknown trend toward desired conditions. Under Alternative C, management is not expected to increase substantially over current levels, but the high departure should also make this PNVT a higher consideration for management depending on available resources. Sustained management at historic levels along with conversion of 1,000 acres to wilderness could lead to a continued increase in canopy cover, altered vegetative structure and composition, and fires burning at a severity, frequency or scale outside historic range of variability (USDA Forest Service 2009). Under Alternative C, this PNVT is expected to remain highly departed with a probable trend away from desired conditions.

Alternative D

Alternative D differs from Alternative B in the following ways:

- Recommends no new wilderness area;
- Allows mechanized recreation (e.g., bikes) on designated trails in botanical and geological areas

Because the differences between this Alternative and Alternative B have no effect on proposed management of vegetation resources, the effects are similar to B.

Semi-Desert Grassland

Alternative A

This PNVT is within 17 different MAs under the 1987 Plan, but 88% is included within MA 10 - Grassland and Sparse Piñon-Juniper Above the Rim, MA 11 – Verde Valley, and MA 27 - Savannah. The direction for prescribed fire, unplanned ignitions and suppression objectives is the same as that listed for Great Basin Grasslands, except MA 27 includes; low-intensity fire is acceptable unless life and property are threatened, low-intensity prescribed burns are desired, and where piñon/juniper woodland is maintained in a grassland condition, eliminate invading vegetation through mechanical and prescribed fire treatments as needed. Once again, the major constraint has been, and would likely continue to be, a lack of funding to accomplish treatments in this PNVT. Beyond using planned and unplanned ignitions used to accomplish resource objectives the existing Forest Plan provides little to no direction in terms of desired conditions for this PNVT.

While grasslands on the Red Rock District are primarily in restorable native condition (65.5%), a large proportion (30.2%) of grasslands have become shrub invaded, and have likely undergone a type conversion with little potential to be restored to open native grassland condition (Shussman 2006). A restorable native condition is defined as a grassland with 10-35% total shrub cover and mesquite or juniper cover < 15% whose herbaceous component is predominantly native perennial grasses and herbs. Shrub cover could be reduced with prescribed burns if sufficient fuels are present to carry a fire of adequate intensity.

During drought, vegetation production is significantly curtailed and litter may increase as plants die, resulting in increased susceptibility to fire. Mesquite is very drought tolerant and is known to invade grasslands. Wind erosion as a result of drought damage to the perennial grasses can be of concern. On sandy soils, large areas left bare by drought could begin to erode with the ever-present spring winds. Sand would drift until it reached fences, mesquite plants, buildings, or other obstacles. Many grass plants not killed by moisture stress could be killed by sand deposition (Herbel Et al 1972).

Open perennial grasslands and herbaceous understory are now present only in trace amounts. Lack of fire has contributed to, and will likely continue, a shift to shrub- and tree-dominated grasslands which were largely absent in the historic landscape (USDA Forest Service 2009).

Semi-Desert Grasslands are currently highly departed and trending away from desired conditions. Under Alternative A, management is not expected to increase substantially over current levels, but the high departure should make this PNVT a higher consideration for management depending on available resources. Continued management at historic levels could lead to an irreversible shift towards shrubs and trees in about 30% of this PNVT (USDA Forest Service 2009), and a shift toward more severe fires. Under Alternative A, this PNVT is expected to remain highly departed but treatments to clear shrubs and trees would start to move toward desired conditions.

Alternative B

This PNVT occurs within 4 proposed MAs under Alternative B, but 91% is included within Verde Valley (64%) and House Mountain Lowlands/Sedona-Oak Creek. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. This vegetation type has an objective to restore/enhance 3,500 acres of Semi-Desert Grassland during every 10 year period during the life of the plan.

Semi-Desert grasslands were modeled for removal of woody vegetation at a rate of 350 acres per year, applied to States C and D, with State B being reset to herbaceous (Table 30).

Table 30. VDDT modeled output for Semi-Desert Grassland PNVT

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	Recently burned, sparsely vegetated	24.0	0.0	0.0	0.0
B	B – Grasses and forbs	76.0	0.0	6.0	15.0

State	Description	Desired %	Current %	Year 15 %	Year 50 %
C	C – Shrubs, seedling, sapling, small & medium Trees, Open	0.0	26.0	15.0	6.0
D	D – Shrubs, Closed Very large trees, Open	0.0	74.0	79.0	79.0
Level of Departure[1]:		0%	100%	94%	85%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Because no fire was applied, State A remains at 0% over the next 50 years. The model predicts a favorable trend in State B as woody vegetation is cleared and grasses and forbs begin to occupy more area within these grasslands.

While grasslands on the Red Rock District are primarily in restorable native condition (65.5%), a large proportion (30.2%) of grasslands have become shrub invaded, and have likely undergone a type conversion with little potential to be restored to open native grassland condition (TNC 2006). A restorable native condition is defined as a grassland with 10-35% total shrub cover and mesquite or juniper cover < 15% whose herbaceous component is predominantly native perennial grasses and herbs. Shrub cover could be reduced with prescribed burns if sufficient fuels are present to carry a fire of adequate intensity.

During drought, vegetation production is significantly curtailed and litter may increase as plants die, resulting in increased susceptibility to fire. Mesquite is very drought tolerant and is known to invade grasslands. Wind erosion as a result of drought damage to the perennial grasses can be of concern. On sandy soils, large areas left bare by drought could begin to erode with the ever-present spring winds. Sand would drift until it reached fences, mesquite plants, buildings, or other obstacles. Many grass plants not killed by moisture stress could be killed by sand deposition (Herbel et al 1972).

Open perennial grasslands and herbaceous understory are now present only in trace amounts. Lack of fire has contributed to, and will likely continue, a shift to shrub- and tree-dominated grasslands which were largely absent in the historic landscape (USDA Forest Service 2009).

Semi-Desert Grasslands are currently highly departed and trending away from desired conditions. Under Alternative B, proposed management is not expected to create a dramatic change over current levels, but the high departure is reduced and reset to a favorable trend. The slight increase in management over historic levels could be enough to impede a possible irreversible shift towards shrubs and trees in about 30% of this PNVT. Under Alternative B, this PNVT is expected to remain highly departed but should begin trending slightly towards desired conditions.

Alternatives B, C, and D

Trends for vegetation as it relates to fire and fire severity would improve in Alternatives B, C, and D in Semi-Desert Grassland PNVT. A trend towards desired conditions means the ecological

system is moving towards characteristic fire, including a reduction in severity and a reduction in the risk of uncharacteristic fire.

Alternative C

This PNVT occurs within 4 proposed MAs under Alternative C, but 91% is included within Verde Valley (64%) and House Mountain Lowlands/Sedona-Oak Creek. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. Semi-Desert Grasslands were modeled for removal of woody vegetation at a rate of 350 acres per year, applied to States B and C, with State B being reset to herbaceous (Table 31). Approximately 12,186 acres are proposed for wilderness under this Alternative, which amounts to about 11 % of this PNVT. This vegetation type has an objective to restore/enhance 3,500 acres of Semi-Desert Grassland during every 10 year period during the life of the plan.

Table 31. VDDT modeled output for Semi-Desert Grassland PNVT

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	Recently burned, sparsely vegetated	24.0	0.0	0.0	0.0
B	B – Grasses and forbs	76.0	0.0	6.0	15.0
C	C – Shrubs, seedling, sapling, small & medium Trees, Open	0.0	26.0	15.0	6.0
D	D – Shrubs, Closed Very large trees, Open	0.0	74.0	79.0	79.0
Level of Departure[1]:		0%	100%	94%	85%

[1]Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Because no fire was applied, State A remains at 0% over the next 50 years. The model predicts a favorable trend in State B as woody vegetation is cleared and grasses and forbs begin to occupy more area within these grasslands.

While grasslands on the Red Rock District are primarily in restorable native condition (65.5%), a large proportion (30.2%) of grasslands have become shrub invaded, and have likely undergone a type conversion with little potential to be restored to open native grassland condition (Shussman 2006). A restorable native condition is defined as a grassland with 10-35% total shrub cover and mesquite or juniper cover < 15% whose herbaceous component is predominantly native perennial grasses and herbs. Shrub cover could be reduced with prescribed burns if sufficient fuels are present to carry a fire of adequate intensity.

During drought, vegetation production is significantly curtailed and litter may increase as plants die, resulting in increased susceptibility to fire. Mesquite is very drought tolerant and is known to invade grasslands. Wind erosion as a result of drought damage to the perennial grasses can be of concern. On sandy soils, large areas left bare by drought could begin to erode with the ever-

present spring winds. Sand would drift until it reached fences, mesquite plants, buildings, or other obstacles. Many grass plants not killed by moisture stress could be killed by sand deposition (Herbel Et al 1972).

Open perennial grasslands and herbaceous understory are now present only in trace amounts. Lack of fire has contributed to, and will likely continue, a shift to shrub- and tree-dominated grasslands which were largely absent in the historic landscape (USDA Forest Service 2009).

Semi-Desert Grasslands are currently highly departed and trending away from desired conditions. Under Alternative C, proposed management is not expected to create a dramatic change over current levels, but the high departure is reduced and reset to a favorable trend. The slight increase in management over historic levels could be enough to impede a possible irreversible shift towards shrubs and trees in about 30% of this PNVT. Under Alternative C, this PNVT is expected to remain highly departed but should begin trending slightly towards desired conditions.

Alternative D

Effects from alternative D are expected to be the same as alternative B, except no wilderness is recommended in alternative D.

Great Basin Grassland

Alternative A

This PNVT is within 16 different MAs under the 1987 Plan, but 85% is included within MA 7 - Piñon-Juniper Woodland, Less Than 40 Percent Slope, MA 10 - Grassland and Sparse Piñon-Juniper Above the Rim, and MA 32 - Deadman Wash. Prevailing direction allows for prescribed fire using planned and unplanned ignitions used to accomplish resource objectives except there is no provision for unplanned ignitions in areas included in the urban interface. Also, maintain and improve grasslands, including removing encroaching Piñon/juniper and re-introducing fire (MA 32). The suppression objective is 10 acres or less in areas mapped as the urban interface. In areas outside urban interface, the suppression objective is to hold fire to 1,000 acres or less. Other than the suppression objectives, this management direction does not hinder actions that would move toward desired conditions, and the suppression objectives can vary depending on conditions and resources at risk. The major constraint has been, and would likely continue to be, a lack of funding to accomplish treatments in this PNVT. Plan direction provides suitable guidance in terms of general desired conditions, but remains silent on composition, structure and function.

Some shrub and tree invasion is occurring along edges of grasslands. There is a shift from small to larger tree sizes, primarily in the northeastern part of the Forest (about 17% of the PNVT), near Wupatki National Monument. Stock tank construction has been attributed to shifts towards grazing tolerant species; reduction in vegetation height; soil compaction and disturbance; and shifts in abundance, density and vigor of herbaceous species in the vicinity around water within this grassland type (USDA Forest Service 2009). Vegetatively, this PNVT is similar to reference conditions although there is a shift in structure and composition to increased shrubs and trees in the northeastern part of the forest. This trend is likely to continue in the future due to lack of fire in the surrounding vegetation types, primarily Piñon-Juniper.

All of the grasslands on the Mogollon Rim, Mormon Lake, and Peaks Ranger Districts were identified as being in restorable native condition, meaning that they have been encroached by

shrubs and woody species, but have the potential to be restored to open native condition (Shussman 2006). Cover of woody vegetation could be reduced with prescribed burns if sufficient fuels are present to carry a fire of adequate intensity.

The restoration of grasslands on the Coconino to open native grassland condition, including the ecological functions that support them, will help promote the large-scale sustainability of important grassland areas within the Southwest (Shussman 2006).

Potential impacts to this PNVT from climate change include decreased ecosystem productivity from water limitations and increased heat. Warmer and drier conditions could potentially reduce the rate of departure by contributing to increased mortality of encroaching trees.

This PNVT is currently at low departure and is trending away from desired conditions. Under Alternative A, management is not expected to change over current levels, which continued encroachment of trees and shrubs and a corresponding decline in herbaceous species that could affect fire's natural role. Departure is expected to remain low over the first 15 years and move into moderate after 50 years.

Alternative B

This PNVT occurs within 7 proposed MA, but primarily within Anderson Mesa (64%) and Painted Desert (24%). No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. This vegetation type has an objective restore/enhance between 10,800 and 12,400 acres of Great Basin Grassland every 10 year period during the life of the plan.

Guidelines for Great Basin Grasslands include:

- Ninety percent potential ground cover should be retained to prevent erosion and gully formation.

Great Basin grasslands were modeled for removal of woody vegetation at a rate of between 1,080 and 1,240 acres per year, applied to States C and D, with these states being reset to herbaceous cover (State B) (Table 32 and Table 33).

Table 32. VDDT modeled output for Great Basin Grassland PNVT (low objective 1,080 acres)

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A - Recently burned, sparsely vegetated	5.0	0.0	2.1	2.4
B	B – Grasses and forbs	70.0	74.0	62.3	60.0
C	C – Shrubs, seedling, sapling, small & medium Trees, Open	20.0	26.0	29.2	24.8
D	D – Shrubs, Closed Very large trees, Open	5.0	0.0	6.3	12.3

State	Description	Desired %	Current %	Year 15 %	Year 50 %
E	E – Noxious weeds/Invasives	0.0	0.0	0.1	0.5
Level of Departure[1]:		0%	10%	11%	13%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

This PNVT covers approximately 93,000 acres (5.1%) of the Coconino National Forest. Historically, nearly three-fourths of the PNVT was open mid-development grasses and forbs (State B), with about one-fifth of it in late development shrubs and trees with open canopy (State C).

Table 33. VDDT modeled output for Great Basin Grassland PNVT (high objective 1,240 acres)

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A - Recently burned, sparsely vegetated	5.0	0.0	2.3	2.5
B	B – Grasses and forbs	70.0	74.0	60.9	61.5
C	C – Shrubs, seedling, sapling, small & medium Trees, Open	20.0	26.0	30.2	24.4
D	D – Shrubs, Closed Very large trees, Open	5.0	0.0	6.3	11.1
E	E – Noxious weeds/Invasives	0.0	0.0	0.2	0.6
Level of Departure[1]:		0%	10%	12%	11%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Under both the low and high acre objectives, the model predicts that State B will trend away from the desired condition. This is attributed to regeneration from established seed sources from encroaching trees and shrubs. Continued establishment and growth of woody species is greater than the area being treated. The area occupied by State C initially increases, but then trends toward the desired condition over time.

As would be expected, established shrubs and trees continue to grow and eventually reach closed canopy conditions. After 15 years State D surpasses the desired condition and continues to increase. After 50 years, this trend is predicted to accelerate to where about 11% of the PNVT is occupied by closed canopy shrubs and very large trees.

This PNVT is currently at low departure with an unknown trend. Under Alternative B, proposed management is expected to maintain a static trend. Departure is expected to remain low over the next 50 years.

Alternatives B, C, and D

Trends for vegetation as it relates to fire and fire severity would remain static in Alternatives B, C, and D in Great Basin Grassland PNVT. A static trend means that the PNVT is neither moving towards nor away from the ecological systems' characteristic fire regime.

Alternative C

This PNVT occurs within 7 proposed MA, but primarily within Anderson Mesa (64%) and Painted Desert (24%). No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above. Approximately 2,327 acres are proposed for wilderness under this Alternative, which amounts to about 2 % of this PNVT. Guidelines for Great Basin Grasslands include:

- Ninety percent potential ground cover should be retained to prevent erosion and gully formation.

The restoration of grasslands on the Coconino to open native grassland condition, including the ecological functions that support them, will help promote the large-scale sustainability of important grassland areas within the Southwest (TNC 2006).

This PNVT is currently at low departure with an unknown trend.

Alternative D

Effects from alternative D are expected to be the same as alternative B, except no wilderness is recommended in alternative D.

Montane/Subalpine Grassland

Alternative A

This PNVT is currently within 18 different MAs under the 1987 Plan, the majority (54%) of which is included in MA 3 - Ponderosa Pine Mixed Conifer Less Than 40 % Slope and MA 9 – Mountain Grassland. Management Areas 10 and 35 account for another 21%. Protection objectives within MA 3 include; suppression is 100 acres or less, prescribed fire using planned and unplanned ignitions is used to meet resource objectives, unplanned ignitions are not used as a management tool in the urban interface, and annual average wildfire acreage burned should not exceed 750 acres per year on the average over a 10-year period. These were designed to protect ponderosa pine suitable timberlands, but could serve to inhibit restoration of this PNVT, although the focus on ponderosa pine restoration should offset. The other MAs have the standard protection and prescribed fire objectives listed above, except Lake Mary Watershed (MA 35) which guides to reintroduce fire's natural role as much as possible. Beyond the guideline to reintroduce fire's natural role, the existing Forest Plan provides little to no direction on desired conditions for this PNVT.

Although some authors have claimed that climate has minimal effect on high elevation grassland composition and structure, others have proposed climate as an important determinant of tree encroachment. Based on field data and historical records, Dyer and Moffett (1999) concluded that climatic change is a more likely explanation for encroachment of trees into adjacent meadows, rather than fire suppression or changes in grazing intensities at this site. The nature of climate change appears to be region- and site-specific, such that in some instances meadow invasion has been ascribed to a climatic warming and drying, whereas in other areas a cooler, wetter climate has been credited with initiating meadow invasion. Dyer and Moffett (1999) found a potential interactive effect was indicated, with periods of establishment occurring with increased precipitation coupled with warmer temperatures however, no unequivocal relationship between climate and tree establishment could be established.

The projected future trend for vegetation structure and composition is static due to lack of fire from the adjacent PNVTs moving into this vegetation type. A continued lack of fire would allow the intrusion of shrubs and trees.

Management at current levels could lead to continued tree encroachment. Under Alternative A, this PNVT is expected to remain at low departure with a static trend.

Alternative B

This PNVT is currently within 10 proposed MAs under Alternative B, the majority (53%) of which is included in the Ponderosa Pine Belt. Long Valley (15%), Flagstaff Neighborwoods (12%), and San Francisco Peaks (11%) account for the majority of the remaining acres. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above.

Guidelines for Montane/Subalpine Grasslands include:

- Ninety percent potential ground cover should be retained to prevent erosion and gully formation.

Montane/Subalpine grasslands were modeled for removal of woody vegetation at a rate of between 760 and 1,140 acres per year, applied to States C and D, with these states being reset to herbaceous cover (State B) (Table 34 and Table 35).

Table 34. VDDT modeled output for Montane/Subalpine Grassland PNVT (low objective – 760 acres)

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Early development, open canopy (herbaceous)	20.0	0.0	17.0	16.4
B&C	B – Mid-development, open canopy (herbaceous)	80.0	68.0	69.1	80.0
D	D – Late development, closed canopy (trees, shrubs & herbaceous vegetation)	0.0	32.0	13.9	0.0

State	Description	Desired %	Current %	Year 15 %	Year 50 %
E	E – Noxious weeds/Invasives	0.0	0.0	0.0	0.0
Level of Departure[1]:		0%	32%	14%	4%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

Although some authors have claimed that climate has minimal effect on high elevation grassland composition and structure, others have proposed climate as an important determinant of tree encroachment. Based on field data and historical records, Dyer and Moffett (1999) concluded that climatic change is a more likely explanation for encroachment of trees into adjacent meadows, rather than fire suppression or changes in grazing intensities at this site. The nature of climate change appears to be region- and site-specific, such that in some instances meadow invasion has been ascribed to a climatic warming and drying, whereas in other areas a cooler, wetter climate has been credited with initiating meadow invasion. Dyer and Moffett (1999) found a potential interactive effect was indicated, with periods of establishment occurring with increased precipitation coupled with warmer temperatures however, no unequivocal relationship between climate and tree establishment could be established.

Table 35. VDDT modeled output for Montane/Subalpine Grassland PNVT (high objective – 1,140 acres)

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Early development, open canopy (herbaceous)	20.0	0.0	18.9	15.7
B&C	B – Mid-development, open canopy (herbaceous)	80.0	68.0	70.9	80.0
D	D – Late development, closed canopy (trees, shrubs & herbaceous vegetation)	0.0	32.0	10.3	0.0
E	E – Noxious weeds/Invasives	0.0	0.0	0.0	0.0
Level of Departure[1]:		0%	32%	10%	4%

[1] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

The projected future trend for vegetation structure and composition is static due to lack of fire from the adjacent PNVTs moving into this vegetation type. A continued lack of fire would allow the intrusion of shrubs and trees. Currently, the Montane/Subalpine Grasslands are currently at a low level of departure with an unknown trend. Management at current levels could lead to continued tree encroachment. Under Alternative B, this PNVT is expected to remain at low departure with a continued static trend.

Alternatives B, C, and D

Alternatives B, C, and D distinguish between grassland types on the forest and provide updated desired conditions that are tiered to the differing conditions of the respective grasslands.

Trends for vegetation as it relates to fire and fire severity would improve in Alternatives B, C, and D in Montane Sub-Alpine Grassland PNVT. A trend towards desired conditions means the ecological system is moving towards characteristic fire, including a reduction in severity and a reduction in the risk of uncharacteristic fire.

Alternatives C and D

Implementation of alternatives C and D is expected to be the same as alternative B. There are 6 acres of this PNVT in the Railroad Draw recommended wilderness in alternative C. There are no impacts from wilderness recommendation due to this small extent.

Interior Chaparral

Alternative A

This PNVT is within 19 different MAs under the 1987 Plan, but 76% is included within wilderness. Four other MAs (11, 14, 24 & 26) make up the majority of the remaining area, combining for 18%. Management direction for Neighborwoods and Redrock Front country provide only scenery and recreation objections, but the other two include; suppression objective is to minimize cost and provide for personnel safety except suppression objective is 10 acres or less in areas mapped as the urban interface, in areas outside the urban interface, the suppression objective is to hold fires to 1,000 acres or less, prescribed fire using planned and unplanned ignitions is used to accomplish resource objectives except no provision for unplanned ignitions in areas included in urban interface, and use prescribed fire and mechanical methods to achieve fire management goals. The latter two include only about 5,500 acres or 11% of the PNVT where active management may occur. Beyond using planned and unplanned ignitions to accomplish resource objectives, the existing Forest Plan provides little to no direction on desired conditions for this PNVT.

Data on effects to chaparral from climate change is sparse. Warmer and drier conditions would likely result in increased dieback and mortality of plants within this PNVT, making it more susceptible to intense fires.

Interior Chaparral is currently at a low level of departure with a static trend. Continued management at current levels could lead to decline in vegetative structure and composition and continued departure away from fire regime condition class. Under Alternative A, this PNVT is expected to remain at low departure with a possible trend away from desired conditions.

Alternative B

This PNVT occurs within 6 different proposed MAs under Alternative B, but 78% is included within Sedona-Oak Creek MA. No additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above.

Data on effects to chaparral from climate change is sparse. Warmer and drier conditions would likely result in increased dieback and mortality of plants within this PNVT, making it more susceptible to intense fires.

Interior Chaparral is currently at a low level of departure with a static trend. Continued management at current levels could lead to decline in vegetative structure and composition and continued departure away from fire regime condition class. Under Alternative B, this PNVT is expected to remain at low departure with a possible trend away from desired conditions.

Alternatives C and D

Implementation of alternatives C and D is expected to be the same as alternative B in terms of plan direction.

Piñon-Juniper Evergreen Shrub

Wooded shrublands are found where local soils and climate support a shrub community, but trees can increase during moist climatic conditions and periods without disturbance and decrease during droughts and following disturbance (Romme et al 2009). The historical role of climatic fluctuation, insects, and disease is less well known for wooded shrublands than persistent Piñon-Juniper. Savannas and wooded shrublands, in particular, are probably dominated by trees during periods of moist climatic conditions or infrequent fires, but by grasses or shrubs during droughts or periods with more frequent fires or insect outbreaks (Romme et al 2009). Because they occupy transition zones between mesic forests at higher elevations and environments too dry for trees at lower elevations, Piñon-Juniper communities may be especially sensitive to even subtle changes in temperature and precipitation. It is possible that some, or even much, of the infill and expansion of piñon and juniper that has occurred during the past 150 years is a natural response to short-term and long-term climatic fluctuation.

Common to All Alternatives

Under all Alternatives, vegetative structure (as it relates to fire) and fire severity in Piñon-Juniper Evergreen Shrub are predicted to trend away from desired conditions due to the anticipated lack of vegetation and fire treatment. Fire return interval is also predicted to trend away. This would result in an increase in the area burned at the higher end of mixed fire severity and increased soil loss and overstory mortality. This would facilitate establishment and spread of invasive plant species, such as cheatgrass, which can alter the fire regime and timing of fires and to which many species may not be adapted.

Alternative A

As mentioned above, the 1987 Plan lumps Piñon-Juniper woodlands together under MA 7 and 8, except for Grassland and Sparse Piñon-Juniper above the Rim (MA 10), which overlaps seventeen of the eighteen PNVTs across the Forest. Piñon-Juniper Evergreen Shrub is primarily covered under MA 7 - Piñon-Juniper Woodlands <40% Slope, MA 11 – Verde Valley, and MA 10. Management Area 10 is made up of grasslands and Piñon-Juniper with less than 10 percent cover above the Mogollon Rim, and emphasizes range management, watershed condition, and wildlife habitat. MA 7 is the only one with a mechanical vegetation management guideline, emphasizing management on a sustained-yield basis for firewood and miscellaneous convertible products, on

0-15 percent slopes. Old-growth, cover, and snags are generally provided on slopes greater than 15 percent. However, exceptions would occur if dispersion requirements for habitat components are not met on these steep slopes.

All Piñon-Juniper MAs in the 1987 Plan emphasize prescribed fire using planned and unplanned ignitions to accomplish resource objectives, except no provision for unplanned ignitions in areas included in urban interface, which have a suppression objective of 10 acres.

All Piñon-Juniper MAs emphasize prescribed fire using planned and unplanned ignitions to accomplish resource objectives, except no provision for unplanned ignitions in areas included in urban interface. Current Plan direction limits mechanical treatment of Piñon-Juniper woodlands to slopes of 15% or less only within MA 7, and generally only provides for old growth on slopes above 15%. This management approach limits treatments on steeper slopes designed to adjust composition and structure, and improve ecosystem function and resilience to disturbance. Although mechanical treatments on slopes over 15% that could set stands on a faster trajectory toward old growth conditions would not occur, old growth within this PNVT is expected to remain static or increase in the absence of major disturbances.

Piñon-Juniper Evergreen Shrub has no treatment objectives under Alternative A, and would likely remain moderately departed and continue trending away because tree density and cover would continue to increase, shading out understory species and maintaining more smaller to medium sized trees than desired. These factors tend to exacerbate the lack of disturbance, primarily fire, modifying the shrub and tree age class distribution and increasing the potential for severe fires. These vegetation structural trends tend to increase vulnerability to insect and disease outbreaks. It is possible under Alternative A, that Piñon-Juniper Evergreen Shrub could become highly departed over the next 15 to 50 years. However, it is also possible that tree densities could begin to decline due to increasing insect or fire activity as result of climate change, which would support increased grass and shrub cover indicative of a more static trend.

Alterative B

The Piñon-Juniper Evergreen Shrub PNVT covers 263,835 acres across 7 proposed Management Areas under Alternative B. Approximately 77% lie within Verde Valley (62%) and Sedona-Oak Creek (15%). These MAs do not list any additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above, except Sedona-Oak Creek which directs that:

- The biological, physical, and human elements of the landscape sustain ecological processes, functions, and structures within a natural range of variability and conditions appropriate to the Sedona/Oak Creek ecosystem. Natural ecosystem disturbance patterns are conserved or restored consistent with human health and safety.

The Piñon-Juniper Evergreen Shrub PNVT is has an objective to treat 3,750 acres every 10 years with low to mixed severity naturally ignited wildfire. This amount would depend on fire starts within this PNVT, conditions at the time of a start, and resources at risk. Fire may be allowed to exceed this acre objective if accomplishing benefits to the resources as determined through interdisciplinary team (IDT) review.

Piñon-Juniper Evergreen Shrub PNVT is likely to remain moderately or become highly departed and continue trending away because tree density and canopy cover would continue to increase, shading out understory species, and maintaining smaller to medium sized trees than desired. These factors tend to exacerbate the lack of disturbance, primarily fire, modifying the shrub and

tree age class distribution and increasing the potential for severe fires. The vegetation structural trends increase vulnerability to insect and disease outbreaks. Because of the natural fire objective, it is possible that under Alternative B, the P-J Evergreen Shrub PNVT could remain moderately departed over the next 15 to 50 years, but more acres would need to be treated. If conditions are suitable for more acres to be treated with naturally ignited fire than the objective, the trend could become static, but it would require 10+ times the current objective level of treatment. Assuming that naturally ignited fires were to occur and were managed in this PNVT, Alternative B would move closer to desired conditions than Alternative A.

The majority of acres proposed for wilderness are within this PNVT. Piñon-Juniper Evergreen Shrub would have over 50,000 acres converted to wilderness, which is almost one-fifth of the entire PNVT. Recommended wilderness in Alternative B would have varying effects to risk of uncharacteristic fire in Piñon-Juniper Evergreen Shrub. The effects would be in small localized areas. As described in Alternative B under Ponderosa Pine, wildfires in about 3,474 of these acres (about 1 percent of the PNVT) would have a moderate to very high likelihood of being suppressed. This is due to a combination of management limitations including: limited accessibility and few vegetative treatments due to wilderness recommendation; vegetative characteristics within the wilderness (e.g., continuous fuels, high departure, closed canopy conditions); and threatened values outside the wilderness. These acres occur within Walker Mountain recommended wilderness. Consequently, there would be localized increased risk of uncharacteristic fire and higher than desired fire severity, along with decreased likelihood of restoring the natural fire interval.

There would be little impact to the remaining Piñon-Juniper Evergreen Shrub acres from wilderness recommendation. There are 741 acres (about 0.3 percent of the PNVT) within Davey's recommended wilderness. Wildfires on these acres would likely be managed to meet resource objectives if possible and would have a low likelihood of being suppressed. Consequently, there would be a lower risk of uncharacteristic fire and uncharacteristic fire severity along with an increased likelihood of restoring the natural fire return interval in this localized area.

Alternative C

The majority of acres recommended for wilderness under alternative C is within Piñon-Juniper Evergreen Shrub. This PNVT would have over 50,000 acres in recommended wilderness, which is almost one-fifth of the entire PNVT across the forest. However, approximately 9 percent of the PNVT would have a moderate to high likelihood of influencing fire suppression decisions because of decreased accessibility and available tools. Because of the condition of these areas and the fact that naturally ignited fires may be managed in the majority of the PNVT, movement toward desired conditions and level of departure are expected to be similar as alternative B.

The effects of implementing alternative C on large tree retention are expected to be the same as alternative B, because treatment objectives would be unchanged and small compared to the size of the PNVT and, as a result, additional wilderness would likely not hinder expected management.

Recommended wilderness in alternative C would have varying effects to risk of uncharacteristic fire in Piñon-Juniper Evergreen Shrub. The effects would be in scattered localized areas. As described in alternative B under Ponderosa Pine, wildfires in about 24,150 of these acres (about 9 percent of the PNVT) would have a moderate to very high likelihood of being suppressed. This is due to a combination of management limitations including: limited accessibility and few

vegetative treatments due to wilderness recommendation; vegetative characteristics within the wilderness (e.g., continuous fuels, high departure, closed canopy conditions); and threatened values outside the wilderness. These acres occur within Black Mountain, Cedar Bench, Tin Can, Walker Mountain, and Deadwood Draw recommended wilderness. Consequently, there would be localized increased risk of uncharacteristic fire and higher than desired fire severity, along with decreased likelihood of restoring the natural fire interval.

There would be little impact to the remaining Piñon-Juniper Evergreen Shrub acres from wilderness recommendation. There are 26,488 acres (about 10 percent of the PNVT) within Railroad Draw, Davey's, Cimmaron-Boulder, and Hackberry recommended wilderness. Wildfires on these acres would likely be managed to meet resource objectives, if possible, and would have a low likelihood of being suppressed. Consequently, there would be a lower risk of uncharacteristic fire and uncharacteristic fire severity along with an increased likelihood of restoring the natural fire return interval in this localized area. However, because of limited access, it is likely that little management has occurred in this area so pretreatment would likely be needed before fire could be used with minimal negative effects. If these five areas become wilderness, pretreatment options would be minimized to the point that an increase in tree density and canopy cover would likely continue in these acres, depending on site-specific conditions.

Alternative D

Because of the similarity between alternatives D and B, effects to this PNVT are expected to be the same as alternative B.

Piñon-Juniper Woodland

Common to All Alternatives

Because Piñon-Juniper Woodland has a long fire return interval and generally has a stand-replacement fire regime, barring a major disturbance, the amount of old-growth forest components, large trees and snags per acre are expected to remain static or increase under all Alternatives. Vegetative structure and fire severity are predicted to remain static. A static trend means that the PNVT is neither moving towards nor away from the ecological systems' characteristic fire regime and current departures would be maintained. Because no fire objectives are included under any Alternative, fire return interval is predicted to trend away from desired conditions.

Alternative A

All Piñon-Juniper MAs in the 1987 Plan emphasize prescribed fire using planned and unplanned ignitions to accomplish resource objectives, except no provision for unplanned ignitions in areas included in urban interface, which have a suppression objective of 10 acres.

Under the 1987 Plan, all Piñon-Juniper woodlands were lumped together under Management Areas (MA) 7 & 8, and not split out by differences in ecological characteristics except for Grassland and Sparse Piñon-Juniper above the Rim (MA 10), which overlaps seventeen of the eighteen PNVTs across the Forest. Piñon-Juniper Persistent falls primarily under MA 7 - Piñon-Juniper Woodlands <40% Slope, MA 11 - Verde Valley, and MA 8 - Piñon-Juniper Woodlands >40% Slope. MA 7 is the only one with mechanical vegetation management guidelines, emphasizing management on a sustained-yield basis for firewood and miscellaneous convertible

products, on 0-15 percent slopes. Recommended mechanical treatments are shelterwood, clearcutting, and uneven-aged silvicultural systems. Old-growth, cover, and snags are generally provided on slopes greater than 15 percent. However, exceptions would occur if dispersion requirements for habitat components are not met on these steep slopes. The Verde Valley MA includes direction to evaluate lands to identify those areas that may meet suitability standards for miscellaneous forest products.

Current Plan direction (MA 7) limits mechanical treatment of Piñon-Juniper Woodlands to slopes of 15% or less only, and generally only provides for old growth on slopes above 15%. The emphasis is primarily placed upon extraction of firewood and miscellaneous convertible forest products rather than restoration of desired conditions. This management approach limits treatments on steeper slopes designed to adjust composition and structure, and improve ecosystem function and resilience to disturbance. Without major disturbances, the amount of old growth within this PNVT should remain static or improve under Alternative A, but mechanical treatments on slopes over 15% that could set stands on a faster trajectory toward old growth conditions would not occur.

Because this PNVT is currently at low departure, and within its historical fire rotation, under Alternative A, the Persistent Piñon-Juniper PNVT would likely remain at low departure with a static trend from reference conditions. Any increase in departure would be considered within the historic range of variability (HRV) because the PNVT has a fire rotation of over 200 years.

Alternatives A and C

In Alternatives A and C, old growth would be distributed in 100- to 300-acre stands primarily on greater than 15 percent slopes across the landscape. This should not result in a change in fire severity because this area is rocky (i.e., fire spread would not change), and high severity is already characteristic of this PNVT. In contrast, distribution of old growth in Alternatives B and D would not be stands but in old-growth attributes of large old trees, snags, and logs across the landscape, not primarily on slopes greater than 15 percent.

Alternative B

Similar to Alternative A, the Piñon-Juniper Woodland PNVT would likely remain at low departure from desired conditions and on a static trend under Alternative B, because there are no treatment objectives and the PNVT is not far from desired conditions. Tree density and canopy cover would continue to increase, shading out understory species, and maintaining smaller to medium sized trees than desired. These factors could tend to exacerbate the lack of disturbance, primarily fire, modifying the shrub and tree age class distribution and increasing the potential for uncharacteristic disturbance. The density and structural trends would continue to increase vulnerability to insect and disease outbreaks, but this PNVT is within its historic range of variability.

Piñon-Juniper Woodland covers 75,393 acres across 14 proposed Management Areas under Alternative B. Approximately 87% lie within Verde Valley (40%), Anderson Mesa (30%), and Volcanic Woodlands (17%). These MAs do not list any additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above.

Guidelines for Piñon-Juniper Woodland are the same as for P-J Grassland:

- On grassland soil types, Piñon-Juniper grasslands, juniper grasslands, or Piñon-Juniper Evergreen Shrub should continue to be treated to maintain seral grasslands.
- Grassland soil inclusions (also called mollisol soils) with tree encroachment within the Piñon-Juniper types should be restored to grassland desired conditions to maintain desired openings, contribute to structural diversity and increased resilience.
- On non-grassland soil types, pushes (also broadly referred to as “chaining’) in Piñon-Juniper grasslands, juniper grasslands, or Piñon-Juniper Evergreen Shrub should trend toward desired condition for the particular woodland type.
- In areas where there is little understory and treatments are proposed, slash treatments (e.g., lop and scatter and mastication) should be used that improve herbaceous vegetation growth, soil and watershed condition, and soil productivity. The intent is to thin to encourage response by herbaceous vegetation and allow smaller debris to decompose in place on the ground.
- Seeding with native species appropriate for the ecological unit (or similar in elevation, soil type, and eco regions) should be used to promote natural species composition and maintain soil in place.

Approximately 13,665 acres are proposed for wilderness under this Alternative, which amounts to about 18 % of this PNVT. Despite the fact that these additional acres would be unavailable for mechanical treatment, the Persistent P-J PNVT would likely remain at low departure from reference conditions, and on a static trend under Alternative B, because there are no treatment objectives and it is not far from reference conditions. Tree density and canopy cover would continue to increase, shading out understory species, and maintaining smaller to medium sized trees than desired. These factors could tend to exacerbate the lack of disturbance, primarily fire, modifying the shrub and tree age class distribution and increasing the potential for uncharacteristic disturbance. The density and structural trends would continue to increase vulnerability to insect and disease outbreaks, but this PNVT is within its historic range of variability.

Recommended wilderness in Alternative B would have varying effects to risk of uncharacteristic fire in Piñon-Juniper Woodland. There would be localized increased risk of uncharacteristic fire and higher than desired fire severity, along with decreased likelihood of restoring natural fire return interval in the Walker Mountain recommended wilderness which has about 665 acres (about 0.8 percent of the PNVT). As described in Alternative B under Ponderosa Pine, wildfires would have a moderate to very high likelihood of being suppressed. This is due to a combination of management limitations including: limited accessibility and few vegetative treatments due to wilderness recommendation; vegetative characteristics within the wilderness (e.g., continuous fuels, high departure, closed canopy conditions); and threatened values outside the wilderness.

There would be localized impact to the remaining Piñon-Juniper Woodland acres from wilderness recommendation. There are 1,483 acres (1 percent of the PNVT) distributed in Strawberry Crater and Davey’s recommended wilderness areas. Wilderness recommendation would have a low likelihood of influencing wildfire suppression strategies. Consequently, there would be a lower risk of uncharacteristic fire and uncharacteristic fire severity along with an increased likelihood of restoring natural fire return intervals in these localized areas.

By focusing more on the desired conditions rather than prescribing how to achieve them, Alternative B would be somewhat less restrictive than Alternative A in terms of vegetation

management. Such direction would offer more flexibility to manage this PNVT toward desired conditions.

Alternative C

Approximately 13,665 acres are recommended for wilderness under this Alternative, which amounts to about 18 percent of this PNVT. Despite the fact that these additional acres would be unlikely to have mechanical vegetation treatment in the future because of recommended wilderness, the Piñon-Juniper Woodland PNVT would likely be similar to Alternative B and remain at low departure from desired conditions with a static trend, because there are no treatment objectives and it is not far from desired conditions. The density and structural trends would continue to increase vulnerability to insect and disease outbreaks, but this PNVT is within its historic range of variability.

Recommended wilderness in Alternative C would have varying effects to risk of uncharacteristic fire in Piñon-Juniper Woodland. The effects would be in small localized areas. As described in Alternative B under Ponderosa Pine, wildfires in about 3,995 of these acres (about 5 percent of the PNVT) would have a moderate to very high likelihood of being suppressed. This is due to a combination of management limitations including: limited accessibility and few vegetative treatments due to wilderness recommendation; vegetative characteristics within the wilderness (e.g., continuous fuels, high departure, closed canopy conditions); and threatened values outside the wilderness. These acres are scattered within five recommended wildernesses: Black Mountain, Cedar Bench, Tin Can, Walker Mountain, and Deadwood Draw. Consequently, there would be localized increased risk of uncharacteristic fire and higher than desired fire severity, along with decreased likelihood of restoring the natural fire interval.

There would be localized impact to the remaining Piñon-Juniper Woodland acres from wilderness recommendation. There are 9,670 acres of this PNVT (0.4 percent of the PNVT), distributed in five different recommended wildernesses: East Clear Creek, Strawberry Crater, Davey's, Cimmaron-Boulder, and Hackberry. It is unlikely that wilderness recommendation would influence wildfire suppression strategies. Consequently, there would be a lower risk of uncharacteristic fire and uncharacteristic fire severity along with an increased likelihood of restoring the natural fire regime in these localized areas. However, because of limited access, it is likely that little management has occurred in these areas so pretreatment would likely be needed before fire could be used with minimal negative effects. If these five become wilderness areas, pretreatment options would be minimized to the point that an increase in tree density and canopy cover would likely continue in these acres.

Alternative D

Plan components for the Piñon-Juniper Woodland PNVT in Alternative D would result in the same effects as Alternatives B and C.

Mixed Conifer with Aspen

Alternative A

This PNVT is accounts for approximately 2% of the Forest with 85% located in MA 3 - Ponderosa pine and mixed conifer on less than 40% slope, MA 1 – Wilderness, MA 4 - Ponderosa

pine and mixed conifer on greater than 40% slope, and MA 36 – Schultz. The majority of this PNVT is included under MA 1, 4, and 36, which have no vegetation management guidelines. All mixed conifer is considered to be MSO restricted or protected habitat. Because of these higher priority objectives and associated treatment limitations, little vegetation management has occurred over the life of the current plan. A large portion of what occurs in MA 3 and outside of protected habitat is currently scheduled for treatment under the Hart Prairie Fuel Reduction and Forest Health Project.

The existing Forest Plan lumps mixed conifer, both with frequent fire and with aspen, with ponderosa pine under Management Areas 3 and 4. As with the Ponderosa Pine PNVT, plan language does not necessarily prevent attainment of the regionally consistent desired conditions for mixed conifer, but the focus on commodity production, dwarf mistletoe eradication, and fire suppression may hinder the process.

Alternative A provides only general desired conditions in regard to the composition, structure and function of mixed conifer compared to Alternatives B, C, and D. These other Alternatives describe desired conditions at multiple scales including desired density ranges in terms of basal area per acre, endemic levels of disturbances such as insects, disease, fire, and weather as part of the desired conditions while Alternative A seeks to minimize them. All mixed conifer outside of MSO protected habitat is considered restricted habitat for MSO. Direction relating to these delineations is listed in the Ponderosa Pine PNVT section.

Additional direction for MSO restricted habitat states that except where otherwise noted, implement forest plan old-growth standards and guidelines to maintain and promote development of owl habitat. Barring any uncharacteristic disturbances, and because of Plan direction, old growth characteristics are expected to increase over time.

Past treatments prescribed under the existing Forest Plan have been too conservative to maintain desired diversity. Treatments have tended to leave higher stocking densities that more closely resembled threshold habitat and actually discriminated against the promotion of early seral species such as aspen and ponderosa pine.

Management direction for the Northern goshawk states: Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer and Spruce Fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape.

Additional management direction for mixed conifer outside of Post-fledging Family Areas (PFA) states that canopy cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 40+%, mature forest (VSS 5) should average 50+%, and old forest (VSS 6) should average 60+%. Maximum opening size is up to 4 acres with a maximum width of up to 200 feet. Retain one group of reserve trees per acre of 3-5 trees per group for openings greater than 1 acre in size. Leave at least 3 snags, 5 downed logs, and 10-15 tons of woody debris per acre. In order to achieve the desired conditions of grass, forb, shrub openings created by disturbance, maintenance of one group of 3-5 leave trees when openings exceed one acre may work against that desired condition, particularly in lower productivity sites.

The primary threat to this PNVT is the lack of characteristic fire disturbance. Canopy cover is denser and more continuous across all developmental stages. The moderate threats of insects and disease are also a function of canopy cover, density, and species composition shifts. Tree density

and relative species abundance (i.e., more shade-tolerant spruce and fir species) are the primary characteristics that are departed. Older tree stages are also missing in some cases, but in others they are present but masked by the overabundance of younger trees (USFS 2008). Because there are a variety of tree species present in mixed-conifer forests, there is a corresponding variety of insects that cause damage in this forest type. On the Coconino N.F., the insects that cause the most significant damage are Douglas-fir beetle, western spruce budworm, and fir engraver (Lynch et al 2007).

Douglas-fir mortality has increased throughout the Southwestern Region during the past 5-10 years. Recent activity by Douglas-fir beetle has been primarily driven by drought conditions. During this drought period, there has been a strong pattern of Douglas-fir beetle attacks focused on large trees heavily infected with Douglas-fir dwarf mistletoe and possibly root disease. Though acreage affected by this insect on the Coconino N.F. is small with respect to the extensive mortality in ponderosa pine and piñon-juniper, resource impacts can be considerable because of the insect's preference for the largest trees, which are often highly valued (Lynch et al 2007). Continued warmer and drier conditions as a result of climate change is expected to result in increased tree mortality resulting from stress-related factors and increased insect and disease activity, which could result in uncharacteristic wildfires.

Under Alternative A, management of this PNVT is not expected to change over current levels, leading to a loss in age class diversity, increased canopy cover, loss of early successional species, and a reduction herbaceous understory, thus maintaining the current level of moderate departure and trend of static movement toward desired conditions.

Alternative B

This PNVT is accounts for approximately 2% of the Forest and is within 5 proposed Management Areas; including San Francisco Peaks (53%), Fort Valley/Mt. Elden (24%), and the Ponderosa Pine Belt (16%). There is no additional management direction for vegetation beyond that listed for this PNVT and all vegetation types above.

The majority of this PNVT is located in wilderness, on slopes over 40%, or within protected wildlife habitat. Because of these limitations and higher priority objectives, little vegetation management has occurred over the life of the current plan. Under Alternative B, management is not expected to change over current levels, leading to a loss in age class diversity, increased canopy cover, loss of early successional species, and a reduction herbaceous understory, thus maintaining the current level of moderate departure and trend of static movement toward desired conditions.

Alternatives B, C, and D

Trends for vegetation as it relates to fire and fire severity would remain static in Alternatives B, C, and D in Great Basin Grassland and Mixed Conifer with Aspen PNVTs. A static trend means that the PNVT is neither moving towards nor away from the ecological systems' characteristic fire regime.

Alternative C

Alternative C is expected to have the same effects as alternative B regarding the level of departure from desired (reference) conditions except for the following.

Alternative C differs from alternative A in the areas outside of old-growth stands. In alternative C, direction for the PNVT outside of these areas would be similar to alternatives B and D.

Recommended wilderness in alternative C would have little effect to departure on Mixed Conifer with Aspen or risk of uncharacteristic fire at the PNVT level primarily due to the small extent of this PNVT. A total of 347 acres (0.9 percent of the PNVT) of Mixed Conifer with Aspen PNVT only occurs within the Abineau recommended wilderness. Wildfires on these acres would likely be managed to meet resource objectives, if possible, and would have a low likelihood of being suppressed. However, because of limited access, it is likely that little management has occurred in this area, so pretreatment would likely be needed before fire could be used with minimal negative effects. If Abineau becomes a wilderness area, pretreatment options would be minimized to the point that an increase in tree density and canopy cover would likely continue in these acres. This analysis process is described under alternative B for Ponderosa Pine.

Alternative D

Alternative D is expected to have the same effects as alternative B for level of departure from desired (reference) conditions.

Spruce Fir Forest

Alternative A

The Spruce Fir PNVT accounts for less than 1% of the Forest and is located primarily within Management Areas that prohibit vegetation management (i.e. – Wilderness = 74% of the PNVT). Virtually no timber/vegetation management has occurred in this PNVT under the current forest plan other than Snowbowl Ski Area removing hazardous trees and expansion of ski runs in 2011.

Based on published research, Lynch (2007) states that because fire suppression and logging occur less on spruce–fir forests than other forest types, disturbance regimes observed today are probably a good reflection of what they had been in earlier historic times. There has been a shift in age class distribution in the Spruce Fir PNVT in response to large wildfires in the early 1900‘s. Spruce beetle outbreaks are typically associated with a disturbance event such as windthrow, logging slash and stand conditions conducive to support an outbreak, and with warm temperatures during the growing season. Outbreaks of spruce beetle tend occur infrequently because it prefers areas dominated by dense stands of large diameter spruce. When outbreaks do occur, their impacts can be impressive often converting Spruce Fir forests to fir-dominated forests. In 2007, there were an estimated 340 acres affected by Spruce beetle. There are an unknown number of acres affected by true fir beetles. Although reference conditions are unknown, this is considered to be within the historic range of variability because a small number of acres are affected, and insects and disease are thought to be at natural background levels for the PNVT (USDA Forest Service 2009).

The response of Spruce Fir to climate change is unclear because of the uncertainty associated with climate change. If localized warmer, drier conditions persist over time, this cold tolerant,

moisture dependent PNVT could have pronounced shifts in composition and structure due to mortality and stress. Insect and disease impacts could increase.

Based on the Minimum Criteria for the Structural Attributes Used to Determine Old-Growth Table in the current Forest Plan (as amended), a majority of this PNVT is at or approaching old conditions. Barring a major disturbance, this trend is expected to continue.

Vegetation, fire return interval, and fire severity appear to be largely functioning within the historic range of variability. This PNVT is vulnerable because it is found mainly in only one location on the Forest and under severe circumstances, could potentially be lost from the Forest (USDA Forest Service 2009).

Under Alternative A, management of Spruce Fir is not expected to change over current levels, leading to a loss in age class diversity, increased canopy cover, loss of early successional species, and a reduction herbaceous understory, thus maintaining the current moderate departure level for vegetation and trend toward desired conditions. Departures for both vegetation and fire regime are considered within the historic range of variability because the PNVT has a fire return interval of over 200 years (USDA 2009).

Alternative B

The Spruce Fir PNVT accounts for less than 1% of the Forest and is located within 2 proposed Management Areas; San Francisco Peaks (98%) and Pine Belt. No additional management direction for vegetation beyond that listed for Wilderness and all vegetation types above.

Guidelines for Spruce Fir include:

- Soil and vegetation disturbance from management activities should occur in confined, localized areas where impacts to soil condition and vegetation is minimized to maintain long-term soil productivity and continue moving the majority of the 6th code watershed towards a functioning Class 1 watershed.

The majority falls within the Kachina Peaks Wilderness Area. Virtually no timber/vegetation management has occurred in this PNVT under the current forest plan other than Snowbowl Ski Area removing hazardous trees and expansion of ski runs. Under Alternative B, management of Spruce Fir is not expected to change over current levels, leading to a loss in age class diversity, increased canopy cover, loss of early successional species, and a reduction herbaceous understory, which not outside the range of variability. This PNVT is expected to remain at the current moderate departure level and trend toward desired conditions.

Alternatives C and D

Effects of alternatives C and D are expected to be the same as alternative B for level of departure from desired (reference) conditions because all of the Spruce Fir PNVT is either in designated wilderness or Mexican spotted owl protected activity centers.

Alpine or Tundra

Alternative A

This PNVT is currently within 4 different MAs under the 1987 Plan, of which 87% is in wilderness. Other than protection, there is little to no management direction for this vegetation type.

Alpine tundra is moving away from reference conditions because the trend is towards increased meadow species and fewer talus slope species apparently due to changes in weather patterns. If localized warmer, drier conditions persist over time, this high elevation dependent PNVT could have pronounced shifts in composition and structure due to plant mortality, stress, or more shifts to meadow species. Departure is assumed to be within the historic range of variability, but changes in weather patterns are causing a shift in species composition. Alpine Tundra is vulnerable because it is found in only one location on the Forest and in the Southwestern Region of the Forest Service. In the worst case scenario, it could potentially be lost from the Forest and Region (USDA Forest Service 2009). Fire is not an ecological determinant for this PNVT.

Due to its high elevation, and lack of land area upslope, alpine tundra is uniquely susceptible to changes in climate, particularly if temperatures continue to increase. However, despite recent warming trends, repeat photography indicates tree-line elevation has been stable in both the northern Rocky Mountains of Montana and Wyoming and central Rocky Mountains of Colorado since at least the beginning of the 20th century, indicating that alpine tundra is slow to respond in spatial distribution to climate change (Smith 2006)

Alpine tundra is currently at a low level of departure and is trending away from desired conditions. Much of the trend can be attributed to climate change, which the Forest has little control over. Under current management direction the departure could rise into the moderate range, and the trend is expected to continue moving away.

Alternatives B, C, and D

All of this PNVT occurs within the San Francisco Peaks Management Area, most of which is in Kachina Peaks Wilderness. Other than protection from recreational activities, there is little to no management direction for this vegetation type. Alpine tundra is currently at a low level of departure and is trending away from desired conditions. Much of the trend can be attributed to climate change, which the Forest has little control over.

Alpine tundra is moving away from reference conditions because the trend is towards increased meadow species and fewer talus slope species apparently due to changes in weather patterns. If localized warmer, drier conditions persist over time, this high elevation dependent PNVT could have pronounced shifts in composition and structure due to plant mortality, stress, or more shifts to meadow species. Departure is assumed to be within the historic range of variability, but changes in weather patterns are causing a shift in species composition. Alpine Tundra is vulnerable because it is found in only one location on the Forest and in the Southwestern Region of the Forest Service. In the worst case scenario, it could potentially be lost from the Forest and Region (USDA Forest Service 2009). Fire is not an ecological determinant for this PNVT.

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Under these Alternatives, the departure could rise into the moderate range, and the trend is expected to continue moving away.

Sub-PNVT Tree Features

Aspen

For the Coconino NF, aspen most often occurs in small localized areas and is included with several different PNVTs, but was not included in the vegetation models because it occurs at too small of a scale for the models (USDA 2009). The 1987 Plan emphasizes a combination of wildlife habitat, visual quality, firewood production, watershed condition, and dispersed recreation with other resources and uses managed to be compatible for MA 5 (Aspen). Guidelines include establishing and maintaining stand diversity through integrated stand management (ISM) to provide suitable habitat for wildlife, while maintaining or enhancing firewood production, age class distribution, and sustained-yield of firewood using even-aged or uneven-aged silvicultural systems depending on the objectives and existing condition of the stand. Protect regenerated areas and assign no grazing capacity until seedlings are established. Protect areas or a group of areas by excluding grazing through fencing or other means where appropriate. If funding is not available for needed protection, do not harvest the area(s).

Primarily because of uncertain funding and low value of products, the Forest has been managing the aspen vegetation type on an opportunistic basis, typically including aspen treatments as part of a larger timber sale when it falls within a projects area. Grants and other outside funding opportunities have been sought to treat additional acres when not part of a larger project. Most aspen treatments have been small in scale (1-5 acres), except for fire rehabilitation, and many have been fenced to provide protection for regenerating areas. Maintenance of fencing to protect aspen from browsing until the stems are large enough to withstand pressure has proved to be a “hidden” cost that has not been funded. As markets have declined and the value of timber products has dropped, opportunities to treat aspen have lessened. Outside funding sources often only support treatment of the vegetation, but not protection. Use of volunteers to build and maintain an aspen fence is being utilized more.

Aspen communities in the southwest have been declining for decades. This decline is attributable to altered fire regimes and heavy browsing by ungulates combined with fires, insect defoliators, drought and the inability of aspen regeneration to survive browsing has resulted in conversion of aspen to coniferous forest (USDA Forest Service 2009). Aspen mortality has been greatest in the low-elevation range. During the past 5-10 years, more than half of aspen sites below 7,500 feet elevation have experienced high rates of mortality. Continued hotter and drier conditions resulting from climate change are expected to exacerbate this decline as stressed trees become more susceptible to damaging agents and mortality. Aspen at higher elevations would become increasingly susceptible and higher rates of mortality should be expected. As overstory aspen weaken and die and competition from conifers increase, successful sprouting (suckering) is expected to decline. Combined with heavy browse pressure from ungulates, aspen regeneration will become less likely to reach maturity, except within fenced areas. Extensive mortality of the established aspen component combined with an almost complete regeneration failure, indicates

that future persistence of aspen on the Coconino N.F. is not assured, except in relict locations (Lynch et al 2007). Acres of aspen qualifying as old growth are expected to experience a corresponding decline.

Alternative A

Under Alternative A, management of aspen is not expected to change over current levels, resulting in continued decline and trend away from desired conditions.

Alternatives B, C, and D

For the Coconino NF, aspen most often occurs in small localized areas and is included with several different PNVTs, but was not included in the vegetation models because it occurs at too small of a scale for the models (USDA Forest Service 2009). The following objective is listed for all vegetation types:

- Achieve 1,000 acres of aspen and maple restoration and maintenance every 10 year period during the life of the plan.

Under Alternative B, management of aspen is not expected to change over current levels, resulting in continued decline and trend away from desired conditions. However, Alternative B's focus on restoring natural processes, such as fire, to the landscape and implementation of the above objective could slow down the trend.

Aspen has been selected as an ecological indicator for Alternatives B, C, and D and is included in the monitoring program for these Alternatives.

Old growth

Please see the DEIS for analysis regarding old growth.

Climate change

Former Forest Service Chief Abigail R. Kimball has characterized the agency's response to the challenges presented by climate change as "one of the most urgent tasks facing the Forest Service." In October of 2008, the Forest Service released the Strategic Framework for Responding to Climate Change[12], which outlines seven key goals for sustaining forest and grassland resources under a changing climate (USDA 2008c). Policy outlined in this framework requires that climate change be incorporated as appropriate, into Forest Service policies, program guidance, and communications, including Land Management Plans (LMPs). One outcome of this direction, was that in January of 2009, the Washington Office, Ecosystem Management Coordination (EMC) Staff issued national direction for addressing climate change in plan revision in the paper *Climate Change Considerations in Land Management Plan Revisions* (USDA 2010a).

[12] See http://www.fs.fed.us/climatechange/documents/strategic-framework-climate-change-1-0.pdf - Accessed 8/23/2011.

Currently there appears to be broad agreement among climate modelers that the Southwestern U.S.is experiencing a drying tend that will continue well into the latter part of 21st century (Seager et al. 2007). The state of knowledge needed to address climate change at the National Forest scale is still evolving. Because none of the current climate models, including multi-model ensembles, adequately resolves important topographic variations (mountain ranges) and phenomena such as ENSO (El Niño), or the North American Monsoon, their results are imprecise and the subject of continuing research. However, these models do reproduce much of the underlying features of the Earth's climate, and their basic structure has been proven under countless experiments and forecasts of the weather systems from which climate is usually described. Therefore, these models remain a credible means of estimating potential future climate scenarios (USDA Forest Service 2010b).

A warmer climate in the Southwest is expected to affect ecosystems by altering the biotic and abiotic stresses that influence and affect the vigor of ecosystems, leading to increased extent and severity of disturbances. Decreasing water availability will accelerate the stresses experienced in forests, which typically involve some combination of multi-year drought, insects, and fire. As has occurred in the past, increases in fire disturbance superimposed on ecosystems, with increased stress from drought and insects, may have significant effects on growth, regeneration, long-term distribution, and abundance of forest species, and carbon sequestration (USDA Forest Service 2010b).

In recent years, areas of western forests have been increasingly impacted by wildfires, burning homes and wildlands, with suppression costs of more than $1 billion per year from federal land-management agencies. Since about the mid-1970s, the total acreage of areas burned and the severity of wildfires in pine and mixed-conifer forests have increased. If temperatures increase, precipitation decreases, and overall drought conditions become more common, fire frequency and severity may be exacerbated. In addition, continued population growth will likely cause greater human-started fires, since humans start nearly half of the fires in the Southwest (USDA Forest Service 2010b).

The restoration of frequent-fire forests in the western United States requires the removal of small-diameter trees either through mechanical thinning, prescribed burning, or a combination of the two. These practices; 1) temporarily lower the amount of biomass in the forest and, thus, the amount of CO^2 the forest sequesters over the short term; 2) reduce the amount of competition for precious water and nutrients, allowing the remaining trees to grow larger and, subsequently, sequester more CO^2 over the long term; 3) Produce small-diameter logs that can be used for either wood products or to produce energy; 4) produce minimal levels of emissions due to logging practices and burning (ERI Fact Sheet 2009).

While forest restoration, like all management strategies, has its advantages and disadvantages, it does two things that are vital for protecting the carbon within a forested ecosystem. It works with the ecology of the given forest ecosystem to produce a situation in which the carbon is stored in its most stable form within the vegetation and soil. It dramatically softens the effects of catastrophic disturbances (e.g., wildfires, insects, disease) and allows natural disturbances (e.g., low-intensity, ground-level fires) to play their essential role (ERI Fact Sheet 2009).

The consistently high storage and low emissions of a pre-settlement restoration treatment suggest that a low-density forest, dominated by large, fire resistant pines, may be a desired stand structure for stabilizing tree-based carbon stocks in wildfire-prone forests (Hurteau and North 2008). The balance of carbon stocks due to a restoration thinning treatment would vary based on site characteristics, tree densities, machinery used, wood utilization rates, the fate of wood products,

and the reduction in wildfire threat. However, there is potential for restoration thinning to play a beneficial role in reducing greenhouse gases when it reduces the threat of wildfire-released carbon to the atmosphere and when carbon can be stored in wood products or be used to offset fossil fuel use (Finkral & Evans 2008).

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There appears to be broad agreement among climate modelers that the Southwestern U.S. is experiencing a warming and drying trend (USDA 2010b). Also, climate scientists agree that the earth is undergoing a warming trend (USDA 2010b). There may be environmental consequences associated with climate change. Changes in temperature and precipitation affect fire regimes and behavior. Fire frequency and severity would likely increase as temperatures rise and precipitation decreases (USDA 2010b). Higher temperatures and a drier landscape increase wildfire hazard and put extra stress on ecosystems (Garfin and Lenart 2007).

Given fire regime disruption and associated degraded ecosystem structure and function, increased stress from climate change would simply compound ecosystem health problems and related issues like increased uncharacteristic fire behavior and threats to community. As we move into what is predicted to be a more fire prone environment, “it makes sense to use fire and fire-related characteristics of structure and composition to enhance resistance to loss and facilitate migration (Fule 2008).”

The environmental consequences of climate change would seem to have similar but pronounced impacts to forest health across the Alternatives. However, climate change emphasizes the need to alter forest structure (reduce departure ratings) to a greater degree to ensure sustainability in light of greater environmental stress.

With changes in climate due to increased atmospheric particulates, water supplies are projected to become increasingly scarce, calling for trade-offs among competing uses, potentially leading to conflict (USDA Forest Service 2010). Potential loss of watershed production due to uncharacteristic fire intensity would amplify this resource shortage. This consequence only amplifies the need to improve ecosystem function and move all PNVTs towards desired conditions. Without an improvement in ecosystem function, health, fire regime, etc. we are forced to accept the consequences that uncharacteristic wildfire can have on climate change.

Cumulative Effects

Cumulative effects are the consequences of foreseeable activities on non-federal lands that, in conjunction with management activities likely to occur on the Forest, may intensify, negate, improve or otherwise affect the vegetation types, habitats, and species of the Forest. Below are considerations of consequences of activities that would likely occur on adjacent or nearby ownerships to the Forest.

Cumulative effects in terms of vegetation would include timber sales, precommercial thinning, prescribed burning and other vegetation improvement projects. The geographic setting for the cumulative effects analysis would include all lands within the Forest boundary. The timeframe for past actions is 20 years and 10 years for future and foreseeable projects. These timeframes were

chosen because harvested sites have normally grown back to pre-treatment conditions within 20 years, and planning beyond 10 years is speculative.

Past vegetation growth, trends, previous management and disturbance patterns, and annual weather patterns have contributed to the current vegetative composition, structure, densities and conditions present today. Past vegetation management actions (including the lack of action) which are still contributing to effects today include the lack of thinning in the sapling, small, and medium diameter classes for many decades, giving rise to a surplus of trees that would likely continue to dominate untreated acres for several more decades. The first 10 years of the 1987 plan was driven much more by the production of forest products, and was managed largely by using even-aged silvicultural methods, such as shelterwood and seed tree cuts. The legacy of this approach is reduced structural diversity and a general deficit of large and old trees.

Recent past and present vegetation management actions on the Forest have been mostly focusing on reducing hazardous fuels and restoration of ponderosa pine toward the full range of historic variability. The 1996 Forest Plan Amendment and adoption of the Northern Goshawk Recommendations (USDA Forest Service 1992) has required the Forest to shift its timber harvest strategy to the use of more uneven-aged silvicultural systems, such as individual tree and group selection. The use of “maintenance” prescribed burning has been analyzed in most vegetation treatment environmental analyses, allowing for increased reintroduction of fire into the fire adapted vegetation types.

Current and recent analyses have put more focus on retention of large and old trees. It is generally accepted that large/old trees are deficit across the landscape in comparison to trees of other size/age. The 4FRI Stakeholder Group put together an Old Growth and Large Tree Retention Strategy (2011) where exceptions to retaining all trees larger than 16-inch d.b.h. are articulated. Because a large tree is not necessarily an old tree and an old tree is not necessarily a large tree, a diameter threshold also creates a “one-size-fits-all” guideline which can lead to treatments that are inconsistent with site-based conditions (Abella et al 2006). Adoption of the Goshawk Guidelines into the 1996 Amendment of the Forest Plan has forced Forests in Region 3 to take a harder look at retention of larger trees to achieve conditions suitable for Northern Goshawk foraging and post fledging family areas.

Future vegetation management strategies across all other National Forests within Arizona are expected to be quite similar to the actions proposed for the Coconino National Forest. They all are revising their Land Management Plans within 1-3 years of each other, using generally the same vegetation desired conditions for forest and woodland PNVTs, with uneven-aged silviculture and returning fire and other natural disturbances to their natural roles as the primary action emphases. Most, if not all, vegetation treatment projects would be planned to restore or move toward desired conditions where “old growth” is well distributed in the landscape. Both planned (prescribed) and unplanned (wildfire) ignitions are expected to continue as management strategies on the Forest.

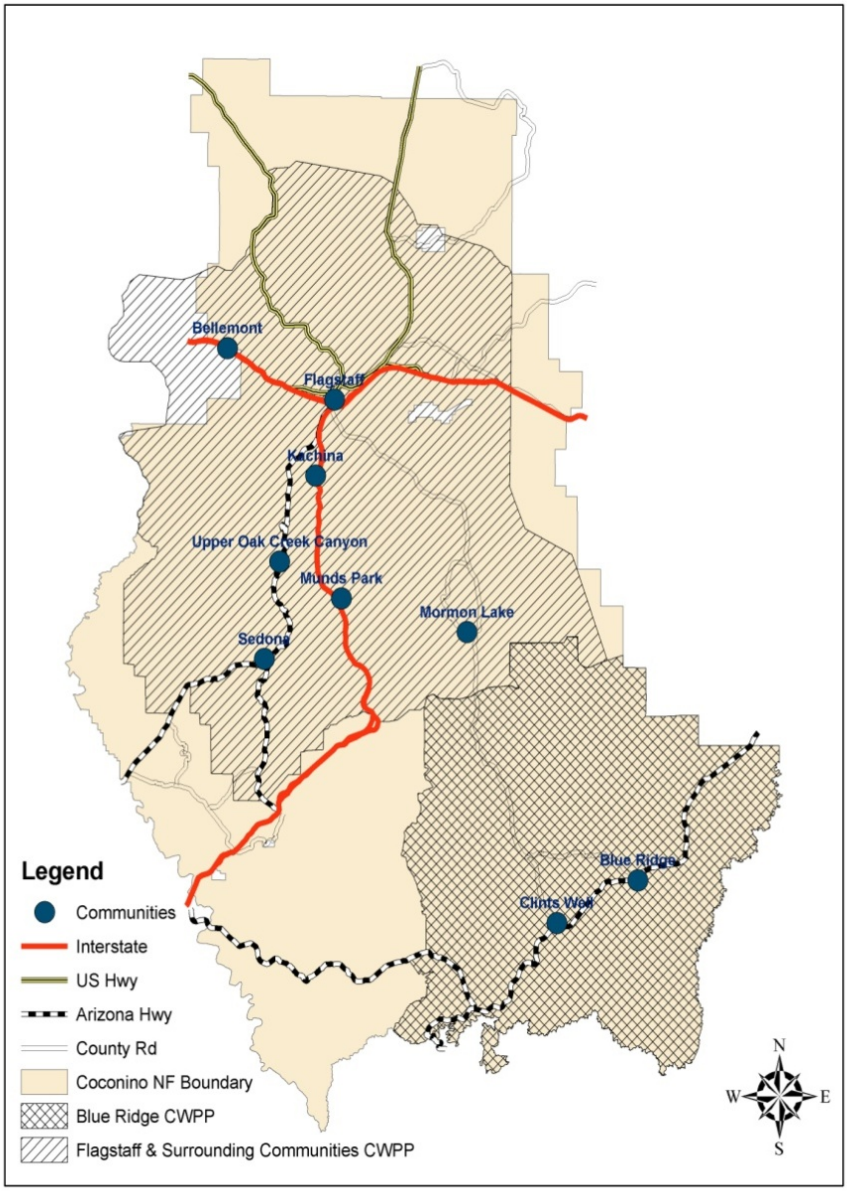
The largest near future effort would be the Four Forests Restoration Initiative (4FRI). National Environmental Policy Act (NEPA) analysis is currently underway for at least 750,000 acres of National Forest System lands across northern Arizona. Treatments are expected to focus on ecosystem restoration, primarily in the ponderosa pine forest type and would include an old growth and large tree retention strategy. Management actions associated with many future projects covered under that large-scale NEPA analysis may be implemented for the duration of this 10-15 year planning cycle.

Smoke Emissions and Wildland Urban Interface

Affected Environment

The existing condition of three PNVTs (Ponderosa Pine, Mixed Conifer with Frequent Fire and Piñon-Juniper with Grass) would be addressed in detail due primarily to their importance to our communities and their dominance of the landscape. Uncharacteristic fire behavior in these PNVTs can lead to direct loss of community infrastructure including communication, transportation, energy and water supplies. Due to limited resources for treatments and elevated values adjacent to these PNVTs, treatments have historically been accomplished almost exclusively in these PNVTs. We anticipate this trend to continue; therefore, analysis of Alternatives for PNVTs would be commensurate.

In an effort to identify and protect community infrastructure, the Healthy Forest Restoration Act (2003) called for preparation of Community Wildfire Protection Plans (CWPP) to define the WUI and establish priorities for wildfire preparedness and hazardous fuels reduction work in these areas. Currently, the Coconino NF has two CWPPs that cover over 1,494,900 acres on federal, county, state and private lands. Of this, approximately 1,304,152 acres is on Coconino NF lands. These two CWPPs are for Flagstaff and Surrounding Communities (GFFP and PFAC 2005) and Blue Ridge Area and Mogollon Ranger District of the Coconino National Forest (Gatewood and Hampton 2009). The Flagstaff CWPP includes the following communities: City of Flagstaff, Munds Park, Kachina Village, Mountainaire, Forest Highlands, Mormon Lake, Bellemont, Timberline-Fernwood, Doney Park, Lower Lake Mary, Flagstaff Ranch, Baderville-Fort Valley, Mt. Elden, Westwood, Pine Dell, Cosnino, Winona, Upper Oak Creek Canyon and Sedona. The Blue Ridge CWPP addresses the following communities: Starlight Pines, Clear Creek Pines, Blue Ridge Estates, Pine Canyon, Stoneman Lake and Clints Well.



Map 1. Map of the Flagstaff and Surrounding Communities CWPP area and Blue Ridge CWPP area boundaries

There are additional areas on the Forest that meet the Forest Service Manual (Southwest Region supplement) definition of WUI (R3 supplement 5140). For plan revision, WUI is defined as follows:

> Wildland Urban Interface (WUI) includes those areas of resident populations at imminent risk from wildfire, and human developments having special significance. These areas may include critical communication sites, municipal watersheds, high voltage transmission lines, church camps, scout camps, research facilities, and other structures that if destroyed by fire, would result in hardship to communities. These areas encompass

not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites, regardless of the distance involved. (FSM 5140.5)

Since there are several definitions of WUI (FSM 5140.5, HFRA, Wisconsin), an explicit line on a map is insufficient. Therefore, WUI is discussed further to emphasize the importance of treatment prioritization to protect associated values while acknowledging that "WUI line" (in terms of threat or risk) moves as conditions change across the landscape. For illustrative purposes, the highest priority would be termed "intensive" WUI.

First, the concept of "societal value" of a feature/value and its impact on WUI follows (Figure 4). Some features are extremely important to our communities. How difficult it is to replace these values, if lost, is also considered here. For example, water supplies, transportation and communication infrastructure are on the most intensive end of the WUI spectrum.

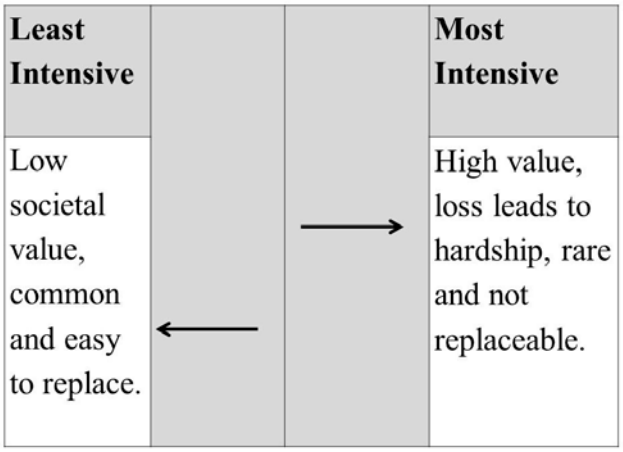


Figure 4. Illustration of WUI regarding "societal values"

Second, the concept of distance to values follows (Figure 5). This refers to the distance of values from locations on the Forest. For example, a fire located 10 miles from a given value compared to the same fire 1 mile from the same value.

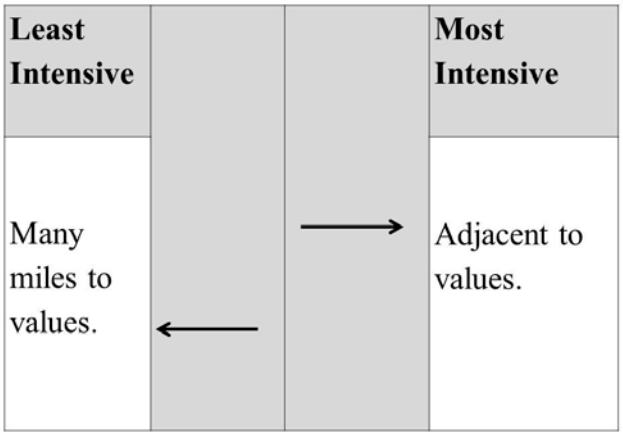


Figure 5. Illustration of WUI regarding "distance to values"

Third, the concept of juxtaposition (relative to pre-dominant winds) to values follows (Figure 6). This refers to the location, regardless of distance, of values relative to pre-dominant wind direction. The idea considers that most fires on the Forest have potential to spread rapidly to the northeast given pre-dominant southwest winds. For example, a given location 2 miles southwest of a value would be more intensive WUI relative to a location 2 miles northeast of the same value.

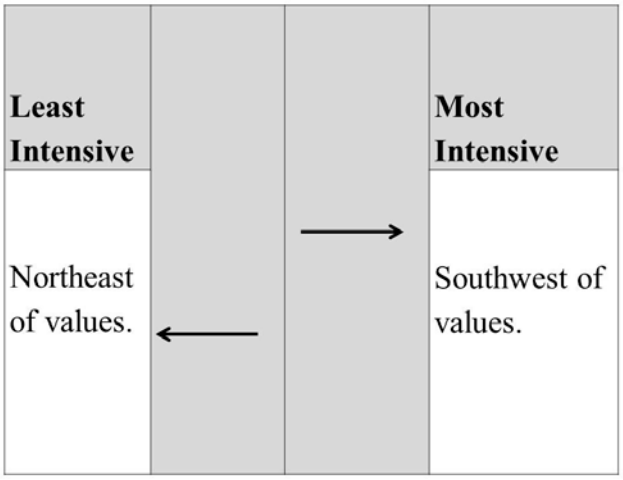


Figure 6. Illustration of WUI regarding "juxtaposition" and typical fire spread

Lastly, the concept of seasonal conditions and fire behavior potential follows (Figure 7). This refers to the fire behavior potential that varies as conditions change. For example, regardless of societal value, distance and juxtaposition, the conditions of the fuels (flammability) impact the "intensiveness" of WUI. Generally, during the most extreme fire danger (historically, around the end of June) the most intensive WUI extends very distant from values. Similarly, the WUI line moves to toward or adjacent to values when the Forest has low fire danger (snow in the winter).

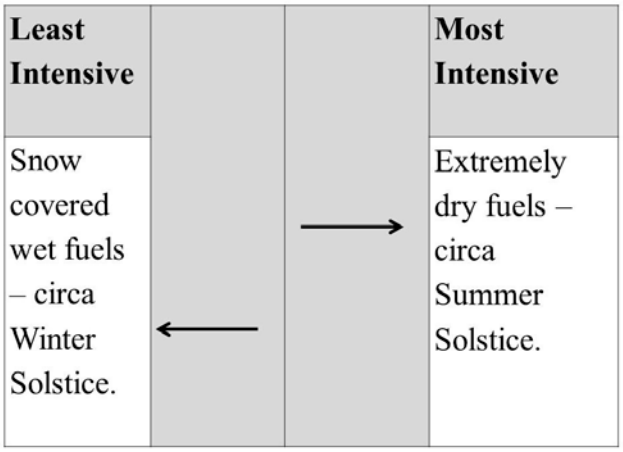


Figure 7. Illustration of WUI regarding "seasonal flammability" and fire behavior potential

The current1987 Plan does not address the hazards associated with WUI however, the Forest has placed a strong emphasis on WUI treatment since about 1998. This is particularly evident on

Coconino NF lands adjacent to Flagstaff. We acknowledge that those most intensive WUI areas are simultaneously the areas of greatest threat to our communities and those of greatest value from (and highest priority for) treatment. Desired treatment is any treatment (mechanical and/or fire treatment (preferably both)) that reduces future (generally 0-10 years) fire intensity and severity.

Environmental Consequences

Common to All

All Alternatives provide direction for fuels reduction treatments and maintenance of vegetation for those areas of resident populations at imminent risk from wildfire, as well as human developments having special significance. These wildland-urban interface areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites regardless of the distance involved.

Alternative A

Alternative A would result in less acreage treated and higher fire intensities (relative to Alternatives B, C and D) mainly due to constraints on unplanned wildfires to meet resource objectives and a lack of emphasis on fire restoration. Overall, trends for vegetation as it relates to fire and fire severity would improve in all Alternatives in Piñon-Juniper with grass, ponderosa pine[13], and mixed conifer with frequent fire PNVTs. A trend towards desired conditions means the ecological system is moving towards characteristic fire, including a reduction in severity and a reduction in the risk of uncharacteristic fire.

Alternatives B, C, and D

Given that frequent fire decreases fire behavior (and resultant severity), the Alternatives that allow for more fire treatment acres would lead to less uncharacteristic fire behavior. A PNVT's vegetative conditions and fire ecology are interrelated because the vegetation and fire co-evolved. Vegetative consequences have impacts to the fire ecology of PNVTs (especially frequent fire PNVTs) and the converse is also true. Since Alternatives B, C, and D would potentially progress the fastest toward and maintain vegetative and fire desired conditions for all PNVTs, these Alternatives would result in less departed fire conditions than Alternative A. In other words, the fire return interval, fire severity, fuels composition, and fire extent/pattern would deviate less from desired conditions under Alternatives B, D, and C, respectively, than Alternative A due to Alternative A having less mechanical and fire treatments. This would be more pronounced for the frequent fire PNVTs because more fire cycles are missed under their shorter fire return interval. Hence, there are greater departures over time in frequent fire PNVTs.

Although prescribed fire and wildfires that meet resource objectives would continue to be permissible when an area is recommended for wilderness designation, the operational decision on

[13] Implementation of the higher end of plan objectives in Alts B, C, and D would result in a trend towards desired conditions. Implementation of the lower end of plan objective would result in a trend away from desired conditions.

whether or not to suppress a fire in an inaccessible area versus letting fire play a natural role on the landscape considers other factors as well. When analyzing the environmental consequences of adding a wilderness designation to an area, several factors that could limit the ability to manage fires, and therefore, future opportunities for conducting fire treatments with wildfires that meet resource objectives, were evaluated. These factors include the continuity and availability of fuels, adjacency to and comparative size of existing wilderness, size of the recommended wilderness area, existing condition of topography and roads affecting accessibility for equipment or foot travel, and proximity to values at risk (e.g., infrastructure such as buildings, water developments, power lines). For example, although prescribed fire wildfires that meet resource objectives are authorized in wilderness areas (it is not prohibited by law or policy), it is accomplished much less frequently than in areas outside of wilderness, primarily due to threatened values. These threatened resource values (e.g., wildlife habitat, timber values, heritage resources, etc.) are much more difficult to protect due to limitations on accessibility and tools that can be used in suppression or fire management activities within the adjacent wilderness area.

When considered cumulatively, these factors help determine the potential of a recommended wilderness area to affect future fire management decisions in that area. Each potential wilderness under Alternatives B and C were ranked to get a sense of the conditions and management implications of each potential wilderness area and how wilderness recommendation would affect fire management response. A range of effects would be expected depending on the time of year and fire behavior. Generally, the higher the rating, the higher the likelihood that suppression would be the primary management response and the higher probability of high severity fire. There would also be a higher probability of adverse impacts to wilderness characteristics from fire suppression efforts. An area was ranked 0 if there would be a lower likelihood of being managed under a suppression response.

Action Alternatives (B, C and D) generally allow for more fire treatment (prescribed fire and wildfires managed for resource objectives) acres; however, this trend could be the opposite in key areas on the far southeast end of the Forest (Mogollon R.D.). These action Alternatives would designate large areas as Semi-Primitive Non-Motorized. This designation has the potential to limit mechanical and fire treatment opportunities due to restricted access. There is uncertainty as to the magnitude of impact to fire treatment in SPNM designated areas. This uncertainty is due to several factors including the following:

Future management implementation practices in SPNM areas (number and extent of road closures, number and extent of temporary roads) would impact fire treatment. Since roads are commonly used to limit the spread of wildland fire and provide firefighting access to fires, less roads means less opportunity for fire treatment.

Interpretation of “evidence of human activities” SPNM could limit fire treatment. For example, requirements to pull slash any distance from roads potentially reduces mechanical treatment of areas due to increased costs and decreased interest from contractors because these areas have more requirements to meet. The subsequent prescribed fire treatment would be reduced in a commensurate manner.

The number, timing and location of future candidate wildfires that may be managed for resource objectives are unforeseeable. Decisions may be made to avoid the use of wildland fire (and simply suppress the fires) if access or other SPNM limitations are determined to have a higher cost than potential benefit. This would depend on the number, timing and location of candidate fires.

SPNM areas can limit prescribed fire treatment opportunities in a similar manner as the use of wildland fire to meet resource objectives. Since forest roads are the most common prescribed fire area boundary, SPNM designation may limit prescribed fire treatment. Generally, the primary reasons the above items have potential to limit fire treatment is increased costs, complexity and opportunity costs.

The trends for Interior Chaparral, Piñon-Juniper Evergreen Shrub, and Spruce Fir PNVTs are trending away from desired conditions for fire severity and vegetation as it relates to fire. These would not change by Alternative. Piñon-Juniper Evergreen Shrub PNVT is adapted to mixed severity in which 25 to 75 percent of the dominant overstory is replaced. Consequently the away trend would result in a higher proportion of the PNVT burning at the higher end of the range for mixed severity fire. Interior chaparral and Spruce fir PNVTs are adapted to high severity fires in which over 75 percent overstory replacement is within the natural range of variability. Similarly, the away trends would result in a higher proportion of Interior Chaparral and Spruce Fir PNVTs burning at high severity compared to characteristic fire regimes.

Trends for vegetation as it relates to fire and fire severity would improve in Alternatives B, C, and D in Montane/Subalpine Grassland, and Semi-Desert Grassland PNVTs. A trend towards desired conditions means the ecological system is moving towards characteristic fire, including a reduction in severity and a reduction in the risk of uncharacteristic fire.

Trends for vegetation as it relates to fire and fire severity would remain static in Alternatives B, C and D in Great Basin Grassland and Mixed Conifer with Aspen PNVTs. A static trend means that the PNVT is neither moving towards nor away from the ecological systems' characteristic fire regime.

Plan objectives for prescribed burning in Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs would move fire return intervals towards desired conditions at a faster rate than in Alternative A. This is a net improvement in ecosystem processes and functions relating to fire as a natural disturbance such as understory productivity, nutrient cycling, and maintenance of open conditions. In the short term, maintenance of open conditions would slow encroachment of trees. In the long run, fire intervals that are closer to desired conditions would also promote age diversity and subdominant species such as aspen and Gambel oak.

Fire return intervals would not improve in those PNVTs with away or static trends for this characteristic. This is due to a lack of plan objectives for prescribed fire. These would include all grassland and Piñon-Juniper PNVTs as well as Mixed Conifer with Aspen and Spruce Fir. Conditions could improve with wildfires that meet resource objectives; however, location and extent of these cannot be predicted.

Alternative C

Compared to Alternative A, Alternative C would lead to less acreage treated (relative to Alternatives B and D) due to the added constraints of Special Areas and wilderness designation however the ability to treat could be easier due to fewer constraints on wildfires to meet resource objectives and a clear emphasis on fire restoration. Wilderness designation constraints to fire treatment are increased logistical complexity (access limitations) and a reduction in fire management tools (chainsaws, engines, bulldozers, aviation resources, etc.). Special Area designation (Research Natural Areas, Botanical Areas, etc.) do not explicitly prohibit fire treatment. However, these designations result in increased complexity due to added coordination requirements and competing resource objectives. For example, RNAs have ongoing research

projects that often have specific requirements (such as no fire, spring fire, fall fire, etc.) that can make fire treatment difficult or impractical. In addition, making necessary contacts to coordinate the use of wildfire to meet resource objectives in emergency timeframes is often impractical. Further, Alternative C would likely reduce mechanical treatment opportunities; therefore, potentially limit fire treatment due to stand conditions being dense and more volatile. Alternatives B and D should provide the most acreage treated and a resultant lower fire intensity (Figure 8).

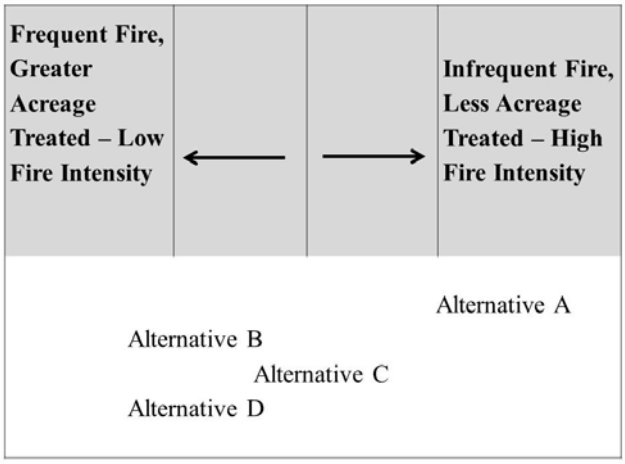


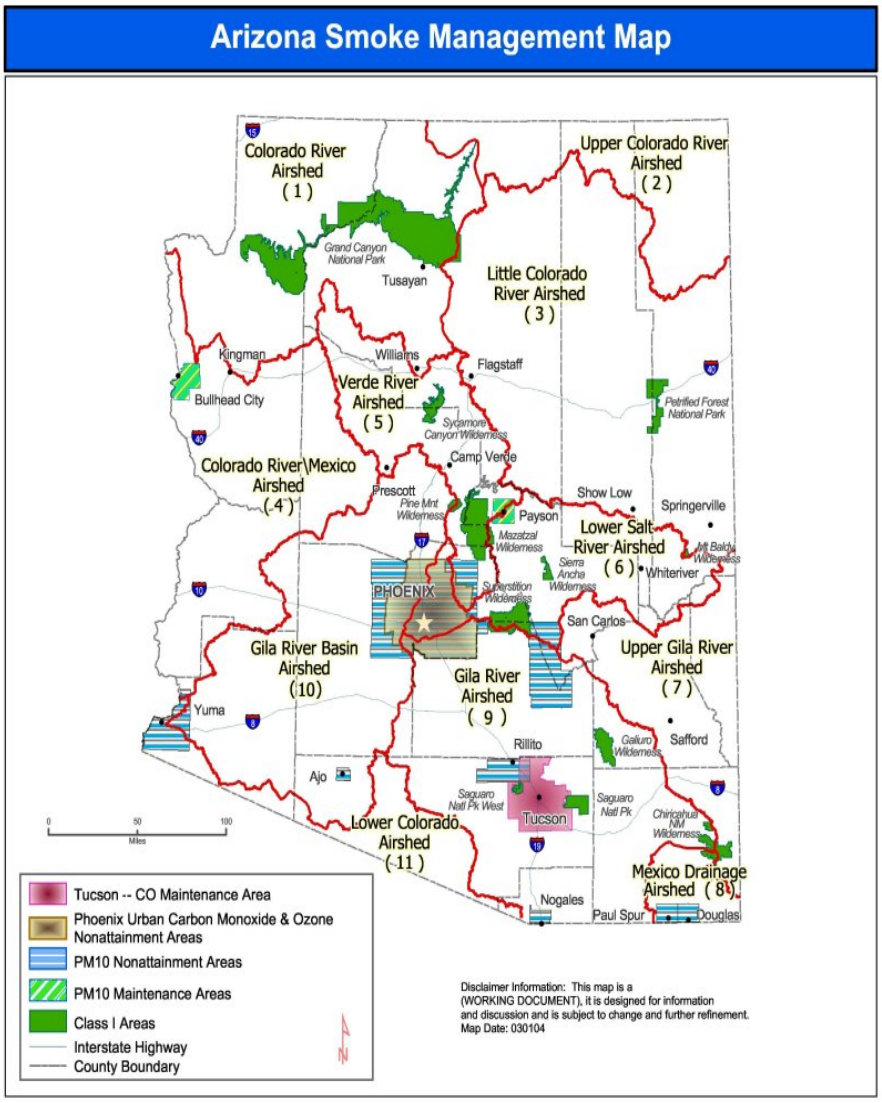
Figure 8. Illustration of potential fire behavior, due to fire frequency, by alternative

Smoke Emissions

Arizona is divided into 11 smoke management units (SMUs) (Map 2). The Coconino NF occurs within 3 units: Colorado River Airshed (1), Little Colorado River Airshed (3) and Verde River Airshed (5). The Forest's fire activity impacts the above 3 SMUs regularly. Also, we infrequently impact the Lower Salt River Airshed (SMU 6).

The current conditions of the airsheds overlapping the Forest are below the national standards for all criteria pollutants (USDA 2009). This means there is no departure in air quality related to airsheds associated with the Forest. The Arizona Department of Environmental Quality (ADEQ), Air Quality Division, considers airshed impairment across northern Arizona to be low.

Periodic prescribed burns and unplanned ignitions to meet resource objectives are tools used to decrease fuel accumulation and to restore ecosystem processes. Wildfires and prescribed burns within the planning area may produce temporary, but major, amounts of smoke, particulates, and carbon monoxide. Prescribed fires and wildfires have the potential to produce smoke that may impact air quality depending on the amount, extent, and duration. This smoke is the Forest's primary contribution to air pollution. However, only prescribed fire activity is regulated for smoke management (visibility and air pollutants).



Map 2. ADEQ Smoke Management Units

Prescribed fire activity (planned ignitions) on the Coconino NF is regulated by ADEQ. The Coconino NF uses prescribed fire to meet resource objectives. The Forest averages 19,143 acres of prescribed fire/year over the last 3 years, with the majority occurring in the ponderosa pine PNVT. The Forest's responsibility to meet air quality regulations requires coordination with the Environmental Protection Agency (EPA) and other air regulatory agencies (state, county, and tribal) including ADEQ. Coordination efforts involve managing and mitigating air pollution from Forest Service activities through adherence to state-specific regulations in addition to EPA standards. For example, the Forest works with ADEQ and follows Arizona's Forest and Range Management Burn Rule (http://www.azdeq.gov/environ/air/smoke/download/prules.pdf). The emissions from implementing any of the prescribed burns generally meet National and State Ambient Air Quality Standards because the size of the burn area and weather conditions under which burning occurs is approved by ADEQ.

Special considerations to address smoke are required when a fire is in a non-attainment area for national ambient air quality standards[14] including insuring compliance and conformity with state and tribal implementation plans. There are no nonattainment areas within SMUs 1, 3 & 5. However, there is a nonattainment area in SMU 6 southeast of the Forest around Payson, Arizona.

Particulate matter (PM) is of the primary pollutant of concern because particulate emissions in smoke can affect both visibility and human health. Particulate matter is very fine solid particles suspended in smoke and is measured as a 24 hour average. PM_{10} particles are 10 microns or less in size; $PM_{2.5}$ particles are 2.5 microns or less in size. The amount of particles present in these size classes, especially $PM_{2.5}$, is important when considering the health effects of smoke. $PM_{2.5}$ particles can become lodged in the deepest part of the respiratory system and are difficult for the body to expel. Studies indicate that 90 percent of smoke particles emitted during wildland fires are smaller than 10 microns in size (PM_{10}), and about 90 percent of PM_{10} is less than 2.5 microns in size ($PM_{2.5}$) (Ward and Hardy 1991).

The Clean Air Act of 1970 mandates that every state have a Statewide Implementation Plan to regulate pollutants. Smoke is regulated with oversight and compliance by the State of Arizona. Arizona's implementation plan requires that federal and state land management agencies submit, prior to implementation of a planned ignition: annual registrations, prescribed fire burn plans, and prescribed burn requests and obtain authorizations to burn (http://www.azdeq.gov/environ/air/smoke/download/prules.pdf).

A Class I area 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. There is one Class I area on the Forest, Sycamore Canyon Wilderness. The Coconino NF infrequently impacts this Class I area due to predominant wind patterns. However, impacts do occur. Petrified Forest National Park is a Class I area about 120 miles east of the Forest. This Class I area is very rarely impacted by fire activities on the Coconino NF due to its distance and relative location.

Wildfire events and associated poor air quality can last for weeks. For example, in 2002 the Rodeo-Chediski Wildfire burned 460,000 acres, across multiple jurisdictions, about 120 miles southeast of Flagstaff. This fire affected air quality in the communities along the Mogollon Rim for weeks. Similarly, the Wallow Fire burned in the same general vicinity and burned over one half million acres, having similar smoke impacts along the Mogollon Rim and New Mexico. These are wildfires that escaped initial attack fire suppression efforts and can be described as "undesirable" due to their uncharacteristic fire behavior and resultant fire effects, threats to community infrastructure and heavy smoke impacts. These undesirable wildfires consume much of the forest canopy as well as litter and duff on the forest floor, resulting in heavily concentrated emissions. These fires also consume fuels not typically consumed in wildland fires (outbuildings, homes, cars) due to their uncharacteristic behavior. The emissions from these non-forest fuels are very toxic. Regardless, these pollutants/emissions are beyond our Forest's control and are analogous to other events such as tornados or floods. Also, these events are unpredictable in terms of when they occur, how many would occur and size. These undesirable wildfires are different than wildfires to meet resource objectives (discussed next).

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[14] The Clean Air Act requires the Environmental Protection Agency to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment.

The Coconino NF uses unplanned wildfires to meet resource objectives. The Forest has only exercised this authority for three years and averaged about 10,000 acres per year of these fires. Because environmental factors and fire management capability vary from year to year, the acreage treated by these wildfires would vary greatly and remains unpredictable.

Other Forest activities, such as mechanical treatment, would likely reduce smoke impacts (indirectly) in the long run because they reduce the probability of undesirable wildfires. Mechanical treatments reduce a PNVTs departure by reducing tree density thereby increasing fire resilience and lower the probability of uncharacteristic fire. However, this is only true given follow-up treatment (piling and burning or just prescribed burning) to reduce the fuels activity created from mechanical treatment.

For additional analysis of the effects regarding smoke and air quality see the Air Quality Specialist Report.

The following environmental consequences are limited to the administrative boundaries of the Coconino NF and assessed in the short term (15 years) followed by the long term (50 years). The trends discussed below are similar in the short term and the long term, except for smoke impacts. Therefore, smoke impacts have a separate section to clarify the inverse relation between short and long term consequences.

It is noteworthy to state that environmental consequences are determined with a fair bit of uncertainty due to the unpredictable nature of unplanned wildfires to meet resource objectives. Since the location and timing of lightning is critical to the opportunity for large treatment acreage, estimating the opportunity gained or lost by Alternatives is imprecise.

Plan Alternatives, independent of PNVT, affect fire smoke impacts to community. The PNVTs are assessed together because vegetation type is not as important at the programmatic level as the factors below. The smoke impacts discussed below consider our actions in the short term (15 years) and then covered at the end of this section in the long term (50 years).

Since actual smoke impacts to communities are dependent on numerous unforeseeable factors such as ventilation parameters, live and dead fuel conditions, wind direction and speed, firing techniques, timing and duration of ignition and various fuel arrangements and loading, smoke impacts are related much more closely to these factors than plan Alternatives. Therefore, smoke impacts estimated below focus on trends. For this analysis, smoke impacts are assessed in terms of number of burn days and acreage burned/day (see Figure 9 &10). A factor that would have more effect on smoke impacts than burn days or acreage burned/day is “season of implementation” which greatly influences ventilation. However, the Alternatives do not impact this factor; therefore, this factor is not discussed.

The majority of the Coconino NF is comprised of frequent fire PNVTs. Therefore, smoke from fires is inevitable, regardless of fire type (unplanned wildfires or prescribed fires).

All Alternatives are expected to achieve the desired conditions for air quality: “Management activities do not exceed State or Federal emissions standards. Air quality on the Coconino NF meets state air quality standards including visibility and public health. Air quality related values, including high quality visual conditions, are maintained with the Class I Areas.”

These desired conditions pertain specifically to management activity of prescribed burning. Alternative A provides related guidance, however, does not specifically state a desired condition, standard or guideline to “not exceed State or Federal emission standards.” Regardless, Forest fire managers have and would likely continue to manage smoke to meet legal standards.

Since wildfires are natural events, they are not regulated. However, on wildfires to meet resource objectives, fire managers can greatly influence emission production by suppressing fires when small or implementing other emission reduction techniques (ERT). Some examples of ERTs used to reduce emissions includes performing burn-out operations when ventilation conditions are optimal, or limiting these operations when ventilation is poor. However, these ERTs are not typically used during undesirable uncharacteristic wildfires. During uncharacteristic wildfires, fire managers must be focused on protection of values and rarely have the luxury of addressing smoke concerns.

The amounts of smoke produced from wildfires to meet resource objectives are roughly similar between Alternatives because fire managers would strive to treat acreage as opportunities arise. And constraints like environmental and fuel conditions, fire leadership and resource availability and socio-political concerns would limit such opportunities, and do not vary across Alternatives. However, Alternatives do differ in other constraints such as added wilderness, ROS designation, and area treatment exclusions. Therefore, resultant variable smoke impact potential is discussed below.

First, Alternatives are discussed in the short term (15 years). Alternative A would have the least impacts, mainly due to constraints on wildfires to meet resource objectives and a general lack to emphasis on the ecological need of frequent fire. Alternative A explicitly prohibits wildfires to meet resource objectives in the WUI; therefore, would tend to have less smoke impacts to communities due to smoke from this type of fire being relatively more distant (spatially). Alternative A also restricts wildfires to meet resource objectives in wilderness areas to the point that the Coconino NF has not used wildfire treatment in wilderness areas.

Alternative C would have slightly more smoke impacts (than A) by not prohibiting unplanned wildfire treatment in the WUI, but fire treatment opportunities could be lessened due to wilderness, Special Area and mechanical treatment constraints discussed in previous section.

Alternatives B and D provide the greatest opportunity for fire treatment because they do not constrain unplanned wildfires to meet resource objectives and they provide emphasis on the ecological need of frequent fire. Therefore, B and D would result in more potential smoke impacts to communities in the short term. Although action Alternatives (B, C and D) have greater short-term smoke impacts than Alternative A, this trend could be the opposite in key areas on the Mogollon R.D. where areas are proposed as Semi-Primitive Non-Motorized. Since this designation has the potential to greatly limit mechanical and fire treatment opportunities due to limited access, short term smoke impacts would be reduce commensurately. Figure 9 illustrates the short term relative trends of smoke impacts to communities by Alternative.

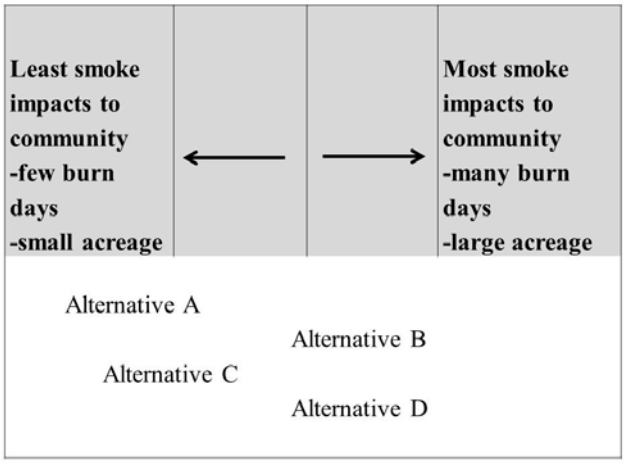


Figure 9. Illustration of short term fire smoke impacts to community by alternative

There is an inverse relationship between short term and long term smoke impacts to community. As shown above, Alternatives that reduce fire treatment also reduce short term smoke impacts. However, Alternatives that increase short term smoke impacts would likely reduce longer term impacts because uncharacteristic wildfires potential is reduced. As discussed in the Affected Environment section, these uncharacteristic wildfires produce more concentrated and toxic smoke impacts. In the long term, Alternative comparisons regarding smoke impacts are the opposite of the short term (Figure 7).

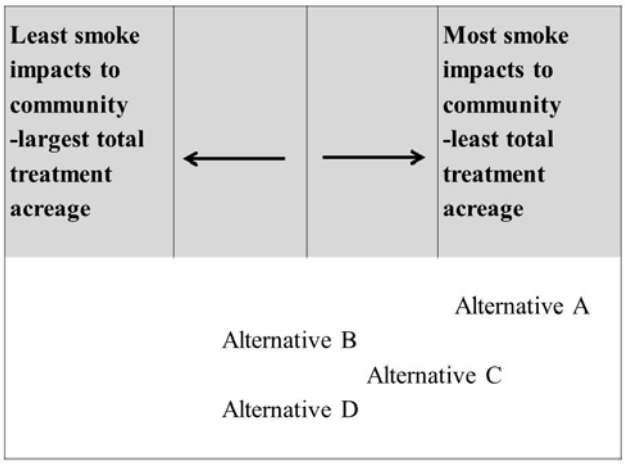


Figure 10. Illustration of long term (50 year) fire smoke impacts to community by alternative

Threat of Uncharacteristic Fire to Communities

Plan Alternatives affect the threat to community in terms of how each Alternative provides opportunity for treatment acres (Figure 11). In other words, the greater the treatment opportunity, the less the threat of uncharacteristic fire to communities. This threat is assessed, independent of PNVT, because the vegetation is simply fuel as it relates to values.

Alternative A presents the least opportunity for implementing treatments, mainly due to constraints on unplanned wildfires to meet resource objectives and a general lack of emphasis on the ecological need of frequent fire. Alternative A explicitly prohibits wildfires to meet resource objectives in the WUI.

Alternative C presents more opportunities for treatment by not prohibiting unplanned wildfire treatment in the WUI. However, the introduction of wilderness and Special Areas presents additional constraints to unplanned and prescribed fire treatment due to increased coordination needs, logistical complexity (mainly access) and a reduction in fire management tools (chainsaws, engines, bulldozers, aviation resources, etc.). Further, Alternative C may reduce mechanical treatment; therefore, potentially limit fire treatment due to stand conditions being dense and more volatile.

Alternatives B and D provide the greatest opportunity for fire treatment by explicitly stating desired conditions and the need for fire restoration. Therefore, Alternatives B and D should lead to the lowest threat to community. Although Alternatives (B, C and D have lower threat to community (compared to Alternative A), this trend could be the opposite in key areas on the Mogollon R.D. where areas are proposed as Semi-Primitive Non-Motorized (SPNM). Since this designation has the potential to limit mechanical and fire treatment opportunities and emergency fire response due to limited access, threat to community could increase. This is most notable for those communities north and east of proposed SPNM. Figure 11 illustrates the relative threat of uncharacteristic wildfire to a community, by Alternative.

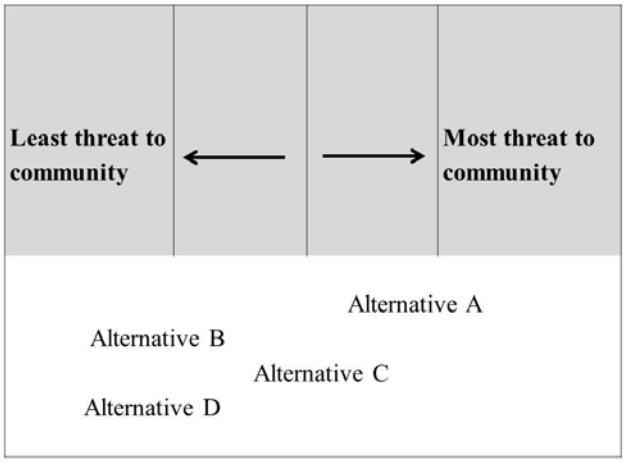


Figure 11. Illustration of threats to community by alternative

Over the last ten years on the Coconino NF, the overall threats to community have decreased with notable increases and decreases in different areas. Variance to the level of threat differs mainly as a function of the level of departure in areas described as intensive WUI in the Affected Environment section of this report. These cumulative effects are assessed here as the result of Alternative A. Areas that have experienced effective treatments (that greatly reduced departure and increased fire resilience) in intensive WUI tend to have relatively low threat levels. Examples of this include areas adjacent to Flagstaff and Mountainaire. However, areas that have not had effective treatments remain at relatively high threat levels. Of particular concern are those areas that have not received treatment and are on the intensive end of the WUI spectrum.

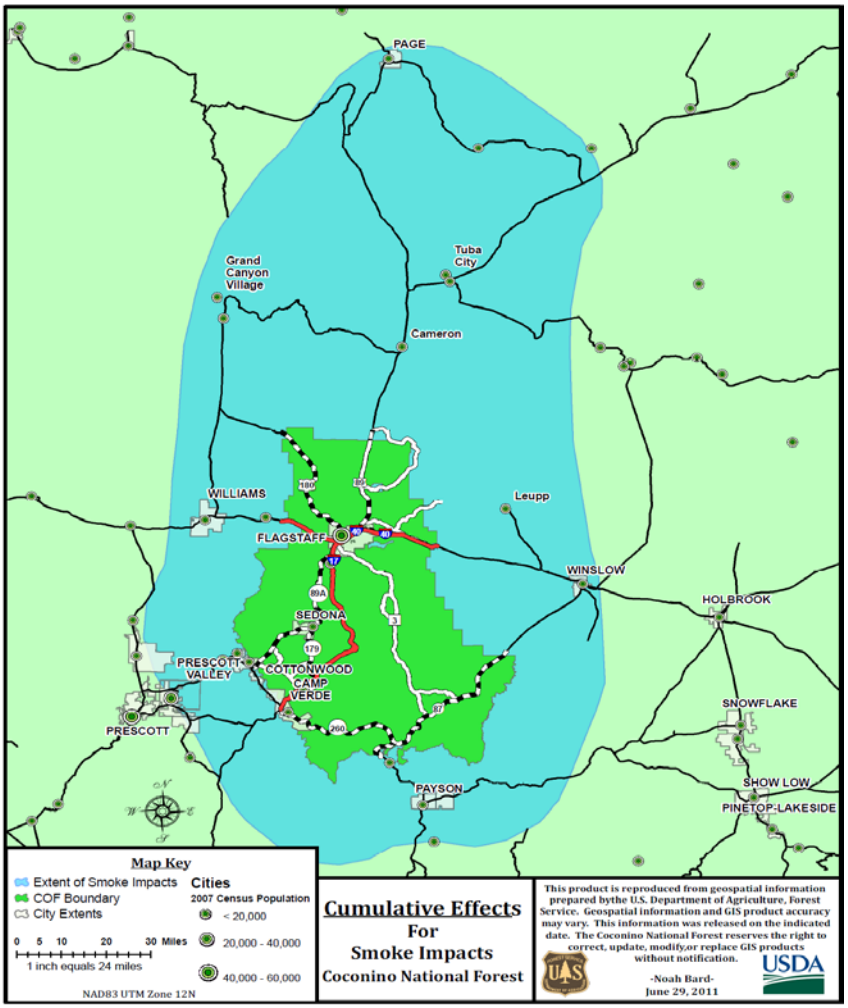
Alternatives B, C and D should reduce the threat to community due to their potential to allow for more treatment acreage. However, this is very dependent on the location of treatment areas and effectiveness/level of treatment (how much these treatments reduce departure). Alternatives B and D would reduce threat to community similarly while C would reduce this threat slightly less.

Considering the larger spatial extent (Map 3) over the last ten years, the overall threats to community has remained constant to slightly increased. Communities in this larger area have not generally received the level of treatment that decreases this threat. However, this is highly variable with different communities having increases or decreases in threat level.

Cumulative Effects

Cumulative effects to fire related to smoke impacts are examined from the standpoint of the sum of the effects of past management activities over the past 10 years on the Coconino NF. Cumulative effects are then explored in the larger spatial context of the Forest's vegetation and fire management practices to the surrounding landscape and assessed in 15 and 50 years. This larger landscape is roughly 20 miles south and west, about 30 miles east and about 100 north northeast of the Coconino NF administrative boundary (Map 3).

Since smoke impacts are transient in nature, the assessment of cumulative effects is different than other issues and resource areas. For instance, a fire smoke source can be off Forest but impact the Coconino NF. The opposite is also true. Also, the cumulative effect is not simply the addition of all emissions (burn days x acres burned/day). Cumulative effects are the concentration of all fire emissions in an airshed at a given time. Regarding NAAQS pollutants, these concentrations have a varying time weighted period depending on the pollutant. For $PM_{2.5}$ and $_{10}$, they are measured as a 24 hour average, as an annual mean. Cumulative effects from prescribed fires on Federal, State and Tribal lands are largely mitigated through implementation of the Enhanced Smoke Management Program in the SIP.



Map 3. Cumulative effects for smoke impacts

Over the last ten years on the Coconino NF, the cumulative impacts to community have only resulted in one exceedence of NAAQS. This occurred on only one monitor for one day for an exceedence in PM_{10} in Flagstaff around 2007. Our ESR (USDA Forest Service 2009) states that "air quality standards are maintained and visibility conditions are trending toward desired conditions. Under current management, airsheds that involve the Coconino are functioning and would continue to function in a way that contributes to ecosystem resiliency and diversity over time."

Future emissions from the Forest's prescribed fire activities would likely remain within legally acceptable limits in 15 and 50 years, with potential for rare exceptions. This would be due to Forest fire managers continuing practices that manage emissions and the ADEQ's regulatory efforts. Alternative impacts would likely not substantially affect future emissions relative to drivers that do not vary across Alternatives (ventilation conditions and implementation practices discussed in Affected Environment)

Across the larger extent (Map 3), state and federal jurisdictions must follow the same regulatory statutes regarding prescribed fire. Therefore, exceedence of air quality standards would likely not

occur. However, all jurisdictions would face increasing challenges of increasing the use of wildland fire treatments while managing smoke impacts.

Wildfire smoke emissions have more potential (relative to prescribed fire) to exceed state and federal standards on the Coconino NF and across the larger landscape in 15 and 50 years.

Timber Suitability

NFMA requires the agency to determine the suitability of national forest system lands for timber production, and has specific requirements for timber suitability analysis in land management plans. The agency makes a distinction between timber harvest as a resource use (hereinafter, timber production) and timber harvest as a management tool to achieve desired conditions; definitions are provided in the following discussion.

Determining Lands Tentatively Suitable for Timber Production

The general analysis process first identifies lands tentatively suitable for timber production (Youtz and Vandendriesche 2012):

- Screens are applied to identify "lands tentatively suitable for timber production." The following features are removed from the total acres of the forest (See Table 1):
    - Non-Forested Land
    - Lands where timber production would cause irreversible resource damage
    - Lands that cannot be adequately restocked
    - Lands that have been administratively withdrawn
- "Lands tentatively suitable for timber production" are then reviewed to determine whether they are "suitable for timber production" or "not suitable for timber production." These suitability determinations may vary by Forest plan Alternative. Analysis of Alternatives allows the Responsible Official to identify where timber production is compatible with the desired conditions resulting from the land management planning process. The timber production objective is defined as growing, tending, harvesting, and regenerating crops of trees on a regulated basis to produce logs or other products for industrial or consumer use [1982 rule provisions section 219.16].
- Lands are identified as "suitable for timber production" if meeting and sustaining desired conditions and objectives would involve planned, periodic timber harvest activities and also include planned regeneration of the stand. Timber production may not be a key management objective for the area. However, if periodic forest harvest and regeneration would either be consistent with or necessary for achieving and maintaining land management goals and desired conditions (fuels conditions, wildlife habitat, etc.), these lands should be classified as suitable for timber production. Designation of "Lands Suitable for Timber Production" does not imply that management would be focused on maximizing timber yields, only that periodic harvests are expected to occur as a tool for meeting land condition outcomes.
- "Lands not suitable for timber production" are determined through the Forest plan analysis of Alternatives process. These are lands where periodic timber harvest is unpredictable, unnecessary, or undesirable to achieve management goals, but harvest is

permitted where necessary to achieve plan or project-level resource objectives. Timber harvest is not scheduled as a periodic activity on these lands, and Long Term Sustained Yield Calculation (LTSYC) and Allowable Sale Quantity (ASQ) calculations do not apply.

Timber components codes (TimCo), vegetation cover type from the vegetation sites GIS layer, and existing wilderness areas were used to classify lands into the five categories of lands Not Suitable for Timber Production (Table 36). TimCos are codes assigned to each stand in the vegetation database that identify areas of suitability or non-suitability for timber management and also identify areas of management for activities other than timber management. For more detailed descriptions of TimCo codes, see the Rocky Mountain Resource Information System (RMRIS) Data Dictionary, Appendix 12, 2002). The Coconino NF has made updates to this database since the original plan was approved, where changes in management or site specific information has indicated a need to change suitability on a site specific basis based on project-level analysis.

Table 36. Categories of lands not suitable for timber production and the specific attributes used to classify these categories

Not Suitable Category	TimCo	Description
Non-Forest Lands	001	Water
	100	Water
	200	Non-Forest
	900	Non-Industrial Wood - Incapable of Producing Industrial Wood
	970	Non-Industrial Wood - Woodland Not Suited for Management
Withdrawn Lands	300	Existing Wilderness Areas
	301	Unsuitable Forest Land - Wilderness
	302	Unsuitable Forest Land - Research Natural Areas
	303	Withdrawn - Other
	400	Pending Final Legislative Action
Irreversible Resource Damage	700	Unsuitable Forest Land - Timberland
	720	Current Techniques Prevent Harvesting (e.g. Steep Slopes)
	730	Irreversible Resource Damage (e.g. Soil Loss)
	740	Lacking Response Data

Not Suitable Category	TimCo	Description
Adequate Restocking not Assured	710	Restocking Not Assured Within 5 Years (e.g. naturally open areas due to microclimates)

Table 37 lists the acres of removed from the Coconino National Forest managed land base, by land category, to determine the "lands tentatively suitable for timber production." Because the lands in these categories have physical or regulatory limitations that apply regardless of how the lands may be managed, the acres in these categories will not vary by Alternative. The next screen in this process, to determine tentatively suitable lands not appropriate for timber production, will take into account how management varies by the Alternatives being considered.

Table 37. Calculation of acres of land tentatively suitable for timber production by alternative

Land Category	Acres for all Alternatives
All Coconino NF Lands	**1,851,626**
Non forested	-992,224
Withdrawn lands	-113,857
Irreversible resource damage	-48,633
Adequate restocking not assured	-80,074
Lands Tentatively Suitable for Timber Production	**616,838**

Determining Lands Not Appropriate for Timber Production and Final Suitability by Alternative

In order to determine lands suitable for timber production, lands that are determined to be not appropriate for timber production are removed from the lands that have been identified as tentatively suitable for timber production. Areas not appropriate for timber production are those that are either not desirable or not feasible to manage for periodic harvests of forest products. Lands Not Appropriate for Timber Production include lands where Management prescriptions preclude Timber Production, Management Requirements Cannot be Met, and where it would be Not Cost efficient in Meeting Timber Objectives.

Each Alternative identified areas of land where management prescriptions precluded timber production. All Alternatives identified lands incompatible with multiple use-Critical Wildlife

Habitat-T&E Wildlife, such as Protected Activity Centers (PACs) for Mexican spotted owls (TimCo 801), lands incompatible with multiple use-Critical Wildlife Habitat-Old Growth (TimCo 803), and lands incompatible with multiple use - Experimental Forest, Range, or watershed (TimCo 810). Alternative B included the lands included in three recommended wilderness areas (TimCo 301). Alternative C included the lands included in 13 recommended wilderness areas (TimCo 301) and Old Growth (TimCo 803).

In addition, areas of land were identified as not cost efficient in meeting timber objectives due to the excessive costs (e.g. road construction) and low/negative returns associated with timber harvesting (preparation/logging costs) and removal (haul costs). These include small lands with low product value (TimCo 850), high road construction costs (TimCo 860), high logging costs (TimCo 880), and isolated patches of commercial timberland (TimCo 870). These were the same for all Alternatives.

For example, road construction costs range from $15,000-$25,000/mile compared to re-construction costs for existing roads that range between $5,000 and $8,000 per mile. Once new roads are constructed they must be either maintained at an average cost of $500-$800 per mile each decade or be obliterated and seeded at an estimated cost of $2,000 per mile. In many of these areas, harvest volumes are low and harvest preparation and logging costs are excessively high. When ground-based mechanical (tractor) logging is not feasible and other harvesting systems (e.g. cable/helicopter) are required, logging costs generally increase by 200 to 300 percent (MFPMN 2006). In areas that would have very high operating costs, regular entry for purposes of timber production is not financially feasible.

The lands “Not Appropriate for timber production varied by Alternative and the specifics are displayed in Table 38.

Table 38. Categories of not appropriate for timber production and the alternative specific attributes that would result in lands not appropriate

Category of Lands Not Appropriate for Timber Production	TimCo	TimCo Description	Areas by Alternative			
			A	B	C	D
Management Prescriptions Preclude Timber Production	800 and 801	Incompatible With Multiple Use - Critical Wildlife Habitat	MSO PACs			
	803	Incompatible With Multiple Use - Critical Wildlife Habitat - Old Growth	Allocated Developing and Existing Old Growth	NA	Allocated Developing and Existing Old Growth	NA

Category of Lands Not Appropriate for Timber Production	TimCo	TimCo Description	Areas by Alternative			
			A	B	C	D
	810	Incompatible With Multiple Use - Experimental Forest, Range, or Watershed	Same for all Alternatives			
	301	Unsuitable Forest Land - Wilderness	NA	3 Rec. Wilderness Areas	13 Rec. Wilderness Areas	NA
	302	Unsuitable Forest Land - Research Natural Areas	NA	New Research Natural Areas		
Not Cost Efficient in Meeting Timber Objectives[15]	850	Cost Efficiency - Low Product Value	Same for all Alternatives			
	860	Cost Efficiency - Road Construction Problems	Same for all Alternatives			
	870	Cost Efficiency - Isolated Patch of Forest Land	Same for all Alternatives			
	880	Cost Efficiency - High Logging Cost	Same for all Alternatives			

[15] See Financial Evaluation section that follows for additional details on cost efficiency.

Category of Lands Not Appropriate for Timber Production	TimCo	TimCo Description	Areas by Alternative			
			A	B	C	D
Lands Where Management Requirements Cannot be Met	NA					

For each Alternative:

$$\begin{aligned} &Lands\ Suitable\ for\ Timber\ Production \\ &\quad = Lands\ Tentatively\ Suitable\ for\ Timber\ Production \\ &\quad - Tentatively\ Suitable\ Lands\ Not\ Appropriate\ for\ Timber\ Production \end{aligned}$$

Acres of land not appropriate for timber production were calculated for each category by Alternative (Table 39). Negative values indicate acres not appropriate for timber production that were removed from the lands Tentatively Suitable for Timber Production.

Table 39. Calculations for acres of lands not appropriate for timber production by alternative

Land Category	Acres by Alternative			
	A	B	C	D
Tentatively suitable for timber production	616,838	616,838	616,838	616,838
Management prescriptions preclude timber production	-143,747	-80,281	-144,797	-80,281
Not cost efficient in meeting timber objectives[1]	-8,876	-8,876	-8,876	-8,876
Management requirements cannot be met	0	0	0	0
Subtotal: Not appropriate for timber production	-464,215	-89,157	-153,673	-89,157
Suitable for timber production	**464,215**	**527,681**	**463,165**	**527,681**
Not suitable for timber production	**1,387,411**	**1,323,945**	**1,388,461**	**1,323,945**

[1] See "Financial Evaluation" section that follows for additional details on cost efficiency.

Financial Evaluation

The Planning Rule provisions at Section 219.14(b) require that tentatively suitable forest lands shall be further reviewed and assessed to determine the costs and benefits for a range of management intensities for timber production. To meet this requirement the Coconino NF used the Financial Evaluation 219.14b spreadsheet (Timber Feasibility Analysis) provided by the Southwestern Regional Office that may be found in the project record. The spreadsheet incorporates information regarding harvest volumes, revenues, and costs over time to calculate the per acre present net value (PNV) and benefit/cost ratios at discount rates of 3, 4, and 7 percent (tables 40 & 41). This was completed based on the guidelines contained in Plan Alternatives for those acres identified as tentatively suitable. The results from this financial evaluation were combined with other categories that relate to lands tentatively suitable for timber production as part of the effort to determine lands suitable for timber production.

The management intensities/prescriptions applied in Alternatives and analyzed are: Free thin all sizes to target basal area (BA) of 50, group select with matrix thin to target BA of 60 (Ponderosa Pine) or 70 square feet per acre (Mixed Conifer with Frequent Fire). These intensities/prescriptions were applied to three different operational scenarios for Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs; Tractor ground – roaded, Tractor ground – unroaded, and Cable/Helicopter ground. Tractor-roaded includes all tentatively suitable acres within ¼ mile of the nearest road. Tractor-unroaded includes all tentatively suitable acres greater than ¼ mile from the nearest road. Cable/Helicopter ground includes all tentatively suitable acres on slopes greater than 40 percent.

Volumes were based on the average yield per acre from the calculations based on acres treated for the Ponderosa pine and Mixed Conifer with Frequent Fire PNVTs. Revenues per thousand cubic feet (mcf) were based on the Transaction Evidence Appraisal (TEA) Bulletin #1, Calendar Year 12, 4th Quarter (January). Costs included harvest preparation and administration, fuel treatment, stocking surveys, stand release (Rx burns), non-merchantable thins, necessary mitigation, and roads (reconstruction and maintenance). Under these cost and revenue assumptions, all estimated net revenues were negative. Management on Tractor ground – roaded produced the lowest negative (i.e. – most positive) net values. All operational scenarios produced positive benefit/cost ratios except Cable/helicopter ground.

Table 40. Per acre present net value (PNV) and benefit/cost ratios for Ponderosa Pine

Combination Free Thin-Group Selection	Percent Net Revenue	Benefit/Cost Ratio
	Tractor Ground - Roaded	
Undiscounted net revenue	-$2,938.56	0.47
PNV @ 3%	-$751.05	0.54
PNV @ 4%	-$587.56	0.56
PNV @ 7%	-$371.40	0.61
	Tractor Ground - Unroaded	
Undiscounted net revenue	-$5,207.07	0.077
PNV @ 3%	-$1,623.75	0.084
PNV @ 4%	-$1,350.51	0.086
PNV @ 7%	-$990.60	0.089
	Cable/Helicopter Ground	
Undiscounted net revenue	-$18,492.66	-0.039
PNV @ 3%	-$5,501.84	-0.046
PNV @ 4%	-$4,501.96	-0.047
PNV @ 7%	-$3,185.81	-0.051

Table 41: Per acre present net value (PNV) and benefit/cost ratios for Mixed Conifer

Combination Free Thin-Group Selection	Percent Net Revenue	Benefit/Cost Ratio
	Tractor Ground - Roaded	
Undiscounted net revenue	-$5,962.34	0.019
PNV @ 3%	-$1,766.11	0.021
PNV @ 4%	-$1,445.10	0.022
PNV @ 7%	-$1,022.66	0.024
	Tractor Ground - Unroaded	
Undiscounted net revenue	-$5,638.08	0.00059
PNV @ 3%	-$1,771.46	0.00063
PNV @ 4%	-$1,475.95	0.00064
PNV @ 7%	-$1,086.86	0.00067
	Cable/Helicopter Ground	
Undiscounted net revenue	-$19,337.16	-0.0022
PNV @ 3%	-$5,288.59	-0.0027
PNV @ 4%	-$4,312.82	-0.0028
PNV @ 7%	-$3,039.07	-0.0030

The Planning Rule Provisions at Section 219.14(c) requires a consideration of costs and benefits for Alternative management of the lands as identified in 219.14.b. Management prescriptions (in this case for timber harvest) shall be defined **to meet management objectives** for the various multiple uses including outdoor recreation, timber, watershed, range, wildlife and fish, and wilderness. It should be noted that in Alternatives B, C, and D, there are no objectives for timber output (MBF, MCF, or CCF), but there are objectives for acres of mechanical treatment. Unlike the 1987 plan, Alternatives B, C, and D are focused on *outcomes*, not *outputs*. Movement toward desired conditions and resilient landscapes is more valuable than revenue received.

Lands were identified as “Suitable for Timber Production” if achieving and maintaining the desired conditions and objectives would involve planned, periodic timber harvest activities and also include planned regeneration of the stand. Designation of “Lands Suitable for Timber Production” does not imply that management will be focused on maximizing timber yields, only

that periodic harvests are expected to occur as a tool for achieving or maintaining desired conditions (Youtz and Vandendriesche 2012).

The Plan Need for Change relative to the mechanical harvest of trees is Maintenance and Improvement of Ecosystem Health:

- Incorporate desired conditions that reflect the composition, structure, and natural disturbance attributes appropriate for the different ecosystems and that are integrated across different resource areas.

The provisions at Section 219.12(f)(8) state that each Alternative shall represent to the extent practicable the most cost efficient combination of management prescriptions examined that can meet the objectives established in the Alternative.

By producing the least negative net revenue, the combination of free thin all sizes to target BA of 50 and group selection with matrix thin to a target BA of 60 square feet per acre for Ponderosa Pine on roaded, tractor ground is the most cost efficient combination of management prescriptions (table 5).

Long Term Sustainable Yield Calculation (LTSYC)

Lands designated as suitable for timber production provide the base for calculating the LTSYC of the Forest. These lands can either be designated by mapping or they can be expressed as a percentage of the lands classed as "Tentatively Suitable for Timber Production." The latter approach assumes that within larger areas that are classed "Suitable for Timber Production", there may be scattered inclusions of areas that are more appropriately managed as "Unsuitable for Timber Production" lands.

During plan development or plan revision and, as appropriate, for plan amendment, the Responsible Official shall estimate the amount of timber that could be harvested annually in perpetuity on a sustained-yield basis from land where timber harvest could occur, once these lands are in their desired condition.

LTSY is computed based upon the premise that periodic harvest and regeneration is desired or necessary to meet land management desired conditions. Desired conditions are based upon multiple use objectives. Highest potential yield was not an objective in any Alternative. The cutting methods and silvicultural management strategy used for these calculations are consistent with the stated land management objectives.

NFMA states that the Secretary shall assure that plans for forest management provide for multiple use and sustained yield of the products and services obtained therefrom in accordance with the Multiple-Use, Sustained-Yield Act of 1960, and in particular, include coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness. ''Sustained yield of the products and services'' means the achievement and maintenance in perpetuity of a high level annually or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land. NFMA requires the Agency to estimate in the land management plan, the amount of commercial wood products that may be sustainably harvested over a long period. This sustainable harvest estimate assumes that lands are already in their desired condition. In reality, most forest lands are not in a desired condition so planners use mathematical models to estimate sustainable harvest levels, and show planned progress towards the achievement of desired conditions and LTSYC levels of harvest. Short-term harvest levels on

lands where timber production is a regular, predictable activity would tend to steadily increase or decrease until those lands are at a desired condition and then remain steady around that level.

Coconino National Forest Approach to LTSYC Analysis

Desired conditions (and their contributions to social, economic and ecological sustainability) are the vision that drives the Forest plan revision and implementation process; for example, see the following sample of citations describing the 1982 Planning Rule procedures taken from "National Forest System Land and Resource Management Planning," 36 CFR § 219 (1999):

Sec 219.11: "Forest Plan Content. The Forest Plan shall contain the following…Forest multiple-use goals and objectives that include a description of the desired future condition of the forest or grassland…."

Sec 219.1: "Purpose and principles.

- (a)(1) "The resulting plans shall provide for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long term net public benefits in an environmentally sound manner."
- (b)(1) "Establishment of goals and objectives for multiple-use and sustained-yield management of renewable resources without impairment of the productivity of the land;
- (b)(2) "Consideration of the relative values of all renewable resources, including the relationship of nonrenewable resources, such as minerals, to renewable resources;
- (b)(3) "Recognition that the National Forests are ecosystems and their management for goods and services requires an awareness and consideration of the interrelationshIps among plants, animals, soil, water, air, and other environmental factors within such ecosystems;
- (b)(4) "Protection and, where appropriate, improvement of the quality of renewable resources…."

Based upon this direction, the Southwestern Region has adopted a Regionally-consistent set of desired condition visions for Forested Potential Natural Vegetation Types (PNVTs). Due to these common desired condition visions, it is reasonable to analyze LTSYC in a consistent fashion for all Forests in the Southwestern Region. For this effort, Alternatives B and D rely on this set of desired conditions. However, Alternatives A and C differ in that they retain the old growth direction from the existing forest plan, requiring at least 20 percent of the naturally forested area by forest type in any landscape be developed to retain old growth function. Because these forested areas would be managed to retain a minimum of 20 18-inch trees per acre with at least 90 square feet of basal area per acre and 50 percent canopy cover, they were removed from the suitable timber base. Management for these conditions differs from the regionally consistent desired conditions which strive to create uneven-aged structure and maintain old growth attributes across the landscape, not just on 20 percent. The LTSYC for Alternatives A and C apply to the 80 percent not to be managed specifically for old growth. The 20 percent to be managed for old growth was removed from Suitable Timberlands and was not included in the LTSYC.

The following assumptions were used as the basis for the Coconino National Forest's LTSYC analyses for all Alternatives:

LTSYC calculations are based upon uneven-aged forest management systems for the following forest PNVTs on the Coconino National Forest:

- Ponderosa Pine Forest (PPF) and its sub-types (PP-Grass and PP-Gambel oak)
- Mixed Conifer with Frequent Fire (assumes management favors retention of shade intolerant species)
- Mixed Conifer with Aspen (assumes management favors retention of wind-firm species; Douglas-fir, Southwestern white pine, although other species are represented and desired)

The uneven-aged management strategy assumed for analysis:

- group selection cutting in mid and very large diameter states
- for Ponderosa Pine types, high site index: 5 age groups, 40-year cutting cycle, 20-year intermediate thinning, 60 basal area target matrix density target matrix[16] density varies by PNVT, for example Mixed Conifer with Frequent Fire has a 70 basal area target matrix density.

Analysis Methods used included:

- Region-wide Forest Inventory Analysis (FIA) plot data, sorted by PNVT and site index
- Forest Vegetation Simulator (FVS) – Regionally calibrated:
    - Mortality
    - Growth
    - Seen defect
    - Merchantable cubic feet volumes (5"+ d.b.h., 4" minimum top dib[17])
    - Merchantable board feet volumes (9"+ d.b.h., 6" minimum top dib)

Overview/Assumptions:

The Long Term Sustained Yield Capacity (LTSYC) is a theoretical calculation based upon achieving a "regulated[18]" uneven-aged condition across the landscape, meaning that there would be more or less balanced age classes, from young to old, at desired densities that are able to cycle through time maintaining the desired uneven-aged distribution (i.e. - even-flow). Each subsequent harvest entry (approximately every 20 years) would strive to adjust stocking levels to continue to move toward desired conditions. The LTSYC is based upon harvest volumes derived from Forest Inventory Analysis (FIA) data averaged across the Southwest Region, and the percentage of high versus low site quality index of ponderosa pine acres across the forest.

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[16] In uneven-aged silviculture, "matrix" refers to the forested area surrounding regeneration groups (group selection) that receives thinning each cutting cycle until it is time to be regenerated again. The matrix accounts for the bulk of a stand or harvest area.

[17] dib stands for Diameter Inside Bark, which provides for more accurate calculation of tree volume by subtracting bark thickness from the calculation.

[18] The technical (in contrast to the administrative and business) aspects of controlling stocking, harvests, growth, and yields to meet management objectives including sustained yield. A direct method of controlling and determining the amount of timber to be cut annually or periodically by calculations based on growing stock volume and increment. Society of American Foresters On-line Dictionary (http://dictionaryofforestry.org/dict/term/forest_regulation) accessed 11/1/2011.

Site quality (index) for ponderosa pine forest-wide was determined by looking at Field Sampled Vegetation (FSVeg) and Forest Inventory Analysis (FIA) data taken over the past decade. Using a site index of 70 (Minor) as the break between high and low sites, 1,382 out of 1,641 stands (84 percent) in FSVeg rated as high site quality, while only 62 out of 202 FIA plots (31 percent) rated as high site quality. Because of budgetary constraints, data collected for FSVeg is typically concentrated in higher site quality stands that have a greater chance for treatment on the ground. Because of this, it is believed that the FSVeg number of 84 percent is skewed to the high side. Conversely, FIA data is a much coarser sample that puts no weight on site quality, thus even unproductive timberlands are sampled. When averaged together, the high versus low site ratio is 78:22, which was rounded down to a 75 percent high site quality index across the forest. The LTSY was calculated assuming that 75 percent of the ponderosa pine type is capable of growing 22.5 cubic feet per acre per year, and 25 percent is capable of growing 15.5 cubic feet per acre per year.

Allowable Sale Quantity

The NFMA at Section 13 (Limitations on timber removal) and the 1982 Planning Rule Provisions at Section 219.16 (Timber resource sale schedule) require that timber harvest levels be based on the principle of sustained yield. Long-term sustained yield (LTSY) is the uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity that is consistent with multiple-use objectives. Allowable sale quantity (ASQ) is the quantity of timber that is planned to be sold from the suitable timberland covered by the forest plan for a time period specified by the plan. ASQ is usually expressed on an annual basis as the “average annual allowable sale quantity” because it may be exceeded in a given year as long as the 10-year average is not exceeded. ASQ and LTSYC apply only to those lands that are suitable for timber production where there is intent to have regular harvests for the purpose of producing commercial timber products, as well as management for other resource objectives.”

These provisions allow for the establishment of an ASQ to depart from (exceed) the projected LTSY provided that such planned departure is consistent with and leads to the better attainment of multiple use management objectives.

The Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs are highly departed in terms of density, structure, and susceptibility to unnaturally high-severity crown fire. To make progress toward desired conditions for the Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs timber harvest levels will have to be significantly greater than the estimated LTSY until such time as desired conditions (reduced tree density, uneven-aged structure & reduced crown fire risk) are attained. LTSY is roughly equivalent to growth/production that can be sustained over time. However, LTSY is only applicable once the desired density and structure have been achieved.

LTSY calculation guidance provided by the Southwestern Region (Youtz and Vandendriesche 2012) was used for the Coconino National Forest LTSY estimates. Table 42 displays the ASQ and LTSY for each Alternative.

Table 42. Allowable Sale Quantity and Long-Term Sustained Yield, volumes (CCF[1]) by alternative

	Alt A	Alts B & D	Alt C
Allowable Sale Quantity	84,348 CCF	194,162 CCF	194,162 CCF
Long-term Sustained Yield	102,910 CCF	114,773 CCF	100,457 CCF

[1] CCF = one hundred cubic feet

Alternative A

Alternative A is projected to be below the LTSYC (10.3 million CF/decade) for the next 5 decades. Existing forest conditions are dominated by single storied (even-aged), closed canopy states consisting of primarily medium sized (10-20 inch DBH) trees. Simulated treatments of uneven-aged group selection and free thinning were modeled using a plan objective of 10,000 acres per year. This Alternative would sustain harvests at approximately 10.3 million cubic feet per decade for the first 10 years, and then slowly decline. Not enough of the overstocked acres would be treated in the first 2 decades, which is why the sale quantity falls short of the LTSYC. The first 2 decades reduces stand densities and starts the landscape on an uneven-aged trajectory moving toward desired conditions, but not enough acres are being treated to reach the LTSY. Over the following 3 decades, structure continues to be slowly adjusted but the proportion of open, uneven-aged states remains far below the closed even-aged states. Because of existing overstocked forest condition and high level of departure, the treatment objective of 10,000 acres would not achieve the long term sustained yield or desired condition in 5 decades.

Alternatives B, C, D

Alternatives B, C, and D are projected to be well above the LTSYC (11.5 million CF/decade for B & D, and 10.05 million for Alt. C) for the next 5 decades. Existing forest conditions are dominated by single storied (even-aged), closed canopy states consisting of primarily medium sized (10-20 inch DBH) trees. Simulated treatments of uneven-aged group selection and free thinning would sustain harvests at approximately 19 million cubic feet per decade for the first 10 years, and then slowly decline. Based upon the objective of silviculturally treating 26,050 acres per year, much of the overstocked acres would be treated in the first 2 decades, which is partially why the sale quantity exceeds the LTSYC by such a large margin. The first 2 decades reduces stand densities and starts the landscape on an uneven-aged trajectory moving toward desired conditions. Over the following 3 decades, structure continues to be adjusted as the proportion of open, uneven-aged states begins to equal the closed even-aged states and the sale quantity begins to level off at about 15 million CF per decade. Because of existing overstocked forest conditions and high level of departure, it may take 80-100 years to reach regulation (Youtz and Vandendriesche 2012), and desired conditions. Suitable timberlands are currently denser, less structurally diverse, and more prone to crown fires than desired. As a result, Alternatives B, C, and D have an ASQ that is higher than LTSY. This planned departure from the LTSY will be

necessary through the next century to achieve the desired density and structure consistent with other multiple-use objectives (Figure 12).

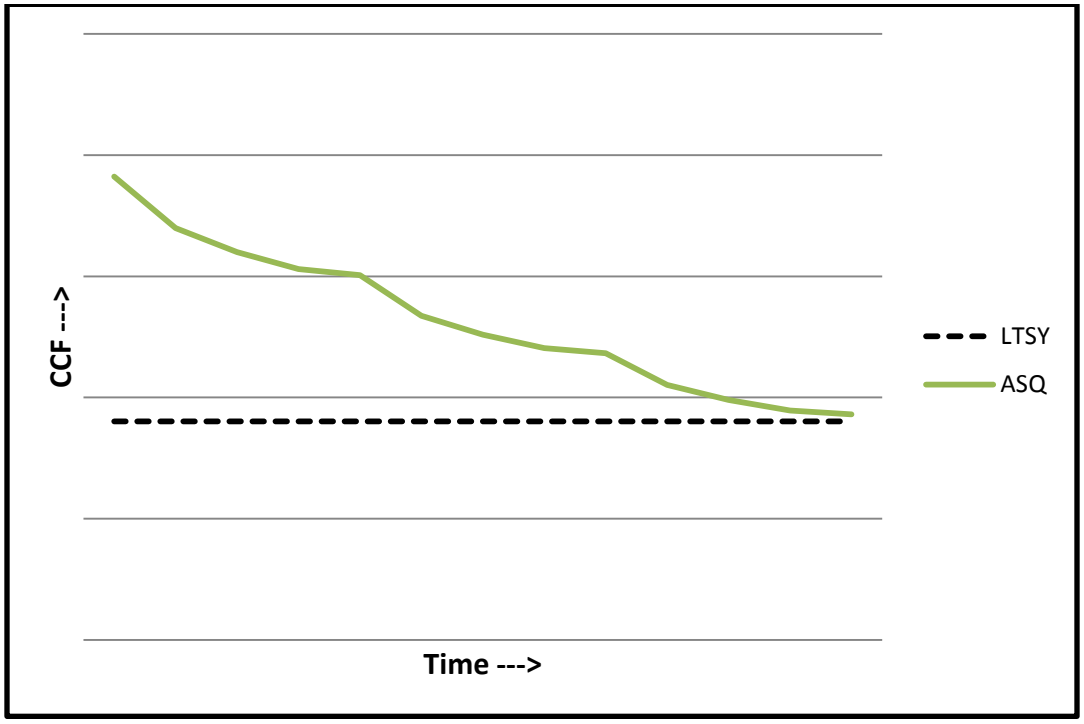

Figure 12. Pattern of Estimated Departure between ASQ and LTSY for Alternatives B, C, and D

Figure 12 assumes full capacity to implement mechanical thinning at the rate identified in the objectives in the proposed revised plan. Actual capacity may be limited due to lack of infrastructure, budget, or successful project planning. Although the estimated number of years in each phase of departure would vary depending on the actual implementation rates, the pattern is expected to remain roughly the same. The total time from plan implementation to achievement of the desired density and structure is estimated to be approximately 100 years, with a minimum of 20 years between treatments designed to achieve uneven-aged structure. Note that due to the current lack of infrastructure, the volumes during the first period may actually start below the ASQ and climb before flattening out at or near the ASQ.

Initially, the Forest would focus mechanical thinning efforts in the areas most at risk of loss. These are the areas containing the greatest percentage of dense states that are dominated by trees in the larger size classes. These states are given higher priority because they are at risk of loss from uncharacteristic high intensity wildfire, and it would take longer to replace the larger trees if they are lost (more than 100 years). The uneven-aged dense states dominated by large trees could potentially be treated to the desired open, uneven-aged state in one treatment. Once the desired density and structure is achieved, the areas would no longer contribute to the vegetative departure. Following the initial treatments in the even-aged, dense, large tree dominated sites; the desired density would be achieved. However, these areas would not have the desired uneven-aged structure, even with the new age cohort (regeneration) that would result from the initial treatment. These two-aged areas would be scheduled for additional treatments to regenerate additional cohorts, creating desired uneven-aged conditions.

Once all of the suitable areas in the dense, large tree states (H, I, L, and M) have had one treatment (minimum of 25 years), the volume would drop and stabilize for another 1 or 2 decades, even though the implementation rate for mechanical restoration would be similar to the first period. During this second phase, the original dense even-aged states would receive a second treatment establishing new regeneration, and the younger dense states (F and G) would receive their first treatments. While implementation rates are expected to be stable, lower yields would likely result because the smaller dense states yield about half the volume of the larger states and because the intensity of treatments on the second treatment of the areas in the larger states is expected to be lower than the first treatment. With a second treatment establishing a third age class, most of these stands would be in the desired uneven-aged open state and would no longer contribute to the departure.

In the third phase, the volumes would drop again to just above the LTSY level and then taper off to a zero departure, where harvest/ASQ would be equal to LTSYC. During this last phase of departure, the areas with one or two age classes would receive their final restructuring treatments to establish regeneration and reduce density which would release the largest trees (component most lacking) so that they may grow more quickly and achieve the desired larger diameters. When all suitable timberlands are in the desired open uneven-aged condition, the yield of wood produced and harvested would stabilize at the identified LTSY. All treatments thereafter would focus on maintaining the desired conditions over time, while yielding a sustainable supply of wood in perpetuity.

Note that commercial wood volume may be produced from restoration treatments or other management to meet resource objectives on non-suitable timberlands. On non-suitable timberland, mechanical thinning would only be used to achieve the desired stand structure and density. Thereafter, the desired density would be maintained with fire. There is no long-term sustained yield or allowable sale quantity assigned to non-suitable areas.

Tables 43 through 48 display ASQ calculations for the Ponderosa pine and Mixed Conifer with Frequent Fire PNVTs for the proposed revised plan (Alternative B), based on the VDDT Analysis described in the Vegetation and Fire Specialist Report (USDA Forest Service 2012).

Key for VDDT States:

- C_SMO = small, open;
- D_MOS = medium, open, single-story;
- E_VOS = very large, open, single-story;
- F_SSC = seedling/sapling, closed;
- G_SMC = small, closed;
- H_MCS = medium, closed, single-story;
- I_VCS = very large, closed, single-story;
- J_MOM = medium, open, multi-story;
- K_VOM = very large, open, multi-story;
- L_MCM = medium, closed, multi-story;
- M_VCM = very large, closed, multi-story.

Table 43: Average yield per acre (CF) in Ponderosa Pine PNVT, by prescription, by applicable VDDT state (1st decade)

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA											
5 - 9" DBH (CF) for ASQ Calcs	978,495	0	0	461,179	2,543,890	0	0	0	0	0	0
9+" DBH (CF) for ASQ Calcs	46,543	0	0	1,518,241	2,295,933	0	0	0	0	0	0
GroupSelect with matrix thin											
5 - 9" DBH (CF) for ASQ Calcs	0	272,837	0	0	0	12,337,884	116,709	454,972	97,531	6,879,111	582,667
9+" DBH (CF) for ASQ Calcs	0	1,703,726	2,108,812	0	0	57,109,524	19,747,377	8,953,357	11,759,674	44,049,577	10,159,614

Table 44: Average annual acres treated in Ponderosa Pine PNVT, by prescription, by applicable VDDT state (1st decade)

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA	2,636	0	0	479	719	0	0	0	0	0	0
GroupSelect with matrix thin	0	839	359	0	0	7,548	1,198	2,276	1,917	4,792	719

Table 45: Average annual yield (cubic feet), in Ponderosa Pine PNVT, by prescription, by applicable VDDT state

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA											
5 - 9" DBH (CF) for ASQ Calcs	97,850	0	0	46,118	254,389	0	0	0	0	0	0
9+" DBH (CF) for ASQ Calcs	4,654	0	0	151,824	229,593	0	0	0	0	0	0

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
GroupSelect with matrix thin											
5 - 9" DBH (CF) for ASQ Calcs	0	27,284	0	0	0	1,233,788	11,671	45,497	9,753	687,911	58,267
9+" DBH (CF) for ASQ Calcs	0	170,373	210,881	0	0	5,710,952	1,974,738	895,336	1,175,967	4,404,958	1,015,961

Table 46: Average yield per acre (CF) in Mixed Conifer Frequent Fire PNVT, by prescription, by applicable VDDT state (1st decade)

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA											
5 - 9" DBH (CF) for ASQ Calcs	0	0	0	0	24,029	269,848	0	0	0	0	0
9+" DBH (CF) for ASQ Calcs	0	173	0	0	266,427	454,234	0	0	0	0	0

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
GroupSelect with matrix thin											
5 - 9" DBH (CF) for ASQ Calcs	0	0	0	0	0	0	301,251	0	16,000	0	587,095
9+" DBH (CF) for ASQ Calcs	0	0	9100	0	0	0	1,736,977	658,059	66,624	638,654	3,625,981

Table 47: Average annual acres treated, in Mixed Conifer Frequent Fire PNVT, by prescription, by applicable VDDT state

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA	0	7	0	0	65	1,09	0	0	0	0	0
GroupSelect with matrix thin	0	0	29	0	0	0	2,32	43	1,01	1,74	5,51

Table 48: Average annual yield (cubic feet), in Mixed Conifer Frequent Fire, by prescription, by applicable VDDT state

	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
Free thin all sizes to target BA											
5 - 9" DBH (CF) for ASQ Calcs	0	0	0	0	2,403	26,985	0	0	0	0	0
9+" DBH (CF) for ASQ Calcs	0	17	0	0	26,643	45,423	0	0	0	0	0
GroupSelect with matrix thin											
5 - 9" DBH (CF) for ASQ Calcs	0	0	0	0	0	0	30,125	0	1,600	0	58,710
9+" DBH (CF) for ASQ Calcs	0	0	910	0	0	0	173,698	65,806	6,662	63,865	362,598

Timber Sale Schedule

The timber sale schedule for the Coconino NF is formulated to provide for a forest structure that will enable perpetual timber harvest which meets the principle of sustained-yield and multiple-use objectives of the Alternative. (1982 Planning Rule, Section 219.16 (a)(2)(iv)). For the base sale schedules, the planned sale for any future decade shall be equal to, or greater than, the planned sale for the preceding decade, provided that the planned sale is not greater than the long-term sustained-yield capacity consistent with the management objectives of the Alternative (Section 219.16 (a)(1). Alternatives with sale schedules which depart from the principles of paragraph (a)(1) of this section and which will lead to better attaining the overall objectives of multiple-use management shall be evaluated when any of the following conditions are indicated:

- (i) None of the other Alternatives considered provides a sale schedule that achieves the assigned goals of the RPA Program as provided in Sec. 219.4(b);
- (ii) High mortality losses from any cause can be significantly reduced or prevented or forest age-class distribution can be improved, thereby facilitating future sustained-yield management; or
- (iii) Implementation of the corresponding base sale schedule would cause a substantial adverse impact upon a community in the economic area in which the forest is located.
- (iv) It is reasonable to expect that overall multiple-use objectives would otherwise be better attained.

Conditions (ii) and (iv) both apply to the Coconino National Forest.

Table 14 below outlines the expected maximum harvest volumes for the Coconino NF for the 10 years following plan approval. The total of these volumes is the allowable sale quantity (ASQ). For the first decade, the ASQ is 1,941,616 CCF (hundred cubic feet).

Table 49: Expected Maximum Harvest Levels

Vegetation Type	Acres	Pulp (ccf)	Saw (ccf)	Total (ccf)
Ponderosa Pine Forest	234,823	247,253	1,594,524	1,841,777
Mixed Conifer with Frequent Fire	14,410	12,161	87,678	99,839
Totals	**249,233**	**259,414**	**1,682,202**	**1,941,616**

Relationship of Short-Term Uses and Long-Term Productivity

Modeled vegetation types within all Alternatives would move toward desired conditions by reducing the level of departure from reference conditions. At the proposed levels of treatment, each Alternative would see marked improvement over existing conditions. The rate of improvement tends to slow down for all Alternatives analyzed between 15 and 50 years, but still generally sees improvement. The only exception is with Piñon-Juniper Grasslands where level of departure starts back on a negative trend between year 15 and 50.

Unavoidable Adverse Impacts

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Before any ground-disturbing actions take place, they must be authorized in a subsequent environmental analysis. Therefore, none of the Alternatives cause unavoidable adverse impacts. Mechanisms are in place to monitor and use adaptive management principles in order to help alleviate any unanticipated impacts that need to be addressed singularly or cumulatively.

Irreversible and Irretrievable Commitment of Resources

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any ground disturbing actions, none of the Alternatives cause an irreversible or irretrievable commitment of resources.

Adaptive Management

All Alternatives assume the use of adaptive management principles. Forest Service decisions are made as part of an ongoing process. The land management plan identifies a monitoring program. Monitoring the results of actions would provide a flow of information that may indicate the needs to change a course of action or the land management plan. Scientific findings and the needs of society may also indicate the need to adapt resource management to new information.

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Specialist Information

Shawn Martin, B.S. Forest Management, Humboldt State University (1992). Professional Forester since 1995, Certified Silviculturist since 2004.

Victor Morfin, M.S. Forest Science, Northern Arizona University (1998). Forest Fuels Specialist.

Wesley Hall, M.F. Masters in Forestry, Northern Arizona University (2012). Resource Specialist Trainee.

Michael Manthei, B.S. Forest Management, Northern Arizona University. Silviculturist.

Appendix A. Executive Orders and Guides Relevant to Fire Management

Executive Orders

- Executive Order 11514: Protection and enhancement of environmental quality (35 FR 4247, March 7, 1970).
- Executive Order 11644: Use of off-road vehicles on the public lands (37 FR 2877, February 9, 1972).
- Executive Order 11988: Floodplain management (42 FR 26951, May 25, 1977).
- Executive Order 11990: Protection of wetlands (42 FR 26961, May 25, 1977).
- Executive Order 13112; Invasive Species (64 FR 6183, February 8, 1999).

Guides

- Interagency Prescribed Fire Planning and Implementation Procedures Guide, July 2008.
- Guidance for Implementation of Federal Wildland Fire Management Policy, February 13, 2009.
- Interagency Standards for Fire and Fire Aviation Operations (Red Book): USDA Forest Service Wildland Fire and Aviation Program Organization and Responsibilities, updated annually.
- Smoke Management Guide for Prescribed and Wildland Fire, 2001.

Other Plans, Guidance, and Regulations

- Arizona Administrative Code, Title 18. Environmental Quality, Chapter 2. Department of Environmental Quality Air Pollution Control, Article 15, Forest and Range Management Burns. State regulations for prescribed burning and smoke.
- "Urban Wildland Interface Communities within the Vicinity of Federal Lands That Are at High Risk From Wildfire" Federal Register Vol. 66, No. 3, 2001: List of communities in the vicinity of federal lands that are at high risk from wildfire.
- National Fire Plan, August 2000: Outlines a plan of action for federal agencies in order to protect wildland-urban interface and be prepared for extreme fire conditions.

The "Federal Wildland Fire Policy" is the principle document guiding fire management on Federal lands. The Policy was developed in 1995, and was further evaluated, and updated in the 2001 and 2003 "Review and Update of the Federal Wildland Fire Management Policy." The "Guidance for Implementation of Federal Wildland Fire Management Policy," 2009, is the accompanying document that guides implementation of the Policy.

Appendix B. Model States for the Ponderosa Pine Forest and Mixed Conifer Frequent Fire PNVTs

Table B-1. Model states for Ponderosa Pine and Mixed Conifer with Frequent Fire PNVTs

Name	Code	Description	Tree Size Class Break in Inches	Story	Tree-shrub Canopy Cover %
A	GFB/SHR	Grass, Forb, Brush/Shrub	N/A	N/A	0 - 10
B	SSO	Seedling, Sapling, Open	0 – 5	Single	10 - 30
C	SMO	Small, Open	5 – 10	Single	10 - 30
D	MOS	Medium, Open, Single story	10 – 20	Single	10 - 30
E	VOS	Very-large, Open, Single story	20 plus	Single	10 - 30
F	SSC	Seedling, Sapling, Closed	0 – 5	Single	30 plus
G	SMC	Small, Closed	5 – 10	Single	30 plus
H	MCS	Medium, Closed, Single story	10 – 20	Single	30 plus
I	VCS	Very-large, Closed, Single story	20 plus	Single	30 plus
J	MOM	Medium, Open, Multiple story and Uneven Aged	10 – 20	Multiple story and uneven aged	10 - 30
K	VOM	Very-large, Open, Multiple story and uneven aged	20 plus	Multiple story and uneven aged	10 - 30
L	MCM	Medium, Closed Multiple story	10 – 20	Multiple story and uneven aged	30 plus
M	VCM	Very-large, Closed, Multiple story	20 plus	Multiple story and uneven aged	30 plus
N	GFB/SHR	Grass, Forb, Brush/Shrub	N/A	N/A	0 - 10

Appendix C. Crosswalk between model states and vegetation structural stages

Table C-1. Crosswalk between model states for Ponderosa Pine Forest and the Mixed Conifer with Frequent Fire PNVTs and vegetative structural stages in the current forest plan

Name	Code	Description	Tree Size Class Break in Inches	Story	Tree-shrub Canopy Cover %	Approx. VSS	RM-217 Description
A	GFB/SHR	Grass, Forb, Brush/Shrub	N/A	N/A	0 - 10	VSS1	<1” dbh Grass, Forb, Shrub (opening)
B	SSO	Seedling, Sapling, Open	0 – 5	Single	10 - 30	VSS2	1-4.9” dbh Seedling, sapling
C	SMO	Small, Open	5 – 10	Single	10 - 30	VSS3	5-11.9” dbh Young Forest
D	MOS	Medium, Open, Single story	10 – 20	Single	10 - 30	VSS4	12-17.9” dbh Mid-age Forest
E	VOS	Very-large, Open, Single story	20 plus	Single	10 - 30	VSS5&6	18”+ dbh Mature & Old Forest
F	SSC	Seedling, Sapling, Closed	0 – 5	Single	30 plus	VSS2	1-4.9” dbh Seedling, sapling
G	SMC	Small, Closed	5 – 10	Single	30 plus	VSS3	5-11.9” dbh Young Forest
H	MCS	Medium, Closed, Single story	10 – 20	Single	30 plus	VSS4	12-17.9” dbh Mid-age Forest

Name	Code	Description	Tree Size Class Break in Inches	Story	Tree-shrub Canopy Cover %	Approx. VSS	RM-217 Description
I	VCS	Very-large, Closed, Single story	20 plus	Single	30 plus	VSS5&6	18”+ dbh Mature & Old Forest
J	MOM	Medium, Open, Multiple story and Uneven Aged	10 – 20	Multiple story and uneven aged	10 - 30	VSS4	12-17.9” dbh Mid-age Forest
K	VOM	Very-large, Open, Multiple story and uneven aged	20 plus	Multiple story and uneven aged	10 - 30	VSS5&6	18”+ dbh Mature & Old Forest
L	MCM	Medium, Closed Multiple story	10 – 20	Multiple story and uneven aged	30 plus	VSS4	12-17.9” dbh Mid-age Forest
M	VCM	Very-large, Closed, Multiple story	20 plus	Multiple story and uneven aged	30 plus	VSS5&6	18”+ dbh Mature & Old Forest
N	GFB/SHR	Grass, Forb, Brush/Shrub	N/A	N/A	0 - 10	VSS1	<1” dbh Grass, Forb, Shrub (opening)

Appendix D. Fire Modeling and Rationale for Using Low, Moderate, and High Weather and Fuel Moisture Conditions to Represent Wildfire Effects

Documented by Linda Wadleigh, Regional Fuels Specialist.

Former Apache-Sitgreaves Forest Fuels Specialist Dan Mindar developed low, moderate, and high fire conditions to be used in the Forest Vegetation Simulator for selected potential natural vegetation types. These conditions included fuel moistures and the weather variables of windspeed and temperature based on historical weather data for the Alpine weather station from 1990 to 2009. Mindar calculated the energy release component for the 15th, 75th and 90th percentile, a value related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire, that is commonly used as a representative of long-term drying in large fuels as the fire season progresses. The fuel and weather conditions derived from the historical weather data were then categorized into the low, moderate, and high conditions by percentile.

These low, moderate and high ranges of conditions can be used to represent prescribed fire prescriptions as well as conditions that might be experienced during an unplanned ignition or wildfire. The high conditions, namely low fuel moistures and higher windspeeds and temperatures, that occur during May and June on the Apache-Sitgreaves National Forests, also coincide with the occurrence of large (1000 acre plus and 6000 acre plus). The two fire sizes of 1000 and 6000 acres were found to be reasonable breakpoints in the fire database and thought to be large enough to allow for a variety of burn intensities and severities to occur. Most of the fires larger than 1000 and 6000 acres burned during the hottest, driest part of the fire season, when potential effects would be the most severe. In the attached graphs, ERC is used as a surrogate for fuel moistures, and the years overlain on the graphs are years that experienced multiple occurrences of large wildfires. The colored triangles display actual wildfires that started on those calendar days and eventually exceeded either 1000 or 6000 acres in size.

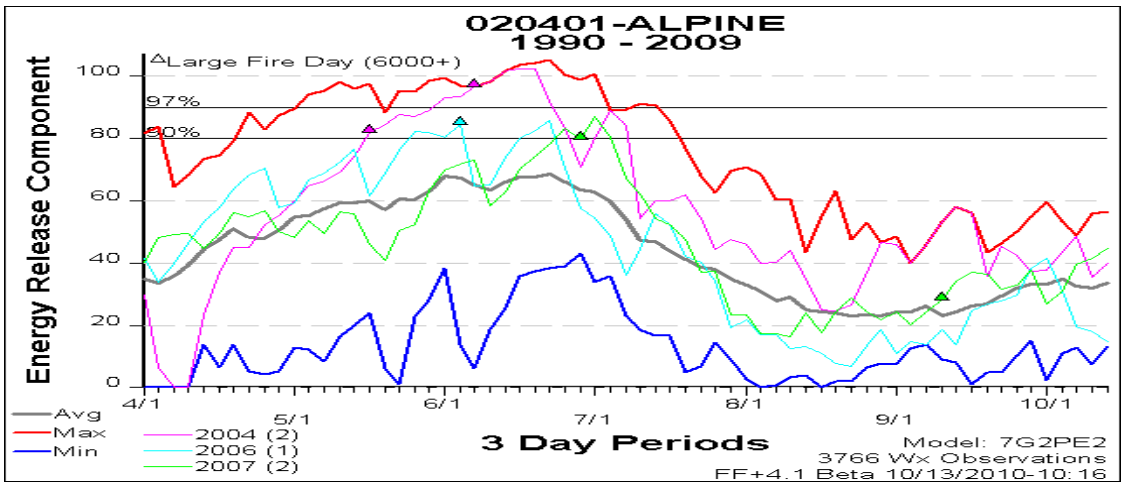

Figure D-1. Graph of Energy Release Component, Alpine Weather Station, 1990-2009

The area below the 90th percentile line on both charts displays those large fires that occurred under moderate and low conditions, suggesting conditions were not right for large fire growth,

not that fires did not occur. The area above the 90th percentile line displays fires that went over 1000 and 6000 acres and coincides with the high fire conditions.

While the fact that a fire started during higher or more extreme conditions does not mean high or extreme fire effects occurred, the resulting size of these fires and the weather and fuel conditions under which they burned provides the opportunity for a range of fire intensity and fire severity to happen.

The Forest Vegetation Simulator (FVS) (v2.02) along with the Fire and Fuels Extension (FFE) were used to simulate the effects of using fire as a restoration tool on various stand conditions. Only one fire cycled per stand was modeled, but each fire was modeled at low, moderate and high intensities. The comparative stand conditions from pre-modeled fire to post-modeled fire were then used as input to the Vegetation Dynamics Development Tool (VDDT. VDDT was used to model vegetation succession over the life of the forest plan and into the future, under the various proposed management Alternatives.

Environmental conditions used to simulate the low, moderate, and high fire conditions are based on historic weather data from the Alpine Remote Automated Weather Station (RAWS). The Alpine RAWS has the most complete and accurate data of all the weather stations on the forest. The data were sorted using Fire Family Plus (v4.1) to produce a Percentile Weather Report. This percentile report was used to determine the 15th, 75th and 90th percentile weather for the past twenty years (1990-2009). Weather data were used for a period from April 1- October 15 each year, representing a typical fire season period. The 15th percentile represents natural fire season conditions for a low intensity fire and the 75th percentile represents moderate and the 90th percentile the high intensity fire conditions (see table below).

These percentile environmental conditions were used to represent both natural fire conditions such as wildfires that may be managed to move vegetative conditions toward desired conditions, as well as burning prescriptions that may be used for management ignited prescribed fires. These environmental conditions approximate natural conditions under which a natural fire may burn and would be a good starting point for development of a management burning prescription. Winds generated from the report were unusually low, so 10, 15 and 20 mph winds were substituted for low, moderate, and high 20’ winds. The percentile weather report does not produce an air temperature, so based on analysis of the weather data and professional judgment 60, 75, and 90 degrees were used respectively. Duff moisture is also not produced by the percentile weather report. These were derived using FVS, FFE defaults for duff moisture under moist 125%, dry 50%, and very dry 15% conditions (Forest Service 2008 p. 43). Varying duff moisture had little effect in the model on fire effects on stand conditions. These conditions were used across all vegetation types to provide consistency. A cooler and moister condition at higher elevation vegetation types compared to hotter and dryer lower elevation vegetation types was not significant in model outcome.

SIMFIRE key word was used to simulate a fire event in 2009. Percent area burned were set at 60% for low, 70% moderate, and 80% for high based on experience and personal observations on fires indicating that cooler fire conditions produce more of a mosaic of burned and unburned area. (Forest Service 2008 p. 93)

MOISTURE key word was employed to set fuel moisture parameters to those indicated by the Percentile Weather Report. (Forest Service 2008 p. 90)

FIRECALC key word was used to set the model to use the new fuel model selection logic and the 40 new Scott and Burgan fuel models. This uses the latest science and model logic for selecting

fuel models based on various stand conditions and selects from the 40 fuel models giving the model greater latitude to select the most appropriate fuel model. (Forest Service 2008 p. 72)

Table D-1. Weather report

Fire Family Plus Percentile Weather Report for RERAP				
Station: 020401: ALPINE Variable ERC				
Model: 7G2PE2 Data Years: 1990 – 2009 Date Range: April 1 – October 15 Wind Directions: S, SW, W				
Percentiles, Probabilities, and Mid-Points				
3772 Weather Records Used, 2200 Days with Wind (58.32%)				
Percent Area Burned: 60 70 80				
Variable/Component Range	**Low**	**Mod**	**High**	**Ext**
Percentile Range	0-15	16-89	90-97	98-100
Climatol Probability	15	75	7	3
Mid-Point ERC	15-15	48-48	90-90	102-102
Num Observations	61	82	61	18
Calculated Spread Comp	4	10	16	16
Calculated ERC	16	49	91	103
Fuel Moistures	**Low**	**Mod**	**High**	**Ext**
1 Hour Fuel Moisture	11.17	4.46	2.42	1.55
10 Hour Fuel Moisture	15.39	6.15	2.81	1.91
100 Hour Fuel Moisture	19.11	10.39	4.36	3.37
Herbaceous Fuel Moisture	108.83	60.23	39.72	33.73
Woody Fuel Moisture	166.06	105.34	60.00	60.00
20’ Wind Speed	10	15	20	30
1000 Hour Fuel Moisture	21.81	13.95	6.06	4.33
Duff Moisture	125	50	15	8
Temperature	60	75	90	100

Appendix E. Crosswalk between VDDT states and qualitative state descriptions for various PNVTs

Table E-1. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Interior Chaparral PNVT

State (VDDT Model)	State (Qualitative)	Reference % Composition	Description, Size & Cover Class
A	Early: grass, forb	2%	Recently burned, sparsely vegetated, and all corresponding herb types
B	Early-mid: grass, shrub	5%	Grass & Shrub-Open All corresponding shrub types
C, D	Mid-Late: dense shrub, no understory	93%	Dense shrub-closed AND all tree size and cover classes

Table E-2. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Semi-Desert Grassland PNVT

State (VDDT Model)	State (Qualitative)	Reference %
A	Grass forb regeneration	24%
B	Open perennial bunchgrass	76%
C	Perennial bunchgrass w/ shrubs and trees, open canopy	0
D	Shrubs and trees w/ perennial bunchgrasses	0

Table E-3. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Great Basin Grassland PNVT

State (VDDT Model)	State (qualitative)	Reference %
A	Early development – recently burned, sparsely vegetated, open canopy	5
B	Mid development – grass, forbs, open canopy	70
C	Late development – open; some shrubs, seedlings & saplings & some mid-size trees	20
D	Mid development – some very large shrubs, closed canopy & some very large trees, open canopy	5

Table E-4. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Montane/Subalpine Grassland PNVT

State (VDDT Model)	State (Qualitative)	Reference %
A	Early development, open canopy (herbaceous vegetation)	20
B/C	Mid development, open canopy (herbaceous vegetation)	80
D	Late development, closed canopy (trees, shrubs & herbaceous vegetation)	0

Table E-5. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Piñon-Juniper PNVTs

State (VDDT model)	State (Qualitative)	Reference % PJ Evergreen Shrub	Reference % PJ Woodland (Persistent)	Reference % PJ with Grass	Size and Cover Class
A	Early Development	5%	10%	5%	Recently burned, grass, forb, and shrub types
B, E, C	Mid-Open	55%	5%	25%	Seed/sap-open Seed/sap-closed Small-open
D	Late-Open	40%	10%	50%	Medium-open, very large-open
F	Mid-Closed	0%	15%	10%	Small-closed
G	Late-Closed	0%	60%	10%	Medium-closed, very large-closed

Table E-6. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Ponderosa Pine PNVT

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
A, N	Early Development	0%	Recently burned, grass, forb, and shrub types
B, F	Early forest	1.4%	**Seed/sap-open** **Seed/sap-closed** Conditions indicative of occasional even-aged stand dynamics and the development of closed mature forest habitat. >10% tree cover
C	Young forest	1.4%	**Small-open** Conditions indicative of occasional even-aged stand dynamics and the development of closed mature forest habitat. <30% cover
D, J, E, K	Mid-age forest, Mature/old forest w/ regeneration,	88%	**Medium-open** (even & uneven-aged) **Very Large-open** (even & uneven-aged) Based on reference condition, and the predominance of uneven-aged dynamics and open forest. The plurality of stands on low-productivity sites likely to occur as Medium-open/uneven-aged, versus high-productivity sites where Very large-open/uneven-aged is more likely. <30% cover
G	Young forest,	1.4%	**Small-closed** Conditions indicative of occasional even-aged stand dynamics and the development of closed mature forest habitat. >30% cover

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
H, L, I, N	Mid-age forest, Mature/old forest w/ regeneration,	7.8%	**Medium-closed** (even & uneven-aged) **Very Large-closed** (even & uneven-aged) Conditions indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al., 2010), particularly on north facing slopes and canyons. The plurality of stands on low-productivity sites likely to occur as Medium-closed, versus high-productivity sites where Very large-closed is more likely. >30% cover

Table E-7. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for Mixed Conifer with Frequent Fire PNVT

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
A,N, B, F	Early Development, all structures	9%	**Seed/sap-open** **Seed/sap-closed** Recently burned, grass, forb, and shrub types, and conditions indicative of even-aged stand dynamics and the development of MSO habitat.
C	Mid development, open	3%	**Small-open** Reference condition, and conditions indicative of even-aged stand dynamics and the development of MSO habitat.

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
D, J, E, K	Late development, open	60%	**Medium-open** (even & uneven-aged) **Very Large-open** (even & uneven-aged) Based on reference condition, and the predominance of uneven-aged dynamics and open forest. The plurality of stands on low-productivity sites likely to occur as Medium-open/uneven-aged, versus high-productivity sites where Very large-open/uneven-aged is more likely.
G	Mid development, closed	3%	**Small-closed** Reference condition, and conditions indicative of even-aged stand dynamics and the development of MSO habitat.
H, L, I, N	Late development, closed	25%	**Medium-closed** (even & uneven-aged) **Very Large-closed** (even & uneven-aged) Conditions indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. The plurality of stands on low-productivity sites likely to occur as Medium-closed, versus high-productivity sites where Very large-closed is more likely.

Table E-8. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Mixed Conifer with Aspen PNVT

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
A	Early Development	7%	Recently burned, Grass/forb w/ aspen or oak ramets, 10-40% tree cover
B	All aspen, and evergreen-deciduous mix tree types	21%	**Seed/sap, small, medium, and very-large - all cover classes.** Aspen/mixed-aspen forest, >40% tree cover, dominated by aspen or oak, conifer understory.
C, G	Early, Mid development-	18%	**Seed/sap, small - all cover classes** **Seed/sap-open, small-open** Mixed conifer forest w/ regeneration, 20-60%+ tree cover (Shade intolerant trees)
D, H	Mid, Late Development	14%	**Medium - all cover classes** Mixed conifer forest w/ regeneration, 20-60%+ tree cover (Shade intolerant, intermediate & tolerant trees)
E, F	Late Development - closed	40%	**Very Large-closed** Mixed conifer old forest w/ regeneration, 20-60%+ tree cover. Higher proportions can be expected for associations with longer stand replacement intervals (Shade intolerant & tolerant trees)

Table E-9. Crosswalk between VDDT states and qualitative state descriptions used in alternative analysis for the Spruce Fir PNVT

State (VDDT Model)	State (Qualitative)	Reference %	Description, Size & Cover Class
A	Early Development	9%	Grass/forb seedling/sapling w/ aspen, Douglas-fir, spruce, fir. 10-40% tree cover
B	Early Forest	13%	**Seed/sap, small, medium, and very-large - all cover classes.** Grass/forb seedling/sapling w/ aspen, Douglas-fir, spruce, fir. Aspen/mixed -aspen, 0-10%
C, G	Early, Mid development-	22%	**Seed/sap, small - all cover classes** **Seed/sap-open, small-open** Conifer early forest, 10-20%. Grass/forb seedling/sapling w/ aspen, Douglas-fir, spruce, fir. Aspen/mixed -aspen early forest, 0-10%. (Shade intolerant, intermediate & tolerant trees)
D, H	Young forest with regeneration	15%	**Medium - all cover classes** (Shade intolerant, intermediate & tolerant trees)
E, F	Mature/old forest w/ regeneration	44%	**Very Large-closed** Mature/old forest w/ regeneration (Shade intolerant & tolerant trees)

Appendix F. Suitable and Non Suitable Lands for Ponderosa Pine Alternative A

Alternative A – Ponderosa Pine Lands Suitable for Timber Production

Table F-1. VDDT modeled output for Ponderosa Pine Forest PNVT on suitable timber lands

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A N	A – Grass, Forb, Brush/Shrub N – Grass, Forb, Brush/Shrub Resulting from Uncharacteristic Fire (delayed recovery time).	0.0	0.0 0.0	0.7 1.5	1.5 1.9
Sub-total (A&N):			0.0	2.2	3.4
B F	B – Seedling, Sapling, Open, SS F – Seedling, Sapling, Closed, SS	1.5	0.0 0.0	1.5 4.6	2.6 9.8
Sub-total (B&F):			0.0	6.1	12.4
C	C - Small Trees, Open	1.5	16.0	4.3	4.5
D E J K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS K – Very Large Trees, Open, MS	86.5	3.0 1.0 2.0 1.0	4.0 3.2 11.3 10.2	2.3 7.1 9.2 17.4
Sub-total (D,E,J,K):			7.0	28.7	36.0
G	Small Trees, Closed, SS	1.5	0.0	8.6	13.8
H L I M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	9.0	44.0 24.0 6.0 3.0	21.3 19.1 5.5 4.3	6.5 14.8 3.0 5.7
Sub-total (H,L,I,M):			77.0	50.2	30.0
Level of Departure[3]:		0%	83%	58%	50%

For suitable timber lands, States A and N start at or near desired conditions and are projected to trend away after the first 15 years and then continue to trend away after 50 years. This state represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. This continued increase in the grass, forb, and brush/shrub state is attributed to larger than desired openings being created as a result of wildfires and the resulting longer time period required to move back into a forested state. It is important to note that the percentage of desired regeneration openings is built into the multistoried (uneven-aged) states.

States B and F are projected to meet and then exceed desired conditions after 15 years and continue to trend away over 50 years. It is desirable to maintain a small percentage of this PNVT in an even-aged state through time to provide additional diversity and future habitat needs, but treatment levels are unable to move enough area towards larger trees and more desired uneven-aged states. Because of both overstory and understory densities, seedlings and saplings tend to get delayed as competition continues to increase.

State C is projected to approach desired conditions after 15 years and then remain static after 50 years. It is desirable to maintain a percentage of small trees in an open, even-aged state to provide for additional diversity and future habitat needs (i.e. - States H & L), but treatment levels are unable to move enough area towards the more desired uneven-aged states.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to increase fourfold after 15 years. The positive trend continues toward the desired condition after 50 years, but treatments do not occur at a large enough level to achieve desired conditions across the landscape. More acres need to be treated, particularly those dominated by smaller trees with single-storied, closed canopy conditions.

State G reflects the percentage of early-mid seral forest necessary to sustain mature closed forest condition (States H, L, I, and M) as northern goshawk nesting habitat, as well as other species that rely on similar stand attributes. This state is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. But after 50 years the negative trend continues, although at a slower pace. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to reverse the trend.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A positive trend of reducing these states was established over the first 15 years and significant progress continues over 50 years, but the amount of area treated is unable to achieve desired conditions. However, the combination of these states is projected to be reduced by more than 50% after 50 years.

Management of suitable timberlands with this Alternative makes the greatest contribution to reducing the overall departure and moving toward desired conditions in the Ponderosa Pine PNVT. After 15 years, suitable timberlands are projected to improve from high to moderate departure. After 50 years, the level of departure improves, falling into the lower range of moderate. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory by increasing in the amount of area occupied, with more than desired in closed canopy states. Movement of medium and larger sized trees would progress toward desired

conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Table F-2. VDDT modeled output for Ponderosa Pine Forest PNVT on suitable timber lands

State	Description	Desired %	Current %	Year 15 %	Year 50 %
D	D – Medium Trees[1], Open, SS	86.5	3.0	4.0	2.3
E	E – Very Large Trees[2], Open, SS		1.0	3.2	7.1
J	J – Medium Trees, Open, MS		2.0	11.3	9.2
K	K – Very Large Trees, Open, MS		1.0	10.2	17.1
			7.0	28.7	35.7
H	H – Medium Trees, Closed, SS	9.0	44.0	21.3	6.5
L	L – Medium Trees, Closed, MS		24.0	19.1	14.8
I	I – Very Large Trees, Closed, SS		6.0	5.5	3.0
M	M –Very Large Trees, Closed, MS		3.0	4.3	5.7
			77	50.2	30.0
Total Area Represented:		95.5	84.0	78.9	65.7

[1] Medium Size Trees = 10-20” DBH

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K represent the medium and very large tree size classes dominated by open canopy and uneven-aged structure, and where the largest percentage of area is desired, are projected to quadruple after 15 years. In particular, States J and K are projected to account for the large majority of this trend, which means that much more area would be represented by very large tree states that are under less competition and free to grow. Very large tree stands increase from approximately 2% to 13%, and uneven-aged, medium sized tree stands see a similar increase. This positive trend continues toward desired conditions after 50 years, but is projected to slow by year 50. However, the area occupied increases 5 times over the current level.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. There is currently a huge surplus of stands across the landscape in these states, particularly even-aged stands dominated by medium sized trees. A positive trend of reducing these states was established over the first 15 years and significant progress continues over 50 years. The largest reduction was seen in State H, where single storied, closed canopy medium size tree classes were significantly reduced. Also worthy of note is that very large trees

in State M are projected to increase in area over 50 years, as uneven-aged structure is emphasized.

Management of suitable timberlands makes a large contribution to improving the representation of medium and very large trees across the landscape and moving toward desired (reference) conditions. Area of medium and very large tree classes in multi-storied, open canopy conditions would progress significantly toward desired conditions. Very large trees in all states would increase except for even-aged with closed canopy, which is attributed to treatments moving them into the open canopy state.

Alternative A – Ponderosa Pine Lands Not Suitable for Timber Production

Table F-3. VDDT modeled output for Ponderosa Pine Forest PNVT on non-suitable timberlands

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A N	A – Grass, Forb, Brush/Shrub N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).	0.0	1.0 1.0	1.2 1.9	1.5 2.7
	Sub-total (A&N):		2.0	3.1	4.2
B F	B – Seedling, Sapling, Open, SS F – Seedling, Sapling, Closed, SS	1.5	0.0 0.0	1.3 5.8	1.7 9.0
	Sub-total (B&F):		0.0	7.1	10.7
C	Small Trees, Open	1.5	24.0	6.0	2.9
D E J K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS K – Very Large Trees, Open, MS	86.5	9.0 1.0 5.0 1.0	5.1 3.1 4.5 1.5	2.4 7.9 4.8 3.6
	Sub-total (D,E,J,K):		16.0	14.2	18.7
G	Small Trees, Closed, SS	1.5	0.0	13.2	16.2
H L	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS	9.0	34.0 18.0	24.6 21.6	11.9 21.8

State	Description	Desired %	Current %	Year 15 %	Year 50 %
I	I – Very Large Trees, Closed, SS		4.0	6.2	6.1
M	M –Very Large Trees, Closed, MS		2.0	4.0	7.7
	Sub-total (H,L,I,M):		58.0	56.4	47.5
Level of Departure$_3$:		0%	74%	72%	68%

States A and N are currently departed above desired conditions and are projected to move further away after the first 15 years and then continue to trend away after 50 years. This state represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. This continued increase in the grass, forb, and brush/shrub state is also attributed to larger than desired openings being created as a result of wildfires and the resulting longer time period required to move back into a forested state.

States B and F are projected to meet and then exceed desired conditions after 15 years and continue to trend away over 50 years. This trend is similar to suitable timberlands. It is desirable to maintain a small percentage of this PNVT in an even-aged state to provide additional diversity and habitat needs, but treatment levels are unable to move enough area towards desired open, uneven-aged states.

State C is projected to move dramatically toward desired conditions after 15 years and then slow down the rate of progress, but continue on a positive trend after 50 years. This trend is also similar to suitable timberlands. It is desirable to maintain a percentage of small trees in an open, even-aged state to provide for additional diversity and habitat needs, but treatment levels are unable to move enough area towards the more desired uneven-aged states.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to decline a little after 15 years. The negative trend begins to reverse and move slightly back toward the desired condition after 50 years. However, the major gains in these states primarily occur within suitable timberlands that have a higher level of treatment. Canopy cover continues to close, regeneration opportunities continue to shrink, and even-aged conditions are maintained. More acres dominated by smaller trees with single-storied, closed canopy conditions need to be treated. In addition, little to no reduction of the overstory is leading to stagnation and reduced growth across all age/size classes.

State G reflects the percentage of early-mid seral forest necessary to sustain mature closed forest condition (States H, L, I, and M) as northern goshawk nesting habitat, as well as other species that rely on similar stand attributes. This state is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small and medium sized tree stands trees from open to closed canopy conditions. Not enough of the middle and larger sized trees are being treated to allow for smaller trees to advance, leading to stagnation and more even-aged conditions. After 50 years the negative trend continues, although at a slower pace. This trend is similar to suitable timberlands, but at an increased rate. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to reverse the trend.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2009), particularly on north facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A slight positive trend of reducing these states was established over the first 15 years and minor progress continues over 50 years, but the amount of area treated is still unable to achieve desired conditions. This state starts moderately departed and closer to the desired condition than suitable timberlands, but is projected to remain moderately departed

Management of non-suitable timberlands with this Alternative makes only a minor contribution to reducing the overall departure and moving toward desired (reference) conditions. While some improvement is achieved, the level of departure is projected to remain high over the next 50 years. Because too few acres and comparatively little of the overstory are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress slightly toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health within non-suitable timberlands, there would continue to be more area of even-aged, closed canopy forest than is desired.

Table F-4. VDDT modeled output for Ponderosa Pine Forest PNVT on non-suitable timberlands

State	Description	Desired %	Current %	Year 15	Year 50
D,E,J,K	D – Medium Trees[1], Open, SS E – Very Large Trees[2], Open, SS J – Medium Trees, Open, MS K – Very Large Trees, Open, MS	86.5	9.0 1.0 5.0 1.0	5.1 3.1 4.5 1.5	2.4 7.9 4.8 3.6
			16.0	14.2	18.7
H, L, I, M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	9.0	34.0 18.0 4.0 2.0	24.6 21.6 6.2 4.0	11.9 21.8 6.1 7.7
			58.0	56.4	47.5
Total Area Represented:		95.5	74.0	70.6	66.2

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which represent the medium and very large tree size classes dominated by uneven-aged structure, and where the largest percentage of area is desired, are projected to double after 15 years. This positive trend continues toward the desired condition after 50 years, but at a reduced pace because treatments do not occur over a large enough area to achieve desired conditions across the landscape. More acres need to be treated, particularly those dominated by smaller trees with single-storied structure and closed canopy conditions to facilitate growth and uneven-aged structure.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. The area currently occupied by this combination of states reflects the current condition of dense, overstocked stands across the landscape. A positive trend of reducing these states was established over the first 15 years and progress continues over 50 years. As with suitable timber lands, the largest reduction was seen in State H, where single storied, closed canopy, medium size tree classes were significantly reduced. Very large trees in State M are projected to increase in area over 50 years, but the amount of area treated is still unable to fully achieve desired conditions.

Management of non-suitable timberlands with this Alternative makes some contribution to improving the representation of large trees across the landscape and moving toward desired conditions. Because too few acres and comparatively little of the overstory is being treated, the trend of medium and larger sized trees would increase toward desired conditions. Medium tree stands in closed canopy states would decline, particularly the even-aged. Very large tree stands increase in all states except even-aged closed canopy, which remains static, over 15 and 50 years. Appendix G. Suitable and Non Suitable Lands for Ponderosa Pine Alternative B.

Alternative B – Lands Suitable for Timber Productions

Table G-1. VDDT modeled output for Ponderosa Pine Forest PNVT on suitable timber lands – alternative B

State	Description	Desired %	Current %	Year 15	Year 50
A N	A – Grass, Forb, Brush/Shrub N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).	0.0	0.0 0.0	1.0 1.2	1.7 1.5
	Sub-total:		0.0	2.2	3.2
B F	B – Seedling, Sapling, Open, SS[1] F – Seedling, Sapling, Closed, SS	1.5	0.0 0.0	2.3 5.5	3.5 9.6
	Sub-total:		0.0	7.8	13.1
C	Small Trees, Open	1.5	16.0	4.6	5.7
D E J K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS[2] K – Very Large Trees, Open, MS	86.5	3.0 1.0 2.0 1.0	4.0 3.0 18.5 18.4	3.6 6.3 11.8 26.1
	Sub-total:		7.0	43.9	47.8
G	Small Trees, Closed, SS	1.5	0.0	7.4	11.4
H L I M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	9.0	44.0 24.0 6.0 3.0	12.6 14.8 3.5 3.3	3.3 10.0 1.0 4.6
Sub-total:			77.0	34.2	18.9
Level of Departure[3]:		0%	83%	44%	39%

[1] SS = Single story (Even-aged).

[2] – MS = Multiple Story (Uneven-aged).

[3] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

For suitable timber lands, States A and N start at or near desired conditions and are projected to trend away after the first 15 years and then continue to trend away after 50 years. This state represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. This continued increase in the grass, forb, and brush/shrub state is attributed to larger than desired openings being created as a result of wildfires and the resulting longer time period required to move back into a forested state. It is important to note that the percentage of desired regeneration openings is built into the multistoried (uneven-aged) states.

States B and F are projected to meet and then exceed desired conditions after 15 years and continue to trend away over 50 years. It is desirable to maintain a small percentage of this PNVT in an even-aged state through time to provide additional diversity and habitat needs, but treatment levels are unable to move enough area towards desired uneven-aged states.

State C is projected to approach desired conditions after 15 years and then remain static after 50 years. It is desirable to maintain a percentage of small trees in an open, even-aged state to provide for additional diversity and habitat needs, but treatment levels are unable to move enough area towards the more desired uneven-aged states.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to increase threefold after 15 years. The positive trend continues toward the desired condition after 50 years, but treatments do not occur at a large enough level to achieve desired conditions across the landscape. More acres need to be treated, particularly those dominated by smaller trees with single-storied, closed canopy conditions.

State G reflects the percentage of early-mid seral forest necessary to sustain mature closed forest condition (States H, L, I, and M) as northern goshawk nesting habitat, as well as other species that rely on similar stand attributes. This state is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. But after 50 years the negative trend continues, although at a slower pace. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to reverse the trend.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A positive trend of reducing these states was established over the first 15 years and significant progress continues over 50 years, but the amount of area treated is unable to achieve desired conditions. However, this state is projected move from a high level of departure to moderate after 15 years, then to low after 50 years.

Management of suitable timberlands with this Alternative makes the greatest contribution to reducing the overall departure and moving toward desired () conditions. After 15 years, suitable timberlands are projected to improve from high to moderate departure. After 50 years, the level of departure improves to the lower range of moderate. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall

ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Lands Suitable for Timber Production

Table G-2. VDDT modeled output for Ponderosa Pine Forest PNVT on suitable timber lands – alternative B

State	Description	Desired %	Current %	Year 15	Year 50
D	D – Medium Trees[1], Open, SS	86.5	3.0	4.0	3.6
E	E – Very Large Trees[2], Open, SS		1.0	3.0	6.3
J	J – Medium Trees, Open, MS		2.0	18.5	11.8
K	K – Very Large Trees, Open, MS		1.0	18.4	26.1
	Sub-total:		7.0	43.9	47.8
H	H – Medium Trees, Closed, SS	9.0	44.0	12.6	3.3
L	L – Medium Trees, Closed, MS		24.0	14.8	10.0
I	I – Very Large Trees, Closed, SS		6.0	3.5	1.0
M	M –Very Large Trees, Closed, MS		3.0	3.3	4.6
			77.0	34.2	18.9
Total Area Represented:		95.5	84.0	78.1	66.7

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to increase threefold after 15 years. The positive trend continues toward the desired condition after 50 years, but treatments do not occur at a large enough level to achieve desired conditions across the landscape. More acres need to be treated, particularly those dominated by smaller trees with single-storied, closed canopy conditions.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A positive trend of reducing these states was established over the first 15 years and significant progress continues over 50 years, but the amount of area treated is unable to achieve desired conditions. However, this state is projected move from a high level of departure to moderate after 15 years, then to low after 50 years.

Management of suitable timberlands with this Alternative makes the greatest contribution to reducing the overall departure and moving toward desired conditions. After 15 years, suitable

timberlands are projected to improve from high to moderate departure. After 50 years, the level of departure improves to the lower range of moderate. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Alternative B – Lands Not Suitable for Timber Production (Issues 3 and 4)

Table G-3: VDDT modeled output for Ponderosa Pine Forest PNVT on non-suitable timberlands – alternative B

State	Description	Desired %	Current %	Year 15	Year 50
A N	A – Grass, Forb, Brush/Shrub N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).	0.0	1.0 1.0	1.0 1.7	1.7 2.7
	Sub-total:		2.0	2.7	4.4
B F	B – Seedling, Sapling, Open, SS[1] F – Seedling, Sapling, Closed, SS	1.5	0.0 0.0	1.6 5.7	1.9 8.6
	Sub-total:		0.0	7.3	10.5
C	Small Trees, Open	1.5	24.0	6.3	3.4
D E J K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS[2] K – Very Large Trees, Open, MS	86.5	3.0 1.0 2.0 1.0	4.0 3.0 18.5 18.4	3.6 6.3 11.8 26.1
	Sub-total:		7.0	43.9	47.8
G	Small Trees, Closed, SS	1.5	0.0	13.5	15.7
H L I M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	9.0	34.0 18.0 4.0 2.0	23.1 21.3 5.7 4.2	12.1 21.2 5.4 7.6

State	Description	Desired %	Current %	Year 15	Year 50
Sub-total:			58.0	54.3	46.3
Level of Departure[3]:		0%	74%	70%	65%

[1] SS = Single story (Even-aged).

[2] MS = Multiple Story (Uneven-aged).

[3] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

States A and N are currently departed above desired conditions and are projected to move further away after the first 15 years and then continue to trend away after 50 years. This state represents openings that are at the mid-scale (100-1,000 acres), and are not generally desired within this PNVT. This continued increase in the grass, forb, and brush/shrub state is also attributed to larger than desired openings being created as a result of wildfires and the resulting longer time period required to move back into a forested state.

States B and F are projected to meet and then exceed desired conditions after 15 years and continue to trend away over 50 years. This trend is similar to suitable timberlands. It is desirable to maintain a small percentage of this PNVT in an even-aged state to provide additional diversity and habitat needs, but treatment levels are unable to move enough area towards desired open, uneven-aged states.

State C is projected to approach desired conditions after 15 years and then remain static after 50 years. This trend is also similar to suitable timberlands. It is desirable to maintain a percentage of small trees in an open, even-aged state to provide for additional diversity and habitat needs, but treatment levels are unable to move enough area towards the more desired uneven-aged states.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to decline a little after 15 years. The negative trend begins to reverse and move slightly back toward the desired condition after 50 years. However, the major gains in these states primarily occur within suitable timberlands that have a higher level of treatment. Canopy cover continues to close, regeneration opportunities continue to shrink, and even-aged conditions are maintained. More acres dominated by smaller trees with single-storied, closed canopy conditions need to be treated. In addition, little to no reduction of the overstory is leading to stagnation and reduced growth across all age/size classes.

State G reflects the percentage of early-mid seral forest necessary to sustain mature closed forest condition (States H, L, I, and M) as northern goshawk nesting habitat, as well as other species that rely on similar stand attributes. This state is projected to increase, reaching and then exceeding the desired condition after 15 years. This is attributed to growth of seedlings and saplings into this size class as well as movement of small trees from open to closed canopy conditions. Not enough of the middle and larger sized trees are being treated to allow for smaller trees to advance, leading to stagnation and more even-aged conditions. After 50 years the negative trend continues, although at a slower pace. This trend is similar to suitable timberlands, but at an increased rate. Canopy closure continues to increase, slowing tree growth and movement into the next size class. The amount of acres treated is insufficient to reverse the trend.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north

facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A slight positive trend of reducing these states was established over the first 15 years and minor progress continues over 50 years, but the amount of area treated is still unable to achieve desired conditions. This state starts moderately departed and closer to the desired condition than suitable timberlands, but is projected to remain moderately departed

Management of non-suitable timberlands with this Alternative makes only a minor contribution to reducing the overall departure and moving toward desired conditions. While some improvement is achieved, the level of departure is projected to remain high over the next 50 years. Because too few acres and comparatively little of the overstory are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress slightly toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health within non-suitable timberlands, there would continue to be more area of even-aged, closed canopy forest than is desired.

Lands Not Suitable for Timber Production

Table G-4. VDDT modeled output for Ponderosa Pine Forest PNVT on non-suitable timberlands alternative B

State	Description	Desired %	Current %	Year 15	Year 50
D	D – Medium Trees[1], Open, SS	86.5	3.0	4.0	3.6
E	E – Very Large Trees[2], Open, SS		1.0	3.0	6.3
J,	J – Medium Trees, Open, MS		2.0	18.5	11.8
K	K – Very Large Trees, Open, MS		1.0	18.4	26.1
	Sub-total		7.0	43.9	47.8
H	H – Medium Trees, Closed, SS	9.0	34.0	23.1	12.1
L	L – Medium Trees, Closed, MS		18.0	21.3	21.2
I	I – Very Large Trees, Closed, SS		4.0	5.7	5.4
M	M –Very Large Trees, Closed, MS		2.0	4.2	7.6
			58.0	54.3	46.3
Total Area Represented:		95.5	65.0	88.2	94.1

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which is where the largest percentage of area is desired, are projected to decline a little after 15 years. The negative trend begins to reverse and move slightly back toward

the desired condition after 50 years. However, the major gains in these states primarily occur within suitable timberlands that have a higher level of treatment. Canopy cover continues to close, regeneration opportunities continue to shrink, and even-aged conditions are maintained. More acres dominated by smaller trees with single-storied, closed canopy conditions need to be treated. In addition, little to no reduction of the overstory is leading to stagnation and reduced growth across all age/size classes.

States H, L, I, and M are indicative of mature closed forest habitat and occasional even-aged dynamics that occurred in the reference condition (Romme et al. 2010), particularly on north facing slopes and canyons. Stands on low-productivity sites are likely to occur as States H/L, versus high-productivity sites where States I/M are more likely. This combination of states reflects the current condition of dense, overstocked stands across the landscape. A slight positive trend of reducing these states was established over the first 15 years and minor progress continues over 50 years, but the amount of area treated is still unable to achieve desired conditions. This state starts moderately departed and closer to the desired condition than suitable timberlands, but is projected to remain moderately departed

Management of non-suitable timberlands with this Alternative makes only a minor contribution to reducing the overall departure and moving toward desired conditions. While some improvement is achieved, the level of departure is projected to remain high over the next 50 years. Because too few acres and comparatively little of the overstory are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress slightly toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health within non-suitable timberlands, there would continue to be more area of even-aged, closed canopy forest than is desired.

Appendix H. Suitable and Non Suitable Lands for Mixed Conifer with Frequent Fire Alternative A

Alternative A – Mixed Conifer Lands Suitable for Timber Production

Table H-1. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable timberlands

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Grass, Forb, Brush/Shrub		0.0	0.4	0.5
B	B – Seedling, Sapling, Open, SS		0.0	0.2	0.3
F	F – Seedling, Sapling, Closed, SS	9.0	0.0	10.7	20.9
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.0	1.5	1.7
Sub-total (A,B,F,N):			0	12.8	23.4
C	C - Small Trees, Open	3.0	1.0	0.3	0.5
D	D – Medium Trees, Open, SS	60.0	2.0	2.2	0.9
E	E – Very Large Trees, Open, SS		0.0	0.9	1.7
J	J – Medium Trees, Open, MS		4.0	7.9	4.3
K	K – Very Large Trees, Open, MS		1.0	8.4	17.2
Sub-total (D,E,J,K):			7.0	19.4	24.1
G	G - Small Trees, Closed, SS	3.0	8.0	6.5	9.5
H	H – Medium Trees, Closed, SS	25.0	22.0	13.0	4.5
L	L – Medium Trees, Closed, MS		51.0	31.6	16.5
I	I – Very Large Trees, Closed, SS		3.0	5.2	5.2
M	M –Very Large Trees, Closed, MS		8.0	11.4	16.4
Sub-total (H,L,I,M):			84.0	61.2	42.6
Level of Departure:		0%	64%	43%	39%

States A, B, F, and N move toward and exceed the desired area occupied after 15 years. The trend away from desired conditions is projected to continue through year 50. This is attributed to seedlings and saplings moving from open to closed canopy conditions delaying transition into the

small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state.

State C is projected to trend away from desired conditions after 15 years as canopies close and competition increases. Small open trees are transitioning to the small closed canopy tree state and not being replaced by seedlings and saplings. When transition of seedlings and saplings into the small trees states does occur it is primarily as closed canopy. The trend is projected to remain static, but still departed, after 50 years.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands.

State G moves initially moves toward the desired condition after 15 years, then starts trending away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. The trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees and treated acres are unable to keep pace with growth.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands.

The overall trend for suitable timberlands under this Alternative reduces departure from reference (desired) conditions, but remains moderately after 15 years. The trend continues moving toward desired conditions and approaches low, still but remains moderately departed. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Table H-2. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable timberlands

State	Description	Desired %	Current %	Year 15	Year 50
D	D – Medium Trees, Open, SS	60.0	2.0	2.2	0.9
E	E – Very Large Trees, Open, SS		0.0	0.9	1.7
J	J – Medium Trees, Open, MS		4.0	7.9	4.3
K	K – Very Large Trees, Open, MS		1.0	8.4	17.2
			7.0	19.4	24.1
H	H – Medium Trees, Closed, SS	25.0	22.0	13.0	4.5

State	Description	Desired %	Current %	Year 15	Year 50
L	L – Medium Trees, Closed, MS		51.0	31.6	16.5
I	I – Very Large Trees, Closed, SS		3.0	5.2	5.2
M	M –Very Large Trees, Closed, MS		8.0	11.4	16.4
Sub-total:			84.0	61.2	42.6
Total Area Represented:		85.0	91.0	80.6	66.7

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. Medium tree stands remain static or increase after 15 years, then decline overall after 50 years. However, the medium, uneven-aged, open stands remain static after 50 years. Very large tree stands increase dramatically over 50 years, going from 14% of the area represented by these states currently to 47% in 15 years and then 79% after 50 years.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. Reduction of area occupied, and movement toward desired conditions is achieved in the medium sized tree stands. Very large tree stands increase by 45% after 15 years and then continue that trend over 50 years. Very large tree stands currently occupy 11% of the area in these states, but after 15 years it increases to 26%, and then 50% after 50 years.

Management of suitable timberlands makes a large contribution to improving the representation of large trees across the landscape and moving toward desired (reference) conditions. Area of medium and very large tree classes in multi-storied, open canopy conditions would more than triple over 50 years. Very large tree stands in all states would increase over existing conditions.

Alternative A – Mixed Conifer Lands Not Suitable for Timber Production

Table H-3. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on non-suitable timberlands

State	Description	Desired %	Current %	Year 15 %	Year 50 %
A	A – Grass, Forb, Brush/Shrub		0.5	0.6	0.7
B	B – Seedling, Sapling, Open, SS		0.0	0.2	0.4
F	F – Seedling, Sapling, Closed, SS	9.0	0.0	11.5	23.6
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.5	2.1	2.0
			1.0	14.4	26.7
C	Small Trees, Open	3.0	1.0	0.5	0.5
D	D – Medium Trees, Open, SS		2.0	2.3	1.2
E	E – Very Large Trees, Open, SS	60.0	0.0	1.0	2.7
J	J – Medium Trees, Open, MS		5.0	6.5	4.2
K	K – Very Large Trees, Open, MS		0.0	1.8	4.9
			7.0	11.6	13.0
G	Small Trees, Closed, SS	3.0	12.0	8.4	11.0
H	H – Medium Trees, Closed, SS		21.0	14.5	6.9
L	L – Medium Trees, Closed, MS	25.0	48.0	34.3	21.7
I	I – Very Large Trees, Closed, SS		3.0	6.0	7.0
M	M –Very Large Trees, Closed, MS		7.0	10.4	13.4
			79.0	65.2	49.0
Level of Departure:		0%	63%	51%	50%

States A, B, F, and N move toward and exceed the desired area occupied after 15 years. The trend away from desired conditions is projected to continue through year 50. This is attributed to seedlings and saplings moving from open to closed canopy conditions delaying transition into the small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state. Acres treated are not sufficient

to keep up with the growth. The trend away from reference (desired) conditions is slightly more than suitable timberlands.

State C is slightly below desired conditions and projected to remain static in its trend after 15 years. Small open canopy trees are transitioning to the medium open or small closed canopy tree states, but seedlings and saplings are not transitioning into this state at a quick enough rate to increase trend. When transition of seedlings and saplings into the small trees states does occur it is primarily as closed canopy. The trend is projected to trend away after 50 years and is similar to suitable timberlands.

States D, E, J, and K, which represent medium and very large tree, primarily open canopy stands and combine for the largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend, although at a reduced rate, through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into the medium and very large tree states, while creating more uneven-aged stands. The trend toward desired conditions is almost half that achieved with treatments on suitable timberlands.

State G moves initially moves toward the desired condition after 15 years, then starts trending away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. However, the trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees with closed canopies and treated acres are unable to keep pace with growth. This trend moves slightly further away from desired conditions than treatments on suitable timberlands.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands with primarily uneven-aged structure, and combine for the second largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years. The positive trend continues through year 50, and departure remains moderate. This is attributed to treatments moving stands from closed to open canopy conditions, and creating more uneven-aged stands. This trend is somewhat less than treatments on suitable timberlands.

The overall trend for non-suitable timberlands under this Alternative reduces departure from reference (desired) conditions, but remains moderately departed after 15 years. The trend then becomes static and remains moderately departed after 50 years. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Table H-4. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on non-suitable timberlands

State	Description	Desired %	Current %	Year 15	Year 50
D,E,J,K	D – Medium Trees, Open, SS E – Very Large Trees, Open, SS J – Medium Trees, Open, MS K – Very Large Trees, Open, MS	60.0	2.0 0.0 5.0 0.0	2.3 1.0 6.5 1.8	1.2 2.7 4.2 4.9
			7.0	11.6	13.0
H, L, I, M	H – Medium Trees, Closed, SS L – Medium Trees, Closed, MS I – Very Large Trees, Closed, SS M –Very Large Trees, Closed, MS	25.0	21.0 48.0 3.0 7.0	14.5 34.3 6.0 10.4	6.9 21.7 7.0 13.4
			79.0	65.2	49.0
Area Represented:		85.0	84.0	76.8	62.0

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired reference conditions. Both medium and very large tree stands are projected to increase or remain static after 15 years. After 50 years, medium tree stands, both even and uneven-aged, are projected to decline. Very large tree stands would continue to increase in area and trend toward desired conditions after 50 years.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired (reference) conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. Medium sized tree stands would reduce in area, particularly even-aged, which is a trend toward desired conditions. Very large tree stands currently occupy 13% of the area in these states, but after 15 years it increases to 25%, and then 41%.

The overall trend for non-suitable timberlands is an increase in the representation of large trees across the landscape. Medium size tree stands decrease in area occupied, which is a trend toward desired conditions because they are over-represented across the landscape. Medium size, open uneven-aged stands initially increase after 15 years, then decrease slightly. Very large tree stands, in all states, would increase over existing conditions.

Appendix I. Suitable and Non Suitable Lands for Mixed Conifer with Frequent Fire Alternative B

Lands Suitable for Timber Production

Table I-1. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable timberlands alternative B

State	Description	Desired %	Current %	Year 15	Year 50
A	A – Grass, Forb, Brush/Shrub	9.0	0.0	0.3	0.3
B	B – Seedling, Sapling, Open, SS[1]		0.0	0.2	0.2
F	F – Seedling, Sapling, Closed, SS		0.0	11.2	16.5
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.0	1.3	1.4
	Sub-total:		0.0	13.0	18.4
C	Small Trees, Open	3.0	1.0	0.3	0.4
D	D – Medium Trees, Open, SS	60.0	2.0	1.3	0.2
E	E – Very Large Trees, Open, SS		0.0	0.4	0.4
J	J – Medium Trees, Open, MS[2]		4.0	10.6	3.8
K	K – Very Large Trees, Open, MS		1.0	28.3	42.7
	Sub-total:		7.0	40.6	47.1
G	Small Trees, Closed, SS	3.0	8.0	6.1	8.0
H	H – Medium Trees, Closed, SS	25.0	22.0	6.8	1.0
L	L – Medium Trees, Closed, MS		51.0	19.1	6.4
I	I – Very Large Trees, Closed, SS		3.0	3.1	1.7
M	M –Very Large Trees, Closed, MS		8.0	11.1	17.2
Sub-total:			84.0	40.1	26.3
Level of Departure[3]:		0%	64%	22%	16%

[1] SS = Single story (Even-aged).

[2] MS = Multiple Story (Uneven-aged).

[3] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

States A, B, F, and N move toward and exceed the desired area occupied after 15 years. The trend away from desired conditions is projected to continue through year 50. This is attributed to seedlings and saplings moving from open to closed canopy conditions delaying transition into the small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state.

State C is projected to trend away from desired conditions after 15 years as canopies close and competition increases. Small open trees are transitioning to the small closed canopy tree state and not being replaced by seedlings and saplings. When transition of seedlings and saplings into the small trees states does occur it is primarily as closed canopy. The trend is projected to remain static, but still departed, after 50 years.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired reference conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands.

State G moves initially moves toward the desired condition after 15 years, then starts trending away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. The trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees and treated acres are unable to keep pace with growth.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands.

The overall trend for suitable timberlands under this Alternative reduces departure from desired conditions, but remains moderately after 15 years. The trend continues moving toward desired conditions and approaches low, still but remains moderately departed. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory.

Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Lands Suitable for Timber Production

Table I-2. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on suitable timberlands alternative B

State	Description	Desired %	Current %	Year 15	Year 50
D	D – Medium$_1$ Trees, Open, SS		2.0	1.3	0.2
E	E – Very Large$_2$ Trees, Open, SS	60.0	0.0	0.4	0.4
J	J – Medium Trees, Open, MS		4.0	10.6	3.8

State	Description	Desired %	Current %	Year 15	Year 50
K	K – Very Large Trees, Open, MS		1.0	28.3	42.7
	Sub-total:		7.0	40.6	47.1
H	H – Medium Trees, Closed, SS	25.0	22.0	6.8	1.0
L	L – Medium Trees, Closed, MS		51.0	19.1	6.4
I	I – Very Large Trees, Closed, SS		3.0	3.1	1.7
M	M –Very Large Trees, Closed, MS		8.0	11.1	17.2
			84.0	40.1	26.3
Total Area Represented:		85.0	91.0	80.7	73.4

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands.

The overall trend for suitable timberlands under this Alternative reduces departure from desired conditions, but remains moderately after 15 years. The trend continues moving toward desired conditions and approaches low, still but remains moderately departed. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Lands Not Suitable for Timber Production

Table I-3. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on non-suitable timberlands in alternative B

State	Description	Desired %	Current %	Year 15	Year 50
A	A – Grass, Forb, Brush/Shrub	9.0	0.5	0.6	0.6
B	B – Seedling, Sapling, Open, SS[1]		0.0	0.2	0.4
F	F – Seedling, Sapling, Closed, SS		0.0	11.6	23.6
N	N – Grass, Forb, Brush/Shrub Resulting from uncharacteristic Fire (delayed recovery time).		0.5	1.8	2.1
	Sub-total:		1.0	14.2	26.7
C	Small Trees, Open	3.0	1.0	0.4	0.5
D	D – Medium Trees, Open, SS	60.0	2.0	2.8	1.5
E	E – Very Large Trees, Open, SS		0.0	1.0	2.4
J	J – Medium Trees, Open, MS[2]		5.0	6.3	4.3
K	K – Very Large Trees, Open, MS		0.0	1.8	4.9
	Sub-total:		7.0	11.9	13.1
G	Small Trees, Closed, SS	3.0	12.0	8.3	11.4
H	H – Medium Trees, Closed, SS	25.0	21.0	14.1	7.2
L	L – Medium Trees, Closed, MS		48.0	35.0	21.1
I	I – Very Large Trees, Closed, SS		3.0	5.7	6.9
M	M –Very Large Trees, Closed, MS		7.0	10.4	13.2
Sub-total:			79.0	65.2	48.4
Level of Departure[3]:		0%	63%	51%	49%

[1] SS = Single story (Even-aged).

[2] MS = Multiple Story (Uneven-aged).

[3] Departure Levels = High (>66%), Moderate (34-66%), and Low (0-33%).

States A, B, F, and N move toward and exceed the desired area occupied after 15 years. The trend away from desired conditions is projected to continue through year 50. This is attributed to seedlings and saplings moving from open to closed canopy conditions delaying transition into the

small trees states, and larger than desired openings are being created as a result of wildfires and increased time period required to move back into a forested state. The trend away from desired conditions is slightly more than suitable timberlands.

State C is projected to trend away from desired conditions after 15 years as canopies close and competition increases. Small open trees are transitioning to the small closed canopy tree state and not being replaced by seedlings and saplings. When transition of seedlings and saplings into the small trees states does occur it is primarily as closed canopy. The trend is projected to become static, but still departed, after 50 years and is similar to suitable timberlands.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired conditions, are projected to be placed on a slightly favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands. The trend toward desired conditions is almost half that achieved with treatments on suitable timberlands.

State G moves initially moves toward the desired condition after 15 years, then starts trending away after 50 years. This is attributed to treatments initially moving stands from the closed to open state, allowing progression into the medium-sized tree states. The trend starts moving away from the desired condition after 50 years as more seedlings and saplings become small trees and treated acres are unable to keep pace with growth. This trend is slightly less than treatments on suitable timberlands.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands. This trend is slightly less than treatments on suitable timberlands.

The overall trend for non-suitable timberlands under this Alternative reduces departure from desired conditions, but remains moderately departed after 15 years. The trend then becomes static and remains moderately departed after 50 years. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Lands Not Suitable for Timber Production

Table I-4. VDDT modeled output for Mixed Conifer with Frequent Fire PNVT on non-suitable timberlands in alternative B

State	Description	Desired %	Current %	Year 15	Year 50
D	D – Medium Trees, Open, SS	60.0	2.0	2.8	1.5
E	E – Very Large Trees, Open, SS		0.0	1.0	2.4
J	J – Medium Trees, Open, MS_2		5.0	6.3	4.3
K	K – Very Large Trees, Open, MS		0.0	1.8	4.9
	Sub-total:		7.0	11.9	13.1
H	H – Medium Trees, Closed, SS	25.0	21.0	14.1	7.2
L	L – Medium Trees, Closed, MS		48.0	35.0	21.1
I	I – Very Large Trees, Closed, SS		3.0	5.7	6.9
M	M –Very Large Trees, Closed, MS		7.0	10.4	13.2
Sub-total:			79.0	65.2	48.4
Total Area Represented:			84.0	77.1	61.5

[1] Medium Size Trees = 10-20” DBH.

[2] Very Large Size Trees = 20”+ DBH.

States D, E, J, and K, which represent medium and very large tree, open canopy stands and combine for the largest portion of desired conditions, are projected to be placed on a slightly favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments maintaining open canopy conditions and providing for movement of small tree states upward into these states, while creating more uneven-aged stands. The trend toward desired conditions is almost half that achieved with treatments on suitable timberlands.

States H, L, I, and M, which represent medium and very large tree, closed canopy stands and combine for the second largest portion of desired conditions, are projected to be placed on a favorable trend after 15 years and continue that trend through year 50. This is attributed to treatments moving these states from closed to open canopy conditions, and creating more uneven-aged stands. This trend is slightly less than treatments on suitable timberlands.

The overall trend for non-suitable timberlands under this Alternative reduces departure from desired conditions, but remains moderately departed after 15 years. The trend then becomes static and remains moderately departed after 50 years. Because too few acres are treated, seedlings, saplings, and small trees would continue on a negative trajectory. Movement of medium and larger sized trees would progress toward desired conditions, but canopy cover would remain predominantly closed, inhibiting tree growth. While some improvement is made toward overall ecosystem health, there would continue to be more area of even-aged, closed canopy forest than is desired.

Appendix G. Effects of a No Prescribed Fire Alternative

Fire is an essential disturbance agent in fire adapted/dependent ecosystems (i.e., ponderosa pine, dry mixed conifer, pinion-juniper types, semi desert grasslands and interior chaparral). For these ecosystems the viability of growth, structure, function, and health of the forest is dependent on a fire regime. An ecosystems fire regime gives a basis of how often and severe a fire needs to burn to maintain the overall ecosystem sustainability and integrity. In general, an ecosystem that is maintained by a natural fire regime has higher biodiversity among plant and animal species (Griffis et al. 2001). Many of the processes that initiate plant germination, maintain wildlife habitat, maintain water quality/quantity, etc. require fire to burn through the forest at a regular interval (Moore et al. 1999). Through these processes, the forest vegetation that is adapted to a fire regime can be said to be more resilient to fire as a disturbance mechanism. Without fire, many of these processes cannot continue at a productive and efficient level. Mechanical removal of vegetation is effective in removing unsustainable density levels and canopy closure of vegetation; however, it does not adequately reduce fuel loading or restore necessary ecosystem processes (Omi et al. 2002). Surface fuel loading is most effectively addressed through the implementation of fire. In fact, mechanical treatment alone can increase available fuel and result in a more intense and faster spreading fire (Omi et al. 2002). Mechanical treatment alone only addresses stand density; however, fire is required to raise canopy base height and reduce surface fuels. If fire is removed from these systems, whether by policy, management decisions, etc., the resultant ecosystem is altered in a way that may jeopardize the overall sustainability and integrity of the system.

Fire is an agent that achieves the maintenance of these ecosystems in a sustainable setting. As vegetation grows, unnecessary foliage is cast off of the plant. That foliage accumulates on the forest floor along with any vegetation that has died. The accumulation of this debris on the forest floor is a major contributor to fire intensity and severity. When an ecosystem is departed from its natural fire regime, the resulting intensity and severity of the fire is uncharacteristic and leads to higher vegetation mortality, and greater threat to values at risk and public or firefighter safety (Moore et al. 1999). In the case of many southwestern forests, fire exclusion by past management actions have led to a change in ecosystem attributes, structure and function. These changes have resulted in altered fire behavior characteristics that intern affect the way managers must manage fire. The buildup of vegetation debris on the forest floor, in conjunction to higher vegetation densities and canopy closure has resulted in an increase in fire intensity and severity, beyond the natural historical range of variability. Subsequent fires can result in rapid spread, high fire intensity, and high fire severity to levels at which managers cannot safely control (Moore et al. 1999).

Currently, federal fire policy provides federal agencies with two tools that can be used to restore wildland fire to fire adapted ecosystems: Managing unplanned ignition for resource objectives, and planned ignition of prescribed fire for resource objectives. We believe that both tools are necessary to successfully restore our fire adapted ecosystems.

Management of unplanned wildland fire to achieve resource objectives, allows managers to utilize naturally caused wildfire. This method is useful in achieving resource objectives, while utilizing the most natural disturbing agent available. Allowing wildfire to burn within its natural season and fire regime, often results in a higher herbaceous growth response, which can lead to increased biodiversity, as opposed to planned ignitions (Griffis et al. 2001). Using unplanned ignitions help to randomize fire across the landscape which leads to an overall mosaic disturbance

pattern. Without the ability to manage unplanned ignitions for resource objectives, the 23,000 acres of wildfire treatment that was conducted on the Coconino National Forest in fiscal year 2009 would not have been possible.

Managers often utilize planned ignitions to address fuel loadings and ecosystem integrity. The use of prescribed fire allows managers to preselect specific parameters/prescriptions under which a fire would be allowed to burn. Using this method, artificial ignitions sources may be used to initiate fire spread when the given fuel and weather conditions are within prescription. Managers can use prescribed fire in a more strategic manner, rather than simply respond to unplanned ignitions in random locations. This allows the selection, prioritization and deliberate placement of fire treatments in locations that increase future protection opportunities (or decrease fire hazard) to infrastructure values. The use of prescribed fire can also be an effective way to bring an ecosystem back within the historical fire regime and range of variability. The use of prescribed fire is perhaps often the safest method of utilizing fire as a management tool, especially when near the Wildland Urban Interface (WUI).

Appendix H. Documentation of VDDT Modeling Outcomes

Background

Alternative A proposes and models 10,000 acres/year of mechanical treatment and 15,000 - 20,000 acres per year underburning

VDDT modeling found that alternative A “would improve ecosystem function and resilience to disturbance in the three modeled PNVTs by moving toward more open, uneven-aged condition.” Specifically, overall departure from desired conditions for Ponderosa Pine, Mixed Conifer with Frequent Fire and Piñon Juniper (PJ) Grasslands are decreased after 15 years. Further, each PNVT is projected to improve over current conditions. These modeling outcomes are not consistent with actual outcomes over the last 15 years (based on about 5,000 acres/year of mechanical treatment and about 17,500 acres/year of prescribed fire treatment).

Mechanical treatment levels around 5,000 to 10,000 acres/years and prescribed fire treatment of 20,000 acres/year seem woefully inadequate considering these PNVTs total over 1.1 million acres. This is especially true in mixed conifer with frequent fire and PJ grasslands, where less than 10% of our mechanical and fire treatment is expected to occur. In ponderosa pine, about 100,000 acres/year of fire treatment would put the Forest on a fire return interval (8 years) in the range of historical conditions. The historical fire return interval is commonly accepted to be about 2-12 years (Dietrich 1980). Alternative A does not approach this level of treatment.

The Coconino National Forest has predominantly implemented even-aged silvicultural systems since the forest was established. At the beginning of the previous planning period in 1987, most vegetative treatments continued to be even-aged, typically shelterwood or seed tree cuts. After the Plan was amended in 1996 to adopt the goshawk recommendations, plan direction was to start implementing uneven-aged management to improve structural diversity and Northern goshawk habitat. However, the forest has been slow in its implementation of uneven-aged management over the past 15 years. Of all acres reported treated since 1996, less than 1% has been with uneven-aged systems. Approximately 90% of the treatments have been commercial thinning, pre-commercial thinning, or thinning for hazardous fuel reduction. This is largely due to almost a century of even-aged management that has resulted in a decrease of structural diversity of mechanically treated forest types. Recently developed regionally consistent desired conditions support the development of uneven-aged stand structure as a means to restore ecological function and resilience.

The Forest has done a better job of implementing uneven-aged “restoration” treatments more over the past 5 years. Uneven-aged group selection was the primary silvicultural treatment modeled to compare alternatives, which is why there seems to be a “disconnect” between modeled results and actual outcomes over the past 15 years. Taking into account the long legacy of even-aged silvicultural treatments, and relatively recent adoption of uneven-aged management, it becomes clear why departure levels within ponderosa pine, mixed conifer with frequent fire and piñon-juniper grassland respond in such a positive manner.

Since there is no effect 10 years after a prescribed fire (ERI Fact Sheet), having a return interval less than 10 years seems appropriate to maintain a forest structure that is fire resilient. Similarly, mechanical treatment effectiveness is bound by time and must be maintained with fire to remain effective.

Appendix I. Differences between Historical Conditions and Desired Conditions for Ponderosa Pine and Mixed Conifer with Frequent Fire

The Southwestern Region of the Forest Service convened a working group to develop regionally consistent desired conditions to be used in plan revision. The work group consisted of specialists from vegetation, fire/fuels, wildlife/ESA, planning, appeals, silviculture, and goshawk research. The work group was directed to base the guidance for desired conditions on the 1996 Amendment to Regional Forest Plans, the Mexican spotted owl Recovery Plan, best available science, and recent MSO/goshawk/old growth project specific plan amendments. The references used to develop the desired conditions are listed at the end of this appendix. Draft desired conditions were reviewed by the forest between October 2008 and April 2009. The Coconino adjusted the desired conditions based on public comment received early in the process. The deviation between historical and DCs was a result of the DCs being adjusted to account for other resources, such as the Northern goshawk, Mexican spotted owl, bald eagle, and concerns about large trees. Forest concerns with DCs that were not within the historic range of variability were expressed; however, regionally approved DCs were used to improve consistency across the Southwestern National Forests.

Forest Desired Conditions (DC) are not the same as historical conditions. Ponderosa Pine and Mixed Conifer with Frequent Fire ecosystems were historically open, park-like and dominated by grass and forbs. The desired conditions in Ponderosa Pine PNVT call for 88% in open mid-age, mature/old forest with regeneration. Desired condition in Mixed Conifer with Frequent Fire calls for at least 63% in open conditions. Differences between Forest DCs and historic conditions are greatest in the "upper density ranges" (basal area of 45-80) of the DCs. These differences are described below.

Landscape Scale Desired Conditions

References to number of snags, logs & woody debris in the draft revised plan may not be consistent with fire restoration goals and objectives. Reference condition fire adapted ecosystems likely do not have these elements (snags, logs, etc.) to this extent. For e.g., contemporary forests showed "significantly more standing dead trees ($t = 3.17$; $P = 0.011$), dead and down ($t = 7.8$; $P < 0.001$). . ." than around 1911 (Moore et al. 2004). At the landscape scale, examples of language in the draft revised plan relative to snags and logs include:

> "The composition, structure, and function of vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability that is similar to conditions prior to 1850 (pre-fire disruption[19]). The landscape is a functioning ecosystem that contains its components, processes, and conditions that result from endemic levels of disturbances (e.g. insects, diseases, fire, and wind), including snags, downed logs, and old trees (FW-Veg-PP-DC2); "Ponderosa Pine is composed predominantly of *vigorous* trees, but *declining* trees are a component. Declining trees are well distributed across the landscape and may occur as clumps or individual trees. They provide for snags, top-

[19] Pre-fire disruption is intended to refer to the period before human activities such as past grazing practices, logging, and fire suppression changed the way fire burned on the landscape, which is approximated to be before 1850.

killed, lightning-scarred and fire-scarred trees, and coarse woody debris (greater than 3-inch diameter, including large logs (FW-PP-DC-5); and "Snags and large dead and downed fuels are irregularly distributed across the landscape and may not exist in some patches. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality" (FW-Veg-PP-DC-6).

Landscape level conditions for Mixed Conifer with Frequent Fire address snags and coarse woody debris: "Old-growth structure occurs throughout the landscape, generally in small areas as individual old-growth components or as clumps of old growth. Old-growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old-growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). Old growth is often mixed with groups of younger trees or as individual groups of mostly old trees (FW-MC-MCFF-DC-2); Mixed Conifer with Frequent Fire is composed predominantly of vigorous trees, but declining trees are a component. Declining trees are well distributed throughout the landscape and provide for snags; top-killed, lightning-scarred, and fire-scarred trees; and coarse woody debris (greater than 3-inch diameter). A variety of snag species and coarse woody debris are well distributed throughout the landscape" (FW-MC-MCFF-DC-4).

At the mid-scale, the draft modified plan provides specific densities for snags, logs, and coarse woody debris: "Ponderosa pine snags are typically 18 inches or greater diameter at breast height (d.b.h.) and average 1 to 2 snags per acre, but this can vary in space and time[20]. They are generally well distributed to meet the needs of species that use snags and to provide for future downed logs. There are varying sizes of snags greater than 18 inches d.b.h.Downed logs (greater than 12-inch diameter at mid-point and greater than 8 feet long) average 3 logs per acre within the forested area of the landscape. Coarse woody debris, including large downed logs, is sufficient to maintain or improve long-term soil productivity and provide important wildlife habitat, and it is generally well distributed and averages from 3 to 10 tons per acre (FW-Veg-PP-DC-11) and allows for flexibility in the Wildland Urban Interface (WUI): ".In order to reduce fire intensity and to maintain the ability to control fire in WUI, forest structure may be at the low range of desired conditions for levels of snags, logs, coarse woody debris, and tree density, and have groups of trees that are more widely spaced or have fewer trees per group (but still within desired condition) than in the non-WUI areas. Crown base heights may also be higher than non-WUI areas to reduce the likelihood of fire reaching the tree canopy" (FW-Veg-PP-DC-14).

Specific densities are also included at the mid-scale in Mixed Conifer with Frequent Fire: Snags are typically 18 inches or greater at d.b.h. and average 3 per acre. Downed logs (greater than 12-inch diameter at mid-point and greater than 8 feet long) average 3 per acre within the forested area of the landscape[21]. They are generally well distributed to meet the needs of species that use snags and to provide for future downed logs. Coarse woody debris (greater than 3-inch diameter), including downed logs, ranges from 5 to 15 tons per acre to maintain long-term soil productivity and provide important wildlife habitat (FW-Veg-MC-MCFF-DC-9). .

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[20] Snags per acre and logs per acre are general measures of abundance at the fine scale and usually an average calculated from data collected at the mid-scale or higher.

[21] Snags per acre and logs per acre are general measures of abundance at the fine scale and usually an average calculated from data collected at the mid-scale or higher.

Mid-Scale Desired Conditions

The draft revised plan talks about openings at the landscape level:

> "Forest arrangement is in individual trees, small clumps, and groups of trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Openings typically range from 10 percent in more productive sites to 70 percent in the less productive sites (FW –Veg-PP-DC 4). There is also language at the Mid-Scale (100-1,000 acres): "At the mid-scale, openings typically range from 30 percent in more productive sites to 60 percent in the less productive sites, but extreme outlying sites can range from 10 percent (i.e., high elevation, mesic sites) and may be as much as 70 percent in low elevation sites on south-facing slopes (FW-Veg-PP-DC 9)".

Openings of 10 to 70% seem inadequate and not consistent with other research. According to Covington et al. 1997, grassy openings and meadows constituted up to 80 percent of the ground cover between clumps of trees.

These fire-adapted ecosystems were dominated by grass/forb cover.

Basal area (20-80ft^2) ranges in the draft revised plan are also inconsistent other literature relative to historic conditions. Desired conditions for the Ponderosa Pine address basal area at the mid-scale:" Tree density within forested areas generally ranges from 20 to 80 square feet basal area per acre (FW-Veg-PP-9).

According to Heinlein et al 2005, Ponderosa pine mixed-conifer sites on the San Francisco Peaks had basal areas of less than 40 and 55 ft^2/ prior to fire exclusion. In addition, several studies point to a threshold basal area around 50-60 ft^2 where we see diminishing growth, increased insect and disease problems and watershed issues. Research shows that stands with basal areas $\geq$ 60 ft^2 show significant reduction in diameter growth and Ponderosa Pine regeneration potential (ERI Fact Sheet 2007). Overall growth was best from 40-60 ft^2 per acre for young growth stands and less in older stands due to lower ratios of sapwood to total basal area (Fiedler, Arno, Harrington 1988). Further, Guillermo and Wagner 2001 and Negron and Wilson 2003 discuss a general threshold for insect and disease prevention to be around 55-60 ft^2. They also note that these thresholds are better determined by a trees/acre metric. Adding trees/acre would improve the descriptions of desired conditions in draft revised plan. . As Covington et al. 2001 point out, basal area alone does not clearly illustrate treatment effects. An acre with few large trees can have the same basal area as a forest with a thousand suppressed trees.

Fine Scale Desired Conditions

Interlocking crowns- The draft revised plan does not mention high crown base heights "Leaving clumps of dense trees lowers the value of the project in terms of fire hazard reduction." (ERI Fact Sheet 2007). Also, the Northern goshawk requires high crown base heights in these clumps (Reynolds et al. 2006). Regardless, a frequent fire restored forest would have evidence of fire (lifted crowns).

The issues presented above are even more pressing in light of climate change.

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