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# Silviculture Specialist Report and Vegetation Effects Analysis

## Jack Smith / Schultz Fuels Reduction Project

**Peaks Ranger District, Coconino National Forest**
**Coconino County, Arizona**

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# Introduction

Historically, ponderosa pine forests of northern Arizona were characterized by frequent, low-intensity surface fires occurring every 2 to 12 years. The historic fire regime maintained an open canopy structure and a variable, patchy tree distribution across much of the forest by thinning smaller trees (Moir et al. 1997, Covington et al. 1997). Ponderosa pine forests were uneven-aged and consisted of fewer smaller diameter trees and a greater number of larger, older trees arranged in groups and interspersed with grassy openings. After Euro-American settlement, several conditions, including fire exclusion, livestock grazing, high-grade timber harvesting, and climatic events, favored dense ponderosa pine regeneration (Long and Smith 2000). As a result, the current forest structure is predominately even-aged and consists of dense, overstocked stands of ponderosa pine with a closed canopy. Changes in the historic fire regime have resulted in increased stand densities, changes in age and size class diversity, altered stand structure, changes in successional dynamics, altered insect and disease dynamics, decreased understory productivity and diversity, decreased tree vigor, increased fuel accumulation and continuity, increased crown fire potential, and increased fire size and intensity (Long 2003).

# Methodology for Analysis

Assumptions

Throughout this document, the terms “sustainability” and “uneven-aged” are used repeatedly. The *Dictionary of Forestry* defines “sustainability” as “the capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use.” “Uneven-aged” is defined as an age arrangement in which the trees differ markedly in their ages. An uneven-aged stand, ideally, contains ***at least*** three age classes (Nyland 1996). An uneven-aged forest structure results in vertical stratification of the forest canopy. Canopy structure affects photosynthetic capacity, growth, productivity, and carbon dioxide exchange, controls microclimate in the understory, regulates inputs, such as precipitation and sunlight, to the forest floor, and creates habitat or vertical niches for many organisms. An uneven-aged forest canopy with a well-stratified vertical structure will support a more diverse biota than an even-aged canopy, resulting in increased biological diversity (Hunter 1990). Because many insects favor trees within a certain diameter range, uneven-aged stands tend to be more resilient to insect attack and mortality due to a diversity of age and size classes. Prior to Euro-American settlement, ponderosa pine forests in the southwest were uneven-aged. During the railroad logging era and subsequent high-grade timber harvesting, much of the older age classes were removed. In 1919, an unprecedented regeneration event occurred, resulting in massive amounts of pine seedlings. Due to fire suppression, these seedlings continued to grow in dense stands, forming a closed canopy across much of the landscape and effectively inhibiting much further regeneration of shade-intolerant ponderosa pine. As a result of these factors, ponderosa pine forests of the southwest are now predominantly “even-aged”, with few trees less than 5 inches dbh or greater than 24 inches dbh. “Even-aged” is defined as an age arrangement in which the trees have only small differences in their ages (Nyland 1996). Even-aged stands are sustained ecologically through either catastrophic events, such as stand-replacing fire, or through management actions that mimic stand-replacing events, such as clear-cutting. Because ponderosa pine forests were historically uneven-aged, the Jack Smith / Schultz Project will utilize uneven-aged management. Long-term age class diversity is an integral component of a sustainable, uneven-aged forest. Age class diversity can be achieved through the use of group selection to create openings for natural regeneration. Thinning can be used to create grassy interspaces between tree groups. Periodic prescribed burning can be used to thin natural regeneration and maintain these grassy interspaces.

One of the major factors affecting stand structure and development, specifically the rate at which individual trees grow and advance through successional stages is inter-tree competition. “Competition” refers to density-related scarcity of one or more environmental factors necessary

for growth, such as moisture, nutrients, and sunlight (Long 2005). Early in stand development and prior to closure of the crown canopy, individual trees are growing at their full potential due to a lack of competition with other trees. As stand development advances, relative densities increase as the size of individual trees increase and the crown canopy begins to close. Individual trees begin to experience some competitive interaction with other trees and self-pruning of lower branches begins. At this stage in stand development, individual trees begin to exhibit height growth differentiation due to genetics, microsite differences, and damage caused by biotic and abiotic factors. As stands continue to develop, competition between trees continues to increase as trees increase in size. Growth rates for individual trees decrease as competition increases. Eventually, stands near the point of full site occupancy and self-thinning occurs due to competition-based mortality. At this stage of stand development, trees are growing at much less than full potential. Tree vigor is compromised and the risk of insect attack and mortality is high. One way in which to quantify stand development and the level of inter-tree competition is through Stand Density Index (SDI). SDI is a relative measure of stand density based on the number of trees per acre and the mean diameter (Reineke 1933). SDI expresses the actual density in a stand relative to the theoretical maximum density possible for trees of that diameter and species. SDI is useful in maintaining sustainable forest conditions because it can be used to measure competition thresholds, which are very important in a moisture-limiting system. At less than 25% of the maximum SDI, stand conditions would be "open", with little inter-tree competition. Individual trees are growing at their full potential and tree vigor is maximized. Between 25% and 35% of the maximum SDI, standards and guidelines can still be met for Northern goshawk and fire hazard reduction. However competition between individual trees begins to increase. Between 35% and 60% of the maximum SDI, inter-tree competition increases significantly. Individual trees exhibit reduced tree growth and vigor due to competitive stress. Unless the number of trees is reduced by thinning or natural disturbance, individual stand densities will eventually approach the maximum stand density, with imminent, competition-based mortality occurring at approximately 50% to 60% of the maximum SDI. These stand densities are not ecologically sustainable and are at high risk for successful bark beetle attack and mortality. Above 60% of the maximum SDI, individual trees exhibit very little or no growth due to inter-tree competition and a lack of adequate moisture, nutrients, and sunlight. Stands are at extreme risk of successful bark beetle attack and mortality and stand-replacing fire.

Methodologies Used

Existing vegetation conditions were obtained through the collection of unbiased, systematic, intensive level stand exam. A coefficient of variation was determined through visual examination of digital orthophoto quadrants (DOQs) to determine the level of homogeneity within individual stand structures. The number of stand exam points within a given stand was calculated using the coefficient of variation and a desired sampling error of 20%. Spacing between stand exam points was then calculated based on the size of the stand and number of stand exam points to be collected. Stand exam was collected using variable radius plots for trees greater than 5 inches dbh and 1/100-acre fixed area plots for trees less than 5 inches dbh. One limitation of variable radius plots is a tendency to overestimate the number of larger trees because the probability that a tree will be counted as "in" the plot is directly proportional to the diameter of the tree.

Definitions of VSS classes were taken from "Management Recommendations for the Northern Goshawk in the Southwestern United States" (Reynolds et al. 1992) and the Rocky Mountain Resource Information System User Guide (USDA Forest Service 1993). VSS classes were determined by calculating the basal area within each diameter class. The diameter class with the highest calculated square foot basal area is the assigned VSS class. The grass/ forb/shrub stage (VSS 1) consists of non-stocked openings and trees 0-1 inch dbh. The seedling/sapling stage (VSS 2) consists of trees 1-5 inches dbh. The young forest stage (VSS 3) consists of trees 5-12 inches dbh. The mid-aged forest stage (VSS 4) consists of trees 12-18 inches dbh. The mature forest stage (VSS 5) consists of trees 18-24 inches dbh. The old forest stage (VSS 6) consists of

trees greater than 24 inches in diameter. The term "old growth" is a special designation giving to stands that meet old growth definitions outlined in the Coconino National Forest plan.

Where stand exam data was not available, VSS was assigned to stands using visual estimates from field visits or doing a comparative analysis using aerial photos from 2005.

Canopy cover is the percentage of the ground area that is directly covered with tree crowns. Canopy cover was determined in three different ways. First, for stands which have basal area information canopy cover was determined by converting BA to CC using the research by Shepperd et. al. Second, an comparative aerial photo analysis, comparing stands with known canopy covers to stands nearby to assign a canopy cover value. Third, data from the Forest Ecosystem Restoration Analysis (Forest ERA) at Northern Arizona University was also used to analyze canopy cover. This data was developed from a mosaic of Digital Orthophoto Quads (DOQs) taken primarily in 1997. The data was developed using a type of advanced exploratory data analysis, in which each one meter pixel in the image is classified as canopy foliage, shadow, or ground vegetation. The pixels of canopy foliage are then aggregated across larger areas to determine percent cover. As provided, this layer has a resolution (pixel size) of 90 meters (2 acres) to match the resolution of other data layers. For accuracy assessments, see the Forest ERA website at http://www.forestera.nau.edu/data_foundational.htm#canopy_cover.

Recent direction from the USDA Forest Service Southwestern Region (2006) provided further clarification of the intent of the "Northern Goshawk Management Recommendations". This direction emphasizes assessment of VSS and canopy cover at the group level, rather than the stand level, to provide a more accurate description of variations in forest structure within a stand. In response to this direction, the Jack Smith / Schultz Project will measure canopy cover, VSS, and stand densities at the group level in areas outside of Mexican spotted owl protected and target/threshold habitat. Data is not averaged across an entire stand. Averages do not include openings or grassy interspaces between tree groups. Data will reflect forested sites only. In this way, data will more accurately describe variations in tree densities and forest structures within a stand, rather than obtaining one average for an entire stand. However, within Mexican spotted owl protected and target/threshold habitat, canopy cover and stand density measures will be assessed at the stand level to meet the intent of the Recovery Plan for the Mexican spotted owl.

Models

Stand exam data for the vegetation effects analysis was projected over 40 years using the Forest Vegetation Simulator (FVS). FVS is an individual tree, distance-independent, growth and yield computer simulation model. The Central Rockies variant of FVS is calibrated to ponderosa pine in the southwest through the collection of stand data specific to the region. FVS represents the most advanced growth and yield modeling available to date. However, FVS has limitations in displaying data spatial within a stand because it is based on an individual tree, distance-independent model. For example, FVS cannot display the number of trees thinned greater than 16 inches dbh for the creation of an opening in a specific location within a stand. To obtain this level of specificity, stem mapping of each tree greater than 16 inches dbh within a stand would be required. Additionally, projected data represents computer estimates based on existing stand conditions and is for comparative purposes only to examine the effects of various alternatives and are not meant to be absolutes. Final numbers of trees per acre, basal area, etc. will not be obtained until each individual stand within the project area has been cruised by the timber marking crew. The FVS model does not create future regeneration. For this analysis, future regeneration rates were informed by Bailey and Covington, 2002. Regeneration of ponderosa pine was added at a rate of 5 trees per acre per decade. Regeneration of other species was added using the best judgment and experience of the author.

Due to limited time and funding, stand exam data was only collected from a number of representative stands. All stands under proposal for treatment were visited to visually confirm the appropriateness of the proposed treatment.
Canopy cover values generated by the model were not used as local canopy cover data provided in the study by Shepperd et. al. was used.

# Existing Condition

The project area consists of a total of 11,827 acres, with 11,727 acres of National Forest land and 100 acres of private land. Table 1 displays a list of the different cover types in the project along with the acres. Cover type was calculated using data collected by the fuels crew for this project.

**Table 1. A list of cover types and acres within the Jack Smith / Schultz Project area.**

| Cover Types | Acres |
|---|---|
| Ponderosa Pine | 9,747 |
| Mix Conifer | 1,618 |
| Pinyon-Juniper | 103 |
| Meadow | 27 |
| Aspen | 62 |
| Open (right of ways and mines) | 175 |
| Total | 11727 |

Past and ongoing silvicultural treatments conducted within and adjacent to the Jack Smith / Schultz Project area used in the cumulative effects analysis are displayed in Table 2. In the early 19th century, high-grade timber harvesting was conducted within the project area to provide wood for the building of the railroad. Portions of the project area were logged repeatedly through the 20$^{th}$ century. Prior to 1980, much of the project area had been pre-commercially thinned. Illegal wood cutting of Gambel oak continues at present. Fire has been excluded from the project area for over 100 years.

## Forest Structure

The forest structure of the Jack Smith / Schultz contains a variety of eco-types. With elevations ranging from 7100 to 9200 feet, the project contains, pinyon-juniper, ponderosa pine, mixed conifer, aspen, and meadows. Ponderosa pine cover type is the most common cover type, followed by mixed conifer. Areas of pinyon-juniper occurred on rocky south facing slopes. The list on table 1 shows only 62 acres of aspen, however this is misleading as many groups of aspen occur within larger stands. Only 27 acres have been identified as meadows. An additional 175 acres of open areas are the result of right of way from utility corridors and mines.

**Table 2. Past and ongoing treatment history of the Jack Smith Schultz Ecosystem Management Area, Coconino National Forest, Arizona.**

| ACTIVITY | WHEN OCCURRED | PERCENT OF EMA | EFFECTS |
|---|---|---|---|
| Livestock Grazing | 1870s – 1980s:<br>1980s – Current: | 100% and adjacent stands<br>None | Reduced understory abundance and productivity. Removed surface fuel. Disrupted the natural, surface fire regime. Contributed to increased regeneration. |
| Railroad Logging | Early 1900s | 50% and adjacent stands | Reduced density of mature sawtimber and "yellow" pines. Decreased crown canopy closure. Contributed to increased regeneration and an even-aged forest structure. |
| Commercial Thin | 1960s, 1970's, 1980s, early 1990's | 50% and adjacent stands | Reduced density of mid-aged and mature sawtimber and yellow pines. Decreased crown canopy closure. Contributed to increased regeneration and even-aged forest structure. |
| Precommercial Thin | 1960s, 1970s, 1980s | 50% and adjacent stands | Reduced density of young forest. Decreased crown canopy closure. Some improvement to forest health and fire hazard. |
| Reforestation | Late 1970's, Early 1980's | <5% | Area burned in Radio Fire |
| Burnt and Radio Fires | 1970's | 20% and adjacent stands | Two large fires created patchy conditions, reduced overall stand density. |
| Eastside Project | Ongoing | 7000 acres | Reduce density of young and mid-aged forest and create groupy pre-settlement like structure. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habit. |
| Fort Valley Project | 1998 to Present | 5000 acres adjacent to the southwestern edge of project. | Reduce density of young and mid-aged forest and create openings. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habit. |
| Dispersed Recreation | Ongoing | 100% and adjacent stands | Affects localized soil conditions (compaction), visual quality (littering), and wildlife (user trails). |
| Illegal Firewood Cutting | Ongoing | 80% in past; 20% current | Reduces density of large diameter pine and oak trees, snags, and logs. |

The current ponderosa pine forest structure is dominated by young even-age stands. About 54% of the ponderosa pine acreage is comprised of stands with the majority of the trees in the 5 to 12 inches dbh class. As shown in figure 1 below, the current forest structure is dominated by VSS classes 3 and 4. VSS classes, 1, 2, 5, & 6 are underrepresented under the guidelines set by the Northern Goshawk guidelines.

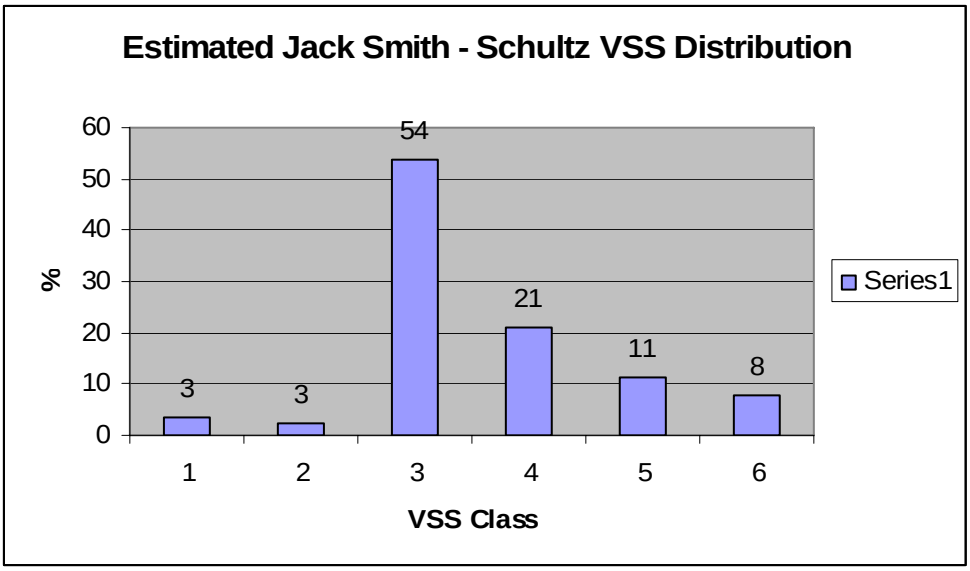



Figure 1: VSS distribution was calculated using stand exam data and field observations.

## Stand Density

Over 80 % of the project area has fairly high stand densities (SDI greater than 25% of max), resulting in increased competition between trees for moisture, nutrients, and sunlight; decreased tree vigor; increased susceptibility to successful bark beetle attack and mortality; decreased diameter growth; decreased "yellow" ponderosa pine and Gambel oak longevity; decreased natural regeneration; and decreased understory productivity and diversity. Eventually, those trees that are out-competed will die, resulting in increased fuel loading, increased fire hazard, and increased risk of bark beetle attack to residual trees.

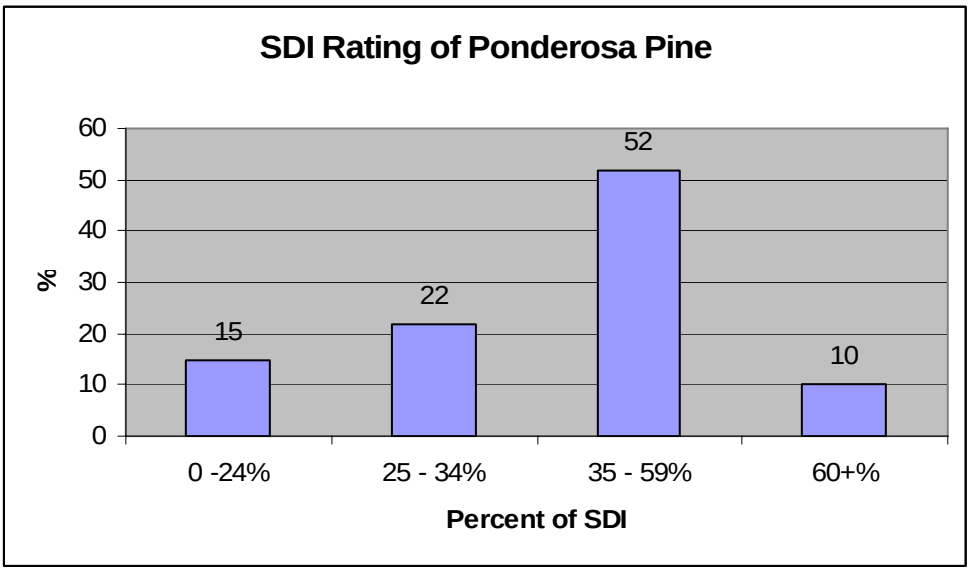
Canopy cover by stand ranges from 15% to 80%. The basal area ranges from 20 to 296 $ft^2$ per acre. Stand Density Index (SDI) is a relative measure of stand density based on trees per acre and mean diameter. There is a maximum density that can be achieved for each species, which is referred as the maximum SDI. Table 3 describes expected growing conditions for the various SDI percentages. SDI is useful in maintaining sustainable forest conditions because it can be used to measure competition thresholds, which are very important in a moisture-limiting system. Figure 2 below shows the percentage of the ponderosa pine areas within the different SDI categories. Currently, only 15% of forested Forest Service lands within the project area are below 25% max SDI. Approximately 85% of the forested stands have densities above 25% of the maximum SDI, suggesting that over half of the stands within the project area are experiencing varying degrees of inter-tree competition. In stands above 35% max SDI there is a significant increase in individual trees exhibit reduced tree growth and vigor due to competitive stress. Unless the number of trees is reduced by thinning or natural disturbance, individual stand densities will eventually approach the maximum stand density, with imminent, competition-based mortality occurring at approximately 60% of the maximum SDI. These stand densities are not ecologically sustainable and are at high risk for successful bark beetle attack and stand replacement fire. Approximately 10% of forested Forest Service lands within the project area are

above 60% of the maximum SDI, with individual trees exhibiting very little or no growth due to a lack of adequate moisture, nutrients, and sunlight.

**Table 3 – Stand Density Index Description**

| % MAX STAND DENSITY INDEX (SDI) | DESCRIPTION |
|---|---|
| 0-24% | Open, pre-settlement conditions with little competition between trees. |
| 25-34% | Competition between trees begins. |
| 35-59% | Significant increase in inter-tree competition, decreased tree growth and vigor due to competitive stress, increased susceptibility to insects, disease, and stand-replacing fire. |
| 60%+ | Trees exhibit little or no growth due to intense competition. Imminent, competition-based mortality occurs. Extreme risk of successful insect attack and mortality. |

**Figure 2 – Stand Density Index of Ponderosa Pine within the Jack Smith Schultz Project Area**




## Forest Health

Bark beetle activity was observed throughout the project area. Signs of past and present activity are occur throughout the project area. Most of the bark beetle mortality with in the ponderosa pine areas has occurred mostly on rocky south-facing slopes. Douglas-fir beetles and mountain pine beetles have also been causing mortality in Douglas-fir and limber pine in the higher elevation mix conifer types.

Dwarf mistletoe is present in pockets throughout the project area. Infection rates are mostly low, with some moderate levels of infection. Within the project area, infected areas typically occur on stands with higher site quality, usually in areas a little higher in elevation (7500+ feet) and or with more moisture. Douglas-fir dwarf mistletoe was also observed in some mix conifer stands. Tiger Moth and Needle Miner activity have been observed in the project area.

There has been a systematic decline in the health of the aspen groups throughout the project area, particularly below 8000 feet. Aspen groups are showing signs of reduced vigor. This may be due to on going drought and encroachment from other species. Aspen regeneration has been largely unsuccessful, mainly due to elk browsing and rubbing.

## Species Diversity

Aspen:
Aspen occurs mostly at higher elevations in the project area near the wilderness boundary. Ungulate browsing and rubbing of aspen regeneration is present in all stands. Successful regeneration of aspen is occurring in the higher elevation stands and clumps. Aspen clumps at lower elevations have little regeneration success, and some are becoming old and decadent.

Mix Conifer:
About 1,618 acres with in the project area has been classified as mix conifer. Mix conifer occurs at the higher elevations, typically near the wilderness boundary, and on north facing slopes in drainages coming off the eastern side of the wilderness area. Species include Douglas-fir and ponderosa pine as the primary species along with white fir, limber pine, and infrequent occurrences of Engleman spruce, corkbark fir, and bristlecone pine. Individual instances of Douglas-fir, White fir, and limber pine occur in the ponderosa pine stands.

Pinyon / Juniper:
There is about 103 acres classified as pinyon-juniper in the project areas. Most of these acres are on rocky south facing slopes of 89 Mesa. Individual pinyon pine and juniper spp. occur in the lower elevation ponderosa pine stands.

Gambel oak:
Gambel oak occurs mostly in the south-east portion of the project in primarily in stands 278-12, 278-14, and 278-19. The oak in these stands is a mix of thickets and large individuals with some 30”+ oaks occurring. Outside of these stands, Gambel oak only occurs infrequently in small clumps.

Understory Vegetation
Data was not collected on understory biomass within the project area. However, research at the Fort Valley Experimental Forest has shown that massive declines in herbaceous vegetation have occurred over the past century due to increased stand densities, increased canopy covers, and increased forest floor depth (Covington et al 1997). Within the project area, understory productivity is low in areas with “closed” and “moderately closed” canopies.
There are also scattered population of shrub species throughout the project area. A partial list includes: elderberry (sambucus spp.), ribies spp., Mexican cliffrose (Purshia mexicana), and mtn. Mahogany (cerocarpus spp.).

Meadows
Approximately three small sites totaling 27 acres within the project area are classified as meadows by Terrestrial Ecosystem units. These meadow areas have been experiencing pine encroachment for over 100 years due to fire suppression.

# Desired Future Condition

## Forest Plan Standards and Guidelines

Northern Goshawk standards and guidelines apply to forested areas outside of Mexican spotted owl protected and restricted areas. The following standards and guidelines apply to vegetation management in northern goshawk areas:

Outside Goshawk Post-fledging Family Area's

- Distribution of vegetation structural stages* for ponderosa pine and mixed conifer is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). The specified percentages area a guide and actual percentages are expected to vary + or – 3%.
- Canopy cover** within ponderosa pine should average 40% in VSS 4, 5, and 6.
- Canopy cover within mixed conifer for VSS 4 should average 1/3 60% and 2/3 40%; VSS 5 should average 50%, and VSS 6 should average 60%.
- In both ponderosa pine and mixed conifer opening size can be up to 4 acres with a maximum width of 200 feet. One group of reserve trees, 3-5 trees, will be left per acre.

Within Goshawk Post-fledging Family Area's

- Distribution of vegetation structural stages for ponderosa pine and mixed conifer is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). The specified percentages area a guide and actual percentages are expected to vary + or – 3%.
- Canopy cover within ponderosa pine for VSS 4 should average 1/3 60% and 2/3 50%; VSS 5 and 6 should average 50%..
- Canopy cover within mixed conifer for VSS 4, 5 and 6 should average 60%.
- In both ponderosa pine and mixed conifer opening size up to 2 acres with a maximum width of 200 feet. One group of reserve trees, 3-5 trees, will be left per acre.

Within Nesting Areas

- Nesting areas should contain only VSS 5 and 6 trees and have a canopy cover between 50 - 70%.

* NOTE: The forest plan does not specify at what scale VSS (group vs. stand) or at what scale these percentages are to be met (stand, project level, or ecosystem)
**NOTE: The forest plan does not specify at what scale to measure canopy cover (group vs. stand) or at what scale these percentages are to be met. It does say that the canopy cover guidelines only apply to VSS 4-6.

## Management Recommendations for the Northern Goshawk (GTR RM-217)

Below is a list of statements from RM-217 which speak directly to the desired future conditions or rational for management towards the desired future condition.

p. 8 – Vegetation management – albeit in a manner that mimics the effects of natural forest disturbances – is an integral part of these recommendations.

p. 9 – As new research information becomes available, and as our understanding of the goshawk and its habitat use and preferences increase, these management recommendations will be refined.

p. 17 – Table 6 – Importance of special habitat attributes for maintaining sustainable populations of selected northern goshawk prey – Openings are of medium to high importance of 50% of the prey species listed. Over 50% of species need openings greater than 2 acres in size.

p. 18 – Herbaceous and shrubby understories provide important foods (seeds and berries), and cover for many of the selected prey. Well developed understories occur in forest with canopy sufficiently open to allow the necessary light to reach the forest floor.

p. 18 – Interspersion measures the degree of intermixing of vegetation structural stages. Only the red squirrel responds negatively to interspersion of structural stages. Other goshawk prey populations either 1) respond positively to high interspersion or 2) are little affected by high levels of interspersion. The level of importance of interspersion is medium to high for 11 out of 14 prey species.

p. 18 – All small mammals, and the majority of birds, of selected prey species are either granivores or herbivores – feeding on seeds, berries, and foliage of plants that occur in openings in forest and in the understories.

p. 18 - In summary, goshawk foraging habitat in the three forest types consists of forest with relatively open understories and large tress. Large trees are required for hunting perches and openness provides opportunity for detection and capture by prey by goshawks.

p. 18 – For the most part, forest in the older age classes are relatively open with increased sunlight and moisture reaching the forest floor. These forest have well developed herbaceous and shrubby understories.

p. 19 – The large tree component, often occurring in clumps with interlocking crowns.

p. 20 – Surface fires typically maintained open forest conditions by continually destroying small trees.

p. 20 – Heavy livestock grazing reduced ground cover, which allowed for the establishment of “dog-hair” thickets. Furthermore, fire suppression, by allowing the encroachment of trees into openings and increasing shading, has reduced forage production.

p. 21 – Increased tree canopy cover results in a loss of herbaceous and/or shrubby foods and therefore reductions in populations of the many herbivorous prey of the goshawk.

p. 26 – Foraging Area: Although portions of natural and permanently created openings close to forest edges may be utilized for foraging by goshawks, these areas are not counted as part of the foraging area. Also do not count created openings (such as forest health, fire) greater than four acres in size as pert of the foraging area.

p. 27 – Stand Structure: A mosaic of vegetation structural stages interspersed throughout for foraging area in small patches.

p. 27 – The large tree component throughout the foraging area should include: snags, downed logs, and mature and old live trees in clumps or stringers with interlocking crowns.

p. 28 – Provide for or preserve existing clumps of trees with interlocking crowns in the three older VSS by avoiding uniform spacing of trees.

p. 76 – Prime squirrel habitat is comprised of stands containing a combination of three age-classes whose size, density and grouping provide all the necessary seasonal foods, cover, and nesting sites. It is especially important to maintain groups of trees with interlocking crowns – an important feature of tassel-eared squirrel habitat.

p. 87 – Clumpiness – The occurrence of trees in groups.

p. 88 – Interspersion of vegetative structural stage – The degree of intermixing of VSS. A low intermixing of the VSS would mean relatively large, contiguous areas of similar VSS: high intermixing would mean relatively small groups of all VSS.

## Forest Structure & Stand Density

The development of the desired future conditions of forest structure and stand density for the proposed action was developed in conjunction the Greater Flagstaff Forest Partnership. This process utilized the latest existing scientific knowledge of pre-settlement conditions of southwestern ponderosa pine forest, while at the same time meeting the northern goshawk standards and guidelines in the Coconino NF plan and following the recommendations in GTR RM-217.

Within the northern goshawk management areas there is a need to create a more variable, patchy tree distribution across the project area that would more closely mimic the historic ponderosa pine forest structure that existed prior to fire suppression. Desired Future Conditions for forest structure within the project area include increased age and size class diversity, uneven-aged stand structure, improved successional dynamics, and increased interspersion of VSS groups. Stand density index is reduced to less than 25% of max SDI. Table 4 below shows the desired VSS distribution for the Northern goshawk in comparison with existing conditions and the resultant gap.

**Table 4. Desired Vegetative Structural Stage (VSS) distribution for the Northern goshawk, according to the Coconino National Forest Plan (USDA Forest Service 1996), for the Jack Smith / Schultz Fuels Reduction Project, Coconino National Forest, Arizona.**

| VSS DISTRIBUTION | VSS 1 | VSS 2 | VSS 3 | VSS 4 | VSS 5 | VSS 6 |
|---|---|---|---|---|---|---|
| DESIRED FUTURE CONDITIONS | 10% | 10% | 20% | 20% | 20% | 20% |
| EXISTING CONDITIONS | 3% | 3% | 54% | 21% | 11% | 8% |
| NEED FOR CHANGE | +7% | +7% | -34% | -1% | +9% | +12% |

The desired tree arrangement includes trees left in groups of 2-40 trees across the landscape. Basal areas within these groups will range from 30 to 100 BA, and canopy cover will range from 30 to 70%. These tree groups will range in shape and size from approximately 0.05 – 0.7 acres. Tree groups will be defined by grassy interspaces. These interspaces will occupy 30 to 50% of the treated areas. To obtain desired future conditions, there is a need to decrease the proportion of the project area in young to mid-aged forest (VSS 3) by approximately 34%. VSS 1 and 2 are lacking across the project area. There is a need to create openings across approximately 14% of forested areas to increase natural regeneration. Openings will range in size from 0.5 acre to 4 acres. Within northern goshawk PFAs and Mexican spotted owl target/threshold habitat, openings will range in size from 0.5 acre to 2 acre. Additionally, there is a need to increase the proportion of the project area in mature and old forest by approximately 12%.

Within Mexican spotted owl protected habitat, canopy cover will average 50%+ at the PAC level. Treatments within the owl habitat will be designed to decrease the risk of catastrophic crown fire, increase trees size, and promote species diversity.

In the northern goshawk treatments in the Proposed Action, stand densities will be driven by pre-settlement evidence data. Table 5 below shows the results from two different studies which examined pre-settlement evidences in order to determine the trees per acre and basal area before Euro-American settlement. The first set of numbers is from Camp Navajo, west of Flagstaff (Fule et al. 1997) and the second set of numbers is from a high elevation ponderosa pine site which is located within the project boundary (Heinlein et al. 2004).
The third set of numbers is the average for the entire project area.

Table 5. Pre-settlement data from Camp Navajo (Fule et al. 1997) & a San Francisco Peaks study area within the current Jack Smith / Schultz project (Heinlein et al. 2004)

| SPECIES | PRE-SETTLEMENT MEAN | | Current JSS MEAN |
|---|---|---|---|
| Trees/ac | Camp Navajo | JS/S | |
| Ponderosa pine | 26 | 23 | 312 |
| Basal area (ft²/ac) | | | |
| Ponderosa pine | 51 | 44 | 110 |
| | | | |

To obtain a more accurate sense of the number of pre-settlement evidences across the project area, 33 plots were established across the project area to count evidences and existing yellow pines. The results are displayed in Table 6 below. These numbers are consistent with the numbers from table above. The numbers in Zone three are a little lower, however this was not unexpected as Zone 3 is on a drier site which would not be expected to support the same kind of densities in more moist areas.

Table: 6 The average number of evidences and yellow pines per acre by zone and across the project area.

| | Zone 1 | Zone 2 | Zone 3 | Project Average |
|---|---|---|---|---|
| Average Evidences / Acre | 16.6 | 22.0 | 16.0 | 17.9 |
| Average Yellow Pines / Acre | 3.6 | 2.3 | 2.0 | 2.8 |
| Total | 20.2 | 24.3 | 18.0 | 20.7 |

Using a restoration model which would base the number of leave trees on the number pre-settlement evidences in a given area, it is estimated that approximately 30-50% of the treated area would be left grassy interspaces in between tree groups. Depending upon resource objectives the ratio of leave trees to evidences would vary from 1.5 to 3.

As defined in the EA, the project is divided into three zones and categorized in order of importance toward treating to protect the wildland urban interface from a catastrophic wildfire. A greater emphasis would be placed upon reducing the risk of wildfire in zones 1 and 2 while in zone 3 a greater emphasis would be placed on protecting and providing for targeted resources while reducing fire risk.

## Forest Health

Desired future conditions across the project area include improved tree vigor, improved forest health, and a forest structure that is more resilient to insects and diseases. Desired Future Conditions for stands infected with dwarf mistletoe include a reduction in the level and extent of infection to isolated groups or pockets. There is a need to decrease stand densities across the

project area to decrease competition between trees for moisture, nutrients, and sunlight, increase tree vigor, decrease the spread of dwarf mistletoe infection, and decrease susceptibility to disease and successful insect attack and mortality.

### Species Diversity

Desired Future Conditions for Gambel oak include: maintenance of Gambel oak across the landscape; protection of existing large Gambel oak; decreased pine density and competition around Gambel oak clumps; and improved health and longevity of large Gambel oak. Desired Future Conditions for understory vegetation include increased diversity, productivity, and abundance of understory species. Desired future conditions for meadows include a decrease in pine density to historic levels prior to fire suppression.

### Old Growth

At least 20% of the Ecosystem Management Area in which the project occurs is designated as existing or developing old growth. Stand which are to be treated and designated as developing old growth will have treatments designed to facilitate the development of old growth in the stand. Existing and developing old growth stands will be managed to move towards and meet or exceed the minimum criteria as set in the Coconino Forest Plan.

## Overview of the Proposed Action and Alt. 2

The proposed actions are those treatments that will implement the goshawk guideline as intended and explained by the author of GTR RM-217 and the Southwest Regional Office. However the Coconino NF forest plan and GTR RM-217 do not discuss the creation of interspaces, but only address the management of tree groups to be left. The proposed action treatment items 7 and 8 are designed to meet the goshawk guidelines at the stand level using a modified restoration treatment and creating interspaces across 50% of the treated areas to define the groups. Alternative 2 treatment items 9 and 10 are designed to meet the VSS and CC provisions in the goshawk guidelines at the stand level. Items 9 and 10 will not be creating interspaces to define groups.

**Items common to PA and Alt 2.**

1) Thin from Below for Fuel Reduction – Less than 9 inches diameter breast height on approximately 305 acres.

2) Thin from Below for Fuel Reduction – Less than 12 inches diameter breast height on approximately 1,110 acres.

3) Target Threshold treatment For MSO on approximately 76 acres

4) Prescribed Burning – all acres identified in the treatments above and an additional 844 acres of burn only would be treated with prescribed burning after thinning and activity slash burning operations have been completed.

5) Meadow Treatments – encroaching pine will be removed from 27 acres of meadows

6) Aspen treatments – Aspen treatment consists of thinning out of pine with in aspen groups and or fencing

**Proposed Action**

7) Uneven-aged management treatments for Fuel Reduction with WUI Emphasis on approximately 3,096 acres.

8) Uneven-aged management treatments for Fuel Reduction with Resource Emphasis on approximately 3,982acres.

**Alternative 2**

9) Uneven-age management treatments for areas outside of PFA on approximately 6,383 acres.

10) Uneven-age management treatments for areas inside of PFA on approximately 697 acres.

**Proposed Action**

An Ecosystem Restoration model (*see* Literature Cited) modified to meet northern goshawk habitat guidelines will be used to guide management of treatments within the ponderosa pine. Pre-settlement evidences (e.g. old stumps, stump holes, and downed logs) will be used to guide placement or retention of trees groups, interspaces, and openings. Tree groups will consist of 2-40 trees ranging in size from 0.05 to 0.7 acres with grassy interspaces between groups. However, there may be cases where existing groups of large trees with no pre-settlement evidence would be retained because they provide important habitat for wildlife. Canopy cover within groups would vary from 30 to 60+ percent. Within northern goshawk PFAs, openings would range in size from 0.5 to 2 acres. Outside of northern goshawk PFAs, openings will range in size from 0.5 to 4 acres. An Ecosystem Restoration approach will create a more open, groupy, uneven-aged forest with grassy interspaces and openings for regeneration that more closely resembles the structure that existed prior to interruption of the historic fire regime.

**Alternative 2**

This alternative will use uneven-age group selection system to meet the northern goshawk habitat guidelines. . Uneven spacing will be used for leave trees. Trees will be left in a groupy clumpy pattern as much as possible; suing tree rooting zones, regeneration openings and uneven spacing, while maintaining cover across the stand. While this alternative is not using an ecosystem restoration model, evidences will be used as a guide for the creation of groups across the stand. Where evidences are absent, clumps and groups will be created to meet the desired conditions. Up to 20% opening will be created in stands for re-generation. Interspaces will not be created under this alternative.

# Environmental Consequences

## *Proposed Action, Alternative 2, &- No Action*

## Direct and Indirect Effects

### Forest Structure & Stand Density

Under the No Action Alternative, there would be no direct effect to forest vegetation because no trees would be harvested. There would be no change in forest structure from the existing forest structure. However, the No Action Alternative would indirectly affect forest structure over the long-term.

The Proposed Action and Alternative 2 will have a direct effect on the distribution of VSS classes within the project area immediately after treatment. The tables below will display the effects on a per acre basis. The treatments were designed to create an even distribution of VSS classes throughout the stand. Treated stands were then projected out 20 and 40 years to show the long term effects.

# Actions Common to Both Alternatives

## 1) Thin from Below to 9 inch DBH

This treatment on 305 acres is located entirely within the Orion and Weatherford PAC's. The stands selected for treatment have a high density of small trees and are rated either high or very high fire danger. Table 7, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure.

Table 7. Average Values from Forest Vegetation Simulator (FVS) for thinning of Ponderosa Pine up to 9" dbh only within the Spotted Owl PAC's. Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | % of max SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 719 | 157 | 75% | 7.0 | 70 |
| **Year 2008** | | | | | |
| After Treatment | 143 | 106 | 41% | 11.5 | 60 |
| **Year 2028** | | | | | |
| No Action | 645 | 191 | 86% | 8.2 | 76 |
| Treated | 137 | 135 | 49% | 13.4 | 67 |
| **Year 2048** | | | | | |
| No Action | 588 | 216 | 93% | 9.1 | 80 |
| Treated | 132 | 159 | 55% | 14.9 | 72 |

### No Action

Existing conditions show a high TPA average and a low average diameter. Already the stands are above 60% maximum SDI. Without action TPA will go down due to competition based mortality, the SDI will continue to increase and cause increasing mortality of trees of all sizes, and the average diameter will only increase slowly. Encroachment will continue into the few small openings that occur in these stands. Understory abundance and diversity of grasses, forbs, and shrubs will continue to decrease as the canopy closure increases. Aspen groups will continue to decline due to increasing competition and encroachment of conifers.

### Proposed Action

The proposed action will thin trees up to nine inches dbh. Some trees less than nine inches will be left in order to provide for vertical diversity. A 50% canopy cover will be maintained across the stand. After treatment, TPA will be greatly lowered. BA, SDI, and canopy closure will be reduced, while the average diameter will increase significantly. By 2048, the stands will have BA and canopy closure similar to the current conditions, however TPA, and SDI will be much lower than if left untreated., Also, the average diameter is much greater which means the stand will have a higher percentage of larger more fire resistant trees. Understory abundance and diversity will be increased temporarily increased and then maintained over time. Small openings will be maintained within the stands. Competition will be reduced to the aspen stands which will increase vigor and be maintained on site.

## 2) Thin from Below to 12 inch DBH

Under the Proposed Action; approximately 1,110 acres will be thinned up to 12 inches dbh. Because ponderosa pine forests were historically uneven-aged, the project area will be treated using uneven-aged management. Under uneven-aged management, age and size class diversity will be improved through selection harvesting to create openings up to 10% of the stand for natural regeneration (VSS 1 groups). Thinning will be designed to create a groupy/clumpy arrangement of trees.

The stands selected for the 12 inch thinning treatment are stands with an over abundance of VSS 2 and 3 size trees and lacking in VSS 4, 5, and 6. For many of the stands this was the result of a prior seed tree harvest, where only a few large trees were left per acre as seed trees. Many of these stands are in areas where access may be limited or cost prohibitive. These stands are often in higher elevations. Treatment may by done by hand or mechanical means. All of these stands will be treated with the objective of moving stand conditions towards meeting the Goshawk guidelines. Table 8, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure. Table 9 below shows a break down of trees per acre and basal area by VSS class for existing conditions and for the no action and treatment alternatives.

Table 8 Average Values from Forest Vegetation Simulator (FVS) for thinning in stands up to 12" Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | % of Max SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 536 | 107 | 49% | 8.1 | 59 |
| **Year 2008** | | | | | |
| After Treatment | 70 | 53 | 21% | 12.0 | 42 |
| **Year 2028** | | | | | |
| No Action | 480 | 146 | 63% | 9.9 | 68 |
| Treated | 77 | 72 | 26% | 13.5 | 50 |
| **Year 2048** | | | | | |
| No Action | 431 | 170 | 70% | 11.5 | 73 |
| Treated | 85 | 87 | 31% | 14.3 | 56 |

Table 9. A display of values for proposed areas to be treated by thinning up to 12". Averaged FVS output by VSS class for trees and BA per acre.

| | **2007** | | **2008** | | **2028** | | **2028** | | **2048** | | **2048** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Existing Conditions** | | **After Treatment** | | **No Action** | | **Treated** | | **No Action** | | **Treated** | |
| **VSS** | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA |
| **1** | 15 | 0 | 7 | 0 | 13 | 0 | 9 | 0 | 15 | 0 | 13 | 0 |
| **2** | 349 | 8 | 13 | 1 | 274 | 10 | 13 | 0 | 229 | 11 | 19 | 1 |
| **3** | 137 | 54 | 15 | 6 | 136 | 53 | 18 | 7 | 111 | 40 | 15 | 6 |
| **4** | 30 | 32 | 31 | 34 | 52 | 61 | 27 | 36 | 65 | 77 | 15 | 20 |
| **5** | 3 | 6 | 3 | 6 | 6 | 14 | 8 | 19 | 13 | 29 | 18 | 39 |
| **6** | 1 | 8 | 1 | 8 | 1 | 8 | 2 | 10 | 3 | 14 | 5 | 22 |
| **Totals*** | 536 | 107 | 70 | 53 | 480 | 146 | 77 | 72 | 431 | 170 | 85 | 87 |
| | | | | | | | | | | | | |

*Due to rounding, displayed numbers do not always equal up to the total.

## No Action

Existing conditions show that on average these stands have over 500 tpa most of which are in the VSS 2 size class, and the SDI is 49% of max SDI. These stands are currently experiencing decreased growth and vigor and are increasingly susceptible to insect disease and stand replacing fire. Within 20 years SDI is up to 63% of max SDI, which means there is widespread competition based mortality occurring and extreme risk of successful insect attack and mortality. Current and projected future conditions show these stands have excessive amounts of trees in VSS 2 and 3. The VSS 5 and 6 size classes remain underrepresented, even after 40 years.

## Proposed Action

These treatments have been identified on approximately **1,110** acres in stands where access by mechanical logging equipment or haul trucks may be prohibitive, but the stands could benefit from thinning in the 12" diameter breast height (dbh) and less size classes to reduce fuel and fire hazard to resources and improve forest health. Attaining a clumpy/groupy arrangement is still desirable in these treatments, but may be limited due to the diameter cutting limitations.

The proposed action will be removing the majority of trees in the VSS 2 and 3 size classes. By doing this, this reduces the competition of the existing larger trees and allows for a greater response and growth. Trees will be left in a groupy/clumpy arrangement, where feasible. After 40 years there will be an increase in TPA and BA in the VSS 5 and 6 classes.

Table 10 below shows the distribution of trees as a percentage on a per acre basis across all VSS classes. Under this treatment the distribution of VSS classes on a per acre basis will be moving towards meeting the Goshawk guidelines.

Table 10. The average VSS distribution as a percentage on a per acre basis in the 12" treatment areas.

| | VSS | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **Desired Future Condition** | 10 | 10 | 20 | 20 | 20 | 20 |
| **Existing Condition** | 3 | 65 | 26 | 6 | 1 | 0 |
| **After Treatment** | 10 | 19 | 21 | 44 | 4 | 1 |
| **No Action 2028** | 3 | 57 | 28 | 11 | 1 | 0 |
| **Treated 2028** | 12 | 17 | 23 | 35 | 10 | 3 |
| **No Action 2048** | 3 | 53 | 25 | 15 | 3 | 1 |
| **Treated 2048** | 15 | 22 | 18 | 18 | 21 | 6 |

## 3) Target Threshold Stand 278/14A

This stand is a ponderosa pine and Gambel oak stand which was identified to be developing towards target threshold conditions for nesting and roosting for the Mexican spotted owl. Minimum requirements to meet target threshold conditions is: 150 BA, more than 20 trees per acre greater than 18 inches dbh, and at lest 15% stand density contained in each of VSS 4, 5, and 6.

### No Action

This stand is currently at 120 BA with the majority of the trees from 9 to 18 inches dbh. The FVS modeling shows this stand will not be able to meet the target threshold conditions in 100 years.

### Proposed Action

A thinning from 5 to 18 inches dbh retaining over 80 BA and maintaining at least 55% canopy cover (as measured across the stand) immediately after treatment would allow for this stand to meet the minimum target threshold within 50 years after treatment. Thinning would emphasize retaining an uneven-age size distribution and the creation of gaps in the canopy to allow for regeneration. Thinning will also target removal of pines encroaching upon established oak. This will help improve the health and vigor of the oaks by reducing competition from the pines.

## 4) Prescribed Burn Only Treatments

Approximately 700 acres will be receiving burn only treatments. These treatments are intended to reduce ground fuels and reintroduce fire. Thinning with fire is not an objective in these stands, however some tree mortality can be expected due to torching of individual trees even under low and moderate fire intensities.

Under the Proposed Action Alternative, in addition to the 700 acres receiving a burn only treatment, all treated stands will receive a broadcast burn. Again, thinning with fire is not an objective in stands that receive prior thinning. It is expected that some tree mortality can be expected due to torching of individual trees from burning of piles and broadcast burning, even under low and moderate fire intensities.

Broadcast burning, in conjunction with harvesting or existing open canopies, will have beneficial effects on understory productivity and diversity. According to research conducted on the San Juan National Forest in ponderosa pine, thinning in conjunction with prescribed burning resulted in a significant increase in herbaceous richness (Lynch et al. 2000). Research conducted at the Gus Pearson Natural Area found that thinning and prescribed burning in ponderosa pine resulted in significant increases in herbaceous biomass and species richness (Moore et al. 1992-1999). Research conducted at the Fort Valley Experimental Forest also found that thinning and

prescribed burning resulted in significant increases in herbaceous production (Covington et al. 1997). Research conducted by Griffis et al. (2001) in ponderosa pine forests of northern Arizona found an increase in overall plant diversity and an increase in the abundance of graminoids in thinned and burned stands. FIRESUM modeling in southwestern ponderosa pine found that thinning and prescribed burning in ponderosa pine resulted in significant increases in herbaceous production (Covington et al. 2001). Additional benefits of prescribed burning include seed bed and site preparation. Research at Chimney Spring found good seedling establishment on burned sites, while unburned sites contained no seedlings (Sackett 1995). Furthermore, prescribed burning is essential to nutrient cycling in ponderosa pine ecosystems. Research at Chimney Spring found significant increases in ammonium levels and microbial nitrogen mineralization on burned plots, compared with control plots (Sackett 1995). Increases in nutrient levels were evident in both understory and overstory vegetation.

## 5) Meadow Restoration

Three historic meadows totaling 27 acres occur on 89 Mesa. These are the only large natural openings of any significance within this project area. There is a need to ensure that this unique feature is retained upon the landscape. All three meadows have ponderosa pine encroachment into the meadow. All pine except historic yellow pine will be removed from the meadows in order to enhance the restore the function of the meadows.

## 6) Aspen Restoration

As described in the species diversity section later in this report: there is a need restore, protect, and regenerate aspen clones. Invading ponderosa pine will be removed from within the clones and up to 66 ft. surrounding the clone. Treated sites may be fenced to protect aspen suckers from ungulate browsing. There are approximately 150 acres on 35 sites that may be treated. Where aspen sites occur in spotted owl PAC's only trees up to 9" dbh will be cut. Treating the aspen clones will help ensure the continued survival and regeneration of aspen clones. This will help to maintain species diversity across the landscape.

## Actions common to only the Proposed Action

## 7) Uneven-aged Treatments with Fuels Reduction Emphasis

Approximately **3,096** acres are treated using this system with a fuel hazard reduction objective and an emphasis on WUI, which includes protection to communities and critical infrastructure. All treatments with fuels reduction emphasis will occur in Zones 1 and 2 only. This is an uneven-age group selection which will provide for meeting fuels reduction, modified restoration objectives, and the goshawk guidelines. Table 11, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure. Table 12 below shows a break down of trees per acre and basal area by VSS class for existing conditions and for the no action and treatment alternatives.

Table 11 Proposed Action only. Average Values from Forest Vegetation Simulator (FVS) for Un-even age fuels emphasis thinning. Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 221 | 132 | 52% | 11.5 | 67 |
| **Year 2008** | | | | | |
| After Treatment | 41 | 45 | 16% | 14.2 | 39 |
| **Year 2028** | | | | | |
| No Action | 206 | 157 | 59% | 12.9 | 71 |
| Treated | 46 | 60 | 21% | 15.6 | 47 |
| **Year 2048** | | | | | |
| No Action | 189 | 174 | 63% | 13.9 | 74 |
| Treated | 51 | 73 | 25% | 16.2 | 52 |

Table 12. Proposed Action only. A display of values for Un-even age fuels emphasis treatment. Averaged FVS output by VSS class for trees and BA per acre.

| | **2007** | | **2008** | | **2028** | | **2028** | | **2048** | | **2048** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Existing Conditions** | | **After Treatment** | | **No Action** | | **Treated** | | **No Action** | | **Treated** | |
| **VSS** | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA |
| **1** | 3 | 0 | 0 | 0 | 6 | 0 | 7 | 0 | 11 | 0 | 6 | 0 |
| **2** | 44 | 2 | 9 | 0 | 32 | 1 | 6 | 0 | 26 | 1 | 14 | 1 |
| **3** | 111 | 41 | 11 | 5 | 88 | 36 | 9 | 3 | 66 | 28 | 6 | 3 |
| **4** | 52 | 60 | 9 | 10 | 54 | 66 | 10 | 12 | 56 | 69 | 8 | 10 |
| **5** | 9 | 20 | 9 | 20 | 19 | 41 | 10 | 26 | 26 | 57 | 9 | 21 |
| **6** | 3 | 10 | 3 | 10 | 3 | 13 | 5 | 19 | 5 | 19 | 9 | 38 |
| **Totals*** | 221 | 132 | 41 | 45 | 206 | 157 | 46 | 60 | 189 | 174 | 51 | 73 |
| | | | | | | | | | | | | |

*Due to rounding, displayed numbers do not always equal up to the total.

## No Action

As displayed on Table 11, the average SDI is 52% which means that there is significant competition, decreased growth, and increased susceptibility to insects, disease, and fire. After 40 of no treatment SDI increases to 63% which brings it above that critical threshold of density which will cause little to no growth, competition based mortality, and extreme risk of insect, disease, and fire mortality. Canopy closure values are very high and become higher, which means there is not much understory to begin with and will continue to decrease over time. Table 12 shows the number of trees and corresponding basal area for each of the VSS classes. There is currently an excessive amount of trees in the VSS 2, 3, & 4 size classes, and in 40 years there will be an excessive amount of trees in VSS 3, 4, & 5 size classes with out treatment.

**Proposed Action**

Forested area consisting of clumps and groups is expected to range between 40 to 50%, increasing over time by as much as 20% as VSS 1 openings regenerate. To insure that there is a diversity of group sizes and that the amount of forested area in canopy cover is well represented within the 30 to 50% range, a minimum of 25% of groups will retain canopy cover greater than 50%, 50% of groups will be retained with canopy cover between 40 and 50% and no more than 25% of groups will retain canopy cover between 30 and 40%. Group size will vary based on the presence of evidence and the number of trees to be retained per evidence. Some groups may be up to 5 acres in size with greater than 50% canopy cover. Efforts will be made to tie larger groups to features such as archaeological sites, drainages, wildlife waters, visually interesting trail niches and wildlife habitat niches.

Structural arrangement within clumps and groups is described as:

VSS 5 and 6 – Usually closed canopy (interlocking crowns desired condition), usually will retain existing conditions.
VSS 4: Desired condition is closed canopy, but will vary by fuel hazard reduction/resource needs. Canopy cover ranges from 40% to existing conditions.
VSS 3: Usually open canopy, but may vary from moderately closed to closed for diversity. Canopy cover ranges from 30% to 60%.
VSS 3, 2, 1: In 70% of the area canopy cover will range from zero to 40%; in 20% of the area canopy cover will range from 41 to 59%; and in 10% of this area canopy cover will be 60%+.

Depending on regeneration needs for VSS 1 and 2, up to 20% openings will be created with the express goal of creating regeneration. All existing VSS 1 and 2 size trees will be retained in openings. Openings will typically be 200 ft. wide or less, and up to 4 acres in size. For openings greater than one acre, 3-5 seed bearing trees will be left per acre.

Interspaces will be created across 50% of the stand area and maintained as grassy non-forested area. Interspaces will be a minimum of 1 ½ times the tree height in order to satisfy fuels reduction objectives. VSS 1 and 2 trees will not be retained in interspaces.

As shown in Table 11, after treatment SDI will be reduced to 16%. Over the next 40 years it only increases to 25%, which continues to meet the desired future condition of maintaining the stand at less than 25% of maximum SDI.

Treatments will use pre-settlement evidences to guide retention tree levels when possible. Retention tree levels will vary between zones when needed to meet specific objectives, such as higher retention in some clumps and groups for wildlife habitat desired conditions, visual quality, and diversity. Treatments in VSS 3 and some VSS 4 stands will generally emphasize more open clumps (less trees per evidence) in all zones.

Table 13 below shows the distribution of trees as a percentage on a per acre basis across all VSS classes. After treatment, tree distribution is fairly even across the VSS classes thus moving towards meeting the Goshawk guidelines, however over time the VSS distribution becomes more uneven with an excess of VSS 5 and 6 in 40 years. To simplify the display of the table, VSS classes 1 and 2 are combined.

Table 13. Proposed Action only. The average VSS distribution as a percentage on a per acre basis in the Uneven-age Fuels Emphasis treatment areas using trees per acre

| | VSS | | | | |
|---|---|---|---|---|---|
| | **1 & 2** | **3** | **4** | **5** | **6** |
| **Desired Future Condition** | 20 | 20 | 20 | 20 | 20 |
| **Existing Condition** | 10 | 39 | 35 | 11 | 5 |
| **After Treatment** | 20 | 12 | 19 | 33 | 15 |
| **No Action 2028** | 7 | 30 | 36 | 22 | 5 |
| **Treated 2028** | 8 | 10 | 21 | 36 | 25 |
| **No Action 2048** | 7 | 22 | 35 | 28 | 8 |
| **Treated 2048** | 11 | 6 | 15 | 29 | 40 |

## 8) Uneven-aged Treatments with Resource Emphasis

Approximately **3,982** acres are treated using this system where due to differing values at risk, fuel hazard reduction is still a primary objective, but resource protection is the emphasis. This is an uneven-age group selection which will provide for meeting fuels reduction, modified restoration objectives, and the goshawk guidelines. Table 14, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure. Table 15 below shows a break down of trees per acre and basal area by VSS class for existing conditions and for the no action and treatment alternatives.

Table 14 Proposed Action only. Average Values from Forest Vegetation Simulator (FVS) for Un-even age resource emphasis thinning. Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 216 | 103 | 42% | 10.5 | 60 |
| **Year 2008** | | | | | |
| After Treatment | 52 | 52 | 18% | 13.1 | 41 |
| **Year 2028** | | | | | |
| No Action | 211 | 131 | 51% | 11.7 | 67 |
| Treated | 60 | 67 | 24% | 14.1 | 48 |
| **Year 2048** | | | | | |
| No Action | 207 | 155 | 58% | 12.7 | 72 |
| Treated | 67 | 81 | 28% | 14.8 | 54 |

Table 15. Proposed Action only. A display of values for Un-even age resource emphasis treatment. Averaged FVS output by VSS class for trees and BA per acre.

| | **2007** | | **2008** | | **2028** | | **2028** | | **2048** | | **2048** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Existing Conditions** | | **After Treatment** | | **No Action** | | **Treated** | | **No Action** | | **Treated** | |
| **VSS** | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA |
| **1** | 12 | 0 | 1 | 0 | 10 | 0 | 8 | 0 | 10 | 0 | 6 | 0 |
| **2** | 84 | 4 | 14 | 1 | 61 | 3 | 7 | 0 | 49 | 2 | 12 | 0 |
| **3** | 78 | 30 | 18 | 6 | 87 | 34 | 21 | 8 | 80 | 32 | 20 | 8 |
| **4** | 33 | 38 | 10 | 12 | 37 | 44 | 11 | 13 | 43 | 50 | 10 | 13 |
| **5** | 7 | 15 | 7 | 15 | 13 | 28 | 10 | 23 | 21 | 48 | 10 | 24 |
| **6** | 3 | 17 | 3 | 17 | 4 | 21 | 4 | 23 | 5 | 23 | 7 | 32 |
| **Totals*** | 216 | 103 | 52 | 52 | 211 | 131 | 60 | 67 | 207 | 155 | 67 | 81 |
| | | | | | | | | | | | | |

*Due to rounding, displayed numbers do not always equal up to the total.

## No Action

As displayed on Table 14, the average SDI is 42% which means that there is significant competition, decreased growth, and increased susceptibility to insects, disease, and fire. After 40 of no treatment SDI increases to 58% which brings it close to that critical threshold of density which will cause little to no growth, competition based mortality, and extreme risk of insect, disease, and fire mortality. Canopy closure values are very high and become higher, which means there is not much understory to begin with and will continue to decrease over time. Table 15 shows the number of trees and corresponding basal area for each of the VSS classes. There is currently an excessive amount of trees in the VSS 2, 3, & 4 size classes. The average VSS in this treatment area is VSS 4. If left untreated there will still be an excess of trees in VSS 2, 3, & 4 size classes.

## Proposed Action

Forested area consisting of clumps and groups is expected to range between 35 to 65%, increasing over time by as much as 20% as VSS 1 openings regenerate. To insure that there is a diversity of group sizes and that the amount of forested area in canopy cover is well represented within the 30 to 65% range, a minimum of 35% of groups will retain canopy cover greater than 50%, 50% of groups will be retained with canopy cover between 40 and 50% and no more than 20% of groups will retain canopy cover between 30 and 40%. Group size will vary based on the presence of evidence and the number of trees to be retained per evidence. Some groups may be up to 5 acres in size with greater than 50% canopy cover. Efforts will be made to tie larger groups to features such as archaeological sites, drainages, wildlife waters, visually interesting trail niches and wildlife habitat niches.

Structural arrangement within clumps and groups is described as:
VSS 5 and 6 – Usually closed canopy (interlocking crowns desired condition), usually will retain existing conditions.
VSS 4: Desired condition is closed canopy, but will vary by fuel hazard reduction/resource needs. Canopy cover ranges from 50% to 70%.
VSS 3: Usually open canopy, but may vary from moderately closed to closed for diversity. Canopy cover ranges from 40% to 60%.
VSS 3, 2, 1: In 60% of area, canopy cover will range from zero to 40%; in 20% of the area, canopy cover will range from 41 to 59%; and in 20% of this area, canopy cover will be 60%+.

Depending on regeneration needs for VSS 1 and 2, up to 20% openings will be created with the express goal of creating regeneration. All existing VSS 1 and 2 size trees will be retained in openings. Openings will typically be 200 ft. wide or less, and up to 4 acres in size. For openings greater than one acre, 3-5 seed bearing trees will be left per acre.

Interspaces will be created across 50% of the stand area and maintained as grassy non-forested area. Interspaces will be a minimum of 1 ½ times the tree height in order to satisfy fuels reduction objectives. VSS 1 and 2 trees will not be retained in interspaces.

Treatments will use pre-settlement evidences to guide retention tree levels when possible. Retention tree levels will vary between zones when needed to meet specific objectives, such as higher retention in some clumps and groups for wildlife habitat desired conditions, visual quality, and diversity. Treatments in VSS 3 and some VSS 4 stands will generally emphasize more open clumps (less trees per evidence) in all zones.

Table 16 below shows the distribution of trees across all VSS classes as a percentage. After 20 and 40 years, tree distribution under the treated alternative has moved towards meeting the desired VSS distribution and meeting the Goshawk guidelines.

Table 16. Proposed Action only. The average VSS distribution as a percentage on a per acre basis in the Uneven-age Resource Emphasis treatment areas using trees per acre

| | **VSS** | | | | |
|---|---|---|---|---|---|
| | **1 & 2** | **3** | **4** | **5** | **6** |
| **Desired Future Condition** | 20 | 20 | 20 | 20 | 20 |
| **Existing Condition** | 23 | 33 | 27 | 10 | 6 |
| **After Treatment** | 20 | 19 | 21 | 25 | 15 |
| **No Action 2028** | 16 | 33 | 27 | 17 | 7 |
| **Treated 2028** | 7 | 21 | 21 | 33 | 18 |
| **No Action 2048** | 12 | 28 | 29 | 24 | 8 |
| **Treated 2048** | 9 | 17 | 17 | 29 | 28 |

## Actions common only to Alternative 2

## 9) Uneven-age Treatments outside of PFAs

Approximately **6,383** acres will be treated using an uneven-age group selection system. This alternative will meet the VSS distribution of forested groups within a stand and minimum canopy cover requirements for the northern goshawk as stated in the Coconino Forest Plan. Openings of up to 20% of the stand will be created for regeneration in stands lacking VSS 1 & 2. The remainder of the stand will be maintained in forest cover. There will be no interspaces created. Canopy cover of 40% will be maintained in VSS 4, 5, & 6 groups across the stand. Table 17, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure. Table 18, below shows a break down of trees per acre and basal area by VSS class for existing conditions and for the no action and treatment alternatives.

Table 17 Alternative 2. Average Values from Forest Vegetation Simulator (FVS) for Uneven-age treatments outside of PFAs. Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 171 | 116 | 44% | 12 | 64 |
| **Year 2008** | | | | | |
| After Treatment | 67 | 52 | 20% | 12 | 43 |
| **Year 2028** | | | | | |
| No Action | 165 | 142 | 52% | 13 | 68 |
| Treated | 90 | 72 | 27% | 12 | 52 |
| **Year 2048** | | | | | |
| No Action | 160 | 162 | 58% | 14 | 72 |
| Treated | 96 | 93 | 34% | 13 | 58 |

Table 18. Alternative 2. A display of values for Un-even age treatment outside of PFAs. Averaged FVS output by VSS class for trees per acre and BA.

| | **2007** | | **2008** | | **2028** | | **2028** | | **2048** | | **2048** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Existing Conditions** | | **After Treatment** | | **No Action** | | **Treated** | | **No Action** | | **Treated** | |
| **VSS** | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA |
| **1** | 4 | 0 | 1 | 0 | 6 | 0 | 5 | 0 | 11 | 0 | 7 | 0 |
| **2** | 41 | 2 | 22 | 1 | 27 | 2 | 30 | 1 | 23 | 1 | 27 | 2 |
| **3** | 66 | 28 | 22 | 9 | 58 | 26 | 23 | 9 | 46 | 20 | 25 | 9 |
| **4** | 48 | 55 | 12 | 14 | 48 | 59 | 17 | 20 | 49 | 61 | 18 | 21 |
| **5** | 9 | 20 | 7 | 16 | 19 | 42 | 9 | 22 | 26 | 59 | 12 | 27 |
| **6** | 3 | 11 | 3 | 11 | 3 | 14 | 5 | 20 | 5 | 21 | 8 | 34 |
| **Totals*** | 170 | 116 | 67 | 51 | 162 | 143 | 89 | 72 | 160 | 162 | 96 | 93 |
| | | | | | | | | | | | | |

*Due to rounding, displayed numbers do not always equal up to the total.

## No Action

As displayed on Table 17, the average SDI is 44% which means that there is significant competition, decreased growth, and increased susceptibility to insects, disease, and fire. After 40 years of no treatment SDI increases to 58% which brings it close to that critical threshold of density which will cause little to no growth, competition based mortality, and extreme risk of insect, disease, and fire mortality. Canopy closure values are very high and become higher, which means there is not much understory to begin with and will continue to decrease over time. Table 18 shows the number of trees and corresponding basal area for each of the VSS classes. There is currently an excessive amount of trees in the VSS 2, 3, & 4 size classes. The average VSS in this treatment area is VSS 4. If left untreated there will still be an excess of trees in VSS 3, 4, & 5 size classes.

### Alternative 2

Forested clumps and groups will be maintained across 80% the stand. Where VSS 1 and 2 are lacking, openings will be created in up to 20% of the stand for regeneration. All VSS 4, 5, & 6 groups will have a canopy cover greater than 40%. Archaeological sites will not receive mechanical treatment. Areas in which higher canopy cover and densities may be maintained include drainages, wildlife waters, visually interesting trail niches and wildlife habitat niches.

Structural arrangement within clumps and groups is described as:
VSS 5 and 6 – Usually closed canopy (interlocking crowns desired condition), usually will retain existing conditions. Canopy cover is greater than 40%
VSS 4: Desired condition is moderately open, but may vary from open to closed. Canopy cover is greater than 40%
VSS 3: Desired condition is open canopy, but may vary from moderately closed to closed for diversity. Canopy cover ranges from 30% to 60%.

Depending on regeneration needs for VSS 1 and 2, up to 20% openings will be created with the express goal of creating regeneration. All existing VSS 1 and 2 size trees will be retained in openings. Openings will typically be 200 ft. wide or less, and up to 4 acres in size. For openings greater than one acre, 3-5 seed bearing trees will be left per acre.

Table 19 below shows the distribution of trees across all VSS classes as a percentage. After 20 and 40 years, tree distribution under the treated alternative has moved towards meeting the desired VSS distribution and meeting the Goshawk guidelines.

Table 19. Alternative 2 The average VSS distribution as a percentage on a per acre basis in the Uneven-age treatment outside of PFA's using trees per acre

| | **VSS** | | | | |
|---|---|---|---|---|---|
| | **1 & 2** | **3** | **4** | **5** | **6** |
| **Desired Future Condition** | 20 | 20 | 20 | 20 | 20 |
| **Existing Condition** | 11 | 29 | 41 | 13 | 6 |
| **After Treatment** | 20 | 21 | 22 | 23 | 14 |
| **No Action 2028** | 8 | 24 | 37 | 26 | 6 |
| **Treated 2028** | 16 | 18 | 25 | 23 | 18 |
| **No Action 2048** | 7 | 17 | 35 | 32 | 9 |
| **Treated 2048** | 12 | 16 | 22 | 26 | 24 |

## 10) Uneven-age Treatments inside of PFAs

Approximately **697** acres will be treated using an uneven-age group selection system. This alternative will meet the VSS distribution of forested groups within a stand and minimum canopy cover requirements for the northern goshawk PFA's as stated in the Coconino Forest Plan. Openings of up to 20% of the stand will be created for regeneration in stands lacking VSS 1 & 2. The remainder of the stand will be maintained in forest cover. There will be no interspaces created. Canopy cover of 50% will be maintained in VSS 4, 5, & 6 groups across the stand, with 1/3 of the VSS 4 groups at 60% canopy cover. Table 20, below shows the existing, treated, and no action numbers for trees per acre (TPA), basal area (BA), % of maximum stand density index (SDI), average diameter, and canopy closure. Table 21 below shows a break down of trees per acre and basal area by VSS class for existing conditions and for the no action and treatment alternatives.

Table 20. Alternative 2. Average Values from Forest Vegetation Simulator (FVS) for Uneven-age treatments inside of PFAs. Canopy closure values are derived from Shepperd, et all 2006

| Year and Action | Trees / Acre | Basal Area | SDI | Average Diameter | Canopy Closure |
|---|---|---|---|---|---|
| **Year 2007** | | | | | |
| Existing Conditions | 402 | 166 | 71% | 9.4 | 73 |
| **Year 2008** | | | | | |
| After Treatment | 80 | 63 | 24% | 12.2 | 48 |
| **Year 2028** | | | | | |
| No Action | 360 | 194 | 78% | 10.6 | 77 |
| Treated | 101 | 93 | 34% | 13.1 | 58 |
| **Year 2048** | | | | | |
| No Action | 312 | 209 | 81% | 11.7 | 79 |
| Treated | 108 | 119 | 42% | 14.2 | 120 |

Table 21. Alternative 2. A display of values for Un-even age treatment inside of PFAs. Averaged FVS output by VSS class for trees per acre and BA.

| | **2007** | | **2008** | | **2028** | | **2028** | | **2048** | | **2048** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Existing Conditions** | | **After Treatment** | | **No Action** | | **Treated** | | **No Action** | | **Treated** | |
| **VSS** | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA | #Tr/ ac. | BA |
| **1** | 5 | 0 | 5 | 0 | 10 | 0 | 6 | 0 | 12 | 0 | 8 | 0 |
| **2** | 98 | 3 | 13 | 1 | 81 | 3 | 32 | 1 | 61 | 2 | 30 | 2 |
| **3** | 236 | 76 | 29 | 11 | 188 | 72 | 19 | 7 | 140 | 56 | 19 | 8 |
| **4** | 53 | 61 | 24 | 28 | 61 | 72 | 27 | 33 | 72 | 85 | 19 | 24 |
| **5** | 9 | 19 | 8 | 17 | 17 | 37 | 16 | 38 | 23 | 52 | 22 | 50 |
| **6** | 1 | 8 | 2 | 8 | 3 | 12 | 3 | 13 | 3 | 14 | 9 | 35 |
| **Totals*** | 402 | 166 | 80 | 65 | 360 | 195 | 102 | 94 | 312 | 209 | 108 | 118 |
| | | | | | | | | | | | | |

*Due to rounding, displayed numbers do not always equal up to the total.

## No Action

As displayed on Table 20, the average SDI is 71% which means that there is intense competition which is causing little growth, competition-based mortality, increased risk of insect attack, and increased fire risk. After 40 years of no treatment SDI increases to 81% which means there is still, little to no growth, competition based mortality, and extreme risk of insect, disease, and fire mortality. Canopy closure values are very high and become higher, which means there is not much understory to begin with and will continue to decrease over time.

Table 21 shows the number of trees and corresponding basal area for each of the VSS classes. There is currently an excessive amount of trees in the VSS 2, 3, & 4 size classes. The average VSS in this treatment area is VSS 3. If left untreated there will still be an excess of trees in VSS 2, 3, 4, & 5 size classes.

### Alternative 2

Forested clumps and groups will be maintained across 80% the stand. Where VSS 1 and 2 are lacking, openings will be created in up to 20% of the stand for regeneration. All VSS 4, 5, & 6 groups will have a canopy cover greater than 50%. Archaeological sites will not receive mechanical treatment. Areas in which higher canopy cover and densities may be maintained include drainages, wildlife waters, visually interesting trail niches and wildlife habitat niches.

Structural arrangement within clumps and groups is described as:
VSS 5 and 6 – Usually closed canopy (interlocking crowns desired condition), usually will retain existing conditions. Canopy cover is greater than 50%
VSS 4: Desired condition is closed canopy, with 2/3 at greater than 50% and 1/3 greater than 60%.
VSS 3: Desired condition is open canopy, but may vary from moderately closed to closed for diversity. Canopy cover ranges from 30% to 60%.

Depending on regeneration needs for VSS 1 and 2, up to 20% openings will be created with the express goal of creating regeneration. All existing VSS 1 and 2 size trees will be retained in openings. Openings will typically be 200 ft. wide or less, and up to 4 acres in size. For openings greater than one acre, 3-5 seed bearing trees will be left per acre.

Table 22 below shows the distribution of trees at the stand level across all VSS classes as a percentage. After 20 and 40 years, tree distribution under the treated alternative has moved towards meeting the desired VSS distribution and meeting the Goshawk guidelines.

Table 22. Alternative 2. The average VSS distribution at the stand level as a percentage on a per acre basis in the Uneven-age treatment inside of PFAs areas using trees per acre.

| | **VSS** | | | | |
|---|---|---|---|---|---|
| | **1 & 2** | **3** | **4** | **5** | **6** |
| **Desired Future Condition** | 20 | 20 | 20 | 20 | 20 |
| **Existing Condition** | 16 | 56 | 20 | 7 | 1 |
| **After Treatment** | 20 | 22 | 30 | 21 | 7 |
| **No Action 2028** | 14 | 45 | 24 | 14 | 3 |
| **Treated 2028** | 16 | 12 | 28 | 35 | 9 |
| **No Action 2048** | 12 | 35 | 29 | 20 | 4 |
| **Treated 2048** | 13 | 10 | 16 | 39 | 22 |

## Mid and Large Scale Analysis for Vegetation Management:

### Forest Plan Standards and Guidelines

Treatments within the Northern Goshawk treatment areas must be analyzed at three levels: small, mid, and large scale. The small scale is represented by the stand, treatments 2, and 7 -10 discussed above address effects at the stand level. The mid scale is the project. The large scale is the Ecosystem Management Area (EMA). On the Coconino NF the EMA is based on 10K areas. Because the project boundaries are in two different 10K's (Jack Smith 10K and Elden 10K) the large scale for this analysis encompasses both 10K's.

To perform this analysis canopy cover and VSS were averaged at the stand level. This means that individual stands which may contain multiple VSS groups within the stand will be classified by VSS class which has the highest amount of basal area with in the stand. Average stand canopy cover will not be accurately reflecting the canopy cover within individual tree groups in the stand. Stands with a high percent of openings will have an average canopy cover which is lower than the canopy cover within the forested group in the stand.

During the course of the analysis it was found that both alternatives had the same effect upon overall stand VSS classification therefore post treatment VSS distribution is not broken out by alternative.

## Project Level

This section will discuss the effects of the treatments on VSS and canopy cover as it pertains to the goshawk guidelines at the project level.

A stand which has met the VSS distribution at the stand level will be classified as a VSS 6. So if all the stands have met the VSS distribution at the stand level then all stands would be classified at the VSS 6 level when looking at the project level. The higher the percentage of stands classified in greater VSS size classes the closer the project is to meeting the goshawk guidelines. In table 23 below, comparing pre-treatment VSS distribution to the post treatment distribution shows an increase in the percent of VSS 4, 5, and 6 size classes, which indicates these treatments are moving towards the desired VSS distribution.

Canopy cover for VSS 4, 5, and 6 forested areas will average 40% or greater. In table 23 which looks at ponderosa pine stands outside of PFAs, the proposed action alternative post treatment canopy cover for VSS 5 is at 39% which would seem to indicate that the standard is not being met, however this number represents the canopy cover for all forested groups in the VSS 5 stands. In this case it is the lower canopy covers in the VSS 1-3 forested groups that has caused this VSS class to average below 40% even though the minimum 40% canopy cover is being maintained in the VSS 4, 5, and 6 groups within those VSS 5 stands.

The five tables below (tables 23 -27) display the project level information. Tables are broken out by ponderosa pine stands and mix conifer stands, and those stands which are inside or outside of PFAs and nest sites. All tables display the amount of acres and percent in each VSS class, the pre treatment canopy cover, post treatment canopy cover by alternative, and post treatment change in VSS distribution if the stand is treated. In all categories where treatment occurred there was no change in VSS distribution or there was an increase in VSS 4, 5, and 6. This shows that these treatments are helping to move the project level towards meeting the northern goshawk guidelines.

Table 23. In ponderosa pine stands outside of PFAs, within the project area: distribution of VSS pre and post treatment, and canopy cover by VSS class before treatment, and after treatment.

| VSS | Acres | Pre-Treatment % of VSS | Pre-Treatment Canopy Cover | Alternative 1 – Post Treatment Canopy Cover in Forested Areas Only | Alternative 1 – Post Treatment Canopy Cover across the whole stand | Alternative 2 – Post Treatment Canopy Cover across the whole stand | Post Treatment VSS Acres for Alt. 1 & 2 | Post Treatment % of VSS |
|---|---|---|---|---|---|---|---|---|
| **1** | 231 | 2 | 16 | 16 | 16 | 16 | 231 | 2 |
| **2** | 554 | 6 | 54 | 43 | 41 | 43 | 52 | 1 |
| **3** | 3993 | 41 | 56 | 43 | 29 | 47 | 1911 | 20 |
| **4** | 2887 | 30 | 60 | 42 | 26 | 49 | 3557 | 36 |
| **5** | 1131 | 12 | 51 | 40 | 30 | 46 | 2774 | 28 |
| **6** | 984 | 10 | 56 | 49 | 46 | 50 | 1255 | 13 |

Table 24. In ponderosa pine stands inside of PFAs, within the project area: distribution of VSS pre and post treatment, and canopy cover by VSS class before treatment, and after treatment.

| VSS | Acres | Pre-Treatment % of VSS | Pre-Treatment Canopy Cover | Alternative 1 – Post Treatment Canopy Cover in Forested Areas Only | Alternative 1 – Post Treatment Canopy Cover across the whole stand | Alternative 2 – Post Treatment Canopy Cover across the whole stand | Post Treatment VSS Acres for Alt. 1 & 2 | Post Treatment % of VSS |
|---|---|---|---|---|---|---|---|---|
| **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 51 | 5 | 51 | 43 | 43 | 43 | 13 | 1 |
| **3** | 369 | 39 | 64 | 43 | 30 | 51 | 191 | 20 |
| **4*** | 429 | 45 | 56 | 42* | 24* | 50* | 213 | 23 |
| **5** | 77 | 8 | 80 | 78 | 78 | 78 | 190 | 20 |
| **6** | 17 | 2 | 69 | 45 | 63 | 52 | 336 | 36 |

*Within PFA's, 1/3 of the VSS 4 groups will have a minimum of 60% canopy cover and the remaining 2/3 VSS 4 groups will maintain a minimum 50% canopy cover. The 50% average shown might indicate this standard is not being met, however this average number is due to the high occurrence of VSS 1, 2, and 3 groups, which have open canopies, within the VSS 4 stands and as a result brings the overall canopy coverage down within these VSS 4 stands.

Table 25. Mixed Conifer – Outside of PFAs Only VSS 4, 5, & 6 mix conifer stands occur within the project area. No treatment of mix conifer stands will occur.

| VSS | Acres | % of VSS | Canopy Cover |
|---|---|---|---|
| **4** | 61 | 8 | 57 |
| **5** | 594 | 81 | 73 |
| **6** | 76 | 10 | 73 |

Table 26. Mixed Conifer – Within PFAs No treatment with in the mixed conifer. This stand is also in the nest site.

| VSS | Acres | % of VSS | Canopy Cover |
|---|---|---|---|
| **5** | 64 | 100 | 83 |

Table 27. Ponderosa Pine Nest Stands (burn only treatments. There was no change in VSS distribution after treatment.

| VSS | Acres | Pre & Post Treatment % of VSS | Pre-Treatment Canopy Cover | Post Treatment Canopy Cover Alt. 1 & 2 |
|---|---|---|---|---|
| **1** | 0 | 0 | 0 | 0 |
| **2** | 12 | 13 | 52 | 47 |
| **3** | 19 | 20 | 70 | 63 |
| **4** | 35 | 36 | 61 | 55 |
| **5** | 13 | 14 | 63 | 57 |
| **6** | 17 | 17 | 69 | 63 |

## Ecosystem Management Level

This section will discuss the effects of the treatments on VSS and canopy cover as it pertains to the goshawk guidelines at the Ecosystem Management Area (EMA) level. The EMA is comprised of the Jack Smith 10K and the Elden 10K.

The analysis of this EMA includes the areas to be treated and areas that will not be treated. Treatments from both the Jack Smith / Schultz and Eastside projects occur within the EMA. Pre and post treatment numbers reflect pre and post treatment VSS and canopy cover of those stands within the Eastside project that will be treated.

The five tables below (tables 28 -32) display the EMA level information. Tables are broken out by ponderosa pine stands and mix conifer stands, and those stands which are inside or outside of PFAs and nest sites. All tables display the amount of acres and percent in each VSS class, the pre treatment canopy cover, post treatment canopy cover by alternative, and post treatment change in VSS distribution if the stand is treated. In all categories where treatment occurred there was no change in VSS distribution or an increase in VSS 4, 5, and 6. This shows that these treatments are helping to move the project level towards meeting the northern goshawk guidelines.

Table 28. In ponderosa pine stands outside of PFAs, within the EMA: distribution of VSS pre and post treatment, and canopy cover by VSS class before treatment, and after treatment.

| VSS | Acres | Pre-Treatment % of VSS | Pre-Treatment Canopy Cover | Alternative 1 – Post Treatment Canopy Cover in Forested Areas Only | Alternative 1 – Post Treatment Canopy Cover across the whole stand | Alternative 2 – Post Treatment Canopy Cover across the whole stand | Post Treatment VSS Acres for Alt. 1 & 2 | Post Treatment % of VSS |
|---|---|---|---|---|---|---|---|---|
| **1** | 926 | 4 | 14 | 14 | 14 | 14 | 926 | 4 |
| **2** | 2052 | 10 | 40 | 36 | 36 | 36 | 1542 | 7 |
| **3** | 5734 | 27 | 55 | 42 | 32 | 44 | 3043 | 14 |
| **4** | 7516 | 35 | 55 | 41 | 35 | 44 | 7903 | 37 |
| **5** | 2897 | 13 | 45 | 40 | 35 | 41 | 5095 | 24 |
| **6** | 2489 | 12 | 56 | 54 | 52 | 54 | 3104 | 14 |

Table 29. In ponderosa pine stands inside of PFAs, within the EMA: distribution of VSS pre and post treatment, and canopy cover by VSS class before treatment, and after treatment.

| VSS | Acres | Pre-Treatment % of VSS | Pre-Treatment Canopy Cover | Alternative 1 – Post Treatment Canopy Cover in Forested Areas Only | Alternative 1 – Post Treatment Canopy Cover across the whole stand | Alternative 2 – Post Treatment Canopy Cover across the whole stand | Post Treatment VSS Acres for Alt. 1 & 2 | Post Treatment % of VSS |
|---|---|---|---|---|---|---|---|---|
| **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 51 | 4 | 51 | 43 | 43 | 43 | 13 | 1 |
| **3** | 401 | 31 | 64 | 45 | 31 | 52 | 223 | 17 |
| **4** | 454 | 35 | 58 | 47 | 33 | 53 | 310 | 24 |
| **5** | 175 | 14 | 70 | 70 | 70 | 70 | 288 | 22 |
| **6** | 216 | 17 | 62 | 52 | 52 | 55 | 463 | 36 |

Table 30. Mixed Conifer – Outside of PFAs. No treatment of mix conifer stands will occur.

| VSS | Acres | % of VSS | Canopy Cover |
|---|---|---|---|
| **1** | 7 | 0.2 | 13 |
| **2** | 60 | 2 | 46 |
| **3** | 134 | 4 | 87 |
| **4** | 1096 | 32 | 78 |
| **5** | 1820 | 53 | 75 |
| **6** | 294 | 9 | 65 |

Table 31. Mixed Conifer – Within PFAs No treatment with in the mixed conifer. This table includes one stand which occurs in a nest stand (the same stand in table 26).

| VSS | Acres | % of VSS | Canopy Cover |
|---|---|---|---|
| **5** | 145 | 47 | 75 |
| **6** | 161 | 53 | 56 |

Table 32. Ponderosa Pine Nest Stands (burn only treatments. There was no change in VSS distribution after treatment.

| VSS | Acres | Pre & Post Treatment % of VSS | Pre-Treatment Canopy Cover | Post Treatment Canopy Cover Alt. 1 & 2 |
|---|---|---|---|---|
| **1** | 0 | 0 | 0 | 0 |
| **2** | 12 | 13 | 52 | 47 |
| **3** | 19 | 20 | 70 | 63 |
| **4** | 35 | 36 | 61 | 55 |
| **5** | 13 | 14 | 63 | 57 |
| **6** | 17 | 17 | 69 | 63 |

# Forest Health

## No Action

Under the No Action Alternative, there would be no direct effect on dwarf mistletoe infection because no trees would be harvested. There would be no change in the level of dwarf mistletoe infection from existing levels. However, the No Action Alternative would indirectly affect the level of dwarf mistletoe infection over the long term. Under the No Action Alternative, dwarf mistletoe infection would continue to spread throughout infected stands, expanding at a rate of 1-2 feet per year. Increased dwarf mistletoe infection would result in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host (Conklin 2000). Reduced tree vigor and altered pitch flow associated with dwarf mistletoe infection would result in compromise of a tree's defense mechanisms to combat bark beetle attack, thus increasing the risk of successful bark beetle attack and mortality. Reduced tree growth and shortened life span would result in stagnation of VSS classes. Additionally, the accumulation of resin and branch deformations associated with dwarf mistletoe infection would result in increased fire hazard. (Conklin, 2007 pers. comm..)

Under the No Action Alternative, increasing stand densities will result in increased inter-tree competition and decreased tree vigor. Natural defense mechanisms against insect attack, such as the production of pitch, would be limited, resulting in increased susceptibility to successful bark beetle attack and mortality. As stand densities continue to increase over time, those trees that are out-competed would die, thus attracting bark beetles to the project area and further increasing the risk of bark beetle attack to residual trees.

## Proposed Action & Alternative 2

The Proposed Action and Alternative 2 will have a direct effect on the level and extent of dwarf mistletoe infection within the project area. Infected acres within the project area will be treated by showing a preference for leave trees that do not exhibit signs of infection or through the placement of openings in infection centers, thus resulting in a decreased level and extent of infection. Both alternatives will also have an indirect effect on dwarf mistletoe infection within the project area. The Proposed Action may result in a greater decrease in the rate of spread between individual trees and throughout the infected stand compared to Alternative 2. Due to the number and size of the interspaces and discontinuous canopy arrangement that will be created in the Proposed Action, dwarf mistletoe will likely not be able to spread as readily than in stands treated under Alternative 2 which will leave much more continuous canopy throughout the stand.

According to Conklin (2000), dwarf mistletoe infection spreads at an average rate of 1-2 feet per decade. Furthermore, dwarf mistletoe populations in the southwest are thought to have increased since Euro-American settlement due to increased forest densities resulting from fire suppression. A more open, patchy forest structure would have limited the spread of dwarf mistletoe infection (Conklin 2000). Additionally, DM infection occurs more abundantly in the lower crown due to its mechanism of spread. The historic fire regime may have decreased the severity of infection through partial crown scorch and a "sanitizing" effect on lightly to moderately infected trees (Conklin 2000). Under both alternatives, broadcast burning will be conducted across infected areas to emulate the effects of the historic fire regime on dwarf mistletoe infection. Although decreasing canopy covers and broadcast burning will decrease the severity and spread of DM infection, the beneficial effects of either alternative will be short-lived without additional treatments. Without additional treatments within 40 years, canopy covers will begin to close and approach pre-treatment conditions. Additional thinning treatments are recommended to decrease canopy cover, maintain a patchy tree distribution, create openings in the canopy, and treat latent infection. Broadcast burning is also recommended each decade to treat dwarf mistletoe infection. Without treatment, DM infection would continue to spread throughout stands and the project area. Increased DM infection results in reduced tree growth, reduced tree vigor, branch

deformations, and shortened life span of the infected host (Conklin 2000). Trees infected with dwarf mistletoe are more susceptible to insect attack, such as bark beetles, and diseases. Reduced tree growth and shortened life span result in stagnation of VSS classes. Additionally, in comparison to uninfected trees, trees infected with dwarf mistletoe are more flammable due to the accumulation of resin and branch deformations (Conklin 2000). Conklin (2000) also states that areas infected with dwarf mistletoe often have higher fuel levels, compared to uninfected areas, resulting in more intense fires. Due to the damaging effects of DM on tree growth, the Coconino National Forest Land and Resource Management Plan states, "Silvicultural prescriptions emphasize treating dwarf mistletoe infections to bring them down to acceptable levels…" (USDA Forest Service 1996, p. 122-1. However, complete elimination of DM from the project area is neither practical nor desirable. Proposed treatments are not designed to completely eliminate dwarf mistletoe from the project area, but rather decrease infection to manageable levels. Although DM increases fire hazard and has many damaging effects on tree growth, it is a natural occurrence in ponderosa pine ecosystems and has many beneficial effects. Increased snag densities and witches' brooms in large, infected trees improve habitat values for several wildlife species. Additionally, infection areas are associated with increased insect populations and, therefore, present increased foraging opportunities for insect-feeding birds. Although not a primary food source, many wildlife species feed on DM fruits, shoots, and infected bark (Conklin 2000). By decreasing canopy cover and creating a patchy tree distribution, the proposed treatments will decrease the rate at which infection spreads to more closely mimic the natural range of variability.

Current stand densities within the project area provide excellent habitat for increases in bark beetle and other insect populations. Insects are attracted to trees under stress from competition and a lack of resources, such as water, nutrients, and sunlight. The Proposed Action and Alternative 2 will have an indirect effect on susceptibility to insect attack and mortality. Decreasing stand densities will reduce competition between trees, resulting in increased tree vigor. Individual trees will be better able to defend themselves against bark beetle attack. After implementation of the Proposed Action or Alternative 2, the risk of insect attack and mortality for residual trees will be greatly reduced across the project area. However, benefits will not be as great in Alternative 2 where higher density of trees will be left compared to the Proposed Action. After the slash generated from thinning activities has been burned, the majority of the project area will be broadcast burned, further reducing the risk of mortality from bark beetles and other insects.

## Species Diversity

### No Action

Mixed Conifer

The no action alternative will not have any effect on mixed conifer. The majority of the mixed conifer occurs at the higher elevations adjacent to the Peaks Wilderness Area and the north slopes of Mt. Elden. Mixed conifer also occurs in drainages, north facing slopes, and infrequently in high elevation ponderosa pine stands. Mixed conifer stands will continue to grow and increase in density. Successional pathways will continue uninterrupted with shade tolerant climax species overtaking early/mid succession seral species. Scattered mix conifer regeneration and encroachment which occurs in the ponderosa pine type areas will continue to persist.

Oak

The No Action Alternative would indirectly affect Gambel oak within the project area. Over a minimum period of 40 years, ponderosa pine would continue to compete with Gambel oak for moisture, nutrients, and sunlight, resulting in reduced oak growth, vigor, and longevity. There would be few replacement oaks of large diameter size for at least 80 to 100 years.

Understory Vegetation
The No Action Alternative would indirectly effect understory vegetation within the project area. Understory productivity and diversity would continue to decrease over the next 40 years as stand densities continue to increase and crown canopies close. With a lack of broadcast burning across the project area, understory production would be further inhibited by increasing fuel loads and a lack of nutrient recycling from fire.

Meadow
The No Action Alternative would indirectly affect meadow within the project area. Over a minimum period of 40 years, meadows would continue to experience pine encroachment. As pine increase in density over time, meadows would experience decreased understory productivity and diversity and loss of functionality in terms of hydrology, biodiversity, horizontal heterogeneity, and wildlife habitat diversity.

Aspen
Aspen groups occur on approximately 300 acres within the project area. The majority of the groups are located along the wilderness boundary. There are also a number of groups scattered within the existing stands at lower elevation. In general aspen stands at lower elevation have inadequate regeneration due to elk browsing, are being encroached upon by pine and other species, and smaller aspens are being used as rub trees by deer and elk which often leads to disease problems and mortality. Stands at higher elevation have higher successful regeneration rates but also are experiencing elk browse. Some of these stands are experiencing encroachment by conifers while others are not.
With out action, and no anticipation of a reduction in elk numbers, aspen stands will continue to decline, especially at the lower elevations. At higher elevations, successful regeneration will allow some stands to persist, while the older mature stands with heavy conifer encroachment from underneath will die out and be replaced by mixed conifer.
The cumulative effects of no treatment within the aspen stands would be an eventual type conversion from aspen to ponderosa pine or mixed conifer and a further loss of genetic diversity between aspen clones.

## Proposed Action & Alternative 2

Mixed Conifer
Under both alternatives all stands classified with a mix conifer cover type are deferred from treatment. There may be up to 100 acres of mixed conifer in small pockets within ponderosa pine cover type stands in the 12” treatment areas. This mixed conifer will be treated along with the pine. Species diversity will be preserved. Overall stand densities will be reduced, which will result in greater individual tree vigor, and increased resistance to insect and disease attack. As much as 200 acres of mixed conifer will receive a prescribed burn treatment. Prescribed burning may result in scatted mortality (depending upon conditions) across the stands, particularly in younger smaller trees. The result will be reduced surface fuel loading, higher crown base heights, and decreased fire hazard. Prescribed burning in the Ponderosa pine stands which contain encroachment of mixed conifer regeneration will likely cause high mortality rates of the mixed conifer.

Oak
Both alternatives will have an indirect effect on Gambel oak health, growth, and vigor. Thinning of smaller, black-barked pine trees around oak clumps will increase nitrogen, carbon, and water uptake of oak, thus decreasing inter-tree competition and stress and increasing tree vigor, growth, and longevity (Stone et al. 1999). Gambel oak is a relatively slow-growing hardwood species. Therefore, increased growth rates in response to thinning will be less noticeable in oak, compared to ponderosa pine. Maintenance burning is recommended each decade to prevent regeneration

from eventually overtopping oak clumps. Additional thinning is also recommended around oak clumps within 20 to 40 years as the pine canopy grows laterally and begins to overtop oak clumps.

Understory Vegetation
Both alternatives will have an indirect effect on understory productivity and diversity. Under the Proposed Action there will be a greater impact. According to research conducted in ponderosa pine around Flagstaff, restoration treatments result in changes in microclimate on the forest floor, specifically increased sunlight penetration to the forest floor, increased soil temperatures, and increased understory productivity (Meyer et al 2001). The interspaces created under the Proposed Alternative are intended to be permanent and thus the increase in understory productivity related to the creation of interspaces would be permanent. Additional studies have shown that understory response to thinning treatments is directly related to the intensity of the treatment and the use of prescribed fire (Griffis et al 2001). Under Alternative 2, there is expected to be a short term increase, but lesser than the Proposed Action, in understory productivity which will slowly be lost as crown canopy increases.

Aspen
Cutting the pine or mixed conifer out of and fencing the aspen stands will help improve the health and regeneration of the aspen stands. Reduced competition for space, water, sunlight, and nutrients from other trees will improve the health vigor and survival of the existing aspen trees. Cutting a one chain buffer around existing aspen and fencing in the stand along with the buffer will prevent elk and deer from eating and killing aspen shoots. Fencing may need to be left in place for a long as 25 years to ensure the success of the aspen regeneration.

Meadow
There is approximately 28 acres of meadow treatments.
The Proposed Action will remove trees within areas that were historically meadows. Under the Proposed Action, meadows will be restored to presettlement conditions. Indirect effects of removing trees in these areas include increased understory productivity and diversity and restoration of their functionality in terms of wildlife habitat, watershed production, fire hazard, and scenic values.

# Cumulative Effects

## No Action

Under the No Action Alternative, no activities are proposed. If no activities are proposed, then there are no effects from the alternative. Since cumulative effects are about putting in context the effects of the alternative with other projects, there are no cumulative effects (The Shipley Group 2005).

## Proposed Action & Alternative 2

Past, present (ongoing), and future activities considered in the cumulative effects analysis are listed in Table 2. Over the past century, several events, including fire exclusion, livestock grazing, and high-grade timber harvesting, occurred over the majority of the project area and in adjacent stands. These events resulted in disruption of the historic fire regime that consisted of frequent, low-intensity surface fires. In 1919, climatic events favored dense ponderosa pine regeneration. At this time, understory production was greatly decreased by grazing and offered little competition with pine regeneration. As fire suppression and sawlog harvesting continued through the 20$^{th}$ century, regeneration from 1919 continued to grow in density. In the mid- to late 1900s, commercial thinning treatments in and adjacent to the project area removed a large proportion of the mature and old trees, contributing to a more even-aged forest structure. At the

same time pre-commercial thinning treatments occurred that reduced the density of younger forest, mainly through even spacing of residual trees. Although these treatments did provide some short-term improvement to forest health, vigor, and growth by reducing stand densities and increasing the growing space of individual trees, they also caused further departure from the variable, patchy tree distribution that typified the historic ponderosa pine forest structure. Additionally, blending treatments were used to produce a single age class deemed "more manageable" in terms of regulated timber harvesting. Past events have resulted in increased stand densities, decreased age and size class diversity, altered stand structure, changes in successional dynamics, altered insect and disease dynamics, decreased understory productivity and diversity, decreased tree vigor, increased fuel accumulation and continuity, increased crown fire potential, increased fire size and intensity, and a more even-aged forest structure (Long 2003). Figure 4 depicts changes in trees per acre by size class on non-reserved forest lands in New Mexico and Arizona. The graph depicts changes that are typical of southwest ponderosa pine around Flagstaff due to past events and activities and is intended as a reference only. The density of trees has increased significantly over time, especially in diameter classes less than 13 inches. With this tremendous increase in smaller size classes, size class diversity has decreased, resulting in a more even-aged forest structure. Currently, there are two ongoing projects located adjacent to the project area. The purpose of both the Eastside and Fort Valley projects is to reduce hazardous fuel accumulation, while improving forest health and promoting the development of VSS distributions recommended by management recommendations for the Northern goshawk.

Treatments in this EA and ongoing projects are not based on spacing guidelines, involve the creation of openings and enhancement of groups, and thin to varying densities. The proposed treatments, in combination with ongoing projects adjacent to the project area, will result in a landscape which is more open, variable, and groupy for a minimum of 40 years into the future. The creation of openings and a more open canopy will result in increased natural regeneration across the landscape and a more uneven-aged forest structure. A mosaic of varying forest structures, patterns, densities, and size classes results in increased horizontal and vertical heterogeneity, increased biological diversity, improved forest health, and a more sustainable forest structure at the landscape-level. A more sustainable forest structure is more resilient and capable of maintaining its health in the face of climate change and other disturbances. Both alternatives and ongoing treatments will result in a decreased risk of insect attack and mortality at both the project and landscape levels.
Also, the risk of a crown fire of sufficient intensity to significantly alter forest structure would be reduced. Additionally, these treatments will also result in faster development of a landscape-level VSS distribution recommended for the Northern goshawk by retaining large trees, creating openings for regeneration, and increasing tree growth and vigor. The creation of grassy interspaces (in the Proposed Action only) and openings (in both alternatives) across the landscape will also result in increased understory abundance, increased diversity at the landscape scale, and increases in insects, such as butterflies, that serve as prey bases for a suite of wildlife species. Lastly, by focusing on the removal of smaller diameter trees, this and other projects will retain and produce larger diameter trees for both ecological and social/aesthetic values.

## Road Density

This project will be decommissioning 38 miles of forest roads. The decommissioning of the roads themselves will have little effect on vegetation. Over time understory vegetation will likely increase on decommissioned road beds and ponderosa pine or mixed conifer seedlings may become established. Indirect effects of decommissioning road would be reduced instances of illegal firewood cutting, and possible reduce response time for the suppression of wildland fire. However since much of the decommissioned road are in areas that will receive treatments, reduced response time for suppression is not likely to have an adverse impact as wildfire are less likely to become crown fires.

**Large Tree Discussion:**
According to Abella, et al.: "Based on published research, diameter caps will not improve and will likely negatively impact canopy cover openings, understory productivity, Gambel oak vigor, soil microorganisms, nutrient cycling, streamflow, fire behavior, and the economics of thinning projects."

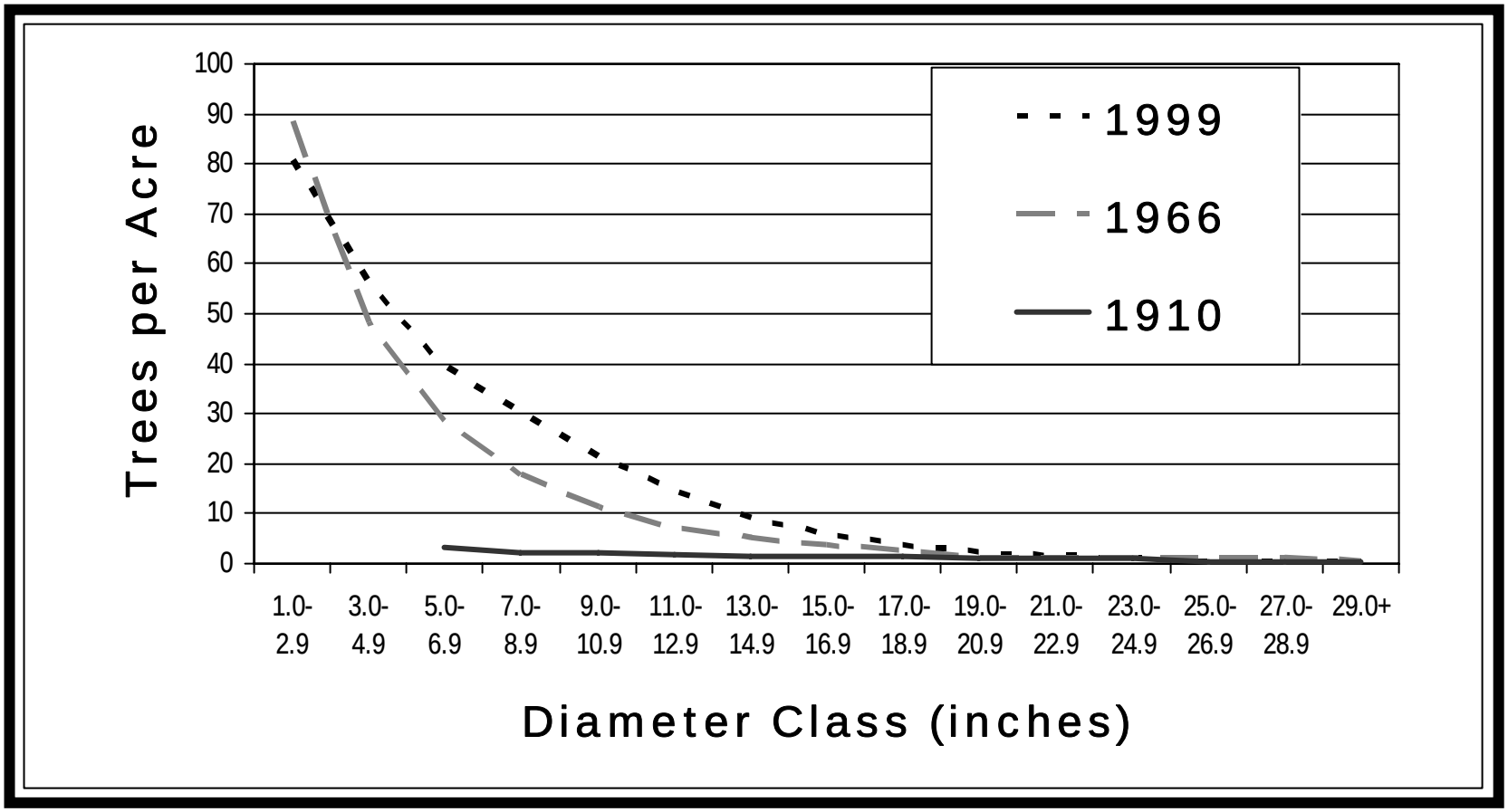
As stated in the Proposed Action: "The desired future condition includes a multi-aged and diverse forest structure that supports frequent low intensity fires. The area is maintained by fire and natural processes." In order to achieve this condition we have proposed to create the groupy/clumpy structure described in this report and a reduction in trees per acre and basal area similar to pre-settlement conditions. A review of the modeling treatment numbers in the Uneven-aged analysis in the Proposed Action alternative will show that on an average acre that none of the trees in the VSS 5 (18" – 24") and VSS6 (24"+) size classes will be cut. In Alternative 2, in the uneven-age treatment outside of PFAs, two trees per acre would be cut in the VSS 5 size class and no trees cut in the VSS 6 size class, and no trees in VSS 5 and 6 size class would be cut in the uneven-age treatment within PFAs. On an 'average' acre, we believe the model accurately depicts the distribution of tree sizes. Observations of the project area have shown that there are areas that have a high number of 16"+ trees which would necessitate cutting some of them to meet the objective of creating a groupy/clumpy structure and support frequent low intensity fires. It is not possible using the existing stand data and modeling program to tease out the number of trees greater than 16 inch dbh that will be cut.

Other management objectives such as improving forest health and retaining species diversity may necessitate the cutting of trees greater than 16". Large trees which are shading out Gambel oak or are heavily infected with mistletoe and may infect the understory may be cut. A 'one size fits all' diameter cap does not allow for land managers to address the variety of management objectives and differing site conditions.

The only areas in which trees over 16" may be cut will be in the Uneven-age treatments, meadow treatments, and aspen restoration treatments. Under the Proposed Action I estimate that within these areas, less than 10% of the trees over 16" dbh will be cut, and for trees over 24 inches dbh, less than 0.5% will be cut Under Alternative 2, I estimate around 5% of the trees greater than 16" dbh will be cut and less than 0.5% of trees greater than 24" dbh will be cut. All other treatments and untreated areas will not have trees over 16 inches dbh cut.

As shown in tables 9, 12, 15, 18, and 21 there will be a greater number of 24 inch trees in 40 years after treatment than without treatment. The tables show there will be fewer trees in the 18 to 24 inch size class in 40 years after treatment than without treatment. This is due to thinning of small trees in the present in order to meet the desired future condition. To not treat and allow the current smaller trees to continue to grow would only serve to perpetuate the issues identified in the needs for change report and which drive the need for treating this area.

**Figure 3. Changes in stand density in southwestern ponderosa pine, non-reserved forest lands, NM and AZ.**



## Old Growth:

Under forest plan guidelines, a minimum 20% of forested acres by ecosystem units is to be managed for old growth habitat. Stands selected as developing old growth tended to be close to the wilderness areas, in areas farther away from the wildland urban interface zone, and in areas which have not received harvesting treatment in the past such as on steep slopes.

No yellow pines will be cut in this project. Existing yellow pine clumps and groups will not be cut. Stand which are being managed toward the Goshawk guidelines will be moving towards 20% of the stand in VSS 6 class. In the majority of these stands VSS 6 groups are comprised of mature older trees which comprise old growth. While many of the goshawk stand are not necessarily designated as developing old growth, a significant portion of these stand will contain clumps and groups of old growth. Treat designed to thin around the yellow pine will have multiple benefits for these trees. Thinning of smaller, black-barked pine trees around oak clumps and the drip lines of existing "yellow" pines will increase nitrogen, carbon, and water uptake of oak and "yellow" pines, thus decreasing inter-tree competition and stress and increasing tree vigor, growth, and longevity (Stone et al. 1999).

The Jack Smith / Schultz project is located within two ecosystem units, the Elden 10K, and the Jack Smith 10K. Below is a break down of forested acres in each ecosystem unit and the amounts of existing and designated old growth.

<u>Jack Smith 10k</u>
All of the 10K is located in the Jack Smith/Schultz and Eastside Projects. There is currently 1,648 acres designated in this 10K. An additional 1,010 acres will be designated.

Total acres in 10k = 16123
Forested ac in 10k (MA 3, 4, 5, 6, 7, 8) = 13028
20% of forested ac (old growth required for the whole 10k) = 2606
Current existing or designated old growth in 10K = 1648
Additional acres designated as developing old growth in project area = 1010 ac
Total existing and designated for 10K = 2658 ac

<u>10k #213</u>
Portions of this 10K are in the Eastside Project and the Jack Smith /Schultz Project with the remainder being Mt. Elden and the Dry Lake Hills. There is currently 938 acres designated in this 10K. An additional 2543 acres will be designated with in the Dry Lake Hills and on Mount Elden for a total of 3481 acres of existing and designated old growth within this 10K.

Total acres in 10k = 14350
Forested ac in 10k (MA 3, 4, 5, 6, 7, 8, 18) = 13499
20% of forested ac (old growth required for the whole 10k) = 2700
Current existing or designated old growth in 10K = 938
Additional acres designated as developing old growth in project area = 2543 ac
Total existing and designated for 10K = 3481 ac

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