Alternative C Modified Large Tree Implementation Strategy

Revision 5 –05-23-2012

Introduction

This implementation strategy is specific to alternative C in the Coconino and Kaibab National Forest's landscape restoration analysis (EIS). It has been incorporated into alternative C in response to comments received during scoping (August, 2011). The strategy focuses on desired conditions for seeps and springs, riparian, wet meadows, encroached grasslands, aspen forest and woodland, ponderosa pine/Gambel oak forest (pine-oak), within-stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees. The strategy provides direction presented as desired conditions for managing large post-settlement trees. For the purpose of this document, large post-settlement trees, as defined by the socio-political process, are those that are 16" diameter breast height (DBH) or larger. Trees ≥ 18" DBH represent vegetative structural stages (VSS) 5 and 6. VSS 5 and 6 represent the largest and (sometimes) oldest trees. These size classes best correspond with the successional stage classification system that was developed to address the forest dynamics of southwestern ponderosa pine.

How This Strategy Would Be Utilized

The purpose of this document is to guide implementation in alternative C. Large post-settlement trees would be targeted for removal if needed to move towards ecological desired conditions implementation. The strategy also identifies conditions in under which large, young trees would be expected to be left.

This strategy may not include every instance where large post-settlement trees may be cut. There may be additional areas and/or circumstances where large post-settlement trees need to be removed in order to achieve restoration objectives. During implementation (prescription development), if a condition exists that does not the meet the desired conditions included in this strategy, no large trees would be cut until the NEPA decision is reviewed by the Forest Service implementation team. The team would decide whether the action is consistent with the analysis and the decision made. This information would be made part of the annual implementation plan checklist/compliance review that is recommended by the team and approved by the Forest Supervisor.

The Forests' landscape restoration analysis does not propose to cut presettlement trees, except under rare circumstances as described in the Old Tree Implementation Strategy. The Old Tree Implementation Strategy has been incorporated into all action alternatives (B-D) and is provided in this document as appendix C for reference. VSS 5 and VSS 6 are under-represented across the project area, which is nearly one million acres in size.

How This Strategy Differs from the Stakeholder Large Tree Retention Strategy (LTRS)

During the issues and alternatives development phase of the analysis, the interdisciplinary team conducted a crosswalk to the original LTRS (Appendix A) and the project's desired conditions. We found that most LTRS recommendations and desired outcomes were reflected in the project purpose and need or had been incorporated into the each action alternative (B-D) because of forest plan (Mexican spotted owl) requirements. Because the conservation of large trees was identified as a key issue for the analysis, potential impacts from removing some large, post settlement trees are addressed in resource-specific environmental consequences including silviculture, fire, and wildlife. Incorporation of the LTRS was further enhanced by including the document's intent into alternative C design features and best management practices. The crosswalk to the LTRS is located in appendix B. This version differs from the original stakeholder-created LTRS in five ways:

(1) The exception categories have been translated into resource-specific desired conditions. This was completed because we found that the exception categories represented the majority of our actions. An exception, by definition, is something that is not included in, or does not fit into, a general rule. As a result of spatially mapping the exception categories, we found that true exceptions were a minor component of the desired condition strategy for managing post-settlement trees. For example, a geospatial mapping exercise (see Appendix B) found that 54,358 acres of the proposed 596,716 acres proposed for treatment did not fit an existing resource (formally exception) category. Most acreage could be classified within the Large, Young Tree category. The 54,358 acres noted above do not necessarily mean a new category has to be developed. The acreage number reflects that vegetation and geospatial data was not able to determine what category these acres should be placed in. On-ground review and validation is planned to rectify the lack of information on these acres,

(2) The original LTRS did not provide the ability to create regeneration openings using a group selection treatment method within the Large, Young Tree category. We found that in the short term (0 to 10 years), this would result in a continued imbalance of size classes that would be contrary to the forest plan desired conditions in non-pfa goshawk habitat. In the long term (10 to 30 years), the understory would be comprised of oak and old pine. There would no movement towards maintaining the older, larger trees as the ability to provide for tree recruitment would be hindered. For this reason, the alternative C version of the LTRS includes the ability to create regeneration openings,

(3) In the original LTRS, movement towards the desired condition in pine-oak was constrained to Mexican spotted owl (MSO) habitat. This would preclude moving towards desired conditions in non-MSO habitat. For this reason, the ability to move all pine-oak within the project area towards desired conditions was included.

(4) The original LTRS would have required the FS to consult with stakeholders should a new exception category be found during implementation. To resolve the potential for FACA issues, this consultation requirement was removed. How this situation would be addressed can be found above in the "How This Strategy Would Be Utilized" section, and,

(5) Other minor additions or variations as disclosed in the January 23, 2012 Summary LTRC Crosswalk to DC document (Appendix B).

Public Involvement

An update on how the LTRS was being incorporated into the EIS was discussed with the stakeholder steering committee and interested stakeholders on October 19, 2011 at the Coconino NF Supervisor's Office. A follow-up invitation to discuss the LTRS was provided by Henry Provencio at the November 2, 2011 4FRI stakeholder meeting held at the Coconino NF Supervisor's Office. On December 7, 2011, an update on the LTRS that included the geospatial map (Appendix B) displaying how exception categories was represented in the project area was presented by Henry Provencio at the 4 FRI stakeholder meeting.

Desired Conditions

Seeps and springs

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock. Standing or running water is infrequent or absent. Vegetation and other biological diversity are adapted to mesic soils. Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water and wet or moist soils. Vegetation and other biological diversity are adapted to mesic soils or aquatic environments (Feth and Hem 1963).

Management Issue

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. Due to the absence of frequent fires in the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of trees that have encroached upon seeps and springs may constitute a relatively small part of an overall seep and spring restoration effort, when compared to fully addressing root causes of overall degradation. Thinning alone, without addressing other sources of degradation, is unlikely to fully restore seeps and springs (Thompson et al. 2002). However, it is a necessary step leading to the restoration of these ecologically important areas.

Desired Conditions

- The biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted, and aquatic native biological diversity depend are conserved and restored.
- The integrity of the spring's unique biophysical attributes is not compromised by tree shading.
- Mesic soils associated with a seep or spring are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remainwhere there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Riparian

Riparian areas occur along ephemeral or perennial streams or are located down-gradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

Management Issue

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted, or aquatic biological diversity. Riparian areas and the streams, springs, and seeps connected to them often harbor imperiled species that can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial wildlife. In the absence of frequent fires and in the presence of other competing factors, large

post-settlement trees may have become established and grown within riparian areas to the point that they compromise available soil moisture or light that support the unique biophysical conditions that are associated with the riparian areas. However, it is likely to be a very rare circumstance that conifer trees of any size would need to be removed from forested riparian zones.

Desired Conditions

- The biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depends are conserved and restored.
- The use of soil and water best management practices (BMPs) minimize the impacts of cutting trees within riparian areas.
- Removal of trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Riparian areas are fully restored by using an array of tools that address all sources of degradation.
- Available soil moisture or light that support that area's unique biophysical conditions is not compromised by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Post-treatment snags and logs that include large trees are available on site.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Wet Meadows

High-elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1 percent of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 hectares of wet meadows occur on national forests in Arizona and New Mexico.

Wet meadows may be referred to as riparian meadows, montane (or high-elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (*Carex* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.) are common species (Patton and Judd 1970; Hendrickson and Minckley 1984; Muldavin et al. 2000). Willow (Salix) and alder (Alnus) species often occur in or adjacent to these meadows (Long 2000, 2002; Maschinski 2001; Medina and Steed 2002). High-elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972; Castelli et al. 2000; Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

Management Issue

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations. Most notably, the lowering of their water tables due to stream down-cutting, surface water diversions, or groundwater withdrawal (Neary and Medina 1996; Gage and Cooper 2008) has occurred. In the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Desired Conditions

- The biophysical conditions of wet meadows upon which terrestrial native biological diversity depend are conserved and restored.
- Wet meadow function is not impaired by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Removal of large trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Wet meadows are fully restored by using an array of tools that address all sources of degradation.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Encroached Grasslands

Encroached grasslands are herbaceous ecosystems that have infrequent-to-no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils. Mollisol soils are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and to a lesser extent by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (*Festuca arizonica*) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands are the most naturally fragmented grasslands in the region, ranging from thousands of acres in size (e.g., in the White Mountains (Baker 1983)) down to only a few acres. They generally occur in small (<100 acres) to medium-sized (100 to 1000 acres) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings. Identification of grasslands in this region should use a combination of the Terrestrial Ecosystem Survey, Southwest Regional GAP Analysis, Brown and Lowe Vegetation Classification (Brown and Lowe 1982; TNC GIS Layer 2006) among other existing vegetation and soils data.

Management Issue

Prior to European settlement, pine trees were rarely established in grasslands because they were either outcompeted by production of cool-season grasses or killed by frequent fire (Finch 2004). In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Allen 1984; Moore and Huffman 2004; Coop and Givnish 2007). Pine encroachment into grasslands has contributed to a significant loss of biodiversity (Stacey 1995) and wildlife habitat particularly for grassland-dependent species such as pronghorn. Plant diversity is particularly important in grassland ecosystems. Grassland plots with greater species diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994). This resilience will become even more important in a warming climate. Pine tree removal, restoration of fire, and complementary reductions in livestock grazing pressure are all necessary to restore structure and function of native grasslands.

Desired Conditions

- Grasslands are enhanced, maintained, and function with potential natural vegetation (as defined by vegetative mapping units).
- Grasslands function with a natural fire regime.
- Existing grasslands are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Aspen Forest and Woodland

Quaking aspen (*Populus tremuloides*) occurs in small patches throughout the 4FRI project area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and, (3) decadent and deteriorating. Almost all of the aspen occurring within ponderosa pine forests of the 4FRI project area is seral aspen, which regenerates after disturbance through root sprouting and rarely from seed production (Quinn and Wu 2001). Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire 4FRI area and map layers are available from existing databases.

Management Issue

Aspen occurs within ponderosa pine forests. It is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970; DeByle 1985; Finch and Reynolds 1987; Griffis-Kyle and Beier 2003). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio and others 2005). Aspen is currently declining at an alarming rate (Fairweather and others 2008).

The lack of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen-dominated lands to succeed to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing ungulates (Pearson 1914; Larson 1959; Martin 1965; Jones 1975; Shepperd and Fairweather

1994; Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with very high mortality occurring in low and mid elevation aspen sites. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather and others 2008) that have served as the "final straws" for already compromised stands.

Desired Conditions

- Aspen forests and woodlands are conserved and restored to their appropriate fire regime.
- Aspen is effectively being regenerated or maintained and regeneration, saplings, and juvenile trees are protected from browsing.
- There is decreased competition from ponderosa pine. Post-settlement ponderosa pine tree numbers do not exceed residual targets that have been identified using pre-settlement conifer tree evidences, site visitations, and collected data.
- Removal of large trees constitutes a relatively small part of the aspen restoration effort, when compared to the fundamental causes of overall degradation. Aspen forests and woodlands are fully restored by using an array of tools that address all sources of degradation.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak trees in locations throughout the 4FRI area in a habitat association referred to as PIPO/QUGA (USFS 1997; USDI 1995).

In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Brown 1958; Kruse 1992; Rosenstock 1998; Abella and Springer 2008; Abella 2008a). Different growth forms provide important habitat for a large number and variety of wildlife species (Neff and others 1979; Kruse 1992). These include, including hiding cover in a landscape with limited woody shrub cover, cavity substrate for birds and bats, roost potential for bats, nest sites for birds, and bark characteristics used by invertebrates. Whether as saplings, shrubby thickets, or larger sized trees, oak adds a high value for wildlife in ponderosa pine forests.

Gambel oak provides high quality wildlife habitat in its various growth forms; and, it is a desirable component of ponderosa pine forests (Neff and others 1979; Kruse 1992; Bernardos et al. 2004). Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998; USDI 1995; Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular fuelwood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

Management Issue

Although management on public lands with regard to oak has changed to better protect the species, illegal fuelwood cutting of Gambel oak and elk and livestock grazing negatively impact oak growth and

regeneration (Harper et al. 1985; Clary and Tiedemann 1992; Rick Miller 1993, unpublished report). Illegal fuelwood cutting of Gambel oak continues to result in the removal of rare, large diameter oak trees (Bernardos et al. 2004).

A literature review by Abella and Fule (2008) found that Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium-diameter stems (<8 inchdbh). Chambers (2002) found that Gambel oak on the Kaibab and Coconino National Forests was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 cm dbh) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 cm) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fule (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

Desired Conditions

All Gambel oak

- Small oak trees develop into larger size classes.
- Fire treatments retain small and shrubby oak in numbers and distribution.
- All growth forms of Gambel oak are present and larger, older oak trees are enhanced and maintained.
- Large, post-settlement trees are not restricting oak development.
- Frequent, low intensity surface fire occurs in ponderosa pine-Gambel oak forests.
- Brushy thicket, pole and dispersed clump growth forms of Gambel oak are present and maintained by allowing natural self-thinning, thinning dense clumps, and/or burning.
- Gambel oak growth forms are protected from damage during restoration treatments including thinning and post thinning slash burning.
- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

In MSO restricted habitat:

- Within MSO habitat and designated critical habitat, the Recovery Plan for the Mexican spotted owl improves key habitat components and primary biological factors, which includes Gambel oak.

- Within 30 feet of oak 10 inch diameter root collar (drc) or larger, post-settlement mixed conifer trees up to 18 inch dbh (that do not have interlocking crowns with oak) are not restricting oak development.

Outside MSO restricted habitat:

- Large post-settlement trees' drip lines or roots do not overlap with those of Gambel oak trees exhibiting diameter root collar (drc) >8 inches.

Within-Stand Openings

Within-stand openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942; White 1985; Covington and Sackett 1992; Sanchez-Meador et al. 2009). For the purposes of this strategy, within-stand openings are equivalent to interspaces. The within-stand opening management approach described below is distinct from, and should not be, considered as guidance relating to regeneration openings.

Pre-settlement openings can be identified by the lack of stumps, stump holes, and other evidence of pre-settlement tree occupancy (Covington et al. 1997). These openings are most pronounced on sites with heavy textured (e.g., silt-clay loam) soils (Covington and Moore 1994). Current openings include fine scaled canopy gaps. It is not necessary to have desired within-stand openings and groups located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees.

Management Issue

Within-stand openings appear to have been self-perpetuating before over-grazing and fire exclusion (Pearson 1942; Sanchez-Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997).

These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within a stand opening as soon as herbaceous vegetation was removed by overgrazing (Sanchez-Meador et al. 2009). Contemporary within- stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within-stand heterogeneity.

Desired Conditions

- The pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved.

- Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands.

- Openings promote snow-pack accumulation and retention which benefits groundwater recharge and watershed processes at the fine (1 to 10 acres) scale.

- The presence of such trees does not prevent the re-establishment of sufficient within-stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives.

  Groups of trees typically range in size from 0.1 acre to 1.0 acre. Canopy gaps and interspaces between tree groups or individuals are based on site productivity and soil type and range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition.

- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Heavily-Stocked Stands (with High Basal Area) Generated By a Preponderance of Large, Young Trees

In some areas, the increase in post-settlement trees has been so rapid that current stand structure is characterized by high density and high basal area in large, young ponderosa pine trees. These stands or groups of stands exhibit continuous canopy which promotes unnaturally severe fire effects under severe fire weather conditions. At the fine scale, the management approach would apply on a case-by-case basis. The cutting of large trees may be necessary to meet site-specific ecological objectives as listed below. For example, the cutting of large trees may be necessary in order to reduce the potential for crown fire to spread into communities or important habitats that include Mexican spotted owls and/or goshawk nest stands. This approach would apply when other options would not alleviate severe fire effects.

Management Issue

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and basal area would be desirable, large post-settlement pines may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. Where evidence indicates higher tree density and basal area would have occurred pre-settlement, only a few large pines may need to be removed. Many of these areas would support crown fire, and thus require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

Desired Conditions

- Natural heterogeneity of forest, savanna and grasslands occurs at the landscape scale and within stands.

- Groups are restored by retaining the largest trees on the landscape to re-establish old growth structure in the shortest timeframe possible.

- Decreased shading and interception from the canopy, decreased litter and duff, and surface fire restore and maintain a mosaic of natural vegetative communities.

- Decreased shading and interception from the canopy fuels allow the growth of continuous herbaceous surface fuels to carry surface fire.

- Horizontal and vertical canopy characteristics, which include tree groups, clumps, and openings, reduce the potential for crown fire as well as the extent of high severity fire effects.

- Fire is the principle regulator of forest structure over time.

- Regeneration openings that contribute to the ecological objective of natural heterogeneity of historical forest structure and age class diversity are not encroached upon by trees.

- The old tree implementation strategy provides direction on how pre-settlement trees would be managed.

Appendix A. Large Tree Retention Strategy

2011-0312-35

March 11, 2011

Old Growth Protection & Large Tree Retention Strategy

Contents

I. Old Growth Protection & Large Tree Retention Strategy (OGP&LTRS) Overview

The goals of the Four Forests Restoration Initiative (4FRI) are to restore healthy, diverse stands, supporting abundant populations of native plants and animals; to protect communities in forested landscapes from destructive wildland fire; and to support sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values. In short, we seek to re-establish largely self-regulating forested landscapes including their associated fire regimes through a process of ecological restoration that benefits communities, economies, ecosystems and biodiversity.

Ecological restoration will require thinning post-settlement ponderosa pine trees[1] in unnaturally dense stands. While there is broad agreement for reducing small diameter tree densities, where and how this should be done has often been the subject of social and scientific debate. The purpose of this document is to affirm recommendations of the 4FRI Stakeholder Group relating to the retention of large post-settlement and old growth trees—recommendations that are critical to moving beyond those debates—and to provide specific, science-based recommendations for incorporation into 4FRI restoration plans and projects.

Retention of Old Growth and Large Post-settlement Trees

"The Path Forward"—a foundational document of the 4FRI—calls for blanket old growth protection, regardless of tree size. It states that, "No old-growth trees (pre-dating Euro-American settlement) shall be cut." The document also includes broad recommendations for retaining large post-settlement trees with some carefully specified exceptions.

In southwestern ponderosa pine forests, old-growth trees are important to ecosystem structure and function. They increase genetic diversity on the landscape; old trees have greater genetic diversity than even-aged groups of young trees (Kolanoski 2002) and, thus, may have a better chance of adapting to changing climatic and environmental conditions, an ability they can pass on to their progeny. In addition, when not surrounded by large amounts of fuel, the thick bark of old-growth trees makes them largely resistant to low-intensity surface fire (Agee 1998). Old-growth trees also increase forest structural diversity, which, in turn, provides more wildlife habitat. For example, large trees provide additional structure for bats, which roost under slabs of bark; nest trees for northern goshawks and Mexican spotted owls; continuous canopy for tassel-eared squirrels; and foraging habitat for bark-gleaning birds (Bull and Hohmann 1994, Humes et al. 1999, Dodd et al. 2003). In addition, old trees often become long-lasting snags when they die, which benefits many species of cavity-nesting birds and mammals (Chambers and Mast 2005). Old, large trees also serve as long-term carbon stores (Harmon et al. 1990) and preserve a record of the past that can inform future research about insect outbreak, fire history, and climate change (Fulé et al. 1997, Soulé and Knapp 2006). Finally, old-growth trees enhance the

[1] Large and old growth tree recommendations offered in this document refer specifically to ponderosa pine trees.

aesthetics of forests (Brown and Daniel 1984) and, thus, increase public support for restoration projects. Old-growth trees are present on the landscape at similar or lower densities compared to presettlement times (Mast et al. 1999, Moore et al. 2004), depending on how many trees have been removed postsettlement by forest management practices (e.g., clearcut, thinning, seed tree, etc.). The three main threats to old-growth trees are high-severity wildfire, competition from mid- or under-story trees, and drought and subsequent bark beetle attacks (Kolb et al. 2007). Restoration treatments (thinning and prescribed burning) around old-growth trees can cause some mortality. However, this threat can be reduced through careful management (Hood 2010). In addition, restoration treatment should result in a reduced threat of wildfire, a release from competition, and increased tree growth (Fajardo et al. 2007, Fulé et al. 2007).

The Path Forward also calls for retaining large post-settlement trees (defined by the socio-political process as those greater than 16 inches diameter-at-breast height [dbh]) throughout the 4FRI landscape, except: (1) as necessary to meet community protection and public safety goals within the Community Protection Management Areas identified in the Analysis of Small Diameter Wood Supply in Northern Arizona and where stakeholder agreement identifies priority areas within approved CWPPs; and (2) when best available science and stakeholder agreement (as defined in the 4FRI Charter) identify sites where ecological restoration and biodiversity objectives cannot otherwise be met – specifically wet meadows, seeps, springs, riparian areas, encroached grasslands, aspen groves or oak stands, within-stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees.

We recognize that there are multiple causes of ecological degradation that may not be affected by mechanical thinning and different types of burning. The exceptions articulated in the following section are intended to be part of a more comprehensive and concurrent approach to treating causes (rather than just symptoms) of ecological decline. To that end, we are asking the Forests to work collaboratively on a comprehensive restoration assessment that identifies possible management actions to stem/reverse ecological decline. We believe this restoration assessment should focus on a wider range of forest resources than just timber and fire; such as hydrology, range, recreation, and wildlife. We ask the four National Forests to initiate this assessment with the 4FRI Stakeholders, upon release of the Draft EIS for the first project area.

The intention of the exception process is to increase landscape heterogeneity and conserve biodiversity. Thus we do not support implementing any exceptions where removing the trees would conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat. We also recognize there may be additional areas and/or circumstances where large trees need to be removed to achieve restoration. These circumstances should be identified through a site-specific, agreement-based, collaborative process as described in the 4FRI Charter.

II. OGP&LTRS Rationale: The Historical Debate Regarding Diameter Caps in the Southwest and the 4FRI's Large Tree Retention Policy

Introduction

Diameter caps for tree cutting have been used in forest management efforts across the West. They have been and continue to be the subject of much debate. In this section of the Large Tree Retention Strategy document, two different perspectives on diameter caps are presented. Recognizing that the 4FRI Large Tree Retention and Old Growth Protection Strategy is not meant to serve as a strict diameter cap, these perspectives are offered here to illuminate elements of the historical debate that have led to the 4FRI's formulation of the existing Large Tree Retention and Old Growth Protection Strategy.

Arguments in Favor of Diameter Caps

There is a generally recognized need to retain larger trees and protect old growth in southwestern ponderosa pine forest restoration. Some proponents of large tree retention have suggested that a 16" diameter cap is both ecologically and socio-politically warranted given the scarcity of mature and old growth forest cover in the region; the need to quickly re-establish lost mature and old forest structure; the necessity of retaining trees larger than 16" dbh to recruit new trees into regionally-underrepresented VSS 5, 6 and "old growth" structural stages; and the regional rarity of trees larger than 16" (approximately 96% of ponderosa pine trees in northern Arizona and New Mexico are smaller than 16-inch dbh).

Such proponents have proposed diameter caps as a means to (1) prevent large-tree logging for production-oriented, uneven-aged silvicultural goals, (2) discourage large-tree logging to pay for small-tree thinning or other activities, (3) favor small-diameter-specific industries over large-tree-dependent ones, (4) avoid population-level effects to imperiled species and wildlife that are associated with larger live and dead trees and denser canopy, (5) mitigate unforeseen large tree mortality during and following restoration treatments, (6) mitigate unknown rates of future large tree mortality resulting from re-establishing natural fire regimes and future climates, (7) mitigate under-estimates of historical tree densities owing to evidence undercounting and loss to fire, logging and decay, (8) accommodate differing reference scales, choices of reference attributes, restoration objectives and desired degrees of precision or rates of change, (9) mitigate uncertainty about future national forest policy, timber and wildlife habitat management, and (10) facilitate a restoration approach that reduces immediate crown fire threat while incrementally moving the forest toward its natural range of variability through a combination of thinning and natural fire.

Diameter limits and exception-thresholds for tree cutting are a common strategy for achieving ecological objectives in western forest landscapes. In their recommendations to Congress and the President, the Eastside Forests Scientific Society Panel proposed a 20" diameter limit for trees younger than 150 years old to protect late-successional and old-growth dry forests of eastern Oregon and Washington. They cited the ecological importance and scarcity of large and old trees and the need to retain them to replenish regionally-depleted supplies of large and old trees, snags, logs and associated wildlife habitat. Those recommendations formed the basis for interim management direction amending nine national forest plans and establishing a 21" diameter limit in dry forests which in turn carried forward into an exception-threshold of 21"

diameter in legislation proposed to restore dry forests of eastern Oregon. The Sierra Nevada Framework set forth a 20" diameter limit for tree cutting to conserve late-seral forests across national forest land in the Sierra Nevada. Larger diameter limit and exception-thresholds in these examples reflect more productive forests and larger mean diameters than in southwestern forests. Diameter limits in Region 3 forest plans restrict large tree cutting in habitat for Mexican spotted owl and northern goshawk for their viability and in "old growth"; diameter-based "vegetative structural stages" guide management of those species' habitats.

Arguments Against Diameter Caps

Arbitrary diameter thresholds (or "caps") may assure that trees of a certain size are retained, but they do not guarantee that short- or long-term ecological restoration goals will be achieved. In fact, diameter caps can actually prevent attainment of ecological restoration objectives because they can have unintended consequences such as interfering with the restoration of herbaceous openings and, where unnaturally dense stands of larger, post-settlement trees predominate, caps can limit fuel reduction and, therefore, undermine the agency's ability to re-establish surface fire (Abella et al. 2006, Sanchez-Meador 2009). A diameter threshold also creates a "one-size-fits-all" guideline which can lead to treatments that are inconsistent with site-based conditions.

In general caps are arbitrarily chosen to achieve socio-political objectives that do not necessarily support comprehensive ecological restoration. Contemporary diameter caps, even as an informal agreement, have become the condition that allows fuel reduction and restoration to move forward without lengthy delays due to appeals and litigation. Examples of their arbitrary application include:

- In order to test restoration treatments in the Grand Canyon, a 5-inch cap was required by environmental advocates (Fulé 2006).
- For restoration to proceed in the White Mountains, a 16-inch cap was required (Abrams and Burns 2007).
- A 12-inch cap was employed to define forest biomass appropriate for generating renewable energy (Arizona Corporation Commission, 2006).
- On the Coconino National Forest, a 16-inch cap was imposed to allow restoration projects proposed by the Grand Canyon Forest Partnership to proceed (Friederici 2003).

Further evidence that caps undermine ecological restoration goals is reflected in a recent decision on the Marshall Fuel Reduction and Forest Restoration Project (USFS 2010). The Forest Service rejected an alternative that proposed a 16-inch diameter cap because, "A 16-inch cap would prevent the restoration of natural openings and more natural spatial distribution of clumps of trees important for wildlife habitat and forest health." When administrative and legal challenges to forest thinning and restoration projects prevail it is generally because of issues related to agency compliance with law and policy (Brown 2009)—not because there is a scientific basis for a diameter threshold.

Finally, a static diameter cap fails to account for the fact that trees grow, that restoration will occur over decades while those trees are growing, and that over time, retention of excess trees may undermine efforts to restore ecosystem resilience in the face of drier conditions associated with climate change (Glicksman 2009, Westerling et al. 2006).

Conclusions

Recognizing a need to move beyond the historical debate and move forward with landscape-scale restoration that is ecologically, socially, and economically viable, the 4FRI Collaborative has agreed that the 4FRI effort should implement large tree retention and old growth protection strategies that are not based on strict diameter limits, but are based upon a 16" diameter threshold that limits the cutting of trees larger than 16" to circumstances and criteria set forth in pre-defined exception categories that follow. In addition, we are committed to monitoring the outcomes of treatments that follow this guidance to determine if they achieve our ecological restoration goals. If they do not we are committed to adapting this policy to achieve better ecological outcomes.

It is our hope and expectation that this approach will balance the approaches and opinions expressed above, and will serve as a policy mechanism for supporting comprehensive ecosystem restoration while addressing stakeholders' needs for protecting old growth and large ponderosa pine trees.

III. Exception Process for Large Post-Settlement Tree Retention

The following section outlines a problem statement, specific identifying circumstances, ecological objectives and selection criteria for instances in which large post-settlement trees may be cut to meet restoration objectives. At specific locations, large trees may need to be removed, felled, or girdled for purposes of ecological restoration and biodiversity conservation. The purpose of this section is to provide sufficient specificity to translate those exception categories—where stakeholder agreement exists to do so—into management actions and tree-marking guidelines. For eight of the nine exception categories programmatic recommendations describe the circumstances and criteria in which large post-settlement trees may need to be removed. For the "Heavily Stocked Stands with High Basal Area Generated by a Preponderance of Large Young Trees" (or "Large Young Tree") exception category, getting to a higher level of social and scientific agreement entails more complexity and challenges, so we propose the initiation of additional collaborative discussion and planning that we hope will bolster restoration efforts by increasing confidence and knowledge-sharing, maximizing agreement and minimizing disagreement.

IV. Exceptions

Seeps & Springs

Suggested Tree Marking Exception Code: "S"

Identifiable Circumstance

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock, where standing or running water is infrequent or absent and that exhibit vegetation and other biological diversity adapted to mesic soils.

Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water, wet or moist soils and that exhibit vegetation and other biological diversity adapted to mesic soils or aquatic environments (Feth and Hem 1963).

Problem Statement

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. Due to the absence of frequent fires in the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of these trees may constitute a relatively small part of an overall seep and spring restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore seeps and springs (Thompson et al. 2002).

Ecological Objectives

(1) Conserve and restore the biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted and aquatic native biological diversity depend.

Criteria

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of seeps & springs according to these criteria:

(1) Where large trees' roots are encroaching on mesic soils associated with a seep or spring, or such trees' drip lines are overlapping or nearly overlapping a seep or spring

such that its shading compromises the integrity of a spring's unique biophysical attributes, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said seep or spring in the past, leave an equivalent number of large replacement trees.

Riparian

Suggested Tree Marking Exception Code: "R"

Identifiable Circumstance

Riparian areas occur along ephemeral or perennial streams or are located down-gradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

Problem statement

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted or aquatic biological diversity. Riparian areas and the streams, springs and seeps connected to them often harbor imperiled species and can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial wildlife. In the absence of frequent fires and in the presence of livestock grazing, water development projects and other factors, large post-settlement trees may have established and grown within riparian areas such that they compromise available soil moisture or light that support those unique biophysical conditions. However, it is likely to be a very rare circumstance that trees of any size will need to be removed from forested riparian zones.

Cutting of any trees within riparian areas should minimize impacts by following Best Management Practices (BMPs).

Whenever possible, large trees identified for cutting should be left onsite as snags or downed logs.

Removal of these trees may constitute a relatively small part of an overall riparian area restoration effort when compared to addressing fundamental causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore riparian areas.

Ecological Objectives

Conserve and restore the biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depend.

Criteria

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of riparian areas according to these criteria:

(1) Where large trees are growing (rooted) within a riparian area and compromising available soil moisture or light that support that area's unique biophysical conditions, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Notes: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said riparian in the past, leave an equivalent number of large replacement trees.

There may be additional areas and/or circumstances identified for riparian restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

Wet Meadows

Suggested Tree Marking Exception Code: "WM"

Identifiable Circumstance

High-elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1% of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 ha of wet meadows occur on national forests in Arizona and New Mexico.

These areas may be referred to as riparian meadows, montane (or high-elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (*Carex* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (Salix) and alder (Alnus) species often occur in or adjacent to these meadows (Long 2000, 2002, Maschinski 2001, Medina and Steed 2002). High-elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

Problem statement

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations, most notably the lowering of their water tables due to stream downcutting, surface water diversions, or groundwater withdrawal (Neary and Medina 1996, Gage and Cooper 2008). In the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Removal of these trees may constitute a relatively small part of an overall wet meadow restoration effort when compared to addressing root causes of overall degradation. Thinning alone without addressing other sources of degradation is unlikely to restore wet meadows.

Ecological Objectives

Conserve and restore the biophysical conditions of wet meadows upon which terrestrial native biological diversity depend.

Criteria

Large (>16"dbh) post-settlement ponderosa pine trees may be removed to conserve the unique biophysical attributes of wet meadows according to these criteria:

(1) Where large trees are growing (rooted) in a wet meadow, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: Where there is evidence of pre-settlement trees having grown in similar root and crown proximity to said wet meadows in the past, leave an equivalent number of large replacement trees.

Encroached Grasslands

Suggested Tree Marking Exception Code: "EG"

Identifiable Circumstance

Encroached grasslands are herbaceous ecosystems that have infrequent-to-no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils, which are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and to a lesser extent by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (Festuca arizonica) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands are the most naturally fragmented grasslands in the region, ranging from thousands of acres in size (e.g., in the White Mountains, Baker 1983) down to only a few acres. They generally occur in small (<100 ac.) to medium-sized (100 to 1000 ac.) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings.

Identification of grasslands in this region should use a combination of the Terrestrial Ecosystem Survey, Southwest Regional GAP Analysis, Brown and Lowe Vegetation Classification (Brown and Lowe 1982; TNC GIS Layer 2006) among other existing vegetation and soils data.

This exception category will require an iterative process of collaborative mapping, field verification, and refinement. There is debate about where and how much the grassland-forest mosaic shifts over time and space. There are also questions about whether some recently-burned areas are early seral forests or stable grasslands, whether or how they may be surrogates for historical grasslands, and if or how that should factor into the overall retention of forest cover. Recognizing the importance of montane grassland restoration, we encourage all parties to seek resolution to these issues on a case-by-case basis through field visits, literature review, and/or discussion.

Problem statement

Prior to European settlement, pine trees rarely established in grasslands because they were either outcompeted by production of cool-season grasses or killed by frequent fire (Finch 2004). In

the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, releasing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Allen 1984, Moore and Huffman 2004, Coop and Givnish 2007).Pine encroachment into grasslands has contributed to a significant loss of biodiversity (Stacey 1995) and wildlife habitat particularly for grassland-dependent species such as pronghorn. Plant diversity is particularly important in grassland ecosystems: grassland plots with greater specie diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994); this resilience will become even more important in a warming climate. Pine tree removal, restoration of fire, and complementary reductions in livestock grazing pressure are all necessary to restore structure and function of native grasslands.

Ecological Objectives

(1) Enhance, maintain, and restore naturally functioning grasslands.

(2) Ensure native grassland composition, increase native species diversity, improve resilience to drought.

(3) Restore natural fire regime.

Criteria

Large (>16" dbh) post-settlement ponderosa pine trees may be cut and/or removed to restore the unique biophysical attributes of grasslands according to these criteria:

(1) Where existing grasslands are being encroached, and large trees are interfering with overall restoration objectives, and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: There may be additional areas and/or circumstances identified for grassland restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

Suggested Tree Marking Exception Code: "AF"

Identifiable Circumstance

Quaking aspen (*Populus tremuloides*) occurs in small patches throughout the 4FRI area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. Almost all of the aspen occurring within ponderosa pine forests of the 4FRI area exists as seral aspen, and regenerates after disturbance both through root sprouting and rarely from seed production (Quinn and Wu 2001). Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire 4FRI area and map layers are available from existing databases.

Problem Statement

Aspen occurs within ponderosa pine forests, and is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finch and Reynolds 1987, Griffis-Kyle and Beier 2003). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio and others 2005). However, aspen is currently declining at an alarming rate (Fairweather and others 2008).

The loss of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen-dominated lands to succeed to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing by livestock and introduced and native wild ungulates in the absence of natural predators like wolves (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1994, Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with 90% mortality occurring in low elevation aspen sites and over 60% mortality observed in mid-elevations. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather and others 2008) that have served as the "final straws" for already compromised stands.

Removal of encroaching pine trees constitutes part of an overall aspen restoration effort. Thinning alone without addressing other sources of degradation, such as excessive herbivory is unlikely to successfully restore aspen forests.

Some stakeholders expressed that considerable uncertainty exists around fire regimes for aspen in ponderosa pine, and that research questions remain unanswered around the prevalence of mixed-severity fire and its ecological role as a driving force for aspen stands at the top of its elevational range, and on steep slopes within this vegetation type.

Ecological Objectives

(1) Conserve and restore aspen forests and woodlands within 4FRI area by restoring appropriate fire regimes and decreasing competition from ponderosa pine.

(2) Protect regeneration, saplings, and juvenile trees from browsing.

Criteria

Large (>16"dbh) post-settlement trees may be cut in conifer-encroached seral aspen stands according to the following criteria:

(1) Where current post-settlement ponderosa pine tree numbers are above and beyond residual targets (identified using pre-settlement conifer tree evidences), and

(2) Where fire cannot be used safely and effectively to regenerate or maintain aspen, or

(3) Where site visitation and/or data collection and analysis indicates the need for encroachment mitigation, and

(4) Where removing large trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat

Note: There may be additional areas and/or circumstances identified for aspen restoration through a site specific agreement-based, collaborative process as described in the 4FRI Charter.

Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

Suggested Tree Marking Code: "P-O"

Identifiable Circumstance

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak trees in locations throughout the 4FRI area in a habitat association referred to as PIPO/QUGA (USFS 1997, USDI FWS 1995). Specifically, any stand within the Pinus ponderosa series where ≥10% of stand basal area consists of Gambel oak (*Quercus gambelii*) ≥13 cm (5 in) diameter at root collar (drc) is considered to be pine-oak within the 4FRI area (USDI FWS 1995). In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Brown 1958, Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number of varying wildlife species (Neff and others 1979, Kruse 1992).

Gambel oak provides high quality wildlife habitat in its various growth forms, and is a desirable component of ponderosa pine forests (Neff and others 1979, Kruse 1992, Bernardos et al. 2004). Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI FWS1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular fuelwood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

Problem Statement

Although management on public lands with regard to oak has changed to better protect the species, illegal fuelwood cutting of Gambel oak and elk and livestock grazing negatively impact oak growth and regeneration (Harper et al. 1985, Clary and Tiedemann 1992, Rick Miller, 1993, unpublished report) and continues to result in the removal of rare, large diameter oak trees (Bernardos et al. 2004).

A literature review by Abella and Fule (2008) found that Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium-diameter stems (<8" dbh). Chambers (2002) found that Gambel oak on the Kaibab and Coconino National Forests was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 cm dbh) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 cm) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fule (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

Ecological Objectives:

(1) Maintain and restore all growth forms of Gambel oak, focusing on enhancing and maintaining larger, older oak trees.

(2) Restore frequent, low intensity surface fire to ponderosa pine-Gambel oak forests.

(3) Restore and maintain brushy thicket, pole and dispersed clump growth forms of Gambel oak by allowing natural self-thinning, thinning dense clumps, and/or burning.

(4) Protect Gambel oak growth forms from fuel wood cutting, damage during restoration treatments including thinning and post thinning slash burning.

Criteria

In pine-oak, which occurs when ≥10% of the stand basal area consists of Gambel oak >13 cm (5 in) diameter at root collar, large (>16 dbh) post-settlement ponderosa pine trees may be removed to conserve oaks according to these criteria:

In MSO restricted habitat:

(1) Within MSO habitat and designated critical habitat, the Recovery Plan for the Mexican spotted owl should be followed to improve key habitat components and primary biological factors, which includes Gambel oak, or

Outside MSO restricted habitat: where large post-settlement trees' drip lines or roots overlap with those of Gambel oak trees exhibiting drc of >12"; and

(2) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Within Stand Openings

Suggested Tree Marking Exception Code: "WSO"

Identifiable Circumstance

Within Stand Openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sanchez-Meador et al. 2009). Pre-settlement openings can be identified by the lack of stumps, stump holes, and other evidence of pre-settlement tree occupancy (Covington et al. 1997). These openings are most pronounced on sites with heavy textured (e.g., silt-clay loam) soils (Covington and Moore 1994). Current openings include fine scaled canopy gaps. It is not necessary that desired within stand openings and groups be located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees. The within stand opening criteria described here are distinct from and should not be considered as guidance relating to regeneration openings. The stakeholder group does not support the cutting of large trees to create regeneration openings.

Problem Statement

Within stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sanchez-Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997). These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within a stand opening as soon as herbaceous vegetation was removed by overgrazing (Sanchez-Meador et al. 2009). Contemporary within stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within stand heterogeneity.

Ecological Objectives

(1) Conserve and restore openings within stands to provide natural spatial heterogeneity for biological diversity.

(2) Break up fuel continuity to reduce the probability of torching and crowning.

(3) Restore natural heterogeneity within stands.

(4) Promote snow-pack accumulation and retention to benefit groundwater recharge and watershed processes at small scale.

Criteria

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to restore the unique biophysical attributes of within stand openings according to these criteria:

(1) When the presence of such trees would prevent the re-establishment of sufficient within stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives, and

(2) Where desired openings are tentatively identified as ≥0.05 acre (these openings should be established wherever possible by enlarging current within stand openings or where small diameter trees are predominant), and

(3) Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened or endangered species or their habitat.

Note: It is not necessary that within stand openings and groups be located in the same location that they were in before settlement. That is, trees might be retained in areas that were openings before settlement, and openings might be established in areas that had previously supported pre-settlement trees.

Heavily Stocked Stands with High Basal Area Generated By a Preponderance of Large Young Trees

Suggested Tree Marking Exception Code: "LYT"

Identifiable Circumstance

The stakeholder group could not identify with sufficient clarity and agreement the identifiable circumstances under which large removal would take place. We aim to have this completed by early May 2011.

Problem Statement

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and BA would be desirable, large post-settlement pines may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. In stands where evidences indicate that higher tree density and BA would have occurred pre-settlement, only a few large pines may need to be removed. Many of these areas would support crown fire, and thus require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

Ecological Objectives

(1) Restore natural heterogeneity of forest, savannah and grasslands at the landscape scale.

(2) Restore natural heterogeneity within stands.

(3) Break up canopy fuel continuity to reduce the probability of torching and crowning and restore herbaceous fuel continuity to carry surface fire.

Criteria

Large (>16" dbh) post-settlement ponderosa pine trees may be removed to meet restoration objectives according to these criteria:

(1) The stakeholder group could not identify with sufficient clarity and agreement the criteria under which large tree removal would take place. We aim to have this completed by early May 2011.

V. Description of Desired Next Steps and Ongoing Collaborative Clarification of OGP&LTRS

Eight of the exception categories listed in this document have been clarified such that they can be operationalized "programmatically", that is, the process of mapping and selecting areas for exceptions is ready to be tested with real data in specific areas. This means that the stakeholder group considers the guidance offered for these exception categories sufficient to operationalize large tree retention/removal per these criteria across the 4FRI area. This process will require the participation of stakeholders and USFS team members to ensure that the suggested process in this document achieves the stated restoration objectives, and is not burdensome in its approach and mechanics.

The "Large Young Tree" exception category listed in this document will require additional collaborative analysis and clarification. Thus far, the group has discussed an opportunity and a need to carry these discussions forward with a combination of additional site visits to representative areas, analysis of USFS stand data, and further exploration of ForestERA remote sensing data that could inform our collective sense of the distribution and extent of areas exhibiting circumstances necessitating large tree removal, and an efficient means of analyzing data and selecting areas for treatment.

Recognizing the importance of finding additional clarity and agreement for these exception categories, the group intends to pursue additional field and data-centered explorations of these exception categories in 2011, working closely with the Forest Service to ensure that additional analysis occurs in a coordinated fashion, and that additional recommendations can be operationalized in a straightforward fashion. Analysis and visitation schedules are intended to be developed by March, 2011, and completed by May 6, 2011.

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Appendix 1 – Reservations

From Scott Harger, Coconino NRCD
From: Scott Harger [mailto:cannonbone@msn.com]
Sent: Friday, March 04, 2011 6:57 PM
To: Windy Greer
Subject: Re: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Dear Windy, and LTRS Sub-Group of the LSWG:

I appreciate the accelerated effort to push this document for timely delivery to the USFS.

I like the descriptions captured here for the large tree strategy overview and rationale for the document and the 8-of-9 exception categories whose language appear to be resolved. Except for some very turgid prose in section V that can be edited, I can support this draft as a partial or preliminary version, subject to review of the 9th exception. Otherwise, I can support approval of this final draft without conditions. I would also support it if "Problem Description" were changed to "Management Issue" or "Concerns driving the Exception" or something that doesn't suggest that habitats are problems.

Scott Harger
Range Conservationist
Coconino NRCD
Flagstaff, AZ
928.527.9050

From Scott Hunt, Arizona State Forester
From: Scott Hunt [mailto:ScottHunt@azsf.gov]
Sent: Friday, March 11, 2011 12:00 PM
To: Windy Greer; 'Ethan Aumack'; Ed Smith
Cc: Kevin Boness
Subject: RE: Old Growth Protection and Large Tree Retention Strategy Document for Stakeholders' review

Thank you Ed and Ethan for the dedicated work on this strategy. The State Forestry Division agrees with reservations on this large tree retention policy. The arguments against diameter caps that you provided in the policy capture most of our reservations. We have two additional items we wish to offer for consideration:

-In the category "Seeps and Springs" under criteria: there should be an allowance for removal of large trees a considerable distance from the seep or spring to help invigorate infiltration and flow. Distance will need to be determined by the effective area that benefits the seep or spring.

-We believe a consideration needs to given for stands that may have a healthy understory of regenerated ponderosa pine with an overstory of trees that are heavily infected with dwarf mistletoe. Objectives for

this type of stand may encourage and favor the vigorous, healthy understory. Removal of the larger trees that are infected would be required to meet the stand objectives.

We will look forward the opportunity to comment on the Larger Young Tree removal category when it is developed. Thanks again for all your time and effort.

Scott Hunt

Appendix B

Crosswalk between Large Tree Retention Strategy (LTRS) and 4FRI Purpose and Need and Alternatives

Created January 20, 2012, Updated on February 6 and May 25, 2012

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
Seeps and Springs								
	The biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted, and aquatic native biological diversity depend are conserved and restored.	The desired condition for springs and seeps is to have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances (USDA 1986; 1987; 2008; 2009).	Y	B-D	Y	Y	Y	Addressed in PN, design features made part of all action alternatives (B-D) to address forest plan requirements, outcomes disclosed in effects analysis
	The integrity of the spring's unique biophysical	See Above	Y	B-D	Y	Y	Y	Addressed in PN, design features made

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	attributes is not compromised by tree shading							part of all action alternatives (B-D), outcomes disclosed in effects analysis
	Mesic soils associated with a seep or spring is not encroached upon by conifers.	See Above	Y	B-D	Y	Y	Y	Addressed in PN, design features made part of all action alternatives (B-D), outcomes disclosed in effects analysis
	If treatment occurs, there is an equivalent number of large replacement trees would be left where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or	The desired condition for springs and seeps is to have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential	Y	B-D	Y	Y	Y	Addressed in PN, evidence based restoration design feature made part of all action alternatives, outcomes addressed in effects;

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	spring in the past.							
	The old tree retention strategy provides direction on how pre-settlement trees would be managed.	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat	Y	B-D	Y	Y	Y	DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
Riparian								
	The biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depends are conserved and restored.	The desired condition is to restore the functionality of both springs and ephemeral streams (USDA 1986, 1987, 2008, 2009). On some springs and channels there is a need to maintain and promote existing vegetation. On others there is a need to reduce tree encroachment, the presence of	Y	B-D	Y	Y	Y	Addressed in PN, design features made part of all action alternatives (B-D) to address forest plan requirements,

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		noxious weeds and limit the potential for future disturbance. On all springs and streams and channels, there is a need to return fire, a natural disturbance processes, to the system.						outcomes disclosed in effects analysis
	The use of soil and water best management practices (BMPs) minimize the impacts of cutting trees within riparian areas.		Y	B-D	Y	Y	Y	Addressed in PN, design features made part of all action alternatives (B-D) to address forest plan requirements (BMPs), outcomes disclosed in effects analysis

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	Removal of trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Riparian areas are fully restored by using an array of tools that address all sources of degradation.	The desired condition for springs and seeps is to have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential The desired condition is to restore the functionality of both springs and ephemeral streams	Y	B-D	Y	N	Y	Range of actions included in all action alternatives provide for complete restoration including protective fencing, outcomes addressed in effects
	Available soil moisture or light that support that area's unique biophysical conditions is not compromised by growing (rooted) trees.	The desired condition for springs and seeps is to have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential The desired condition is to restore the functionality of both springs and ephemeral streams	Y	B-D	Y	Y	Y	Addressed in PN, all action alternatives, post treatment condition will be addressed in effects analysis
	If treatment occurs, there is an	See above	N	B -D	Y	N	Y	Addressed in PN, Evidence based

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	equivalent number of large replacement trees would be left where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.							restoration design feature part of all action alternatives, outcome addressed in effects;
	Post-treatment snags and logs that include large trees are available on site.		Y	B-D	Y	Y	Y	Evidence based restoration design feature part of all action alternatives (forest plan compliance), outcomes addressed in effects;
	The old tree retention strategy provides direction on how pre-settlement trees would be managed.	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale	Y	B-D	Y	Y	Y	DC is addressed in P/N (compliance with forest plan), Old Tree Imp.

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		*Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat						Strategy is part of all action alternatives
Wet Meadows								
	The biophysical conditions of wet meadows upon which terrestrial native biological diversity depend are conserved and restored.	The desired condition is to move towards the historic range of variability. **In grasslands,** tree canopy cover would range from 0 to 9 percent and grasses and forbs would dominate. **In both wet and dry meadows, biological diversity would be conserved or restored.** The fire return interval would less than 35 years (USDA 2008). Fire would function as a natural disturbance across the landscape without causing loss to ecosystem function or to human safety, lives, and values. When fire did occur, vegetation would return close to pre-fire conditions within a few years (Johnson 1998) and	Y	B-D	Y	Y	Y	Clarification has been added to P/N (bold text) to include wet meadows , design features are included in all action alternatives, outcomes are addressed in effects

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		would typically replace less than 75 percent of the overstory (USDA 2009).						
	Wet meadow function is not impaired by growing (rooted) trees.	See above	Y	B-D	Y	Y	Y	See above
	If treatment occurs, there is an equivalent number of large replacement trees would be left where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.	See above	Y	B-D	Y	Y	Y	Evidence based restoration design feature is part of all action alternatives, outcomes are addressed in effects
	Removal of large trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall		Y	Y	BMP #22 – springs BMP #13, #20 – riparian sites, BMP #24 - grass	Y	Y	All action alternatives provide design features to restore function. Effects analysis provides

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	degradation. Wet meadows are fully restored by using an array of tools that address all sources of degradation.							outcomes
	The old tree retention strategy provides direction on how pre-settlement trees would be managed.	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat	Y	B-D	Y	Y	Y	DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
Encroached Grasslands								
	Grasslands are enhanced, maintained, and function with potential natural vegetation (as defined by vegetative mapping	The desired condition is to move towards the historic range of variability. Tree canopy cover would range from 0 to 9 percent and grasses and forbs would dominate. The fire return interval would less than 35 years (USDA 2008).	Y	B-D	Y	Y	Y	All action alternatives are designed to restore function to grasslands.

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	units)	Fire would function as a natural disturbance across the landscape without causing loss to ecosystem function or to human safety, lives, and values. When fire did occur, vegetation would return close to pre-fire conditions within a few years (Johnson 1998) and would typically replace less than 75 percent of the overstory (USDA 2009).						
	Grasslands function with a natural fire regime		Y	B-D	Y	Y	Y	All action alternatives are designed to restore function to grasslands.
	Existing grasslands are not encroached upon by conifers		Y	B-D	Y	Y	Y	All action alternatives are designed to restore function to grasslands.
	If treatment occurs, there is an equivalent number of large replacement trees would be left where there is evidence that pre-		N	Y	Y	N	Y	Evidence based restoration design feature is part of all action alternatives,

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.							outcomes are addressed in effects
	The old tree retention strategy provides direction on how pre-settlement trees would be managed	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat	Y	B-D	Y	Y	Y	DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
Aspen and Woodland								
	Aspen forests and woodlands are conserved and restored to their appropriate fire regime.	The desired condition is to maintain and/or regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen.	Y	B-D	Y		Y	See fire design feature for aspen
	Aspen is effectively		Y	B-D	Y	Y	Y	All action

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	being regenerated or maintained and regeneration, saplings, and juvenile trees are protected from browsing							alternatives provide design features to promote aspen and protect post-treatment
	There is decreased competition from ponderosa pine. Post-settlement ponderosa pine tree numbers do not exceed residual targets that have been identified using pre-settlement conifer tree evidences, site visitations, and collected data		Y	B-D	Y	Y	Y	See above
	Removal of large trees constitutes a relatively small part of the aspen restoration effort, when compared to the fundamental causes of overall degradation. Aspen forests and		N	B-D	Y	N	Y	See above

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	woodlands are fully restored by using an array of tools that address all sources of degradation							
	The old tree retention strategy provides direction on how pre-settlement trees would be managed	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat	Y	B-D	Y	Y	Y	DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
Alternative B-D Design Features: (1) Inclusions of aspen remnants within portions of ponderosa pine stands would be regenerated by removing all post settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground disturbing activity or burning may occur to stimulate suckering. Each clone would be evaluated as to need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen, (2) Implement prescription parameters, ignition techniques, raking, wetting, leafblowing, thinning, or otherwise mitigating fire impacts to the degree necessary to meet burn objectives, (3) Design burns to avoid high-severity burning though entire stands with large aspen, (4) If jackstrawing has been implemented in or around a stand, fire behavior will be mitigated by the above techniques to ensure only a minimal amount is consumed.								
Ponderosa Pine/Gambel Oak								

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	Small oak trees develop into larger size classes.	The desired condition is to develop and maintain a variety of oak size classes and forms, where they occur. Oak should range from shrubby thickets and pole-sized clumps to large trees across the landscape in order to provide habitat for a large number and variety of wildlife species (Brown 1958; Kruse 1992; Rosenstock 1998; Abella and Springer 2008; Abella 2008a; Neff and others 1979).	Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	Fire treatments retain small and shrubby oak in numbers and distribution.		Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	All growth forms of Gambel oak are present and larger, older oak trees are enhanced and maintained		Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	Large, post-settlement trees are not restricting oak		Y	B-D	Y	Y	Y	All action alternatives have design

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	development							features to promote oak (forest plan compliance)
	Frequent, low intensity surface fire occurs in ponderosa pine-Gambel oak forests		Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	Brushy thicket, pole and dispersed clump growth forms of Gambel oak are present and maintained by allowing natural self-thinning, thinning dense clumps, and/or burning		Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	Gambel oak growth forms are protected from damage during restoration treatments including thinning and post thinning slash burning.		Y	B-D	Y	Y	Y	All action alternatives have design features to promote oak (forest plan compliance)
	The old tree		Y	B-D	Y	Y	y	DC is

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	retention strategy provides direction on how pre-settlement trees would be managed.							addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
	Within MSO habitat and designated critical habitat, the recovery plan for the Mexican spotted owl improves key habitat components and primary biological factors, which includes Gambel oak.		Y	B-D	Y	Y	Y	The purpose and need is based on moving towards forest plan desired condition – all action alternatives include features designed to favor Gambel oak
	Large post-settlement trees' drip lines or roots do not overlap with those of Gambel oak trees exhibiting drc of >8"		Y	B-D	Y	Y	Y	The purpose and need is based on moving towards forest plan desired condition – all

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
								action alternatives include features designed to favor Gambel oak
Alternative B-D Design Features: (1) Gambel oak, juniper and pinyon species may only be cut as necessary to facilitate logging operations (skid trails and landings) and by design as follows: (a) Areas within UEA, IT, SI and WUI mechanical treatment, seedling/sapling, young and mid-aged pinyon and juniper up to 11" DRC may be cut within a 40' radius of individual or groups of old ponderosa pine (as defined in the old tree retention strategy), (b) Areas within Savanna and WUI PJ mechanical treatment, seedling/sapling, young and mid-aged pinyon and juniper up to 11" DRC may be cut., (2) In MSO restricted habitat, Gambel oak, juniper and pinyon species will not be cut as part of the treatments. These species may only be cut as necessary to facilitate logging operations (skid trails and landings). (3) In MSO restricted habitat, manage for large oaks by removing conifers up to 18" dbh that do not meet the "old tree" definition within 30 feet of oak 10" drc or larger, (4) For meadow restoration, Gambel oak would not be cut, (5) Fire may be used to manipulate oak growth forms and stem densities, stimulate sprouting, and accomplish other management objectives. Higher intensity fire may be used where the objective is to topkill oak for the purpose of stimulating resprouts. Low severity fire effects would be the objective in areas where oak stems are >6". Lightning near the bases of large oak boles will be avoided.								
Within-Stand Openings								
	Pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved.	At the fine scale, the desired condition is a ponderosa pine ecosystem consisting of groups of trees that typically range in size from 0.1 acre to 1.0 acre in size with an open tree canopy density mixed with interspaces. There is a need to use management strategies that promote tree regeneration and understory	Y	B-D	Y	Y	Y	The best available science and forest plan direction was used to design features that would restore structure, pattern, composition,

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		vegetation and move towards the historic range of variability for tree canopy density and patterns of tree groups and interspaces. The desired condition is to restore tree density and pattern to the natural range of variability, while meeting forest plan requirements for Mexican spotted owl (hereafter referred to as MSO) protected and target/threshold habitat and goshawk nest stands. Canopy gaps and interspaces would provide adequate space for the development of rooting zones for tree groups and an increase in the grass/forb understory. Canopy gaps and interspaces between tree groups or individuals, based on site productivity and soil type, would range from 10 percent on highly productive sites to as high as 90 percent on those						and function to the ponderosa pine ecosystem

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		soil types that have an open reference condition						
	Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands.	Fire, as a disturbance process, would maintain a mosaic of diverse native plant communities. No more than 10 percent of the project area should be prone to crown fire (Swetnam and Baison 1996; Roccaforte et al. 2008). When crown fire does occur, it should be mostly passive crown fire, occurring in single trees, groups, or clumps, or areas where there had been mortality (wind throw, insects, etc.) Fire would function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives and values.	Y	B-D	Y	Y	Y	The purpose and need is based on moving towards forest plan desired condition – all action alternatives include features designed to favor Gambel oak
	Openings promote snow-pack accumulation and retention which benefits groundwater recharge and watershed processes		Y	B-D	Y	Y	Y	All action alternatives have design features aimed at restoring function , the effects analysis will

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	at the small scale							address outcomes
	The presence of such trees does not prevent the re-establishment of sufficient within stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives.		Y	B-D	Y	Y	Y	All action alternatives have design features aimed at restoring function , the effects analysis will address outcomes
	Desired openings are ≥0.05 acre in size and are established wherever possible by enlarging current within-stand openings or where small diameter trees are predominant.	The desired condition is a ponderosa pine ecosystem consisting of groups of trees that typically range in size from 0.1 acre to 1.0 acre in size with an open tree canopy density mixed with interspaces; Canopy gaps and interspaces between tree groups or individuals, based on site productivity and soil type, would range from 10 percent on highly productive	Y	B-D	Y	N	Y	All action alternatives include design features that encompass range of opening size recommended in LTRS

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		sites to as high as 90 percent on those soil types that have an open reference condition						
	The old tree retention strategy provides direction on how pre-settlement trees would be managed.	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat	Y	B-D	Y	Y		DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all action alternatives
Alternative B-D Design Features: (1) Treatments are designed to move vegetation toward the desired condition as outlined in the Coconino NF and Kaibab NF forest plans, (2) Treatments are designed to create tree groups and interspaces that stimulate grass, forbs and increase residual tree growth, (3) Priority location for interspace is in currently non-stocked areas and in areas that lack pre-settlement evidence, (4) Treatments will focus on reducing the most abundant tree size classes and maintaining the under-represented tree size classes in order to achieve and/or set the project area on the trajectory to attain greater diversity (heterogeneity) in spatial patterns and size class distribution, (5) Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting, (6) Treatments are designed to decrease the potential for undesirable fire behavior and effects, (7) Live conifer trees with potential to provide nesting habitat cavities (due to trunk decay) will be favored for retention, (8) Within goshawk habitat, tree groups, on average would range in size from 0.1 to 1 acre with the exception of AZGF experimental UEA treatments.								
Large Young Trees								
	Natural	*moving vegetation structure	Y	B-D	Y	Y	Y	All action

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	heterogeneity of forest, savanna and grasslands occurs at the landscape scale and within stands.	and diversity towards desired conditions by creating a mosaic of interspaces and tree groups of varying sizes and shapes *moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat *moving towards desired conditions for vegetation diversity and composition by maintaining and promoting Gambel oak, aspen, grasslands, and pine-sage						alternatives used best available science and forest plan direction to include design features which would restore structure, composition, pattern, and function in the ponderosa pine ecosystem
	Groups are restored by retaining the largest trees on the landscape to re-establish old growth structure in the shortest timeframe possible.	*moving vegetation structure and diversity towards desired conditions by creating a mosaic of interspaces and tree groups of varying sizes and shapes *moving towards a forest structure with all age and size	Y	B-D	Y	Y	Y	All action alternatives used best available science and forest plan direction to include design features which would restore

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat						structure, composition, pattern, and function in the ponderosa pine ecosystem
	Decreased shading and interception from the canopy, decreased litter and duff, and surface fire restore and maintain a mosaic of natural vegetative communities.		Y	B-D	Y	Y	Y	All action alternatives used best available science and forest plan direction to include design features which would restore structure, composition, pattern, and function in the ponderosa pine ecosystem
	Horizontal and vertical canopy characteristics, which include tree groups, clumps, and openings, reduce the potential for crown		Y	B-D	Y		Y	All action alternatives used best available science and forest plan direction to

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
	fire as well as the extent of high severity fire effects							include design features which would restore structure, composition, pattern, and function in the ponderosa pine ecosystem
	Fire is the principle regulator of forest structure over time.	Overall, the desired condition is to have fire, as a disturbance process, maintain a mosaic of diverse native plant communities. No more than 10 percent of the project area should be prone to crown fire (Swetnam and Baison 1996; Roccaforte et al. 2008). When crown fire does occur, it should be mostly passive crown fire, occurring in single trees, groups, or clumps, or areas where there had been mortality (wind throw, insects, etc.) Fire would function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives and values. Overtime, conditions	Y	B-D	Y	Y	Y	All action alternatives used best available science and forest plan direction to include design features which would restore structure, composition, pattern, and function (including fire) in the ponderosa pine ecosystem

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		would allow managers to use wildfire and prescribed fire to maintain the area as a functioning ecosystem.						
	Regeneration openings that contribute to the ecological objective of natural heterogeneity of historical forest structure and age class diversity are not encroached upon by trees.		Y	B-D	Y	Y	Y	All action alternatives used best available science and forest plan direction to include design features which would restore structure, composition, pattern, and function in the ponderosa pine ecosystem
	The old tree retention strategy provides direction on how pre-settlement trees would be managed.	*Managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale *Moving towards a forest	Y	B-D	Y	Y		DC is addressed in P/N (compliance with forest plan), Old Tree Imp. Strategy is part of all

LTRS Criteria	LTRS Desired Condition (DC)	Purpose and Need	LTRS DC Addressed by 4 FRI P/N? (Y/N)	LTRS DC Addressed in: (1) Alternative design features, (2) project design for forest plan compliance, (3) Effects Analysis?				Comments
				Applicable Alternatives	Design Feature	Forest Plan	Effects	
		structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat						action alternatives
Alternative B-D Design Features: (1) Treatments are designed to move vegetation toward the desired condition as outlined in the Coconino NF and Kaibab NF forest plans. (2) Treatments are designed to create tree groups and interspaces that stimulate grass, forbs and increase residual tree growth, (3) Priority location for interspace is in currently non-stocked areas and in areas that lack pre-settlement evidence, (4) Treatments will focus on reducing the most abundant tree size classes and maintaining the under-represented tree size classes in order to achieve and/or set the project area on the trajectory to attain greater diversity (heterogeneity) in spatial patterns and size class distribution, (5) Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting (see Old Tree Implementation Strategy), (6) Treatments are designed to decrease the potential for undesirable fire behavior and effects, (7) Live conifer trees with potential to provide nesting habitat cavities (due to trunk decay) will be favored for retention, (8) In goshawk habitat, treatments are designed to enhance uneven-aged forest structure, balance Vegetation Structural Stages (VSS) and meet canopy cover requirements within the mid-age and older tree groups, (9) cutting prescriptions within northern goshawk habitat lands shall be consistent with the forest plan guidelines for minimum canopy cover in mid-aged, mature, and old forest structure groups (VSS 4-5-6). Implementation guides will be employed to assure that tree groups are not be marked for thinning below the minimum canopy cover prescribed in the forest plan by habitat type (FA or PFA) and by VSS class 4-5-6 groups/patches. Implementation guides will also be employed to assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4-5-6, (10) Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50% of the mid-aged groups to the lower range of desired stocking conditions, approximately 20% each to the middle and upper range of desired stocking conditions and approximately 10% remain unthinned, (11) Enhance and maintain mid-aged, mature or old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling and poles within the larger group, (12) Thin tree groups and establish interspace adjacent to groups to an average of 50-70 square feet of basal area within FA and 70-80 square feet of basal area within PFA, (13) Crown spacing between tree groups is dependent on treatment intensity and would average from 25 feet to 100 feet within the FA and 25 feet to 70 feet in the PFA, (14) Regeneration openings up to four acres in the FA and up to two acres in the PFA may be created to recruit a new age class depending on current VSS structure to move toward or maintain uneven-aged stand conditions. Regeneration openings would average from 0.3 to 0.8 acres and would be implemented on 10 to 20 percent of the area. Priority location for regeneration openings is within moderate to severe dwarf mistletoe infection centers, (15) for Intermediate Thinning (IT) and stand improvement (SI) treatment within goshawk habitat manage for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe								

LTRS Mapping

Assumptions used in the 4-FRI Large Tree Retention Strategy Mapping Exercise

Springs Category
100m buffer of spring locations

Riparian Category
100m buffer of riparian stream courses

Aspen Category
Aspen category was based on aspen restoration treatments in aspen cover type stands.

Savanna Category
Savanna category was based on savanna restoration treatments. (4FRI savanna treatments were developed based on factors including site class, ponderosa pine open soil reference condition, proximity to grassland soil reference condition and wildlife corridors.)

Pine-Oak Category
Pine-Oak category was based on MSO restricted habitat with the knowledge that oak can also occur outside of MSO restricted habitat.

Grasslands Category
Grasslands category was based on grassland soils defined by the 4FRI soil stratification.

Wet Meadows Category

Wet Meadows category was based on wet meadows soils defined by the 4FRI soil stratification.

Preponderance of Large Young Trees Category
The preponderance of large young trees category was only analyzed within areas managed for goshawks (PFA and non-PFA) because it was based on desired conditions. Outside PFAs, the preponderance of large young trees was defined as stands with BA of trees in size classes 4's and 5's greater than 33 and with a total stand BA greater than 70. Likewise, the preponderance of large young trees inside PFAs was defined as stands with BA of trees in size classes 4's and 5's greater than 38 and with a total stand BA greater than 80. Outside PFA: [BA VSS 4] + [BA VSS 5] > 33 AND [BA All] > 70 and Inside PFA: [BA VSS 4] + [BA VSS 5] > 38 AND [BA All] > 80(The combination of BA VSS 4 and 5 is based on how the desired condition is broken out into BA for each size class as described in Youtz et al. 2007 and adjusted to the high end of the desired condition. The assumption is that the majority of the trees in these sizes classes could be described as young.)

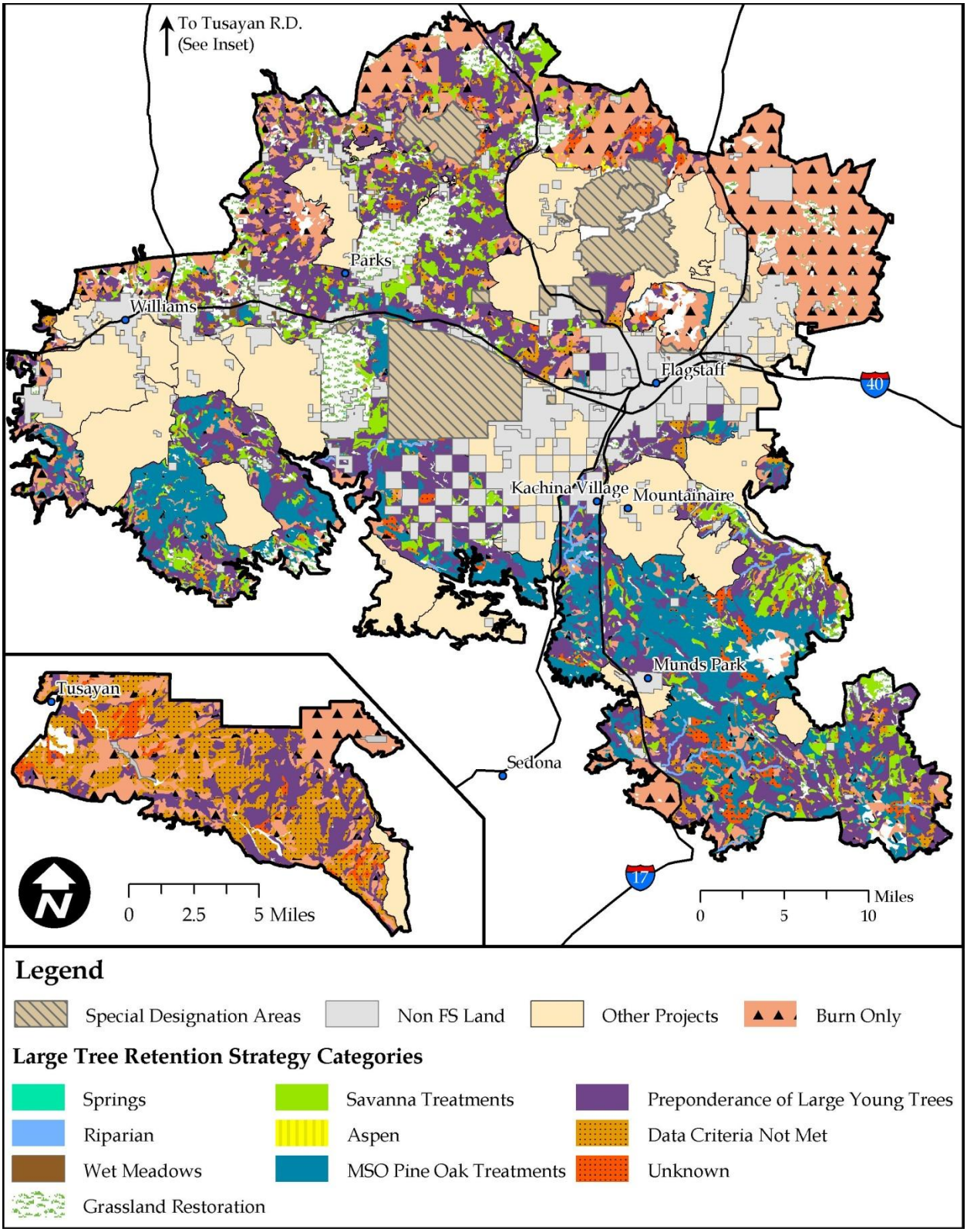

Figure 1. Alternative C Large Tree Implementation Strategy Mapping Exercise

Appendix C. Alternatives B-D Old Tree Implementation Strategy

Background: Scoping for the Four-Forest Restoration Initiative on the Coconino and Kaibab National Forests has been underway since January of 2011. Several comments have been received recommending that a design feature of the proposed action be no cutting of old growth (pre-settlement trees). The recommendation specifically comes from Wally E. Covington of the Ecological Restoration Institute (ERI), the 4FRI Stakeholders, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, Center for Biological Diversity, Sierra Club and Grand Canyon Trust. The 4FRI Forest Supervisors have decided to implement an Old Tree Implementation Strategy that seeks to clarify the desired conditions for the ponderosa pine ecosystem and how this project would perpetuate old growth in both the short (10-year analysis window) and long term (10 years +).

Project Objective: The objective of the 4FRI Coconino/Kaibab project is a movement towards ecological restoration of ponderosa pine systems. Ecological restoration strives to re-establish and retain ecological resilience.

Desired Conditions: The desired condition for ponderosa pine should be addressed at three scales; landscape, mid and fine:

Landscape Scale:

The forest is composed of trees from structural stages ranging from young to old. Mature and old structural stages are well distributed on the landscape. Forest appearance is variable but generally uneven-aged and open. The forest spatial arrangement is in individual trees, small clumps and groups of trees interspersed within variably-sized opening of grass/forbs/shrubs similar to historic patterns. The size, shape, age, and number of trees per group are variable across the landscape.

The ponderosa pine forest vegetation is composed predominantly of vigorous trees, but declining and old trees are a component and provide for snags, top-killed, lightning and fire-scarred trees, and coarse woody debris, all well-distributed throughout the landscape.

The landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from endemic levels of disturbances and include snags, downed logs, and old trees.

Mid-Scale:

The ponderosa pine forest is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. A mosaic of tree groups generally comprises an uneven-aged forest with all age classes present.

Fine Scale:

Trees typically occur in irregularly-shaped groups and are variably-spaced with some tight clumps that consist of 2 to approximately 40 trees per group. In some cases a single large tree may have the structure necessary to act as a clump.

Scientific Basis for Old Growth:

There are unique characteristics only found in old trees that provide an essential structural feature of old growth forest

Old-growth in frequent-fire ponderosa pine forests are typically uneven-aged at the fine-scale (Meyer 1934, Weaver 1951). They are composed of a mosaic of small (0.1-0.5 ac) old tree groups interspaced with similar sized groups of younger trees, seedlings to mid-aged (Cooper 1961, Morgan et al. 2002, Harrod et al. 1999).

Scientific Basis for Balance of Age Classes:

Some early reports on ponderosa pine age structure demonstrated an approximate balance of age classes at the mid-scale (Woolsey 1911, Pearson 1950); this reference condition of age-balanced forests with a multitude of old growth characteristics was likely self-sustaining at the fine to mid-scales.

Vegetation dynamics, including the establishment, development, senescence (aging), and its composition, structure, and pattern, can be estimated and modeled (see Oliver and Larson 1990, Reynolds et al. 1992, Franklin et al. 2002, Reinhardt and Crookston 2003). Using the reference condition as a baseline, vegetation dynamics of SW ponderosa pine forest was used to approximate the maximum sustainable amount of mature and old vegetation structural stages (VSS). Reynolds et al. (1992) determined this would be achieved with about 20 percent of a landscape in VSS 1 and VSS 2 (grass/ forb, seedlings/saplings), 20 percent in VSS 3 (young forest), 20 percent in VSS 4 (mid-aged forest), 20 percent in VSS 5 (mature forest), and 20 percent in VSS 6 (old forest) These proportions reflect forest development from cohort establishment through canopy closure to old forests. It is unrealistic to expect the desired conditions immediately after treatment. It is important to note that movement towards balanced age class distribution is something that will, in most cases, take decades to achieve. As a comparison the estimated VSS distribution for the 4FRI Coconino/Kaibab project is 4 percent VSS 1 and 2, 37 percent VSS 3, 43 percent VSS 4, 9 percent VSS 5, and 7 percent VSS 6.

Strategy and Intent: Through the implementation of the 4FRI Coconino/Kaibab project resource specialists would strive to retain old pre-settlement trees. Recruitment and retention of old trees would, in the long term, would help to restore a balanced age class distribution at multiple scales and would help to restore the variability of structure and patter of the ponderosa pine system within the project area. Treatments would focus on the reduction of the most abundant age classes and conservation of the under-represented age classes in order to restore a balance of age classes. This would not preclude the removal of trees larger or those smaller than the most abundant size classes in order to meet restoration, resource protection, or health and human safety objectives. Each age class is important and the end result of having abundant old trees is dependent on providing conditions that allow younger trees to grow into older trees.

Movement towards a restored condition would provide greater opportunity for resource managers to restore natural fire patterns and frequency over time. Restored landscapes or those that are closer to achieving the desired condition would result in fewer uncharacteristic wildfire events, higher quality wildlife habitat, and improved hydrologic function across the landscape.

How the Project Would Meet an Objective of Recruiting and Retaining Old Trees: The temporal aspect of moving towards desired conditions is important. Most restoration objectives won't be met immediately post-treatment. The treatments proposed for the project would move the area, in the long term, towards a restored condition that more closely represents the natural range of variability with respect to the structure, pattern, and composition of the ponderosa pine system within the project area. Restoration would be a stepwise process, which in most cases would require multiple entries and decades before the desired condition is achieved.

The preceding discussion describes the importance and function of old trees in the ponderosa pine ecosystem. Old trees (approximately $\geq$ 150 years old) would be retained regardless of their diameter within the Four-Forest Restoration Initiative on the Coconino & Kaibab EIS area. Removal of old trees would be rare. Exceptions would be made for threats to human health and safety and those rare circumstances where the removal of an old tree is necessary in order to prevent additional habitat degradation