TRESTLE FOREST HEALTH PROJECT

SILVICULTURAL REPORT

Tim Howard, January 3, 2014

Updated by Dana Walsh September 30, 2014

APPENDICIES

Appendix A – Description of silvicultural prescriptions

DEFINITIONS

These are common definitions used within this report. Included is the definition and any symbology that references the silvicultural term.

Diameter at Breast Height (DBH) – height at which tree diameter is normally measured specified as 4.5 feet above ground base of the tree on the uphill side.

Basal Area (BA) – the cross-sectional area of all stems in a stand measured at breast height (4.5 feet) and expressed per unit of land area, generally square feet per acre.

Stand Density Index (SDI) – the relationship between tree size and the number of trees per acre.

Stocking – an indication of growing space occupancy relative to a pre-established standard, such as basal area or trees per acre.

Quadratic Mean Diameter (QMD) – is the mean diameter of a tree with the mean basal area. This measurement quantifies the midpoint-diameter of the stand, taking into account the number of trees per acre and their respective diameters.

QMD = $\sqrt{\frac{\sum x^2}{n}}$

Shade-tolerance – Species that have a tolerance to shading by other species. Shade tolerant species will grow and regenerate under a stand's over-story.

California Wildlife Habitat Relationships (CWHR) – a system developed jointly by the California Department of Fish and Game that classifies forest stands by dominant species types, tree sizes and tree densities and rates the resulting classes in regard to habitat value for various wildlife species or guilds.

TABLE 1 CWHR CONIFER TREE SIZE AND CANOPY CLOSURE DEFINITIONS

Standards for Tree Size					Standards for Canopy Closure		
WHR	**Size Class**	**Conifer Crown Diameter**	**Hardwood Crown Diameter**	**DBH**	**WHR**	**WHR Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Tree	N/A	N/A	<1”	S	Sparse Cover	10-24%
2	Sapling Tree	N/A	<15’	1”-6”	P	Open Cover	25-39%
3	Pole Tree	<12’	15’-30’	6”-11”	M	Moderate Cover	40-59%
4	Small Tree	12’-24’	30’-45’	11”-24”	D	Dense Cover	60-100%
5	Medium/Large Tree	>24’	>45’	>24”			
6	Multi-layered Tree	Size class 5 trees over a distinct layer of size class 4 or 3 trees, total tree canopy exceeds 60% closure					

Plantation Classification - Timber strata classification to rank the average size of plantation trees

TABLE 2 PLANTATION SIZE CLASS DEFINITIONS

Size Class	Average Plantation Tree Sizes
0X	Seedling less than 4.5’ tall
1X	<1” d.b.h.
2X	1”-12” d.b.h.
3X	12”-23.9” d.b.h.

INTRODUCTON

The purpose of this report is to provide information about the vegetation resources, proposed treatment activities, silvicultural prescriptions, marking guidelines, and environmental consequences for the Trestle Forest Health Project EIS for the Alternatives analyzed in detail. The objectives of vegetation treatments are intended to meet the Purpose and Need for the Trestle Forest Health Project. Project activities include both commercial and non-commercial thinning, tractor piling, grapple piling, prescribed fire, road work, restoration of roads and dispersed use areas, trail reroutes, obliteration of non-system routes, mine closures, meadow enhancement activities, and relocation of fence posts.

The Trestle project area covers 20,463 acres (19,136 acres FS Lands and 1,325 acres of Other Ownership) located entirely in El Dorado County, California. The area is accessed from Grizzly Flat using the Capps Crossing Road (9N30) or the North South Road (10N83). The elevation ranges from 3,200 feet on the west side of the project area to 5,800 feet on the east side of the project area.

The landscape designations within the area are Wildland Urban Intermix (WUI) Defense Zone, WUI Threat Zone, California Spotted Owl Home Range Core Area, California Spotted Owl Protected Activity Center (PAC), Northern Goshawk PAC, and Great Grey Owl PAC.

ANALYSIS FRAMEWORK: STATUTE, REGULATORY ENVIRONMENT, FOREST PLAN AND OTHER DIRECTION

FOREST PLAN

Sierra Nevada Forest Plan Amendment: Final Supplemental Environmental Impact Statement Record of Decision: Forest-wide Standards & Guidelines (USDA Forest Service, 2004)

The Eldorado National Forest Land and Resource Management Plan (dated 1989) was amended in January, 2001 with the Sierra Nevada Forest Plan Amendment Record of Decision. In 2004, the Sierra Nevada Forest Plan Amendment Record of Decision, 2004 (SNFPA ROD, 2004) was signed by the Pacific Southwest Region Regional Forester and replaced the 2001 decision in its entirety. The SNFPA ROD, 2004 adopted an integrated strategy for vegetation management that is aggressive enough to reduce the risk of wildfire to communities in the WUI while modifying fire behavior over the broader landscape. Treatment of strategically placed areas on the Landscape (SPLATS) and WUI areas are priority areas for fuels treatments, but the strategy was broadened to include other management objectives such as reducing stand density for forest health, restoring and maintaining ecosystem structure and composition ((USDA Forest Service, 2004) pp. 2-3).

Eldorado National Forest Land Resource Management Plan (LRMP) (USDA Forest Service, 1989)

The Eldorado National Forest LRMP instructs the Forest to "Employ an integrated pest management program to minimize resource losses and to maintain or improve productivity by the coordinated application of the full range of techniques available to prevent damage, reduce pest populations when necessary, and create vegetative conditions that are least susceptible to damage. Coordinate with other federal and state agencies when appropriate. The Forest Plan recognizes that vegetation management would be the primary method of long term pest management.

NATIONAL FOREST MANAGEMENT ACT

The minimum specific management requirements for vegetation / timber management projects and activities that must be met in carrying out projects and activities for the National Forest System (NFS) are:

- Soil, slope, or other watershed conditions will not be irreversibly damaged.
- There is assurance that the lands can be adequately restocked within five years after final regeneration harvest (FSM 1921.12g).
- Streams, streambanks, shorelines, lakes, wetlands, and other bodies of water are protected from detrimental changes in water temperatures, blockages of water courses, and deposits

of sediment where harvests are likely to seriously and adversely affect water conditions or fish habitat.

- The harvesting system to be used is not selected primarily because it will give the greatest dollar return or the greatest unit output of timber.
- A Responsible Official may authorize projects and activities on NFS lands using cutting methods, such as clearcutting, seed tree cutting, shelterwood cutting, and other cuts designed to regenerate an even-aged stand of timber, only where:
    - For clearcutting, it is the optimum method; or where seed tree, shelterwood, and other cuts are determined to be appropriate to meeting the objectives and requirements of the relevant plan (16 U.S.C. 1604 (g)(3)(F)(i)).
    - The interdisciplinary review has been completed and the potential environmental, biological, aesthetic, engineering, and economic impacts have been assessed on each advertised sale area and the cutting methods are consistent with the multiple use of the general area (16 U.S.C. 1604 (g)(3)(F)(ii)).
    - Cut blocks, patches, or strips are shaped and blended to the extent practicable with the natural terrain (16 U.S.C. 1604 (g)(3)(F)(iii)).
    - Cuts are carried out according to the maximum size limit requirements for areas to be cut during one harvest operation (FSM 1921.12e).
    - Timber cuts are carried out in a manner consistent with the protection of soil, watershed, fish, wildlife, recreation, esthetic resources, cultural and historic resources, and the regeneration of timber resources.
    - Stands of trees are harvested according to requirements for culmination of mean annual increment of growth (16 U.S.C. 1604 (m); FSM 1921.12f; FSH 1909.12, ch. 60).

FOREST SERVICE POLICY DIRECTING VEGETATION MANAGEMENT ACTIVITIES

ECOLOGICAL RESTORATION (FSH 2020)

FSH 2020.3 – POLICY

The Forest Service policy on Ecological Restoration states that all resource management programs have a responsibility for ecological restoration including, but not limited to, management of vegetation, water, wildland fire, wildlife, and recreation. This policy directs the Forest to establish ecological restoration goals and objectives in strategic plans to maintain the adaptive capacity of ecosystems - recognizing uncertainty related to climate change. Identify opportunities to sustain ecological refugia that may serve as vital sources of ecological diversity. Develop goals and objectives within the framework defined by laws, Indian treaties, regulations, collaboratively developed public and Indian tribal values and desires, historical conditions, current and likely future ecological capabilities, a range of climate change projections, the best available scientific information, and technical and economic feasibility--to achieve desired conditions (FSM 1905) for National Forest System lands. Ecological restoration activities should be planned, implemented, monitored, and evaluated in consideration of current and desired conditions and the potential for future changes in environmental conditions, including climate change. Where appropriate, integrate resource management programs and projects to achieve complementary or synergistic results contributing to ecological restoration. Within existing authorities, revenue from commercial uses of natural resources may be used to help fund restoration activities.

SILVICULTURAL PRACTICES (FSH 2470)

2470.3 - POLICY

The policy on silvicultural practices directs the Forest to use only those silvicultural practices that are best suited to the land management objectives for the area while considering all resources, as directed in the forest plan. It also directs the silviculturist to prescribe treatments that are practical in terms of the cost of preparation, administration, transportation systems, and logging methods.

The policy on timber-stand improvement directs the Forest to base treatments on silvicultural prescriptions written to meet specific site and resource requirements (FSH 2476.03).

STAND EXAMINATION, DIAGNOSIS, AND ANALYSIS METHODS

Stand examinations, extensive walkthroughs, ID Team meetings, fieldtrips with the public and IDT members were conducted to determine the existing conditions to aid in making stand diagnosis and the development of the stand management objectives and finally the stand management prescriptions for each natural stand proposed for treatment.

STAND EXAMINATIONS

Stand exams were conducted in natural stands, commercial plantations, and non-commercial plantations. The natural stands were grouped and sampled based on the existing California Wildlife Habitat Relationships (CWHR) of each stand using the Eldorado NF "corporate" GIS coverage of existing vegetation from 2005. Stands with similar CWHR classification were grouped and sampled for description and analysis. Not all stands proposed for treatment were sampled. Two hundred variable radius and fixed plots were systematically located throughout the thirty-eight stands. Stand data attributes collected by diameter classes (4-9.9", 10-11.9", 12-19.9", 20-29.9", and 30 inches + dbh classes) include: number of trees per acre; basal area per acre; percent canopy cover per acre; species composition; snags and down logs per acre; stand density index; quadratic mean diameter; and, status of forest insects and pathogens.

The stand exam data was processed using the USFS Field Sampled Vegetation Database and Common Stand Exam program1. Extensive walkthroughs of the treatment areas (commercial harvest stands and plantations) were also conducted to further evaluate and validate stand conditions and appropriate silvicultural treatment options.

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[1] USDA Forest Service. 2012. *Common Stand Exam User's Guide*. Forest Service Natural Resource Information System: Field Sampled Vegetation.

Stand exams were designed to characterize the units where mechanical thinning treatments are proposed and not the landscape in general. Commercial thinning under Alternative 2 (which is the most extensive Alternative for commercial thinning) is proposed for less than 23% of the landscape area. While some areas outside of commercial thinning units are similar to the thin units, especially those that were not previously thinned as part of a CASPO project, many areas in this landscape have different characteristics than proposed thin units.

TABLE 3PERCENT OF LANDSCAPE SLOPE POSTION BY EXAMINATION AREA

Slope Position	Project Area	Commercial Thin Alt 2	Stand Exam
Canyon/Drainage Bottom	27%	14%	7%
Midslolpe NE <30%	9%	10%	12%
Midslolpe NE >30%	5%	4%	2%
Midslolpe SW <30%	22%	29%	37%
Midslolpe SW >30%	7%	5%	2%
Ridge	30%	38%	39%

While the Canyon/Drainage Bottom landscape position occupies almost a quarter of the area within the project landscape, proposed thinning treatments is represented by 14 percent of this slope potion and stand exams sampling included less than 10 percent of this area. Ridge top areas were a focal point for treatment compared to their proportion on the landscape and sampling design. This is consistent with recommendation in GTR 220 and 237 to focus reducing stand density and ladder fuels more on ridgetops and south slopes where there is less capability of carrying excess material into the future while focusing retention on areas with higher site capability to support late seral forest conditions. However, as Canyon/Drainage Bottom have higher capability of supporting late seral conditions these areas typically have higher snag densities, greater abundance of large trees, and additional down wood compared to other slope positions which are not represented in proportion by stand exams.

TABLE 4 PERCENT OF CWHR SIZE CLASS BY EXAMINATION AREA

CWHR Size	Project Area	Alt 2	Stand Exam
1	0%	0%	1%
2	5%	6%	2%
3	9%	7%	6%
4	59%	73%	84%
5	23%	13%	7%
Blank	4%	2%	1%

Likewise, while CWHR size class 4 , primarily density class D represents less than 60% of the project area, commercial thinning treatments are composed of nearly three-quarters of this size class, and stand exams were almost entirely located in size class 4 stands (mainly density class D). Meanwhile, CWHR 5D stands represent almost a quarter of the project area, just over 10% of commercial thinning areas are characterized as 5D and less than 10% of the sampled. CWHR 5D areas are avoided for treatment where possible in accordance with the Forest Plan, so it is not surprising that these areas would not make up a substantial portion of the proposed commercial treatment areas, however, as these areas typically are those with late seral structure (abundant snags, large down logs, and large trees in general) these structures on the landscape are under represented by stand exams.

MODELING

The Forest Vegetation Simulator Growth and Yield Model (FVS)2, version 2.03 (revised 11/20/13) was used to portray and provide information of the existing condition and aid in analyzing and predicting the immediate, short and long-term effects of the Alternatives for selected vegetation attributes on commercial treatment units. FVS is a distant-independent individual tree growth and yield model. FVS treats a stand as the population unit and utilizes stand examination data. Changes and trends of attributes were analyzed in the following years: 2013 (inventory), 2016 (immediate effects), and 2026 (short-term effects).

TABLE 5 FVS MODELING CRITERIA FOR THE ALTERNATIVES

Alternative	FVS Treatment	Notes	Timing
Alternative 2	Thin Basal Area	Thin to a residual basal area of 0 between 10.0 and 29.9 inches with a cutting efficiency of 25%	2015
	Thin Basal Area	1.0 to 9.9 inches with a cutting efficiency of 90 percent	2015
Alternative 3	Thin Basal Area	1.0 to 9.9 inches with a cutting efficiency of 90 percent	2015
Alternative 4	Same as Proposed Action		
Alternative 5	Same as Proposed Action		

Changes resulting from hand thinning and prescribe fire only treatments were not modeled since treatment efforts in those units will be primarily focused on reducing surface fuels. There is potential for some reduction in small trees per acre and a potential that some snags could be created thereby reducing canopy cover slightly in some treatment units however, these results are not expected to be consistent across treatment areas.

ASSUMPTIONS

There are basic assumptions associated with modeling silvicultural prescriptions and stand growth. It is important to understand that parameters describing stand conditions and the underlying

[2] USDA Forest Service. 2003, Revised 2006. *Essential FVS: A User's Guide to the Forest Vegetation Simulator*. Gary E. Dixon. Forest Management Service Center, Fort Collins, CO.

growth of stands are outcomes of an empirical growth model (FVS). These outcomes are statistical in nature and are an attempt to represent future stand conditions over time. Outputs from the modeling represent an average of "what" might occur over time and interpretation should consider the modeling a tool in understanding ecological processes. The output data reflects silvicultural assumptions (model's underlying equations) and the variability in the input data. There are inherent uncertainties in the use of these models, especially for projections that are more than a couple of decades into the future. The plot based nature of these models requires that for interpretation, they should only be considered to present an average growth condition (e.g. average expected values per acre or per unit time, rather than actual predicted conditions). Future actual growth and mortality of vegetation is affected by dynamic and stochastic events that cannot be accurately modeled but are instead represented by user presupposed assumptions. Nonetheless, for analysis, the use of these models represents the relative difference between alternatives and a generalized expectation for future conditions.

Assumption 1: The collected inventory plot data (Common Stand Exam (CSE)) statistically represents the current "average" stand condition by vegetative type in the treatment stands. Therefore stands that were sampled as part of the stratified sample and later dropped from the proposed action are still modeled for treatment, since they were selected to represent other stands that are still proposed for treatments based on vegetation, size class and density.

Assumption 2: The FVS model and the underlying equations of the Western Sierra Nevada variant statistically represent future tree/stand growth and mortality. The model's output of stand conditions provides a statistically non-biased representation of silvicultural activities and stand conditions over time.

Assumption 3: Immediate effects are those that would occur at the end of the first year. Short-term effects are assumed to occur at the end of 5-years and long-term effects at the end of an additional 10-years. For purposes of discussion, the long-term effects assume no other activities would occur in the planning area during the 10-year planning period. Although it is unlikely that the entire project would be implemented in this time frame, for the commercial thinning that is included as part of the proposal it does help to highlight changes in the vegetation that allow alternative comparisons to be made.

FOREST VEGETATION INDICATORS

Indicators are used to compare the differences in effects to forest vegetation from the alternatives.

INDICATOR MEASURE 1: STAND STRUCTURE

Measures: Basal Area (BA), TPA, Diameter Distributions, Canopy Cover, Canopy Bulk Density, Canopy Base Height, Understory Characteristics, Snags and Down Logs

Methodology: Stand structure is assessed by analysis of stand tables, and FVS output tables. This assessment either looks at a direct numerical record, or as a ratio/percentage of the total.

Spatial Boundary: The project area and the treatment units would be the assessment levels of this indicator.

INDICATOR MEASURE 2: STAND VIGOR AND GROWTH

Measures: Competition for resources and risk of tree mortality (stand density index (SDI) and Basal Area), Tree Growth

Methodology: Stand density is the measurement of tree spacing within a stand. This can be measured in square feet of basal area, or as an index of stocking, SDI. These measures describe stand stocking and allow the evaluation of stand conditions the Forest is managing for specific goals and objectives.

Stand density is an indicator of forest health when viewed over the landscape. A variety of stand densities are required to maintain biological diversity over the landscape. The general concerns addressed in this analysis are density as it relates to canopy cover, density as it relates to susceptibility to damage from wildfire, and insect infestations. Three measures of density were utilized to analyze the effects as a result of implementing the alternatives; (1) Square feet of basal area per acre is used because it is easily measured in the field, and is commonly referenced as an indicator of density, (2) Percentage of canopy closure is more difficult to measure but is widely used in determining wildlife habitat capability, and (3) Stand density index (SDI) is used because it is easily measured in the field and the advantage of using a base or index to relate stands to each other.

Basal area per acre, the cross sectional area of trees measured 4.5 feet above the ground, can be used as an indicator of stand density. From the onset of intertree competition in a stand, trees on sites with similar productivity are subject to increased moisture stress as basal area increases. As moisture stress increases, stands become more susceptible to the effects, including mortality, of disease and insect attacks. The effects of moisture stress often show up during a year, or during several years, of extended drought.

Stand Density Index can be used as an indicator of stand density and potential risk of insect attack. It is applicable regardless of site class or age. SDI can be compared to a maximum stand density index. Stands which are rated at 55% of the maximum SDI or above are considered to be imminently susceptible to insect attack due to inter-tree competition. This does not mean that an attack will happen; only that it is likely. At the lower end (55%) would indicate a high likelihood of mortality concentrated in the lower crown classes and the more shade-intolerant species. At higher densities, mortality would be expected across all size classes (Bakke, 1997)[3]. However, even some stands at lower densities can be subject to insect attack due to intertree competition.

Each species has a specific upper limit in which it can survive that depends on site characteristics and species life history. Maximum SDI for desired species as incorporated in the FVS western Sierra Nevada variant are: 571 for ponderosa pine and Jeffery pine, 647 for sugar pine, 547 for Douglas-fir, 382 for California black oak, 759 for white fir, 800 for red fir, and 706 for incense cedar. Oliver (1995)[4] however showed that for relatively pure ponderosa pine stands, stand density is held at a

[3] Bakke, D. 1997. Definition of Imminent Susceptibility to Insect Attack as Applied to Stands within the Eldorado NF. Placerville, CA: Eldorado National Forest, Pacific Southwest Region, Forest Service, U.S. Department of Agriculture.

[4] Oliver, W. 1995. Is self-thinning in ponderosa pine ruled by Dendroctonus bark beetles. . Forest health through silviculture proceedings of the 1995 National Silviculture Workshop, Mescalero, New Mexico,

limiting density of 365 by Dendroctonus bark beetles with mortality increasing above a SDI of 280 (60% of this limiting density), thus placing plantation stands at risk of high levels of insect mortality at lower levels than modeled in this analysis. While each species has its own limiting and maximum SDI, because one of the objectives of the project is to restore species composition of oak and pines, discussions of SDI are primarily focused on the SDI for Ponderosa Pine using the FVS defaults.

Spatial Boundary: The project area and the treatment units would be the assessment levels of this indicator.

INDICATOR MEASURE 3: SPECIES COMPOSITION

Measure: Trees per Acre of Each Species, Basal Area per Acre of Each Species

Methodology: Species composition is generally determined through a numerical assessment using trees per acre (TPA) or basal area. This assessment either looks at a direct numerical record, or as a ratio/percentage of the total.

Spatial Boundary: The project area and the treatment units would be the assessment levels of this indicator.

CUMULATIVE EFFECTS ANALYSIS

Methodology: In order to understand the contribution of past actions to the cumulative effects of the Proposed Action and alternatives, this analysis relies on current environmental conditions as a proxy for the impacts of past actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. There are several reasons for not taking this approach. First, a catalog and analysis of all past actions would be impractical to compile and unduly costly to obtain. Current conditions have been impacted by innumerable actions over the last century (and beyond), and trying to isolate the individual actions that continue to have residual impacts would be nearly impossible. Second, providing the details of past actions on an individual basis would not be useful to predict the cumulative effects of the proposed action or alternatives. In fact, focusing on individual actions would be less accurate than looking at existing conditions, because there is limited information on the environmental impacts of individual past actions, and one cannot reasonably identify each and every action over the last century that has contributed to current conditions. Additionally, focusing on the impacts of past human actions risks ignores the important residual effects of past natural events, which may contribute to cumulative effects just as much as human actions. By looking at current conditions, we are sure to capture all the residual effects of past human actions and natural events, regardless of which particular action or event contributed those effects. Third, public scoping for this project did not identify any public interest or need for detailed information on individual past actions. Finally, the Council on Environmental

May 8-11, 1995 / National Silviculture Workshop. (pp. 213-218). Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Quality issued an interpretive memorandum on June 24, 2005 regarding analysis of past actions, which states, "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions."

The cumulative effects analysis method is consistent with Forest Service National Environmental Policy Act (NEPA) Regulations (36 CFR 220.4(f)) (July 24, 2008), which state, in part:

"CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions. Once the agency has identified those present effects of past actions that warrant consideration, the agency assesses the extent that the effects of the proposal for agency action or its alternatives will add to, modify, or mitigate those effects. The final analysis documents an agency assessment of the cumulative effects of the actions considered (including past, present, and reasonable foreseeable future actions) on the affected environment. With respect to past actions, during the scoping process and subsequent preparation of the analysis, the agency must determine what information regarding past actions is useful and relevant to the required analysis of cumulative effects. Cataloging past actions and specific information about the direct and indirect effects of their design and implementation could in some contexts be useful to predict the cumulative effects of the proposal. The CEQ regulations, however, do not require agencies to catalogue or exhaustively list and analyze all individual past actions. Simply because information about past actions may be available or obtained with reasonable effort does not mean that it is relevant and necessary to inform decision making. (40 CFR 1508.7)"

Spatial Boundary: The project planning area and the treatment units would be the assessment levels of this indicator.

PRESCRIPTION DEVELOPMENT

Prescriptions for individual treatment areas and treatment types were developed to meet the project objectives. Prescriptions were developed to accomplish management objectives described in the purpose and need for the project and to incorporate design criteria described developed for the project. Prescriptions were developed through stand review during layout, stand exam information, and input from resource specialists.

Within 2004 Sierra Nevada Framework guidelines, silvicultural prescriptions have been designed to incorporate recommendations and concepts from PSW-GTR-220[5] and 237[6], such as using topographic variables (slope shape, aspect, and slope position) for varying residual stand densities and focusing on retaining tree species that are fire resistant and important to wildlife such as pine and oak. Silvicultural prescriptions would be designed to meet the following goals:

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[5] North, M., P. Stine, K. O'Hara, W. Zielinski, and S. Stephens 2009. An ecosystem management strategy for Sierran mixed-conifer forests. Gen. Tech. Rep. PSW-GTR-220. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific South West Research Station.

[6] North, M. (editor). 2012. Managing Sierra Nevada Forests. USDA Forest Service General Technical Report PSW-GTR237.

- Reduce shading around oaks to improve growing conditions
- Increase the percentage of shade intolerant pine and hardwoods
- Retain clumps of large trees
- Retain large trees with defects such as rot, cavities, and multiple tops
- Improve forest resiliency by reducing stand densities by thinning
- Manage the intermediate size class (20 to 30 inch DBH), thinning this class primarily by species (shade tolerant), growth form (those acting as ladder fuels), and topography (middle to upper slopes)
- Increase stand variability
- Increase understory light conditions for shrub establishment

To achieve desired outcomes silvicultural prescriptions are further described in Appendix A.

EXISTING CONDITIONS

The principle forest cover types found in the project area are Sierra Nevada Mixed Conifer and Ponderosa Pine. The major species mixed in this forest cover type are white fir, Douglas fir, ponderosa pine, Jeffrey pine, sugar pine, incense cedar, and oaks. In a large proportion of the project area, stands are dominated by an understory that is dominated by dense, shade tolerant white fir and incense cedar samplings and small trees. Some areas have been thinned in the past and understories are less dense, but maintenance of stand understory and overstory is needed to continue to achieve desired fuels and density conditions. Within the project area there are also areas of brush species including choke cherry, green leaf manzanita, deer brush, bear clover, and whitethorn. The average age of the dominant trees within the natural stands in the project area is generally around 130 years, and an understory which is about 30-80 years of age. Scattered across the project area are large conifers, primarily Douglas fir, sugar pine, and ponderosa pine, that exceed 300-400 years of age.

TABLE 6 VEGETATION COVER TYPES WITHIN THE PROJECT AREA

Wildlife Habitat Relationship Type	Acres
Agricultural	116
Barren	6
Mixed Chaparral	224
Montane Chaparral	368
Montane Hardwood Conifer	375
Mixed Hardwood	164
Perennial Grassland	154
Ponderosa Pine	2736

Sierra Mixed Conifer	16277
Urban	10
White Fir	9
Wet Meadow	24
Grand Total	20463

The existing plantations within the Trestle area were planted primarily with ponderosa pine. Plantations established during the early 1960s, 1980s, and 1990s have a low to high component of competing brush species (whiteleaf manzanita, bitter cherry, deerbrush, white-thorn, and natural regeneration of shade tolerant conifers (incense cedar and white fir). Based upon existing stocking levels and stand densities of conifer plantations within the project area, inter-tree competition is extremely high with a relatively moderate risk of insect epidemics coupled with low growth rates of individual trees.

Historically, at the lowest elevations or higher up on the drier south or west aspects and ridges within the project area, fires were generally frequent, ranging from fire return intervals of 5 to 15 years, with individual sites sometimes burning two years in succession. Current vegetative conditions in the Trestle project area differ markedly from the historic condition and most of the current stands exceed the historical range of variability in terms of ecosystem structure and process. Multiple decades of fire exclusion, grazing by domestic livestock, and logging have altered fire regimes, fuel loadings, and vegetation composition and structure (Miller et al, 2009)[7] (Bouldin, 1999)[8] (Beesly, 1996)[9] (McKelvey, 1992)[10]. Unhealthy conditions are indicated by increased densities of trees which results in elevated levels of insect-related tree mortality, and an accumulation of ground and ladder fuels within the project area.

Dense, closed canopied forests tend to favor shade tolerant white fir and incense-cedar, and to exclude shade intolerant ponderosa pine, oak, and sugar pine. The shade tolerant species generally are more susceptible to mortality from fire, and form dense understory thickets, which act as fuel ladders to the larger, overstory trees. Dense stands demand more water and other limited resources and, as a result, over-dense stands are less resistant to insect and disease-related attack, especially during periods of extended drought. The structure of the current forested landscape represents an unstable, unsustainable, and therefore, undesirable departure from the historic landscape for this area.

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[7] Miller, J. H., H.D. Safford, m. Crimmins, and A.E. Thode. 2009. Quantitative Evidence for Increasing Forest Fire Severity in the Sierra Nevada and Southern Cascade Mountains, California and Nevada, USA. Ecosystems.

[8] Bouldin, J. 1999. Twentieth Century Changes in Forest of the Sierra Nevada Mountains. Dissertation. Davis: University of California.

[9] Beesly, D. 1996. Reconstructing the Landscape: An Environmental History. 1820-1960. In S. N. Congress, Vol. II Assessments and Scientific Basis For Management Options. Davis: University of California, Centers for Water and Wildland Resources.

[10] McKelvey, K. A., and J.D. Johnston 1992. Historical Perspectives on Forests of the Sierra Nevada and the Transverse Ranges of Southern California: Forest Conditions at the Turn of the Century. USDA Forest Service Gen. Tech Rep. PSW-GTR-133 , pp 225-246.

Key observations regarding insect and disease in the project area are: 1) Throughout the project area, white fir of all age classes were found to have moderate levels of white fir dwarf mistletoe (*Arceuthobium abietium*) infection in association with Cytospora cankers (*Cytospora abietis*). 2) Overstocking, vegetation density, and pole-sized (10 inch d.b.h. and larger) trees within Jeffrey and ponderosa pine plantations combine to increase the risk of Jeffrey pine beetle (*Dendroctonus jeffreyi*), western pine beetle (*Dendroctonus brevicomis*), and pine engraver beetle (*Ips* species) related mortality. 3) The pathogen *Heterobasidion occidentale (*aka *H. annosum "*S" type*)* is present, but only in a nominal amount. *Heterobasidion irregular* (aka *H. annosum* "P" type) has not been discovered in ponderosa pines in the Trestle project area.

ENVIRONMENTAL CONSEQUENCES

This section discloses the environmental impacts of implementing the proposed action, no action, and other action alternatives. The consequences are organized by resource element under each alternative.

Environmental effects can be direct, indirect or cumulative. Effects might be adverse or beneficial, actual or potential, ineffectual, short-term or long-term, unavoidable, irreversible, or might conflict with the plans of other agencies. The following discussion describes these effects in three categories: ***direct effects*** or those occurring at the same time and place as the triggering action; ***indirect effects***, or those occurring at a later time or distance from the triggering action; and ***cumulative effects***, which includes an assessment of past actions and present actions coupled with the proposed action and any reasonably foreseeable actions in the cumulative effects analysis area for each affect resource in the future.

IMPACTS OF FOREST ACCESS AND TRANSPORTATION MANAGEMENT, HAND THINNING, PRESCRIBED FIRE, DISPERSED RECREATION AND OHV MANAGEMENT ACTIVITIES

Impacts of these activities were not analyzed in depth because of the minor effects that would occur on forest health and growth from this activity. Roads and trails present the most profound impact on vegetation as activities completely remove vegetation and retard or completely prevent reestablishment depending on surfacing, however, the small amount of transportation activities proposed in this project compared with the land area would have negligible impact on the overall forest health and growth of the forest within the Trestle Project. Decommissioning roads and areas would not alter any vegetation, but would encourage reforestation of non-forested acres. Over time vegetation would encroach and establish within the old road profiles. Road construction and reconstruction would remove all forest vegetation within the road prism, however the total area proposed for these activities is a very small percentage of the total acres being treated through other activities, and therefore a very low impact on the forest vegetation overall.

Burn only units may experience loss of some desired residual trees if trees are damaged during burn activities as stand densities of residual trees would remain higher and trees are more stressed from competition for resources. However, cooler burn prescriptions in these burn only units are expected minimize damage to residual trees and reduce this risk. Additionally, thinning of trees with piling of thinned material has some increased risk for residual stands in the short-term as beetles have the potential to use thinned material for a brood source until this material dries. Depending on the season of cutting, beetles may spread from piled material into neighboring residual trees, however attacks resulting from insects that use piles as a brood source is not expected to occur at a level that compromises achievement of management goals.

ALTERNATIVE 1

No activities would be undertaken in this alternative. Implementation of the No Action Alternative would not contribute to the attainment of the Desired Condition for vegetative resources in the project.

Direct effects from project-related activities would not occur. Therefore, in the discussion that follows, only indirect and cumulative effects are presented. The effects of an inevitable fire are described as an indirect effect, and because there are an infinite number of wildfire scenarios, the discussion presented is of a general nature.

Effects are described under the following subheadings: timber resources; stand density and basal area; quadratic mean diameter; species composition; hardwoods snags and down logs; canopy cover, and plantation management. Values displayed in tables are based on FVS modeling.

GENERAL OVERVIEW

Plant community composition and structure would remain unaltered, except by the processes of succession or catastrophic events.

Short-term effects of this Alternative would be displayed as continued moderate levels of tree mortality in all size classes and all species diseases, mechanical damage, tree age, or insects. A great number of understory trees would continue to survive, although their growth rates would be extremely slow. There would be no major shifts in tree species or stand growth. Some individual trees that are in dominant crown positions would continue to grow well. However, insect and disease mortality would continue to take tolls on the trees with low vigor and experiencing inter-tree competition, even if they are in dominant or co-dominant positions. Canopy bulk densities and canopy base heights would not change significantly.

Long-term effects of this alternative would be evidenced by stands wherein the number of suppressed shade intolerant trees have diminished substantially because of natural mortality caused by inter-tree competition of light demanding ponderosa pine and sugar pine trees and limited soil moisture. The number of shade tolerant trees (incense cedar, white fir and Douglas-fir) in the understory is expected to continue to increase into the future. The over-story and mid-story would experience substantial amounts of natural thinning in all species, while the ingrowth of cedar and fir move to dominate the main canopy.

The forest floor would generally be absent of natural regeneration because of heavy fuels and a deep duff layer, except in those areas where windthrow or insect or diseased-caused tree mortality had sufficiently opened the stand to allow for regeneration of conifer and hardwoods species.

Diameter and height growth would vary greatly in the stand and be largely dependent upon crown position of the tree. The understory trees would experience a substantial decrease in diameter and height growth due to competition for natural resources by the over-story and mid-storied trees. The overstory and mid-storied trees would experience only nominal change is diameter and height growth. Basal area growth would be nominal in the understory and smaller diameter classes; while in the overstory and mid-storied trees basal area growth would minimal causing the stand basal area growth to be low.

STAND DENSITY AND BASAL AREA

There would be short and long-term effects of the trees per acre in various diameter classes and in basal area per acre within the treatment areas as displayed in the table below. In the short-term, numbers of trees per acre is expected to decrease due to density dependent mortality. In the long-term, number of trees per acre in the larger diameter classes is expected to continue decreasing, primarily due to density dependent mortality. This analysis does not display regeneration and ingrowth that is likely to occur and increase the number of small trees per acre in the smaller diameter classes. Therefore while the number of trees per acre in the smaller diameter classes and correspondently the total number of trees per acre, this is likely not an accurate representation.

TABLE 7 ALTERNATIVE 1 – TREES PER ACRE BY DIAMETER CLASS OVER TIME.

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	64	12	33	24	12	145
2016	51	21	32	23	12	139
2026	33	20	31	23	14	122

TABLE 8 ALTERNATIVE 1 –BASAL AREA PER ACRE (SQUARE FEET PER ACRE) BY DIAMETER CLASS OVER TIME.

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	20	7	41	73	92	233
2016	15	13	42	74	94	237
2026	10	14	43	77	110	253

As displayed in the table above basal areas/acre is expected to increase in the short and long term.

QUADRATIC MEAN DIAMETER

Quadratic mean diameter (QMD) is expected to be constant in the short term and increase slightly in the long-term as displayed in the table below.

TABLE 9 ALTERNATIVE 1 –CHANGE IN QUADRATIC MEAN DIAMETER OVER TIME

DBH Class Year	Total
2013	18
2016	18
2026	20

SPECIES COMPOSITION

The effects of the Alternative 1 on the species composition within the treatment areas are displayed in the table below. During the analysis timeframe changes to species composition are not expected to be evident.

TABLE 10 ALTERNATIVE 1 – PERCENT (%) SPECIES COMPOSITION (TREE PER ACRE BY SPECIES OVER TIME

Year	PP/JP	SP	WF/RF	DF	IC	OAK	TOTAL
2013	28	6	18	11	31	6	100
2016	28	6	18	11	31	6	100
2026	28	6	18	11	31	6	100

PP - Ponderosa Pine, JP – Jeffrey Pine, SP – Sugar Pine, WF – White Fir, RF – Red Fir, DF – Douglas Fir, IC – Incense Cedar, Oak – Black Oak.

Hardwood species (Oak species) would continue to occupy the area at present growth rates caused by competition for light and soil resources. Even with continued mortality caused by insects, diseases, and droughts, white fir, red fir, and incense cedar would continue to be the dominant tree species within the proposed treatment areas.

In addition, the accumulation of increased duff layers would also preclude the species from seed regeneration, however, vegetative root crown sprouting would continue at nominal levels.

STANDING DEAD TREES AND DOWN LOGS

Stand exams in 2012 and 2013 showed stands proposed for commercial thinning containing approximately 3 dead trees per acre greater than 15 inches d.b.h. an average diameter of 25 inches and about 60 feet tall. Snags range in size from 15 - 88 inches dbh with heights ranging from about 50 feet to 170 feet. Dead trees are mostly white fir and nominal amounts of sugar pine and ponderosa pine snags in various stages of decomposition, from recent dead to buckskin hard snags. More numerous snag numbers were observed in drainages and lower slopes outside of the proposed thinning units, which are primarily located on ridge top and south slopes. Additional mortality from insects, likely associated with the prolonged drought has been observed to increase in 2014 in these stands and in areas adjacent to stands to the extent that there are likely few areas with less than 4 snags per acre greater than 15 inches d.b.h.

Within the stands, exams show that there is an average of 42 logs (>12 inches and 10 feet long) per acre with an average diameter of diameter of 22 inches and an average length of 32 feet.

Stand dead trees 12 inches d.b.h. and larger would slightly increase, primarily due to mortality caused by insect and diseases. Down logs 12 inches in diameter and larger would only slightly increase due to normal snag fall. The recruitment rate of dead trees and down logs would continue to be dependent upon the interplay of precipitation levels, stand density and other natural elements, such as the incidence of insect attack, natural mortality, and amounts of windthrow.

Indirect Effects: Short-term and long-term indirect effects on snag and down logs numbers would occur. A catastrophic fire would create additional new snags and down logs while consuming existing snags and down logs.

Additional long-term effects would be likely, but difficult to predict. The general upward trend in snags and down logs would continue until conditions suitable for tree growth improve. This change could occur with increased rainfall levels or less competition for the available moisture.

CANOPY COVER

In the short and long term, there would be only nominal changes in the percent of canopy cover as a result of taking no action. Short and long-term effects of taking no action are displayed below.

TABLE 11 ALTERNATIVE 1 – CHANGE IN CANOPY COVER (%) BY DIAMETER CLASS OVER TIME

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	12	4	17	22	25	80
2016	9	6	17	22	25	79
2026	7	6	17	22	28	80

STAND DENSITY INDEX

In the short and long term, there would be only nominal changes in SDI as a result of taking no action. Short and long-term effects of taking no action are displayed below.

TABLE 12 ALTERNATIVE 1 – CHANGE IN STAND DENSITY INDEX BY ALL DIAMETER CLASSES OVER TIME

Year	Total
2013	341
2016	341
2026	352

PLANTATIONS

Indirect Effects: On the 505 acres of plantations, composition and structure would remain unaltered, except by the processes of succession. Tree growth and vigor objectives for the project would not be achieved. If a wildland fire occurred, fire behavior would be such that mortality would be expected to be extensive and the attainment of old forest conditions would be curtailed. As trees increase in diameter and height, their susceptibility to insect attack also significantly increases without decreasing competing vegetation.

CUMULATIVE EFFECTS

Because no direct impacts would result from project related activities, no cumulative effects to forest vegetation are expected from implementation of the No Action Alternative. Under the No Action Alternative, it is assumed that fires would continue to be suppressed. As previously stated the fire interval in the project area has already been altered, with fires all but eliminated in the area since the early 1900s except for the fires that have escaped control and burned with higher severity results. Since fire is the primary mechanism that controlled forest structure and composition, it is safe to assume that other components of the ecosystem have likewise been altered and would remain altered into the future.

ALTERNATIVE 2

GENERAL OVERVIEW

The emphasis of this alternative is to approach the desired vegetation conditions to reduce the risk of wildfire to communities in the urban-wildland interface while modifying fire behavior over the broader landscape in the Trestle treatment areas. Special emphasis in designing project vegetation management prescriptions has been placed on utilizing recommendations of PSW GTR 220 and GTR 237. The fuels reduction activities would retain trees in the various diameter classes, basal areas, vertical and horizontal structures, and species composition with the intent of meeting laws, regulations and policy stated in the LRMP as amended by SNFPA.

The selection of treatment areas under this alternative is a reflection of the effort to balance the desirability of wildlife habitat improvement, forest health and stand density, and fuels reduction. Treatment areas would be prioritized and selected based on wildlife and fuels objectives, stand conditions and locations, combined with economics. Management activities tend to be concentrated where mutual objectives of wildlife, fuels and timber management coincide.

The implementation of this alternative would substantially reduce the likelihood of tree mortality caused by insect attack or stand replacement wildfires within the planning area. The effects of this reduced risk would be substantial in terms of vegetation management implications. Some of these effects would include the following:

- The substantial reduction in the likelihood of an insect epidemic and/or wildfire would provide better assurance that the existing stands could be carried through to maturity.

- By reducing the risk of a major fire, the loss of investments associated with the destruction of high value large trees and plantations would be curtailed.

- The planning area would be managed in more of a mosaic, without large blocks of contiguous, even-aged stands dominating the landscape. This would allow greater variation in stand age, species composition, structure and function, thus providing additional resilience against insect or disease problems.

- A more constant flow of forest products would be assured, thus facilitating long-term timber management.

The expected results of implementing Alternative 2 include meeting combined wildlife, fire, fuels, and timber objectives by a combination of management activities. Results include the reduction of fuels accumulated on the ground and present as fuel ladders. Prescribed burning would favor ponderosa pine establishment and growth due to the ponderosa pines adaptation to fire. Those forested stands that have a dense understory and heavy fuel accumulations would become more open following treatment.

STAND DENSITY AND BASAL AREA

Short and long term effects of the proposed action are displayed in the Tables below. For the proposed treatment areas, approximately 69 trees per acre (4-29.9" d.b.h.) would be removed. Trees 30 inches dbh and larger would be retained in all treatment units. Even though tables show an increase in the 10-11.9 inch DBH Class, there would be an immediate decrease due to harvesting. The increase is due to ingrowth from the smaller diameter classes.

Since the typical tree selected for removal would be smaller than the stand average, the actual basal area reduction would not be directly proportional. The estimated reduction in basal area is expected to be approximately 17% of the existing basal area. The standard for basal area retention is 40 % basal area in the largest trees in all treatment units (SNFPA ROD 2004, page 5). The maximum reduction in the percentage canopy cover allowed in treatment units to meet SNFPA standards and guidelines constrains basal area reduction.

TABLE 13 ALTERNATIVE 2– TREES PER ACRE BY DIAMETER CLASS OVER TIME

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	64	12	33	24	12	145
2016	5	17	25	18	12	76
2026	4	9	29	19	14	74

TABLE 14 ALTERNATIVE 2 –BASAL AREA PER ACRE (SQUARE FEET PER ACRE) BY DIAMETER CLASS OVER TIME

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	20	7	41	73	92	233
2016	2	10	33	56	93	194
2026	1	6	38	62	109	217

There would be short and long-term effects on basal area for the treatment areas as displayed in the table above. Basal areas/acre would drop due to harvest activities. In the long term, basal area would increase in 12 inch + diameter classes and drop in diameter classes less than 12 inch DBH classes.

Long-term effects of decreased tree density would be a corresponding decrease in inter-tree competition. Reduced competition would permit individual trees greater access to light, water and nutrients. The result would be displayed by increased rates of diameter and height growth with observable growth responses 2-10 years after harvest, particularly in the smaller diameter classes that have been released from competing brush species, hardwoods, and conifers. Height growth and corresponding crown development in large trees (generally trees greater than 36 inches D.B.H. and larger) would be nominal because height and crowns have reached their biological potential. Since the treatment areas would have improved growing conditions, the overall resistance of the timber stands to environmental stress, including insect attack, drought, or disease would improve. As a result, mortality levels would decrease and net cubic volume and gross cubic volume growth of the timber stands would become more nearly the same. Effects of wind would be minimal because the canopy would remain relatively intact and the large windfirm trees are retained in the treatment units.

The body of forestry research shows how thinning stands helps reduces the incidence of pest damage to the stand (Cochran and Barrett, 1995)[11]. Less competition increases the health and vigor of the remaining trees, leading to a reduction of risk to bark beetle attack. As trees grow, spatially trees become crowded and fewer resources are available for each individual tree leading to a decrease in tree and overall stand vigor. Reductions in stand density increase resources available to residual trees. Increased resource availability leads to increased tree growth rates thereby

[11] Cochran, P., and J Barrett. 1995. Growth and Mortality of Ponderosa Pine Poles Thinned to Various Densities in the Blue Mountains of Oregon. Res. Pap. PNW-RP-483. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

enhancing the development of large trees, adding to the vigor of residual trees (greater crown mass for photosynthesis), which results in a proportional increase in overall stand health. The increase in stand health reduces the susceptibility of the stand to insects, drought and disease. Studies have found that growth in large older trees increases significantly when high densities of adjacent small stems are removed (Latham and Tappeiner, 2002)[12]. The lower the basal area, the faster individual trees will grow. In stands with lower basal area, individual trees generally have larger diameter and larger crowns indicating a higher level of vigor compared to stands with high basal area. However it should be noted that increases in vigor and growth are not expected to result immediately after reductions in density occur as residual trees in overstock stands may need to grow additional roots and leaves to capture newly available resources. It is expected that it will take approximately 3 to 5 years after thinning before increases in growth and vigor are fully realized.

There has been some research that has shown some increase in mortality to larger diameter pines after burning treatments, which has the potential to impact ability to meet stated objectives. Maloney et al. (Maloney et al, 2008)[13] showed an increase in beetle attack to residual Jeffery and Sugar pine in treatment units in burn treatments. While some mortality can be expected, high levels of loss of these desired residual trees are not expected based on experience with thinning and follow-up burn projects on the Eldorado National Forest. Although some insect mortality has occurred as a result of additional stress to the trees from burning, this mortality has typically been concentrated near landing piles or where excessive radiant heat has caused damage. The Quintette project, on the Georgetown Ranger District did result in some undesirable loss of large pines in areas of units prescribed understory burned following understory thinning. This mortality has been attributed to cambial damage from burning of duff buildup around the base of large trees in concert with beetle activity present in the area (Report SSA 13-4)[14]. Raking of legacy pine proposed with this project is expected to reduce the risk of loss of these trees from burn activities to desirable levels for retention of these trees.

QUADRATIC MEAN DIAMETER

Short-term immediate effects would include an increase in the average QMD of the treatment areas. The degree of increase varies between treatment areas depending on the existing distribution of tree diameters and the intensity of proposed treatment activities.

Average QMD is modeled to increase from approximately 18 to 22 inches. (Note: In actuality and past experience, the QMD of the existing stands is approximately 6 inches, so it could be said the QMD increases from 6 to 21 inches as a result of implementing Alternative 2.) This is a direct result of harvesting smaller trees and not strictly a growth response.

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[12] Latham, P., and J. Tappeiner. 2002. Response of add-growth conifers to reduction in stand density in western Oregon Forests. Tree Physiology 22 , 137-146.

[13] Maloney, P. S., T. Smith, C. Jensen, J. Innes, D. Rizzo, M. North. 2008. Initial tree mortality and insect and pathogen response to fire and thinning restoration treatments in an old-growth mixed-conifer forest of the Sierra Nevada, California. . Canadian Journal of Forest Research. 38 , Pages 3011-3020.

[14] State and Private Forestry, Forest Health Protection. 2012. Assessment of Tree Mortality in Quintette and Hartless Projects 2012. Report SSSA13-4

In the long-term, it is expected that average diameter growth would increase. This is primarily due to a decrease in stand density and an increase in crown expansion and volume growth of the residual trees.

TABLE 15 ALTERNATIVE 2 – CHANGE IN QUADRATIC MEAN DIAMETER OVER TIME

Year	Total
2013	18
2016	22
2026	23

SPECIES COMPOSITION

Short term immediate effects on species composition would be slightly changed as a direct result of implementing Alternative 2. This change would not be uniform because of current irregular species distribution across the stands.

TABLE 16 ALTERNATIVE 2 – PERCENT (%) SPECIES COMPOSITION (TREE PER ACRE BY SPECIES) OVER TIME

Year	PP/JP	SP	WF/RF	DF	IC	OAK	TOTAL
2013	28	6	18	11	31	6	100
2016	32	7	15	10	26	10	100
2026	30	6	13	10	24	17	100

PP - Ponderosa Pine, JP – Jeffrey Pine, SP – Sugar Pine, WF – White Fir, RF – Red Fir, DF – Douglas Fir, IC – Incense Cedar, Oak – Black Oak.

Oak species are not designated for treatment; however, some minor damage may occur to individual trees during treatment activities adjacent conifers. It is expected that there would be some minor losses of individual trees through the post-treatment machine piling and pile burning. Immature oak species may be severely damaged by relatively hot prescribed fires. Fire may weaken the stem and make the oak more susceptible to pathogens. However, burning also provides a beneficial effect by removing pests that infest the acorn crop and by removing competing vegetation. Since some of post-treatment burning is proposed within and adjacent to hardwood aggregations, it is expected that some mortality and root crown sprouting of hardwoods would occur.

Within treated areas, selectively thinning around individual oak and pine would likely increase the amount of resources to those trees, even where average densities are not substantially affected so long as sufficient thinning occurs in proximity to those trees.

SNAGS AND DOWN LOGS

Short term direct effects upon snags and down logs would occur. This alternative would involve the felling of snags that are adjacent to roads and some trails open to the public and that pose a safety concern for operations. Additional direct effects on snag and down logs numbers are likely to occur as part of the prescribed fire, machine piling and pile burning activities.

The specific number of created or lost snags and down logs is impossible to predict because of variations in tree age, size, fuel moisture levels, duff depth, location of snags and down logs within the treatment areas. It is anticipated that those snags and down logs consumed by escaped prescribed and pile fires would be replaced by snags falling after the burn is complete. These newly created down logs would be in a variety of diameter classes and would have different ecological functions. However, it can be presumed that in the long term, location of individual snags and down logs remaining within the planning area would closely approximate the natural range that existed prior to the time of fire exclusion. Reduction in future fire intensity would reduce snag and down log recruitment.

Reduction in tree numbers and stand densities through harvest would reduce the competition between trees and the development of future snags. There would be a dramatic decrease in the number of new snags formed, once stand density is reestablished within the normal range compared to Alternative 1.

CANOPY COVER

Canopy cover is the stand-level composite of individual tree crowns. It is the percentage of ground surface area covered by foliage, crown projection area, branches, and stems together.[15]

Effects on canopy cover would occur as a result of the proposed action treatment activities. The immediate, short and long-term effects upon canopy cover are displayed in the table below. Average canopy cover is expected to decrease approximately 18% as a result of thinning activities. Canopy covers changes would not be uniform however. Due to the variable density marking high density and low density areas of canopy cover would result in the average condition across the area, rather than an attempt to maintain an average cover throughout the area. For some stands, canopy cover would be virtually unchanged, while for others, particularly those areas dominated by trees less than 20 inches in d.b.h., the decreases would be greater.

TABLE 17 ALTERNATIVE 2– CHANGE IN CANOPY COVER (%) BY DIAMETER CLASS OVER TIME

Year	4-9.9" d.b.h.	10-11.9" d.b.h.	12-19.9" d.b.h.	20-29.9" d.b.h.	30.0"+ d.b.h.	Total
2013	12	4	17	22	25	80
2016	1	5	14	17	25	62
2026	1	3	15	18	28	65

STAND DENSITY INDEX

Stand Density Index (SDI) is a useful tool as this index can be applied regardless of site class or age. In the short term, the existing SDI is 341 would drop to 194 under Alternative 2. As described in a Regional Forester Memo (7/14/2004), to avoid health risks related to density, thinning should be designed to ensure that stand densities do not exceed a threshold (for example: 90% of normal basal area, or 60 % of maximum SDI) for at least 20 years after thinning. In the long term, SDI would increase to 287. The table below displays the effects of Alternative 2 on SDI.

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[15]*Silviculture and Ecology of Western U.S. Forests*. John C. Tappeiner II, Douglas A. Maguire, and Timothy B. Harrington. 2007.

TABLE 18 ALTERNATIVE 2 – CHANGE IN STAND DENSITY INDEX BY ALL DIAMETER CLASSES OVER TIME

Year	Total
2013	341
2016	194
2026	287

PLANTATIONS

There are 505 acres of ponderosa pine/Jeffrey pine plantations that would receive some form of fuel/vegetation treatments. Natural conifer and hardwood regeneration would be retained where appropriate to attain the desired densities, species composition, vertical and horizontal structure. Thinning activities would favor ponderosa pine, and sugar pine, removing other conifer species (incense cedar and white fir) to meet the desired tree densities, species composition, and structure. Follow-up pruning of conifers would also occur to increase the height to live crown ratio, while retaining 50% or more of the live crown to increase resistance to wildland fire. It is expected that retaining approximately 5% of the treated areas in an untreated condition would not substantially adversely affect the overall fire resiliency of the plantations.

Treatment activities would directly decrease the susceptibility of the plantations to drought, insects and diseases, and generally promote the health and growth of trees within the plantations.

Indirect benefits to old forest conditions would also be achieved because of the decreased time to reach these conditions and the reduced likelihood of widespread tree mortality that would be expected to occur from a wildland fire. Tree diameter, height, and volume growth and vigor are expected to be increased with the treatment actions stated above.

CUMULATIVE EFFECTS

The Proposed Action, in addition to other projects in the area would improve forest health by moving stands toward a condition that is closer to that of a forest with an active fire regime. This project in conjunction with other planned and ongoing projects in the area would enable the forest to better meet desired conditions for this landscape. With this and other projects in the area, the project area landscape would be managed as more of a mosaic. This would allow greater variation in stand age, species composition, structure and function, thus providing additional resilience against insect or disease, and resilience of the stands following fire.

Treatment with the Proposed Action is not expected to change the vegetation typing or size class measure over a majority of the project area. Mechanical thinning activities would reduce the trend of treated stands toward species dominance by shade tolerant white fir and incense cedar. Some ponderosa pine stands that have been classified as Sierra Mixed conifer as a result of in-growth of shade tolerant species may be converted back to ponderosa pine type. In the long term it is expected some of the plantation stands identified as Ponderosa pine would be converted to Sierra Mixed Conifer as a result of silvicultural practices. Additionally, benefits to oaks from treatment are expected to decrease the trend of declining oak within the project area. However, the majority of stands in this landscape managed as part of the National Forest System would not be modified through this project.

It is expected that this project would not measurably contribute to the trend of declining large trees (greater than 30 inches d.b.h.) within the project area, that has resulted from past harvest practices and mortality of larger trees removed in salvage operations, and that this project may increase the longevity of some of these trees.

This project is expected to alter some snag and down log location and distribution within the project area, however, this project is not expected to contribute to a decrease in these structures that resulted mainly from past treatment practices.

ALTERNATIVE 3

GENERAL OVERVIEW

The emphasis of this alternative is to approach the desired vegetation conditions to reduce the risk of wildfire while modifying fire behavior over the broader landscape in the treatment areas employing a 12-inch d.b.h. limit on harvesting activities, a nominal number of trees slightly larger than 12-inches d.b.h. are expected to be cut and harvested to facilitate operations of mechanized equipment within nature stands.

The fuels reduction activities would retain trees in the various diameter classes, basal areas, vertical and horizontal structures, canopy cover, and species composition with the intent of meeting laws, regulations and policy stated in the LMP as amended by SNFPA. Results include the reduction of fuels accumulated on the ground and present as fuel ladders.

STAND DENSITY AND BASAL AREA

Short and long term effects are displayed in the tables below and show changes in the number of trees per acre and basal area per acre, respectively.

Since the typical tree selected for removal would be smaller than the stand average, the actual basal area reduction would not be directly proportional. The estimated reduction in basal area is expected to be less than 1% of existing basal area in the treatment areas.

Immediate effects of decreased tree density would be a corresponding decrease in inter-tree competition for some trees. Reduced competition would permit individual trees greater access to light, water and nutrients. However, as reductions in trees per acre would be restricted to the smallest size classes and because basal area would not be reduced much, reductions in competition for resources is expected to be nominal.

TABLE 19 ALTERNATIVE 3– TREES PER ACRE BY DIAMETER CLASS OVER TIME

Year	4-9.9” d.b.h.	10-11.9” d.b.h.	12-19.9” d.b.h.	20-29.9” d.b.h.	30.0”+ d.b.h.	Total
2013	64	12	33	24	12	145
2016	5	21	32	23	12	93
2026	4	13	34	24	14	88

TABLE 20 ALTERNATIVE 3 – BASAL AREA PER ACRE (SQUARE FEET PER ACRE) BY DIAMETER CLASS OVER TIME

Year	4-9.9” d.b.h.	10-11.9” d.b.h.	12-19.9” d.b.h.	20-29.9” d.b.h.	30.0”+ d.b.h.	Total
2013	20	7	41	73	92	233
2016	2	12	42	74	94	224
2026	1	9	45	79	111	246

QUADRATIC MEAN DIAMETER

Short-term effects would include an increase in the average diameter of the residual because of the removal of the smallest size classes of trees within the stands. The In the long-term, QMDs would gradually increase.

TABLE 21 ALTERNATIVE 3 – CHANGE IN QUADRATIC MEAN DIAMETER OVER TIME

Year	Total
2013	18
2016	21
2026	22

SPECIES COMPOSITION

The effects of the Alternative 3 on the species composition within the treatment areas are displayed in the Table Below.

Short term effects on species composition would be slight as a direct result of implementing Alternative 3. This change would not be uniform because of current irregular species distribution across the treatment areas. There would be a moderate decrease of shade tolerant white fir and incense cedar in the understory (suppressed and intermediate crown classes) and a slight increase in the proportion of shade intolerant species, such as ponderosa pine due to harvest practices and prescribed burning activities. Benefits to shade intolerant species are expected to be short in duration due to the minimal amount of trees being removed. Incense cedar and white fir (shade tolerant species) would continue to dominate the understory layer, while oaks, ponderosa and sugar pine would continue to be displaced as these trees grow into the main canopy. This is simply because these shade tolerant species are more successful at regenerating in the absence of canopy openings.

Release of California black oak from overtopping conifers would not occur and though their proportion increases as a result of harvesting the abundant small cedar and white fir regeneration, oaks are expected to be continued to be overtopped and crowded out by competing conifer species.

TABLE 22 ALTERNATIVE 3 – PERCENT (%) SPECIES COMPOSITION (TREE PER ACRE BY SPECIES) OVER TIME

Year	PP/JP	SP	WF/RF	DF	IC	OAK	TOTAL
2013	28	6	18	11	31	6	100
2016	31	6	15	10	25	13	100
2026	32	6	15	10	25	12	100

PP - Ponderosa Pine, JP – Jeffrey Pine, SP – Sugar Pine, WF – White Fir, RF – Red Fir, DF – Douglas Fir, IC – Incense Cedar, Oak – Black Oak.

SNAGS AND DOWN LOGS

The direct and indirect effects of implementing Alternative 3 would be the same as described for Alternative 1.

CANOPY COVER

Effects on canopy cover would occur as a result of implementing Alternative 3. The immediate, short and long-term effects upon canopy cover are displayed in the table below. Changes in the percentage of canopy cover would vary among the treatment areas. Since most of the trees that would be removed are in the understory and smaller diameter classes, the overall reduction in canopy cover would not be proportionate to the reduction in the number of trees or the basal area. For some natural stands, canopy cover would be virtually unchanged, while for others, particularly those areas dominated by trees less than 12 inches in d.b.h., the decreases would be greater.

TABLE 23 ALTERNATIVE 3 – CHANGE IN CANOPY COVER (%) BY DIAMETER CLASS OVER TIME

Year	4-9.9” d.b.h.	10-11.9” d.b.h.	12-19.9” d.b.h.	20-29.9” d.b.h.	30.0”+ d.b.h.	Total
2013	12	4	17	22	25	80
2016	1	6	17	22	25	71
2026	1	4	18	23	28	74

STAND DENSITY INDEX

The direct and indirect effects of implementing Alterative 3 are displayed in the table below. There would be a slight decrease in SDI in the short term as time passes, SDI continues to increase showing a continued risk of higher mortality levels in these stands resulting from higher inter-tree completion for resources.

TABLE 24 ALTERNATIVE 3– CHANGE IN STAND DENSITY INDEX BY ALL DIAMETER CLASSES OVER TIME

Year	Total
2013	341
2016	305
2026	325

PLANTATIONS

Effects would occur as a result of implementing Alternative 3 would be similar to Alternative 2.

CUMULATIVE EFFECTS

Treatment with Alternative 3 is not expected to change the vegetation typing or size class measure over a majority of the project area. Benefits to oaks from treatment are not expected to decrease the trend of declining oak within the project area. It is expected that this project would not measurably contribute to the trend of declining large trees (greater than 30 inches d.b.h.) within the project area, that has resulted from past harvest practices and mortality of larger trees removed in salvage operations. This project is expected to alter some snag and down log location and distribution within the project area, however, this project is not expected to contribute to a decrease in these structures that resulted mainly from past treatment practices.

ALTERNATIVE 4

GENERAL OVERVIEW

The emphasis of this alternative is to take a conservative approach to treatment activities to minimize impacts to California spotted owl habitat. The selection of treatment areas under this alternative is a reflection of the effort to balance the desirability of wildlife habitat improvement, forest health and stand density, and fuels reduction. Treatment areas would be prioritized and selected based on wildlife and fuels objectives, stand conditions and locations.

Treated stands would become more resilient to fire, disease and insect infestation through the removal of dense, competing, young-growth trees, and would achieve a greater percentage of large trees in a shorter time frame than Alternative 1, however less stands would be treated under this alternative than either Alternative 2 or 5.

Stands that are commercially thinned would have effects similar to those described for Alternative 2. Stands that are treated with non-commercial mechanical thinning would have effects that are similar to the Non-Commercial Alternative Stands that are prescribed burned only in this alternative will only have nominal changes.

Because of the reduced thinning intensity in some stands and the treatment of some stands proposed for thinning in other alternatives with prescribed fire only, several hundred acres within the project area would continue to maintain higher densities and inter tree competition compared with Alternative 2. Therefore this alternative would not achieve the same benefits of improving species composition and residual tree vigor across the landscape as compared to Alternative 2 or Alternative 5.

Increased tree density and competition for resources would be expected to result in more snags and down logs in the short and long term as compared to Alternative 2 or 5.

CUMULATIVE EFFECTS

Treatment with Alternative 4 is not expected to change the vegetation typing or size class measure over a majority of the project area. Benefits to oaks from treatment are not expected to decrease the trend of declining oak within the project area. It is expected that this project would not measurably contribute to the trend of declining large trees (greater than 30 inches d.b.h.) within the project area, that has resulted from past harvest practices and mortality of larger trees removed in salvage operations. This project is expected to alter some snag and down log location and distribution within the project area, however, this project is not expected to contribute to a decrease in these structures that resulted mainly from past treatment practices.

ALTERNATIVE 5

GENERAL OVERVIEW

The emphasis of this alternative is to take a conservative approach to treatment activities to minimize impacts to California spotted owl habitat while still providing for a more effective treatment near the community and in key locations across the landscape to provide for increased implementation feasibility. The selection of treatment areas under this alternative is a reflection of the effort to balance the desirability of wildlife habitat improvement, forest health and stand density, and fuels reduction

Treated stands would become more resilient to fire, disease and insect infestation through the removal of dense, competing, young-growth trees, and would achieve a greater percentage of large trees in a shorter time frame than Alternative 1, however less stands would be treated under this alternative than Alternative 2.

Stands that are commercially thinned would have effects similar to those described for Alternative 2. Stands that are treated with non-commercial mechanical only would have effects that are similar to the Non-Commercial Alternative. Stands that are prescribed burned only in this alternative will only have nominal changes.

Because of the reduced thinning intensity in some stands and the treatment of some stands proposed for thinning in other alternatives with prescribed fire only, some areas within the project area would continue to maintain higher densities and inter tree competition compared with Alternative 2. Therefore this alternative would not achieve the same benefits of improving species composition and residual tree vigor across the landscape as compared to Alternative 2. However, more areas would have reduced intertree competition compared to Alternative 4, resulting in improved species composition over time compared to that Alternative.

Increased tree density and competition for resources would be expected to result in more snags and down logs in the short and long term as compared to Alternative 2 but less than Alternative 4.

CUMULATIVE EFFECTS

Treatment with Alternative 5 is not expected to change the vegetation typing or size class measure over a majority of the project area. Benefits to oaks from treatment are not expected to decrease the trend of declining oak within the project area. It is expected that this project would not measurably contribute to the trend of declining large trees (greater than 30 inches d.b.h.) within the project area, that has resulted from past harvest practices and mortality of larger trees removed in salvage operations. This project is expected to alter some snag and down log location and distribution within the project area, however, this project is not expected to contribute to a decrease in these structures that resulted mainly from past treatment practices.

SILVICULTURE REPORT - APPENDIX A

DESCRIPTION OF SILVICULTURAL PRESCRIPTIONS

MECHANICAL THIN

Silvicultural control measures are the most efficient method for managing the bark beetle populations. The most effective strategies for managing beetle populations are preventative measures that involve reducing stands susceptible to beetle infestations through maintenance of vigorous stands. Thinning stands prevent or minimize beetle-caused mortality. In many stands mechanical thinning followed by prescribed fire is necessary to achieve forest resilience. Generally, mechanical thinning is the preferred operation to achieve both silviculture and fire behavior objectives. Mechanical thinning operations have the ability to effectively (both economically and ecologically) remove trees of varying sizes while managing the reduction of canopy cover.

THIN FROM BELOW

A "strict" thin from below is designed so that smaller diameters are the first component thinned. This thinning is done to achieve a residual stand basal area or number of trees per acre. A single-storied residual stand structure remains containing primarily a large tree component, leading to conditions that limit the stand's ability to provide effective wildlife habitat and options for future silvicultural treatments. The residual single-story leaves primarily dominant and co-dominant trees and does not consider species composition.

VARIABLE DENSITY THIN

The "modified" thinning from below prescription uses a species preference marking guideline and a variable density thinning approach based on landscape position, aspect, and stand structure, in an effort to promote resilient stands and desired conditions. Thinning would remove trees based on canopy position, species, and health, up to a maximum 29.9 inches diameter breast height. There would be preference given to leaving fire resistant pine. Larger fire-prone, shade tolerant species may be harvested over smaller fires resistant species. The goals of this type of thinning would be to reduce ladder fuels and remove shade-tolerant trees when possible.

Variable density thinning is a thinning technique in which the goal is to mimic the natural diversity of the stand after thinning. It is a silvicultural technique synonymous with selection thinning, or free selection. Variable density thinning attempts to generate a multiple storied stand consisting of various classes both at the stand level and across the project area. The structural complexity would be greater under this type of thinning, as there would be ecosystem level interactions that would benefit growth rates of residual trees, shrubs and grasses. Ladder fuels would vary depending on structural stage, and canopy layers would be discontinuous to minimize crown fire risk. Large trees would be maintained in clumps and basal areas would be reduced to ameliorate the effects of stand level epidemic insect and disease issues (Graham R. J., 2007)[16]. The creation of "gaps" and "clumps" would attempt to restore vegetative conditions prior to fire exclusion and increase stand resilience through variability.

The underlying theory is explained in depth in several General Technical Reports from the Pacific Southwest Experimental Research Station, PSW-GTR-220, North et al (2009)[17]; PSW-GTR-237, North (2012)[18]; and PSW-GTR-203 Graham (2007). In the North et al. (2009) GTR report the authors theorize a method to increase both vertical and horizontal heterogeneity in vegetative stands. They suggest creating "variability" over the landscape by mimicking forest conditions that would occur under normal fire behavior and natural processes. The main difference between this prescription and the "thinning from below" approach is that a thin across all diameter sizes occurs. By thinning across diameters a residual stand of all trees sizes and diameter is created which research has shown to exist in fire-prone forests (Lydersen and North, 2012; Bouldin, 1999; O'Hara, 1996; and O'Hara, 1998).

There is no set procedure on how a "variable density thin" is to be implemented; however current stand conditions and geographic location would influence the residual stand (Sherlock, 2007)[19]. Residual stand conditions would be influenced because normal stand densities and tree species are often found on different aspects, and slope conditions. North and his associates addressed "variable density thins" from the standpoint of clumps of large trees and managing the intermediate size classes (North et al, 2009). Their basic presentation is that the natural forest is not an evenly spaced set of trees, but consists of clumps of trees with higher stand densities and gaps with lower densities, even openings. Their conclusion indicated that managing stands using different silvicultural objectives within different size class components (i.e. large trees, intermediate trees, small trees) increased stand diversity and created stand conditions that most replicate historically normal fire behavior.

Through historic reconstruction of Sierran forests, clumps of large trees have been consistently part of the landscape structure. However, since higher levels of fire risk is a natural occurrence within Sierran landscapes, fire behavior and intensity is a concern in maintaining and managing these large tree features. North et al, suggest that the goal and objective should be to thin intermediate and small trees within these clumps reducing fire laddering and the potential loss from fire. The second objective in variable density management is treating the intermediate size classes not

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[16] Graham, R. J., T. Jain. and J. Sandquist (2007). Free selection: a silvicultural option. In Restoring Fire-Adapted Forested Ecosystems. In R. Powers (Ed.), 2005 National Silviculture Workshop, Lake Tahoe, CA. General Technical Report PSW-GTR-203. (pp. 121-156). Albancy Ca: USDA Forest Service, Pacific Southwest Research Station.

[17] North, M., P. Stine, K. O'Hara, W. Zielinski, and S. Stephens (2009). An ecosystem management strategy for Sierran mixed-conifer forests. Gen. Tech. Rep. PSW-GTR-220. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific South West Research Station.

[18] North, M. (editor). (2012). Managing Sierra Nevada Forests. USDA Forest Service General Technical Report PSW-GTR237.

[19] Sherlock, J. W. (2007). Integrating stand density management with fuel reduction. USDA Forest Service, Pacific Southwest Region, General Technical Report PSW-GTR-203.

present around the large tree structures; what is considered intermediate versus large varies with forest type and site productivity of the stand.

Objectives for this thinning intermediate sized trees includes species composition, tree growth, health and form, topographic positioning of the stand on the landscape, and socioeconomic considerations. By using these objectives to manage the intermediate sizes, thinning would be more responsive to current stand conditions than "thinning from below". By thinning "across the diameter range", managers have a greater degree of control on the species and conditions needed for wildlife and fire resistance. At the same time the concept of variable density can improve forest tree health and increase tree growth, as a prevention against insect and disease leading to a lower fire risk. Thinning throughout the intermediate diameter range (10" to 30" DBH) also allows for revenue to help pay for fuel treatment, provide for rehabilitation projects and improve economic stability to local communities.

Authors had very little discussion of the smaller size classes (<11" DBH), under this variable density concept. With the emphasis of the discussion on fire risk, the lack of discussion of these small size classes is understandable. Studies have been done on natural regeneration within multistoried and prescribed fire active stands, indicating that desirable regeneration and overall regeneration is not consistent (Gray, 2005)[20] (Zald, 2008)[21]. The lack of consistent regeneration was strongly contributed to constant fuel treatments, dense over-stories that tended to limit future regeneration and micro-site conditions that did not favor desirable species. Because regeneration has inconsistently not met silvicultural expectations, consideration on treating and maintaining a smaller diameter structure should be part of the discussion and implementation of this prescription. The addition of a few smaller diameter trees would not increase fire risk significantly in the majority of situations if consideration was given to spacing, location and the type of species being managed. By incorporating consideration for small trees into the variable density thinning discussion, two major concerns can be addressed beyond fire risk. The first would be increasing the vertical heterogeneity of the stand from the ground up to the upper reaches of the canopy. This would help increase wildlife habitat quality. The second is to provide the regeneration needed for maintaining stands into the future, by managing smaller trees as future ecological replacements for trees naturally dying from age or background mortality.

In order to emphasize heterogeneity in this project:

- Topographic features, land allocations, and structures within stands would be used to aid in determining appropriate post treatment stand conditions to move stands toward desired conditions.
- Within commercial thinning units trees with identified wildlife use characteristics, such as broken tops, multiple tops, protected platforms, forked-tops with overhead canopy cover, large mistletoe brooms and hollow chambers would be preferentially retained.

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[20] Gray, A., H. Zald, R. Kern, and M. North. (2005). Stand conditions associated with tree regeneration in Sierran mixed-conifer forests. Forest Science 51 , 198-210.

[21] Zald, H., A. Gray, M. North, and R. Kern. (2008). Initial tree regeneration responses to fire and thinning treatment in a Sierra Nevada mixed-conifer forest, USA. Forest Ecology and Management 256 , 168-179.

- Selected areas of the individual units ranging in size from a few individual trees providing wildlife use characteristics throughout the proposed thinning areas to areas ¼ acre or larger, would be retained to provide for horizontal and vertical structural diversity with a focus on providing structure for wildlife use. Where available, retention would be placed to include areas with:
    - multi-layer canopies
    - higher percentage of ground cover compared to adjacent areas
    - concentrations of snags and large woody debris
    - vertical and horizontal structural continuity and diversity
    - hiding and escape cover
    - Control areas such as RCAs, equipment exclusion zones, cultural resource sites and botanical areas would be evaluated for retention characteristics.

CRITERIA FOR MECHANICAL REMOVAL OF NON-COMMERCIAL MATERIAL

Leave Trees: Select leave trees between 4 than 10" diameter based on the following criteria:

- Pines (sugar, ponderosa)
- Dominance of trees in relation to others of the same age class.
- Dark green colored foliage over which is thick over the entire tree
- Straight bole
- Single branch terminal
- Free from physical defect
- Free from insect and disease damage
- Planted seedlings should be favored, but some species composition of in-growth should be retained.
- 20-25 foot approximate spacing should exist post treatment. This may be smaller in some areas but would not fall below 16 feet to allow for equipment operation.
- Pacific yews, black oaks, dogwoods, elderberries, and California nutmeg should not be cut.

Retention areas should be avoided in order to provide for diverse structure within treatment units.

SMALL TREE AND BRUSH THINNING

Cut and remove all conifer trees not designated as leave trees between 4 and 10 inches dbh outside of retention areas.

TRACTOR PILE/GRAPPLE PILE AND PILE BURNING

Units with tractor pile or grapple pile activities would treat brush, slash and downed woody debris. Residual piles would be burned as soon as they are cured. Residual fuel loading would be low enough that a final prescribed burn treatment could be implemented. An understory burn may be conducted at the same time that piles are burned.

Piling intensity would vary within stands based on fuel loading and by slope with north slopes piled less intensively than south slopes.

Tractor pile or otherwise treat brush and trees between 1 and 4 inches outside of identified retention areas in units where this material is removed.

In units where piling is proposed, jackpot pile on slopes less than 35% and hand pile on slopes greater than 35% where machine piling is not possible. Greater than 90% of all cut brush, trees, dead brush, conifer slash, preexisting vegetative debris >1 inch in diameter and >3 feet in length, and non-merchantable down logs less than or equal to 12 inches at the small end diameter, not removed to the landing should be piled. Piling is expected to result in a range of piles 5' to 20' in height

Machine piling should be conducted to retain ground cover such as duff and litter largely to maintain intact soil cover.

Burning should consume 70 to 100% of piled debris.

Mortality of <20 percent of conifers over 18" in dbh is acceptable within 50 feet of a large landing slash piles.

BRUSH CUTTING

This activity would treat brush, shrubs, slash, and potentially sapling sized trees by mulching the green material into fine chip. Operational machinery would utilize a tractor with a masticator attachment or hand crews with a chipper. This treatment would create a residual fuel bed of chips in the residual stand. Further post-treatment is generally not done and the residual material is left to decay and provide mulch cover for soils, however, burning may be conducted in these stands if the risk of excessive damage to residual trees due heat damage to fine roots is below the acceptable level.

HAND THIN

Hand thinning treatments would be accomplished by use of a chainsaw and manual labor for creation of burn piles. These units are proposed for treated by this method generally due to restrictions such as specific sensitive resource protection measures, limitations on treatment option for land allocations, steep slopes or lack of access by mechanized equipment. Hand thinning is the most costly method of forest vegetation management proposed under this project. Hand thinning of trees smaller than 6 inches in diameter and piling of material would occur prior to prescribed fire treatments along fire lines and within areas of treatment units where reduction in ladder fuels is needed to achieve desired treatment objectives.

PRESCRIBED FIRE

Prescribed fire is used to describe fire that is intently applied to manage fire fuels or to improve vegetative fire risk. Pile burning and underburning are the two primary techniques of prescribed fire proposed in this project. Underburning is used to reduce slash, shrub vegetation, and duff/litter component of the stands. Establishment of understory tree vegetation may be dependent on consumption of surface fuels. Prescribed fire treatments may result in mortality of individual or pockets of trees; however, they are not expected to immediately create shifts in forest species composition or structure. Underburning may increase regeneration and encourage establish of young trees. This indirect result of underburning has the potential to change species composition to fire resistant species, and growing understory structures overtime.