Forest Vegetation/Silviculture _____

Affected Environment

The Sugar Pine Adaptive Management Project area has a history of numerous past logging activities. Over the past 125 years several small lumber mills have been supplied with logs from conifer stands within and adjacent to the proposed project area. During the 1880s a lumber mill along California Creek within Nelder Grove processed giant sequoia trees from Nelder Grove. Other small mills in the vicinity of the project as well as larger mills in the Oakhurst area also processed trees from within the project boundaries. Between 1923 and 1927 heavy railroad clearcut logging was carried out by the Madera Sugar Pine Company. through much of the project area. Logs from railroad logged stands were transported to the mill at Sugar Pine over its 140 miles of track. The mill operated for 32 years averaging a 40 million board foot cut each year. Seven locomotives and 100 log hauling cars were in use during its peak.

During the railroad logging at the beginning of the last century, logs were yarded by a system of cable settings. Deep gouging occurred in a number of places where logs dug into the soil as they were yarded to landings. As logs approached landings, more soil was generally displaced. In many cases, this reduced soil depths to almost bare rock. Settings can often be distinguished by a lack of conifer reproduction and an abundance of brush still today. However, between cableways, existing reproduction was often protected from damage. Logging slash was not treated following harvest. Today, much of this early reproduction remains as stands of generally 90 to 110 year old 6 to 24 inch dbh incense cedar, sugar pine, ponderosa/Jeffrey pine, and white fir.

During the 1960s, a significant effort was made throughout California to reforest, previously forested areas that were understocked. Approximately 180 acres that were railroad logged within the proposed project boundaries were planted during this period.

Exclusion of fire from the vast majority of the area since the fires of the early 1900s resulted in the development of multi-layered stands. The understory layers consist of fir and incense cedar beneath young growth stands of ponderosa/Jeffrey pine, sugar pine, incense cedar, and white fir with, in some cases, an additional layer of brush beneath or adjacent. In pine plantations, incense cedar and white fir and /or brush have seeded in, thus creating significant fuel ladders.

Although pockets of older trees can be found scattered through the proposed project area, past railroad and other logging as well as stand replacing fires have resulted in little of the area being vegetated with trees older than 130 years. The natural stands proposed for thinning within the project area generally consist of approximately 90 to 110 year old trees that were young saplings during the railroad logging era. Due to the warmer and drier predominately west and south aspects within the project area, the majority of stands present are considered to be pine types. These stands, once heavy to more fire resistant ponderosa and sugar pine, have become very heavy to less fire resistant incense cedar and fir. Plot data indicates that in many areas incense cedar comprises 40 to 80 percent of the basal area sampled. Mixed conifer aggregations and stands occupy areas near cooler, damper draws and at the higher elevations within the project area. Pine, mixed conifer and white fir stand basal area stocking varies from 120 ft^2 per acre in more open areas to oak pockets to densely stocked pockets of 350 to 400 ft^2 per acre or more. Canopy cover varies substantially across the project area. Canopy cover ranges from quite dense (80 to 100%) in overstocked areas to clumpy dense patches in less uniformly stocked areas to more moderate (50 to 70%) to fairly light in other locations. A number of brushfields, resulting from previous fires and early 1900s logging, are broken up by clumps of live and black oak and are found throughout the project area.

Climatic Changes

Tree ring studies have established that compared to the previous two centuries weather during the 20th Century was relatively moist without the decades-long droughts that occurred earlier (Ferrell 1996). Beginning in the 1970s temperatures began to warm noticeably. This warming resulted in a greater fraction of the Sierra Nevada precipitation falling as rain rather than snow, earlier snowmelt and earlier streamflow peaks (Dettinger 2004). The combination of reduced stand vigor and excessive stocking combined with increasing temperatures and decreasing soil moisture availability is greatly increasing the threat of loss due to mortality from insect attack, diseases, competition, or fire.

The wetter than normal 20th Century coupled with the exclusion of fire has set the stage for stands to become overcrowded with competing conifers, oaks and other vegetation. Wide swings in climatic conditions over the past 30 years have placed stress on many of these stands. Inter-tree competition, drought, rising temperatures, and insect attacks are beginning to take a toll on both plantation and wild stand trees. White pine blister rust has also been killing a number of sugar pine over the past 10 to 15 years. Dead and down fuel loadings have been on the rise. These conditions are not unique to the Sugar Pine area. More extreme examples can be found in the Lake Tahoe Basin, San Bernardino National Forest and in Arizona and New Mexico where entire stands of trees are dieing. In southern California the amount of ponderosa pine mortality associated with western pine beetle, *D. brevicomis* Le Conte, infestations reached unprecedented levels after years of extended drought (Fettig 2007).

Recurrent droughts are characteristic of the Sierra Nevada climate. Summers are usually hot and dry, with the bulk of the precipitation occurring in winter, much of it as snow. But in addition to the dry summers, there have been droughts of 1 or more years in duration in every decade of this century. Increased mortality usually occurs first at the lower and middle elevations on both western and eastern slopes of the range and spreads to the upper elevations only if the drought is protracted. During droughts, lack of spring precipitation has a particularly large influence, not only by increasing the susceptibility of the trees, as indicated by their rates of growth and beetle-caused mortality, but also probably aiding dispersal of and host selection by the flying beetles. In the ponderosa pine type because of the relatively low elevation, water availability, not temperature, is the strongest factor limiting forest growth (Ferrell 1996).

As stated previously, beginning in the 1970s temperatures began to warm noticeably. Seasonal snowmelt and streamflow is projected to occur a month earlier during the current century. By the end of the 21st Century, 30 percent less water is anticipated to arrive in reservoirs between April and July. Soil moistures will dry out earlier and by summer be more severely depleted. Substantial changes in extreme temperature episodes (fewer frosts, more heat waves) are anticipated (Dettinger 2004). Over the past 17 to 29 years noncatastrophic mortality rates were found to have doubled over a series of 76 western forest plots. Increasing mortality rates could result in substantial changes in forest structure, composition, and function. This doubling of background mortality could cause a >50% reduction in average tree age in a forest, and a potential reduction in average tree size (van Mantgem 2009). Current projections of warming climates provide a greater opportunity for fire ignitions due to longer fire seasons. A higher probability of fire starts coupled with the changes in forest fuel conditions that occurred over the past century lead many to predict that large, generally more intense fires will become more likely than occurred historically (Skinner and Stephens 2004).

Desired Condition

The Sierra Nevada Forest Plan Amendment Record of Decision, 2004 (USDA-FS 2004) addressed the desired condition, management intent and management objectives for individual

land allocations. These were brought forward in the Fresno River Landscape Analysis (July 2005).

The Sugar Pine Adaptive Management Project boundary encompasses many different land allocations, some with specific desired conditions, i.e. spotted owl/goshawk/pacific fisher habitat and some with generalized desired conditions. In effect, all center on the need to restore both the structure and processes of old forest habitat ecosystems as a long-term strategy and with short-term goals of reducing the adverse effect of wildfire and reducing stand susceptibility to insects/pathogens, competition and drought-related tree mortality.

Density Management Measures

Basal Area Stocking Levels

Normal basal area stocking is considered to be that level at which mortality begins as additional growth takes place. Normal is generally described as basal area per acre and is the maximum amount of vegetation an acre can be adequately sustain over time. For a short period of time, basal areas in excess of normal can be maintained in some areas. A normal stand—or fully stocked stand—is a stand that, so far as any practical consideration is involved, utilizes its site completely. Maximum stocking is not implied; it practically never exists over a continuous area of more than a few acres (Meyer 1938). These normal stocking levels were calculated during the abnormally wet 20th Century and are most likely too dense to be maintained during the drier periods that are more likely the norm. Fairly recent studies have indicated that the exclusion of fire may have also resulted in normal basal area densities in excess of what would have been found during previous centuries.

Four different yield tables are being used to determine normal stocking within the project area:

- Yield of Even-aged Stands of Ponderosa Pine, Technical Bulletin No 630 (Meyer 1938).
- Preliminary Yield Table for Second-growth Stands in the California Pine Region, Technical Bulletin 354, Mixed Conifer (Dunning and Reineke 1933).
- Yield, Stand, and Volume Tables for White Fir in the California Pine Region, Bulletin 407 (Schumacher 1926).
- Growth Models for Ponderosa Pine: I. Yield of unthinned plantations in northern California, Research Paper, PSW-133 (Oliver and Powers 1978).

As stands approach 80 to 90 percent of normal stocking, growth rates begin to decline significantly, stand vigor begins to suffer, and susceptibility to insect and disease attacks and drought stress increases. To reduce growth losses, maintain more viable stands, and retain canopy covers less susceptible to crown fires, this entry would thin stands to stocking levels that with growth will result in reaching 80 percent of normal in 15 to 20 years when the next thinning entry would need to take place. Utilizing basal area to describe desired stocking automatically takes into account varying diameters of trees within stands. For a given basal area, more trees per acre are retained in the residual stand in areas with smaller diameter trees than in areas of larger trees. The silvicultural prescriptions for ponderosa pine, mixed conifer and fir will be described utilizing basal area per acre.

The desired condition for stocking levels and the measure used for comparison of alternatives is:

- Average basal area in pine, mixed conifer, and white fir grouped by lightly and heavily stocked aggregations
- Average potential basal area growth
- Basal area following thinning - ponderosa pine - 135 ft^2 per acre (50% normal)

- Basal area following thinning - mixed conifer - 210 ft^2 per acre (60% normal)
- Basal area following thinning - white fir - 240 ft^2 per acre (60% normal)

Stand Density

Another approach to stocking density management is Stand Density Index (SDI). This method compares stocking density to the maximum number of stems found by species which is substantially greater than that utilized for normal yield. Mortality studies completed in pine stands have been described using this density management approach rather than normal yield tables. Since SDI was used as a frame of reference for ponderosa pine in these studies, it will be used as well as basal area to describe the silvicultural prescriptions for pine stands. SDI studies have determined that the onset of competition between trees begins when stands reach 25 percent of SDI max. At 35 percent of SDI max the lower limit of full site occupancy and susceptibility to bark beetle attack begins, and at 60 percent SDI max is where the lower limit of self-thinning begins (normal stocking). Stands that approach SDI 365 usually suffer large losses from bark beetle epidemics—losses that equal or exceed periodic growth. The limiting SDI for ponderosa pine stands in northern California as defined by Dendroctonus bark beetles is 365 (45 percent of SDI max—approximately 200 ft^2 basal area). Studies have shown that the vigor of trees in a stand is related to their ability to quickly respond to thinning and their susceptibility to various pests. A live crown ratio of at least 40 percent has been cited for a number of conifers as representing a generally acceptable level of individual tree vigor. For several coniferous species, a live crown ratio of 40 percent seems to correspond with an SDI of about 50 percent of the maximum SDI for the species. Catastrophic (extremely high) tree mortality from bark beetles can be prevented by reducing stand density below 150 ft^2 per acre in basal area (33 percent of SDI max) (Long 1985). To ensure prompt response to thinning and minimize mortality, pine stands should be maintained between 30 and high of 50 percent of SDI max.

For this proposed project, forested stands would meet stocking (as measured by percent of normal for the given site) and the associated density levels (as measured by basal area for a given site) that would maintain or improve growth rates, would increase resistance to mortality agents (insects/pathogens/fire) and would provide the potential to begin the perpetuation of both the structure and processes of old forest habitat ecosystems. This desired condition incorporates both short and long-term goals, but is focused on the need for continued maintenance of stands that are healthy and sustainable.

The desired condition for Stand Density Index and the measure used for comparison of alternatives is:

- SDI - ponderosa pine 30 percent of SDI max (135 ft^2 per acre)

Methodology for Analysis

In determining the existing condition and analyzing the effects of the alternatives associated with the Sugar Pine Adaptive Management Project, many sources of information were utilized. These included aerial photography interpretation, field verification of stand conditions, cruise plot data validation, evaluation and summarization, California Wildlife Habitat Relationship site-specific vegetation type correction and verification, and experience in the implementation of similarly designed past projects. Scientific and research documentation was utilized to evaluate the potential effects of all alternatives and in determining the measures to be evaluated for meeting the purpose and need with regards to forest health.

The SNFPA 2004 describes the use of thinning from below as the primary silvicultural prescription to utilize in managing stand densities to provide resiliency and sustainability during drought conditions and climate variations. Stand density index and basal area (ft^2 per acre) are

used as common measures in determining the effects of management actions on coniferous stands. For retention of maximum growth and vigor, thinning entries should be timed to occur before growth rates in potential leave trees begin to slow. At this point, leave trees are still retaining substantial crown ratios and have the greatest potential for maximum growth. Thinning should be undertaken before crown ratios drop below 40 percent (Emmingham 1983) (Long 1985). As competition between trees increases, crown vigor decreases. A stand's ability to respond to thinning progressively declines the longer it remains in competition. Some stands proposed for treatment are currently at this maximum potential response level while others are beginning to decline and should have already been treated.

For this project stand density (number of stems per acre) as well as basal area (ft^2 per acre) is used to determine which stands/aggregations are considered overcrowded and in need of thinning (treatment area designation), at what stocking level the stand/aggregation needs to be (desired condition), the silvicultural prescription for each alternative and the associated short (immediate) and long-term (length of effectiveness of treatment) effects of design criteria (specifically those associated with old forest habitat dependent species), and the effects the standards and guidelines and land allocations have on meeting the purpose and need for forest health.

Alternative 1 – No Action

Direct Effects

With this alternative, no commercial, biomass or pre-commercial thinning would be accomplished. Understory incense cedar, white fir and brush cover would continue to increase in size and density. Fuel ladders and competition between trees would increase. Growth rates and vigor would continue to decline as stands, or portions of stands, continue to approach or exceed normal stocking. Understocked plantations would not be replanted.

Indirect and Cumulative Effects

Wide swings in climatic conditions as has been experienced over the past thirty years would continue to place increased stress on these untreated stands. Trees in overstocked and/or brush choked plantations would continue to experience increased competition. Mixed conifer and fir aggregations and stands with stocking levels approaching or exceeding normal would become increasingly susceptible to mortality. Excessive stand/aggregation densities in ponderosa pine stands would result in the likelihood of heavy mortality. Drought and insect induced mortality would escalate. Insect infestation centers would likely move onto private property and organizational camps. Snags and jack-strawed down material would increase. Basal area tree growth of only 15 to 20 ft^2 per acre would occur over a 15 to 20 year period (if excessive mortality does not occur) in more densely stocked aggregations. Forest health in the area would decline and elevate the risk of loss due to wildfire. Not only would the potential for loss of these stands to insect attack and drought increase, but their ability to respond to future thinning would continue to decline as crown vigor deteriorated as treatment was postponed. Experience has shown that even a course of no action is not without consequence (Fettig 2007). Doing nothing will result in forests that continue to deteriorate over time because wildfire today no longer operates in its historical fashion, that of frequent low-intensity surface fires (Fitzgerald 2005).

Fuel continuity would not be broken up. Brushfields and over stocked precommercial size conifer pockets would not be treated. The threat of fire moving into or out of population centers within the Wildland Urban Intermix (WUI) would increase, not decrease. Nelder Grove would remain highly susceptible to significant damage from fire. The threat of loss of wildlife habitat designated as Protected Activity Centers (PACs), Home Range Core Areas (HRCAs) and fisher den site buffers would increase. Agee (2005) concludes in his report that the No Action Alternative is not a risk-free option, as dry climates regularly predispose forests to burn in a

typical dry summer. He further states that the impacts of no action in dry forest ecosystems must recognize the likelihood of stand-replacing, intense fire where stand density has increased and dead fuel accumulated in excess of historical levels.

Alternative 2 – Proposed Action

Under Alternative 2, the development of Strategically Placed Area Treatments (SPLATs) would occur. Additional areas would be treated to provide a defensible fuels profile near key transportation corridors and within the defense zone of the wildland urban intermix. In addition to those treatments needed to meet fire and fuels objectives, treatments would be undertaken to reduce stand densities (basal area and/or pre-commercially thin) to a level that maintains or improves the growth and vigor of remaining trees. Treatments included in this alternative are: thinning from below in conifer stands (either precommercially, biomassing or commercially), and/or masticating excess vegetation (conifers and brush) to reduce lower, mid-level (intermediates and co-dominants) canopy stand densities; masticating brush and shrub patches; prescribed burning, both understory and piles; manually reducing and/or prescribed burning noxious weed infestations; and site preparing, planting and subsequently hand releasing failed conifer plantations.

As part of the proposed action, design criteria common to all alternatives have been incorporated and are part of the proposed action. As such, analysis of the direct, indirect and cumulative effects of the action alternative addresses not only the proposed action, but the effects of these design criteria as they relate to vegetation and silvicultural management in the project area.

Direct Effects

Commercial thinning needs to be undertaken in the approximately 90 to 110 year old young growth stands and pine plantations to reduce competition and provide room for crown expansion by removing the more poorly growing trees, excess trees, and fuel ladders from these stands before competition results in much additional reduction in growth, or competition, insect, disease or fire related mortality increases.

Studies have shown that active management through thinning is critical to maintaining healthy trees that are less susceptible to mountain pine beetle attack. A 1998 study assessed the effects of thinning from below (alone and in combination with prescribed burning) on tree growth, leaf physiology and several environmental factors in ponderosa pine on the Gus Pearson Natural Area in Arizona. Soil water content was greater in thinned treatments than in the unthinned control. Similar findings have been reported in northern Arizona and western Montana, and can be attributed to increased water availability resulting from decreased tree competition. Trees in thinned treatments had greater foliar nitrogen content, needle toughness and basal area increment. The results suggest that restoration treatments improved tree vigor, growth and decreased the likelihood of bark beetle attacks on individual trees. A similar study compared measures of tree susceptibility to bark beetle attack in thinned ponderosa pine plots in northern Arizona. Phloem thickness significantly increased with decreasing stand density. Duration of resin flow and 24 hr resin flow were significantly higher in thinned plots. Increases in these variables suggest improved host vigor and reduced likelihood of bark beetle attack. An increase in predawn xylem water potential, net photosynthetic rate, foliar nitrogen concentration and bud and needle size resulting in increasing foliar growth and uptake of water and nutrients was reported in similar stands. It has been noted that phloem thickness and basal area increment were lower in unmanaged stands than in managed. Studies have shown that thinning significantly reduced the amount of ponderosa pine mortality caused by mountain pine beetle in northeastern California (Fettig 2007). The largest increase in photosynthetic rate and predawn water potential increases due to thinning was found to be during periods of drought (Feeney 1998). Several studies have

shown that thinning from below not only reduces ladder fuels and the risk of torching, but by reducing stand density tree vigor is improved and risk to bark beetle attack reduced (Fitzgerald 2005). By reducing competition through thinning, mistletoe infected residual trees will experience increased height growth thus slowing the upwards spread of mistletoe into tree crowns (Ferrell 1996). By increasing tree vigor, diseased trees will be better able to withstand the effects of drought or insect attack.

This entry would commercially or biomass thin stands on slopes generally less than 35% outside of PACs, and Old Forest Linkages to stocking levels that, with current growth, would result in returning stands to 80 percent of normal basal area stocking 15 to 20 years following harvesting (Table 37 in Appendix D displays a sampled data comparison of existing to proposed action conditions for species composition, age, site, numbers and sizes of trees, basal area, crown closure, mean diameters and number of plots taken). Maintaining a stocking level that remains at 80 percent or less of full (normal) stocking will ensure a healthy rate of growth while retaining a level of stocking that will be better able to survive the lower levels of yearly precipitation that were common prior to the past century. Black oaks will be retained in treated stands longer by reducing competition and overtopping by nearby conifers. Treated stands would also be less susceptible to climatic fluctuations and longer summer dry spells which appears to be becoming more and more prevalent. Reentry in 15 to 20 years was chosen for several reasons: (1) reduce the number of entries into the stand, (2) increase the volume removed to make the entry more economically viable, (3) open the stand sufficiently to permit harvest operations with a minimum of damage to the residual stand, (4) treat the stand to a level where for a period of at least 10 years, fires except under the most extreme conditions, would remain as ground fires and not become crown fires as directed by the National Fire Plan, (5) retain canopy covers that meet or exceed those directed under the SNFPA 2004 while opening the canopy to maintain or improve growth and vigor over 15 to 20 years.

To obtain some benefits from thinning, while retaining species specific canopy cover levels following harvest, thinning in wild pine stands is proposed to generally reduce stocking to leave basal areas of around 150 to180 ft^2 per acre depending on age, site, and existing crown condition (55 to 60 percent of normal—32 to 40 percent SDI max). This entry will still result in the retention of basal areas substantially above the stand density index recommends for thinning (150 ft^2 should be in locations where leave trees have full crowns and 180 ft^2 per acre should be in areas with poorer crown leave trees, higher growing sites, older trees and in HRCAs). Normal stocking for this site and age is 270 to 290 ft^2 per acre. Portions of stands with larger diameter trees present will generally have fewer residual trees per acre than those with smaller diameter trees. Because this entry would retain a higher basal area than the desired condition, to maintain stand resiliency, the next thinning entry may need to take place at 10 to 15 years in these pine stands rather than the planned 15 to 20 as the more limited growing space becomes reoccupied.

Where diameter restrictions permit, young growth, approximately 90 to 110 year old, mixed conifer and white fir stands would be thinned to 55 to 65 percent of normal. Leave basal areas, depending on site index and age, would be around 210 ft^2 per acre (MC) and 240 ft^2 (WF). (Normal basal area stocking for 90 to 110 year old mixed conifer stands on similar sites ranges from 330 to 360 ft^2 per acre. Normal for White Fir ranges from 420 to 445 ft^2 per acre). Canopy covers that meet or exceed those directed under the Sierra Nevada Framework would be retained following treatment. To obtain maximum growth and reduce fuel ladders, 4 to 9 inch dbh trees not needed for stocking are planned to be removed with this entry within the treatment areas not designated as mastication or prescribed fire. Portions of a number of units include short, steep pitches to 50 percent. These can be harvested by directional felling and endlining logs to more gentle slopes where they can be skidded to landings. Except for mastication equipment, equipment use on these steeper slopes should be avoided.

Thinning to these target basal areas in these approximately 90 to 110 year old young growth stands should result in basal area increases of 70 to 80 ft^2 per acre over 15 to 20 years. If thinning did not occur, this increase in growth over the same time period would be 15 to 20 ft^2 per acre within the more heavily stocked aggregations if mortality does not occur.

Except where retained for wildlife purposes, suppressed, intermediate, damaged and diseased then finally co-dominant trees, in order of removal, would be harvested until the prescribed stocking level has been reached. This is known as thinning from below as directed in the 2004 ROD and recommended in the North, et al, 2009 paper. The poorest quality trees are removed first, leaving the best trees in the stand. Thinning from below retains the majority of the crown cover and generally the largest trees. Many small, poor crowned trees are removed during the operation. Some poorer crowned co-dominant trees are removed, as needed, to create openings on one or more sides of other co-dominant and dominant trees. These openings provide room for crown expansion of the residual trees. Without room for expansion, remaining tree crowns will become less vigorous resulting in reduced photosynthesis and declining growth. Removal of only intermediate and suppressed trees results in "little more than the salvage of trees which will inevitably die (Smith 1962)". Removal of some of the trees that compete for the limited water and soil nutrients will make more water and nutrients available for the remaining trees. Thinning also opens the stand's crown canopy, making more light available for the remaining trees. The increased water, nutrients, and light that result from thinning increase photosynthesis in the remaining trees. More food is produced making more carbohydrate available for new cell formation and growth. After competition begins and the stand develops all crown classes, removing only intermediate and suppressed trees may not significantly reduce the competition faced by the larger dominant and co-dominant trees. Suppressed trees, in particular do not compete significantly with larger trees. Intolerant species (pines) require nearly full sunlight to thrive and grow. A successful low thinning removes all suppressed, most intermediates, many co-dominants, and even some dominant trees (Emmingham 1983).

The effects of fuel treatments on tree based carbon storage are currently being studied. Healthy forests play an important role in carbon sequesterization. Studies indicate that "in wildfire-prone forests, tree-based C stocks were best protected by fuel treatments that produced a low-density stand structure dominated by large fire resistant pines (Hurteau 2009). Average stand diameters increase significantly following thinning as smaller diameter trees are removed in favor of retaining larger trees. Concentrating removal on the smaller diameter trees also reduces fuel ladders and susceptibility to fire loss as average residual diameters and fire resistance increases. Biomass and follow-up treatments to remove submerchantable trees and brush will further reduce stress on the remaining stand. Where choices exist, more fire resistant pines would be favored over fir and incense cedar as leave trees. In most areas, stand composition following treatment will consist of a greater percentage of more fire and drought resistant ponderosa and sugar pine as recommended in the North paper (2009). Although existing stand composition averages about 40 percent pine and sugar pine, 39 percent incense cedar, 15 percent white fir, and 6 percent oaks, it is estimated that 75 percent of the trees to be removed will be incense cedar, 10 percent will be white fir and 15 percent will be ponderosa and sugar pine. Thirty (30) inch harvest tree diameter limitations dictated by the SNFPA 2004 ROD will, in many areas, result in basal area retention levels in excess of proposed residual basal areas. In some cases in pockets of larger trees, no trees will be harvested. In these types of thinnings, the smaller size of the product to be removed makes harvest operations much more expensive than those where larger trees are removed.

Thinning to the proposed basal areas will result in increased diameter growth and crown expansion on the remaining trees as the residual trees respond to reduced competition. Since increased diameter growth will occur over fewer stems per acre, substantial increases in diameter will result. Repeated thinning will result in larger diameter, taller, healthier crowned trees over

much shorter time frames than in unthinned stands. Shade intolerant pines and oaks will be retained in a more vigorous condition as a result of more available sunlight due to reduced competition. As the diameters of the residual trees become larger, they will become better able to survive a fire should one occur. Thinning is an effective technique for creating stands that more closely represent those present prior to railroad and other extensive logging and the exclusion of fires during the 20th Century.

Biomass, hand and mastication thinning and release of natural stands/aggregations of conifers and plantation trees generally less than 10 inches dbh would be undertaken as part of this proposal. These thinned aggregations would occupy large and small openings surrounded by larger trees as described in the North paper (2009). Depending on tree size these stands would be thinned to around 150 to 200 leave trees per acre. Hand thinning slash concentrations would generally be tractor piled and piles burned. Slash concentrations on steeper slopes would generally be hand piled and burned. Areas of only light slash (10 to 20 tons per acre) would be lop and scattered to 18 inches. Stand hetrogenity would be maintained through retention of these precommercially thinned clumps as well as untreated clumps on steeper slopes, the more dense clumps of larger diameter trees, SMZs, archaeological sites, and the two to three untreated larger oaks per acre.

Some underburning is proposed as a fuels reduction and understory management treatment within the proposed project boundaries. Underburning should only be done in portions of those stands with larger, more fire resistant residual trees and fairly light slash concentrations. Where scattered heavy slash concentrations are present, some piling of slash may need to be done prior to underburning. Due to the location of much of the proposed underburning, it is anticipated that late fall and early winter (after wetting rains) as well as early spring underburning may be possible. Late spring burning should not be attempted due to the high susceptibility of new growth to heat damage. In most cases, areas that have been masticated should not be underburned. Brush seed requires heat scarification to germinate; underburning will only help germinate brush seed present in the soil. Since white leaf manzanita is a non-sprouting species, in those areas where large white leaf manzanita has been masticated below the lowest live limb, reestablishment of manzanita brushfields would mostly occur through germination of manzanita seed. The masticated mulch layer covering the ground will reduce soil temperatures which will assist in keeping brush seed dormant and reduce the likelihood of brushfield reestablishment. The fuels officer and silviculturist should field coordinate all areas to be underburned prior to undertaking underburning.

Indirect and Cumulative Effects

Within HRCAs (Home Range Core Areas) and Old Forest Linkages the aim as stated in the SNFPA 2004 is to retain 60 percent or greater canopy cover, where available. (The intent of the Sugar Pine project is to retain canopy cover of 60 percent or greater in CWHR 4 and 5 size classes where it presently exists.) Within those portions of Spotted Owl and Goshawk PACs (Protected Activity Centers) where thinning is proposed, the aim is to retain 70 percent or greater canopy cover, where available.

In addition to the denser canopy cover proposed for PACs and Old Forest Linkages, groups or patches of five or more larger trees, generally 30 inches and larger, are planned to be retained through the project area. These small groups will have residual basal areas of 240 ft^2 or more for mixed conifer and 210 ft^2 or more for pine and in many instances may reach 300 to 400 ft^2 per acre. Approximately 2 to 3 black oaks 20 inches dbh and larger per acre would also have a 35 foot buffer, measured from the bole, around them where no fuels treatment would occur.

Retention of these higher basal areas to provide a more dense canopy cover will result in not fully meeting the silvicultural objectives for maintaining or improving forest health. The impact will not be as great in mixed conifer and fir stands as it will be in pine. Retaining 60 percent or greater

basal area in pine stands leaves them at a level where stand density index studies have shown them to be susceptible to insect attack. Pine stands left at 70 percent or greater will remain at SDI max levels of 50 percent or greater (SDI 400 or more) and will be highly susceptible to insect attack. Oliver 1995, stated that a SDI 365 (200 ft^2 per acre), defines the threshold for a zone of imminent bark beetle mortality where pine stands suffer large losses from bark beetle epidemics. These losses can equal or exceed periodic growth. Subsequent growth of these stands will add further to the problem. Sufficient thinning will occur in some of the proposed scattered clumps to provide a short term benefit to stand vigor while in other clumps little, if any, thinning will occur resulting in a continued decline in clump vigor. Pine clumps left at these higher basal area retention levels will continue to be at a very high risk of loss due to insect, disease, competition, and/or drought induced mortality. A 2004 report found that plots infested by mountain pine beetle had significantly higher total basal area, ponderosa pine basal area, stem density and stand density index (Fettig 2007). Heavily stocked pine clumps attacked by insects have the potential to serve as infection centers for increased mortality in the surrounding pine stands as insect populations build and move into adjacent stands. To maintain more vigorous, drought and insect resistant stands, a shorter reentry period will be needed. The reentry time frame within HRCA, PAC, and Old Forest Linkage pine stands and these more heavily stocked clumps will likely be reduced by 5 or more years.

Since the vast majority of the crown covers and ground cover will remain in place following thinning operations, properly conducted thinning has only a minor short term affect on the environment. Leave trees will continue to contribute needles as well as small branches to the forest floor. Little soil movement and little, if any, increased runoff should occur as a result of this entry. Standard Streamside Management Zones will be maintained with any thinned trees being endlined out of the SMZs. Therefore, stream course stability will not be adversely affected. Long term affects will be to maintain or increase growth and vigor of treated stands, accelerate development of old forest characteristics in plantations, and improve the protection of human communities from wildland fires as well as minimize the spread of fires that might originate in urban areas, and reduce the threat of wildfire burning into and significantly damaging Nelder Grove. Over the past fourteen years, the district has planned and completed several projects, treating several thousand acres, similar to the proposed action. Canopy cover retention following harvest has met or exceeded expectations. Residual crowns have rapidly filled in openings created by harvest treatments.

In addition to the benefits obtained through density management several other benefits have been noted in treated stands. Several studies have shown that in addition to increasing residual tree vigor, increasing temperatures and windspeeds are common in recently thinned stands. This may accelerate development of certain bark beetle species and force them to overwinter in stages that are more susceptible to freezing or cause turbulences that disrupt pheromone plumes used for recruiting conspecifics during initial phases of host tree colonization (Fettig 2008). Moderate thinnings may result in less potential extreme fire behavior compared to unmanaged stands. Greater fuel depths, mid–flame wind speeds and lower fuel moistures in heavily treated stands (>60 percent basal area reduction) might increase potential fire behavior compared to unmanaged stands. Thinning followed by sufficient treatment of surface fuels usually outweighs changes in fire weather factors (wind speed and fuel moisture) resulting in an overall reduction in expected fire behavior (Jenkins, et al 2008). Thinning followed by tractor piling and burning or whole tree yarding have been shown to be effective in reducing fire severity under severe fire weather conditions. Thinning from below where the largest trees are retained within the stand contributed to increased fire resistance (Stephens 2009). Thinning makes fire suppression more efficient. Once heavy fuels are removed, the residence time (duration) of the fire is reduced, often resulting in a non-lethal surface fire (Fitzgerald 2005). The thinning proposed within the Sugar Pine project is designed to reduce existing basal area by generally 30 percent or less. Biomass and post sale

treatments are designed to remove fuel ladders as well as slash concentrations. This relatively light level of thinning should both realize the benefits of thinning stands to reduce the adverse effect of bark beetles while reducing expected potential fire behavior.

Alternative 3

This alternative is the same as Alternative 2 except that within the Fisher den buffer only fuel ladder removal and precommerical thinning will be undertaken.

Direct Effects

Except for the Fisher den buffer, the effects of thinning will be the same as described under Alternative 2. Within the Fisher den buffer (mostly involving treatment area T-4) very little to no density management will occur. Fuel ladder removal will be concentrated on suppressed and some intermediates. Few, if any, co-dominant trees would be removed. Table 40, Appendix D displays a sampled data comparison of existing to proposed action conditions for treatment area T-4, the predominant area affected by the Fisher den buffer. Except for some intermediate trees greater than 10 inches dbh with green crowns growing to within 10 feet of the ground, few trees greater than 10 inches dbh would be removed. It is estimated that within this buffer area only about 74 trees per acre would be removed instead of the proposed 159. One-hundred and forty-two (142) trees would remain instead of 57. A large percentage of these additional trees would be fire prone incense cedar. The average stand diameter within the buffer would increase only slightly. Of the existing 320 ft^2 of basal area sampled, 310 ft^2 would remain in the stand following treatment. This compares to 190 ft^2 that would be remaining under Alternative 2 (The prescribed leave basal area for this pine stand is 150 to 180 ft^2 per acre—normal stocking is 270 to 290 ft^2 per acre).

As stated previously, Smith (1962) stated that removal of only intermediate and suppressed trees results in “little more than the salvage of trees which will inevitably die”. Emmingham (1983) stated that a successful thinning from below requires the removal of many codominants as well as most intermediates and suppressed trees. Fuel ladder removal alone would not remove sufficient competition to meet density management objectives. Failure to remove some of the co-dominants and intermediates growing into the bottom portion of the co-dominant layer of the stand will not create openings in the canopy to provide room for crown expansion of the residual trees. Shade intolerant oaks and pines will not be able to benefit from increased light and rates of photosynthesis provided by openings created in the canopy cover.

Indirect and Cumulative Effects

Except for the Fisher den buffer, the indirect and cumulative effects of thinning will be the same as described under Alternative 2. The indirect and cumulative effects for density management for the Fisher den buffer will be the same as in the No Action Alternative. Post treatment stocking levels within the buffer would be too dense to withstand the stresses of drought and climatic variances within the Fisher den buffer.

Alternative 4

This alternative proposes to only remove fuel ladders and pre-commercially thin throughout the treatment areas.

Direct Effects

Very little to no density management would be accomplished with this alternative. Fuel ladder removal would be concentrated on suppressed and some intermediates. Few, if any, co-dominant trees would be removed. (Table 37 in Appendix D displays a sampled data comparison of existing

to proposed action conditions.) Except for some intermediate trees greater than 10 inches dbh with green crowns growing to within 10 feet of the ground, few trees greater than 10 inches dbh would be removed. Ninety (90) to 100 per cent of the existing basal area 5 inches dbh and larger would remain. Two to three times as many trees 5 inches dbh and larger would remain compared to Alternative 2. The percentage of fire prone incense cedar and fir would remain close to existing. The average stand diameter would increase only slightly. Shade intolerant pine and oaks would become less vigorous and continue to drop out of the stands. Post treatment stocking levels would be too dense to withstand the stresses of drought and climatic variances.

As stated previously, Smith (1962) stated that removal of only intermediate and suppressed trees results in "little more than the salvage of trees which will inevitably die". Emmingham (1983) stated that a successful thinning from below requires the removal of many co-dominants as well as most intermediates and suppressed trees. Fuel ladder removal alone does not remove sufficient competition to meet density management objectives. Failure to remove some of the co-dominants and intermediates growing into the bottom portion of the co-dominant layer of the stand will not create openings in the canopy to provide room for crown expansion of the residual trees. Shade intolerant oaks and pines will not be able to benefit from increased light and rates of photosynthesis provided by openings created in the canopy cover. This alternative does not meet the purpose and need for density management emphasized in the SNFPA, 2004 decision and being examined as a part of this project.

Indirect and Cumulative Effects

The indirect and cumulative effects for density management for this alternative will be the same as in the No Action Alternative. Post treatment stocking levels within the buffer would be too dense to withstand the stresses of drought and climatic variances.