Chapter 3 – Affected Environment and Environmental Effects

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Introduction

The Interdisciplinary Team that assembled this draft of the Kings River project has relied, in part, on technical work completed for earlier drafts, supplemented with additional analysis where it was appropriate. When the consequences of a new alternative were less than those of an alternative already analyzed, that has been noted, and often no new analysis was required. Each resource area was reevaluated and re-assessed to avoid duplicative work and to ensure that the full consequences of each alternative have been disclosed.

This chapter presents the scientific and analytical basis for the comparison of five alternatives for the Kings River Project. Effects of the proposed alternatives are discussed in terms of direct, indirect, and cumulative impacts.

Direct effects would be caused by proposed activities and are immediate in nature. Indirect effects would be caused by proposed activities but are later in time or farther removed in distance, and are reasonably certain to occur. Cumulative effects are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR 1508.7). Historically, the Kings River Project area has been disturbed for various reasons including timber harvest, plantations, wildfire and prescribed fire. The area is open to hiking, camping, and other recreational activities and special uses such as mining and grazing.

Historically, the Kings River Project area has been managed for various purposes including timber harvest; plantation establishment; road construction and maintenance; and prescribed fire. The project area has also been affected by wildfire. The area is open to hiking, camping, and other recreational activities and special uses such as mining and grazing.

Past, Present and Reasonably Foreseeable Activities in the Kings River Project Area

Past activities are those that occurred in the past 30 years. Present activities are those that are ongoing at this time. Reasonably foreseeable activities are those that have developed to the point where it is possible to identify the planned location and activity so as to reasonably predict the consequences. Relevant cumulative effects are described in the individual resource sections.

Table 3-1. Past, Present and Reasonably Foreseeable Activities

Activity Type	Description	Year of Initial Implementation	Unit of Measure
FS Veg. Mgt. – plantation maintenance	Thinning, hand release, chemical release, and planting in plantations <25 yrs old. Includes Power1, Nutmeg, Lost, Men, Bretz, Flat, Progeny Site and Fence.	Ongoing	2,400 acres
Veg. Mgt. – SCE Pvt. Land	Uneven-aged thinning and Rx burning.	1980 – 2005	1,500 acres annually
Veg. Mgt. – Pvt. Land	Grand Bluffs National Fire Plan grant (shred brush and plant conifers). Harvest	2004 & 2005 2009	80 acres 320 acres
Private land	Two timber sales near the N_soapro Management Unit		
Veg. Mgt. – PG&E Transmission Line	Right of way 370 acres.	2005 & 2006	about 1,030 dead trees removed and other work on 399 acres
Private Land residential development	Wildflower subdivision, type conversion to housing tract.	2005	160 acres
Roadside Hazard Tree Removal	Removal of damaged, rotten, dead trees to abate roadside hazard.	2002 - present	90 miles and 4,400 trees across 6,500 acres
Prescribed fire	Underburn program to reintroduce fire, maintain DFPZ & reduce ground fuels.	1994 – present and ongoing	17,300 acres
Wildfires	The average size of wildland fires in the last 35 years is 1,866 acres		
NF Veg. Mgt. Timber Sales	Timber management projects.	1978 - 1990	32,484 acres
Research	Teakettle thinning & Rx burning	1998	60 acres
Fuels Reduction	Jose 1, 10S18 and South of Shaver thinning & Rx burning projects	1996 – present	1,687 thinned acres 3,745 burned acres 156 planted acres
Livestock Grazing	Annual grazing on the Blue Canyon, Dinkey, Haslett, Patterson Mtn, and Thompson Allotments	Ongoing	unknown
Roads	Maintenance of existing roads (grading and cleaning of culverts)	Ongoing	
Motorized Recreation	4X4, Off Road Vehicle (OHV), snowmobile travel on designated routes.	Ongoing	

The following maps display general locations of activities.

Figure 3-1. Ongoing Activities in the Project Area

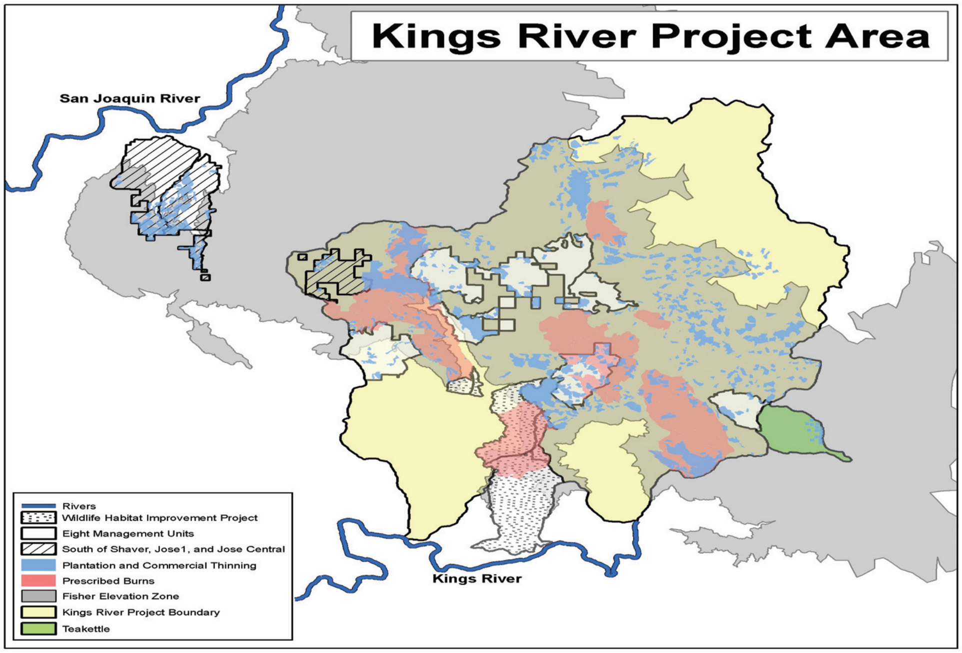
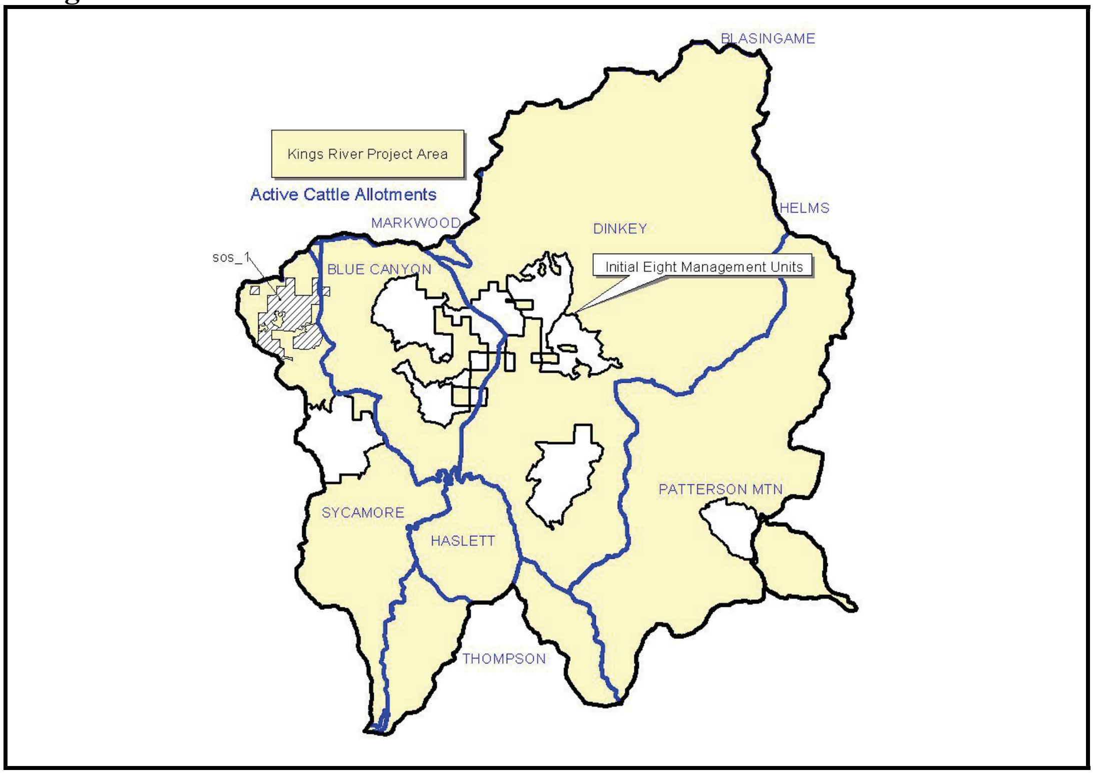
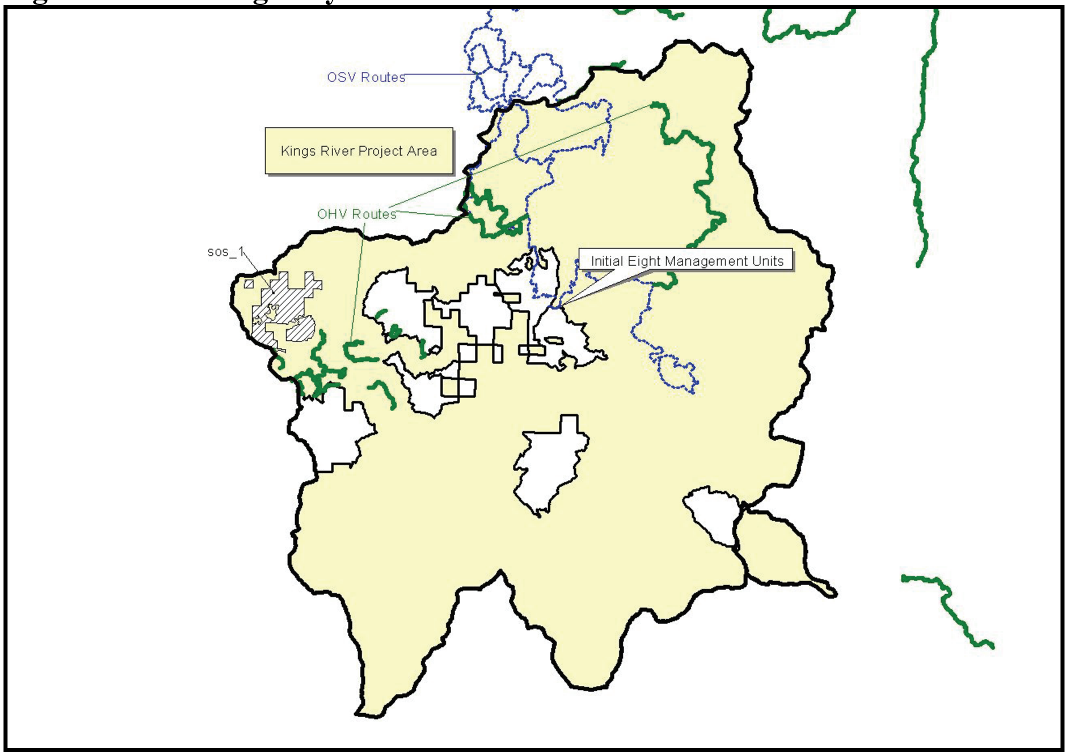


Figure 3-2. Active Cattle Allotments



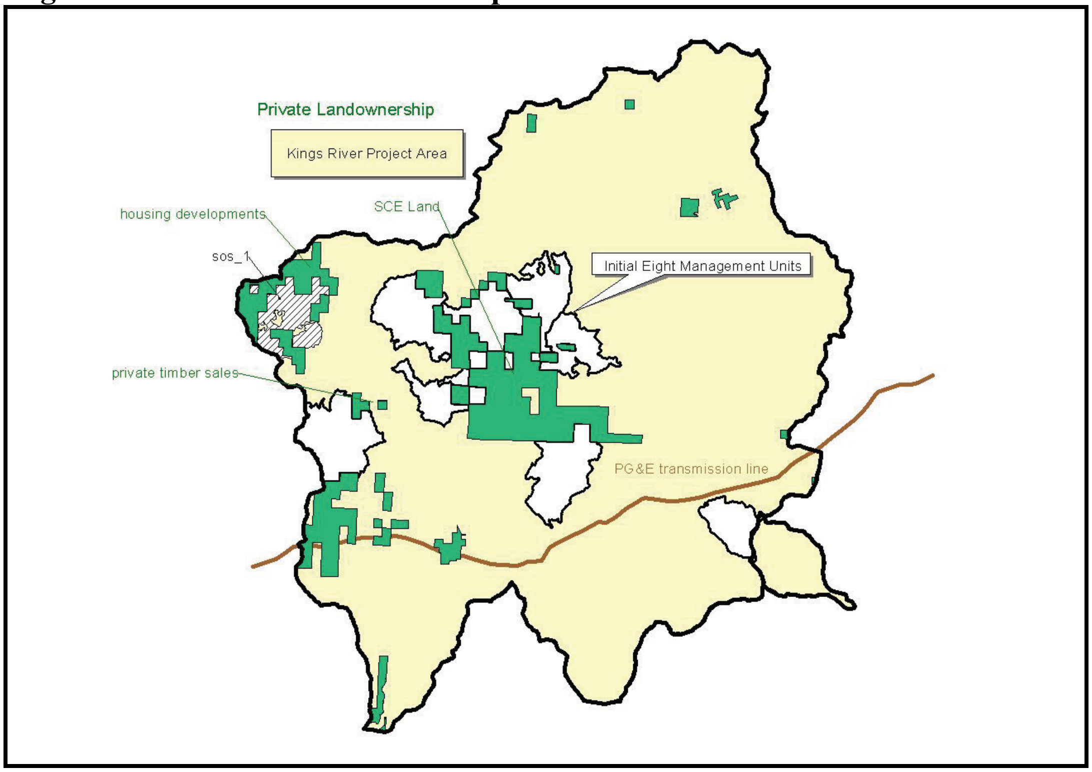
sos_1=South of Shaver project

Figure 3-3. Off-highway Vehicle and Over-snow Vehicle Routes



Routes overlap the Kings River Project area
sos_1=South of Shaver project
osv=over-snow vehicles

Figure 3-4. Private Land Ownership



sos_1=South of Shaver project
sce= Southern California Edison
pg&e=Pacific Gas and Electric

Vegetation and Fuel/Fire Behavior Affected Environment

The Kings River area covers approximately 131,500 acres. Eight management units have been identified for treatment in the proposed action. The eight units cover approximately 13,700 acres.

The South of Shaver project; plantation maintenance; vegetation treatments on private land; hazard tree removal; and residential construction are analyzed as part of the cumulative effects of past, present and reasonably foreseeable activities.

Past Disturbance - Vegetation within the project area has been affected by past disturbances. These disturbances include harvests, wildfire, even-aged management, insect mortality, and underburning. Management disturbances from 1975 to present are detailed in management history in the project file. Harvests within the larger Kings River landscape began in 1870s with removal of sugar pine and ponderosa pine, typically in small groups or single trees. These disturbances occurred in the Rush creek drainage or on the ridges above the Big Creek drainage (Sudworth 1900a, Flintham 1904, Hurt 1940). Extensive steam, donkey and railroad logging began in the 1890s and continued through 1910. The period from 1890 to 1910 resulted in large clear cuts in the Rush Creek (North_soaproot_2), Summit Creek (Providence_1) and Big Creek (Providence_4) drainages. Scattered remnants of pre-settlement stands are found throughout. Some of these stands regenerated naturally from the seeds of these scattered trees. Most stands harvested in this early period are now dominated by white fir or incense cedar that had established in the understory prior to the earlier harvests. Similar encroachment of white fir has been documented in the Teakettle Experimental Forest adjacent to the Krew_bul_1 Management Unit found at 7000 feet elevation (North and others 2004). Management units that exemplify this regeneration pattern are El_o_win_1, Krew_prv_1 and Bear_fen_6. Other areas logged during the turn of the century, such as those in the Summit Creek area or lower Rush Creek drainage exist as dense shrub fields.

Many of these early cutover stands were burned by wildfire in 1918, 1931, 1932, and 1947. These fires affected the South of Shaver Project and the North_soaproot_2, Providence_1, Providence_4 and Krew_prv_1 Management Units. Stand-replacing fires in 1961, 1981 and 1989 resulted in areas dominated by shrub species in many stands to this day. Reforestation efforts in fire areas (1947 to 1989) used tractor site preparation and herbicide release to reforest some of these cutover and burned stands.

Recent Management - An uneven-aged management strategy with group regeneration and underburning has been used in the project area since 1994. These treatments have focused on the uneven-aged management strategy creating regeneration in groups, prescribed fire and defensible fuel profile zones (Smith and Exline 1998). Projects include the 10S18 project (1,647 acres), I-rock project (885 acres) and the Reese project (1,244 acres). Underburning has been used in the project area to consume fuel created from harvests; to maintain desired fuel loads; and reduce fuel ladders (McCandliss 1998).

Existing Vegetation **-** Vegetation within the project area is described using the California Wildlife Habitat Relationship model (CWHR (Mayer and Laudenslayer 1988)). This model describes vegetation by forest type, quadratic mean diameter, and canopy density. Existing vegetation type acreages were determined by using vegetation mapping completed by Rojas in 2004. Existing structure was determined from more than 1900 stand examination plots collected from 1996 to 2004.

Acres of different forest types across the project's eight management units are displayed in Table 3-2. Ponderosa pine (28 percent) and Sierra mixed conifer (43 percent) are dominant forest types. Forest types that occur less frequently include mixed chaparral (5 percent), montane chaparral (2 percent), montane hardwood (8 percent), montane hardwood conifer (3 percent), red fir (3 percent), barren (7 percent), and other types (1 percent). Medium size class trees and moderate to dense canopy cover classes dominate the landscape. These medium size class trees originated following disturbances of 1880 to 1961. Scattered older trees are found across conifer dominated types individually and in clumps. Shade-intolerant species (incense cedar, white fir, and red fir) have invaded forest understories. Ponderosa pine, Jeffrey pine and California black oak are found at lower frequencies than in the past, as described at both 75 and 150 years ago (Bouldin 1999, Taylor 2004, North and others 2005). Shrubs are also a dominant component in the understory. This is especially true in ponderosa pine and mixed conifer stands. Bear clover is found throughout all ponderosa pine stands and accounts for forty percent cover. Mixed conifer stands average 24 percent shrub cover. Shrub cover ranges from 0 to 100 percent with approximately half the plots containing greater than fifty percent shrub cover.

Table 3-2. Acres of Forest Types for the Current Condition

CWHR Type	Bear_fen	El_o_win	Glen_mdw	Krew_bul	Krew_prv	N-soapro	Prov_1	Prov_4	Total
Annual Grass Land	0	7	0	0	0	0	0	4	11
Barren	1	115	216	81	107	304	93	5	922
Lodgepole Pine	0	18	7	0	0	0	0	0	24
Mixed Chaparral	0	0	0	0	1	490	63	104	658
Montane Chaparral	34	10	10	9	8	5	128	29	232
Montane Hardwood Conifer	29	0	0	0	4	132	217	12	394
Montane Hardwood	0	0	0	0	0	657	279	107	1,044
Ponderosa Pine	1,043	0	0	0	246	833	1.105	698	3,925
Red Fir	0	0	0	428	0	0	0	0	428
Sierra Mixed Conifer	1,094	1,184	1,341	587	1,504	0	129	87	5,926
Urban	0	0	29	0	0	0	0	0	29
Water	0	1	1	0	0	0	0	0	2
Wet Meadow	3	25	15	47	29	0	0	0	120
Total	2,204	1,359	1,619	1,152	1,899	2,421	2,014	1,047	13,715

Table 3-3. Acres of Plantations Proposed for Treatment

Date	Bear_ fen	El_o_ win	Glen_ mdw	Krew_ bul	Krew_ prv	N- soapro	Prov_ 1	Prov_ 4	Total
1948	0	0	0	0	0	0	0	0	0
1950	0	0	0	0	13	0	47	0	60
1962	0	0	0	0	0	24	0	0	24
1963	0	0	0	0	0	0	0	0	0
1964	5	0	0	0	0	0	0	0	5
1966	7	0	0	0	0	0	0	0	7
1968	69	0	0	0	0	0	0	0	69
1969	4	0	0	0	0	26	0	0	30
1970	25	0	0	0	0	0	0	0	25
1972	0	0	0	40	0	0	0	0	40
1977	0	0	0	0	0	31	0	0	31
1980	0	0	0	0	0	26	0	0	26
1981	0	0	0	0	0	56	17	0	73
1982	6	0	0	0	0	0	0	0	6
1984	0	0	0	16	0	0	0	0	16
1987	0	0	2	0	0	0	0	0	2
1989	0	0	1	0	31	0	0	0	32
1990	0	2	0	0	11	0	0	0	13
1991	88	0	0	0	0	0	0	0	88
1992	107	0	0	0	0	0	0	0	107
1993	0	0	0	0	0	0	0	0	0
1994	26	39	0	0	148	0	27	0	240
1996	0	34	0	0	0	0	0	9	43
1997	0	0	0	0	45	0	0	0	45
Original Overstory Removal	68	0	0	0	21	72	61	0	222
Shelter-wood	0	25	0	94	0	0	0	0	119
Total	405	100	3	150	269	235	152	9	1,323

Acres of plantations proposed for treatment in the project's eight management units. The year of creation was developed from photo interpretation and GIS. Acres with overstory removal contain acres with residual young trees left behind after the previous overstory harvest. These acres are somewhat different then those extracted from the FACTS database.

<u>Plantations</u> - Plantations and shelterwoods occur on 2,162 acres in the project's eight management units. Plantations and shelterwoods with current NEPA decisions or with no proposed treatments make up 852 acres. Plantations proposed for treatments in this EIS occur on 1,321 acres. These plantations and shelterwoods were created from even-aged management from 1975 to 1994; shrub field conversion; and fire recovery. Table 3-3 displays the acres by management unit for plantations by year of origin or planting for plantations and the acres of shelterwood harvest. Plantations are dominated by small sapling to pole size ponderosa pine, Jeffrey pine, and sugar pine, less than 10 inches diameter at breast height (dbh). Red fir, white fir and incense cedar are minor components of most existing plantations and shelterwood harvests. The density of

plantations proposed for treatment often exceeds 300 trees per acre. Some plantations have as many as 900 trees per acre. Scattered trees, greater than 10 inches diameter breast height are found within plantations as part of the shelterwood or left for diversity in "clumps and holes" prescriptions. Shrub species found in the understory include *Ceanothus cordulatus* (whitethorn*)*, *Ceanothus integerrimus (*deer shrub*)*, *Arctostaphylos patula* (greenleaf manzanita*)*, *Arctostaphylos vicida (*whiteleaf manzanita*)*, *Chamaebatia foliolosa* (Bear clover*)*, and *Ribes roezlii* (Sierra gooseberry*)*. Cover of the understory shrub in proposed treatment plantations varies from 0 to 140 percent cover. Values over 100 indicate overlapping canopy cover. Average shrub cover for plantations is 52 percent total cover.

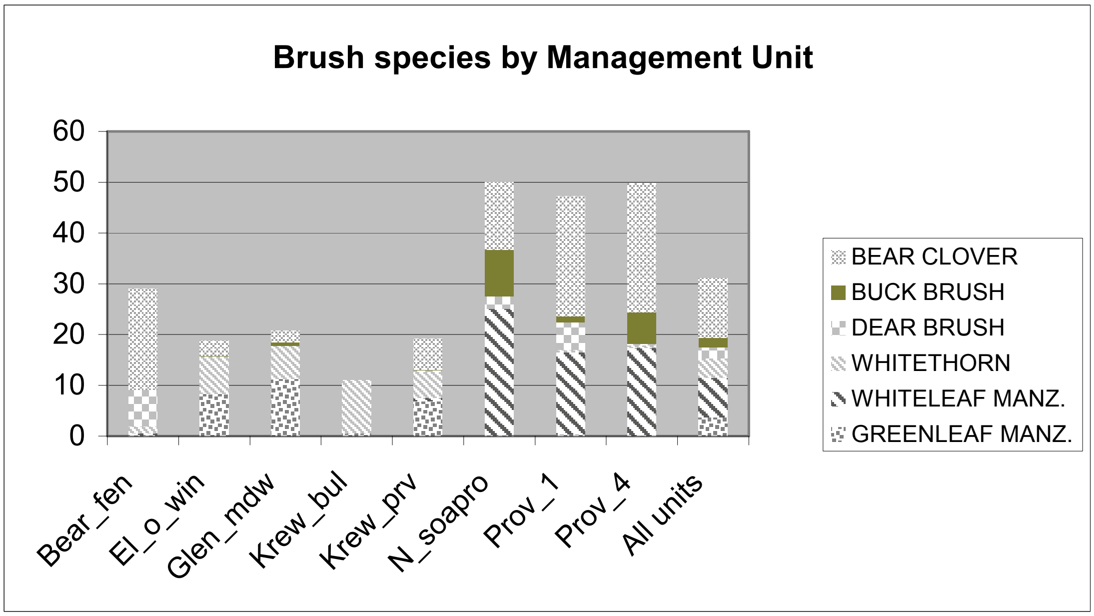
<u>Shrub fields and Canopy Gaps</u> - Areas disturbed by fire, insects or harvest create conditions suitable for secondary succession. Secondary succession is a process of reinvasion by plant species following disturbance (Barbour and others 1980). The response to disturbance is determined by the availability of seed and the competitive advantage of the first species to arrive following that disturbance. Conifer and oaks can survive or establish after disturbance; however, the pattern of response is often dictated by available seed; conditions suitable for tree growth; and previous treatments (McDonald and Fiddler 1995). Disturbance can change the proportion of species. Succession would result in predictable combinations of species that form vegetative communities. This tendency for vegetation to form communities is often referred to as potential natural community or potential natural vegetation (Potter 1994).

Areas with existing understories of shrubs tend to become occupied by these existing shrub species following fire and harvests. Treatments that create conditions for tree growth are often needed to establish tree cover (McDonald and Fiddler 1995). Shrub fields within the project's eight management units are dominated by a complex of shrub species: deer shrub, white leaf manzanita, bear clover, whitethorn, gooseberry, and green leaf manzanita. Shrub fields are areas large enough to be visible and easily distinguished from aerial photographs, generally larger than three acres. These shrub fields are identified as chaparral (found on soils not suitable for conifer growth) or montane chaparral (better soils suitable for conifer growth). The proposed action and reduction of harvest tree size alternatives proposed to plant trees on montane chaparral areas as part of existing openings and gaps. Gaps are small openings in the forest canopy. Some are distinct and can be mapped. Most; however, are small and only found after field review. Gaps are subject to the same effects of secondary succession as shrub fields; however, because of the small size gaps have more forest edge relative to the opening. This results in the neighboring intact forests having a strong influence on the growth of vegetation in the gap (York and others 2004).

<u>Competing Vegetation and Reforestation</u> - Plantations, shrub fields or existing openings proposed for reforestation and release treatment have a combination of montane shrub types (grasses, bear clover, *Ceanothus* and manzanita). The canopy cover of shrub species across the project's eight management units is displayed in Figure 3-5. A description of vegetation aggregations is displayed for each stand in project prescriptions. The complete set of shrub data is located in the project record. Competition from shrub cover that exceeds 20 percent severely curtails seedling survival and growth (McDonald

and Oliver 1984). This effect of decreasing survival and growth with increasing shrub cover has been noted by other studies (Powers and others 2004, Wagner and others 1989, Oliver 1984, McDonald and Fiddler 1989, Fiske 1984). The past 20 years of survival and growth data on plantations on the Sierra National Forest shows that areas dominated by shrubs limit conifer survival. Aggressive control of competing vegetation in previous uneven-aged reforestation groups have averaged 92 percent of acceptable stocking with less than 10 percent shrub cover and sixty-eight percent grass cover. Reforestation knowledge indicates that release treatments within the first five years have significant effects on survival and growth of conifers (Fiske 1981, Tappenier and McDonald 1996).

Figure 3-5. Average Canopy Cover



Average canopy cover of shrub species displayed by management unit and combined for all units

Secondary succession, shrub competition, and conifer survival have long been recognized as an important consideration in forest regeneration (Isaacs 1956). The practice of "high grading" or economic selection was conducted throughout western forests from the 1920s through the early 1960s. This is also true for the Kings River Project. This practice of high grading was criticized for the lack of control of competing regeneration; the resulting lack of adequate regeneration; and the removal of important phenotypes (Isaacs 1956). Later studies would confirm the importance of controlling competing vegetation within the first five years of conifer establishment (Fiske 1981, Powers and others 2004). Other studies have quantified the reduction in seedling survival and growth as a result of competing vegetation and overstory tree density. The project's alternatives can be compared by how they meet the need to maintain plantations and carry out reforestation.

Grasses - Grass plants initiate growth prior to conifers in the spring, gaining a competitive advantage for available soil moisture. This causes mortality and reduced growth of conifers. This is especially true of cheat grass (McDonald and Fiddler 1989, McDonald 1986, Larson and Schubert, 1969). Monitoring of reforestation site preparation and release units have determined that the control of shrub species provides additional soil moisture for both grasses and conifers. Grasses can successfully compete with conifers as well as oaks, for soil moisture, because they begin and end growth prior to conifers. Grasses and forbs make up approximately five percent cover. Grass and forb cover averages from less than one percent to as much as ten percent within the management units. Maximum grass cover does exceed more than 40 percent. A population of cheat grass is found in management unit Providence_4.

<u>Bear clover</u> – This species is found across all management units dominated by ponderosa pine and mixed conifer. Bear clover is found at low densities in dense stands beneath the forest canopy or fully occupying openings. Bear clover is also found in understories of existing shrub fields. Fire, hoeing, and machines have been used on the Sierra National Forest to remove the aboveground portion of bear clover; but due to the rhizome type root system, sprouting of plants occurred soon after treatment. Sprouts quickly reinvaded these treated areas. Survival of planted seedlings has been below desired stocking levels. Herbicide application has proven to be the only effective control method for bear clover on the Sierra National Forest. These results agree with reforestation research that indicates that, after three years, only 13 percent of planted conifers were alive in a study area with bear clover cover of less than 40 percent (Tappenier and Radosevich 1982). This contrasts with 71 percent survival in areas where bear clover was reduced by treatment. Over a 19-year span, only nine percent of the trees planted in an area with no vegetation control survived. Growth of surviving seedlings has also been impacted. In the same study, three-year-old seedlings with no bear clover competition were twice as tall as the seedlings with no vegetation control. A review of bear clover control measures by McDonald and others (2004) also indicate that treatments that kill bear clover rhizomes, such as herbicides, are the only effective control measure, while other treatments have been failures.

<u>Ceanothus -</u> Deerbrush (*Ceanothus intergerrimus*) is the most abundant species, but buckbrush (*Ceanothus cuneatus*), whitethorn (*Ceanothus cordulatus*), and little leaf (*Ceanothus parvifolious*) are also found in many units. Ceanothus species dominate in different management units. Deerbrush (*Ceanothus intergerrimus*) is found in Providence_1, Providence_4, Bear_fen_6 and North_soaproot_2. Whitethorn (*Ceanothus cordulatus*) is found across Krew_prv_1, Glen_meadow_1, Krew_bul_1 and El_o_win_1. Buckbrush is found on the drier sites in North_soaproot_2 and Providence_4. Existing deerbrush is four to twenty-five feet tall and buckbrush and whitethorn average three to six feet in height. Ceanothus species in existing openings are well established and have deep root systems. Deerbrush is found in combination with bear clover in the Bear_fen_6 Management Unit. Deerbrush and Bear Clover are often found dominating the understory of mixed conifer stands and pine plantations.

<u>Manzanita</u> - Manzanita (both whiteleaf and greenleaf) is another major competitive species found in the project area. Whiteleaf manzanita (*Arctostaphylos viscida*) germinates from seed; sometimes reaching densities of 4,000 stems per acre. Greenleaf manzanita (*Arctostaphylos patula*) germinates from seed, but also sprouts from the root collar after disturbance. Greenleaf manzanita is found in El_o_win_1, Krew_prv_1 and Glen_meadow_1. Greenleaf manzanita is often found in combination with *Ceanothus* species, dominating openings and understories. Whiteleaf manzanita dominates North_soaproot_2, Providence_1 and Providence_4. This species is often found in

combination with bear clover. These two species often form two-storied stands of shrubs with bear clover under dense canopies of whiteleaf manzanita.

Canopy Cover – Canopy cover is the measure of crown area that occupies the ground as seen from above a forest stand. Canopy cover is often combined with average tree size and vegetation type to describe wildlife habitat. The California Wildlife Habitat Relationship model (CWHR) is used to categorize habitat (Mayer and Laudenslayer 1988) across the project area.

Canopy cover is also a factor in crown fire. Agee (1996) and van Wagtendonk (1996) have both described forty percent canopy cover as a threshold for sustaining crown fires. Canopy cover alone is not a predictor of crown fire (Van Wagner 1977). Ground and ladder fuels, species, topography and overstory canopy cover are all factors in the initiation and movement of crown fires (Scott and Reinhardt 2001, Agee and Skinner 2005). Modeling efforts for the Sierra Nevada indicate that increasing canopy cover increases the potential for crown fire initiation (van Wagtendonk 1996, Holfenstien and others 2002).

Design criteria in the proposed action plans to maintain canopy density at the landscape scale, above 50 percent cover on 50 percent of acres capable of supporting dense large- and medium-sized trees. Criteria for Alternative 3 plans to leave 60 percent canopy cover on 50 percent of the acres capable of supporting dense large and medium trees outside the Wildland Urban Interface (WUI) zone. These acres would exclude chaparral, rock or soils not capable of supporting dense tree stands. The design criterion is proposed to balance the need for fuel treatment and restoration with protection and sustainability of spotted owl, fisher, and other wildlife habitat. Alternatives are compared against these two standards for the retention of canopy cover.

Density-Related Risk - Resilience is the ability of a forest to undergo disturbance and change and return to the same structure, function, forest type, and ecological processes. A healthy forest is one that has the ability to rebound from disturbance and maintain important forest structures after the disturbance (Kolb and others 1995). Alternatives that resist changes to canopy cover; large trees, and variable structures following wildfire or drought events are more resilient.

The western pine beetle (WPB) is the primary cause of mortality in ponderosa pine (Oliver 1995, Oliver and Uzoh1997). Fir mortality is typically linked to a combination of the fir engraver, density-induced stress, and pathogens (mistletoe and root disease) (Oliver 1995, Oliver and Uzoh 1997). These insects and pathogens are native to the project area. Insect attack and mortality has increased (relative to the historical forest) due to higher forest densities and reduced tree vigor resulting from many decades of fire suppression (Kilgore 1973, Savage 1994, Ferrell 1996, North and others 2005). More trees in dense forests are susceptible to insect and pathogen attack because increased competition for resources exists, particularly during extended drought.

The range in stand density for the transition from endemic insect attack to epidemic insect attack has been identified on the basis of stand density index (SDI). Stand density index is a relative measure of tree density based on the Self-Thinning Rule, also known as the 3/2 rule (Drew and Fleweling 1979). The 3/2 rule was first described in the Sierra Nevada (Rieneke 1933). "*Very simply, it proposes that all environments with finite resources whether that be a goldfish pond or an acre of ground can support a finite amount of liming biomass. Therefore, as individuals grow in size the number of individuals decline - an intuitive relationship* (Oliver and Uzoh 1997)." Maximum densities have been determined for Sierran tree species based on plot data (Dixon 1994, Oliver 1995). The transition from endemic insect mortality occurs well before the maximum SDI is reached (Oliver 1995, Oliver and Uzoh 1997).

Increasing the resistance to bark beetle attack and increased tree vigor is an objective of this project. Stand structure conditions that lead to attacks by western pine beetle and other insects that kill conifers are not completely understood. Studies indicate that stand density is one important factor in insect mortality and tree vigor (Miller and Keene 1960, Oliver 1995, Smith and others 2005). Other factors important for insect mortality and tree vigor are prolonged drought or injury and the presence of other diseases (Larsson and others 1983, Ferrel 1996). Tree density at the local tree or clump plays an important role in creating conditions suitable for insect attack (Miller and Keene 1960, Ferrel 1996). Some studies indicate that well established trees in the Southern Sierra Nevada use water held in rock fissures or water deep in the soil (Hubbert and others 2001). An inference that can be made from this research is that large trees are more resistant to drought and its effects.

Stand Density Index (SDI) allows for comparisons of tree density between different species and different site quality. Stand density index compares density to a reference maximum density. While SDI has been shown to have an ecological basis for site occupancy by tree species, recent information for intermountain and Cascade conifers indicates that it may underestimate the site occupancy by large trees and overestimate the occupancy by small trees in uneven-aged stands (Woodall, Fiedler, and Milner 2003). SDI has been shown to have implications for tree competition for site resources (Rieneke 1933, Drew and Fleweling 1979, MacCarter and Long 1986, Dean and Baldwin 1996). In addition, others (Oliver 1995) have described threshold levels for insect attack and tree vigor in the Sierra Nevada.

Insect mortality is possible (Oliver 1995, Oliver and Uzoh 1997) as SDI increases beyond 35 percent of maximum. Insect mortality is imminent when stand density increases beyond approximately 60 percent of maximum. Zones for the onset of tree stress do not predict when a tree or clump of trees may be attacked. This uncertainty is due in part to the unpredictable nature of drought and the random dispersal of insects. SDI at the plot level is used to display effects of alternatives on reducing the potential for insect mortality and reducing tree stress. Approximately 25 percent of measured plots currently exceed the threshold for epidemic insect attack. Approximately 70 percent of plots exceed values for endemic insect attack and reduced resistance to insect attack. Another measure used to compare the effects of alternatives is the numbers of trees removed from stands and the numbers of trees that remain. Comparisons are made at different diameter size classes for each alternative. While absolute numbers of trees do not reveal the relative dominance of trees, they can describe the direct effects of treatments on stand structure and large trees.

White pine blister rust (*Cronartium ribicola*) is found in the project area and is responsible for the death of sugar pine and western white pine (white pines). This introduced disease infects and kills white pines that lack the major gene that provides natural resistance. White pine blister rust is found in all eight management units. Infection rates are highest in the Krew-prv_1, Glen_meadow_1 and El_o_win_1.

Historic Forest Conditions

Sources of Data

This EIS uses various data sources to describe the historical condition within the Kings River Project. Historical conditions were examined at the landscape scale and the stand scale. The landscape scale represents how stand canopy varied across the large King River Project area. Landscape scale data is not available for the 1850 forest. The analysis of the landscape variability relied on literature that described the process that likely controlled stand structure. Canopy cover varied across the project's landscape based on aspect, site quality, slope, forest type, and fire return interval. Determinations of historical canopy were made using potential natural vegetation; site quality; historical descriptions; early photographs of the project area; aerial photographs (1940); early cruise data 1914 to 1926 (USDA 1926); and historical data sets. These determinations were inherently subjective.

The stand scale examines the variability of individual stand characteristics (trees per acre, basal area, and tree distribution). The analysis of historical conditions examined many data sets to determine historical conditions: existing unmanaged stands at the Teakettle Experimental Forest (adjacent to the project area); historical data from the turn 19^{th} century and the 1930s (Bouldin 1999, Hasel 1931, Minnich 1995, Sudworth 1900a, Sudworth 1900b Stephens and Fiske 1998); reconstructed stands (North and others 2006, Taylor 2003, Covington and others 1997); analogous relic mixed conifer forests at the Sierra San Pedro Martir in Baja California (Stephens and Gill 2005, Minnich 2000); and existing relic Sierra Nevada forests not subject to fire suppression (Oliver 2000) at the Beaver Creek Pinery. The analysis compared the data sets listed above to data sets for reconstructed ponderosa pine found in Montana (Arno and others 1995) and the Southwest (Covington and others 1997). Each type of data has limitations and shortcomings (Swetnam and others 1999, Stephenson 1999).

Figure 3-6. Historical Reference Conditions

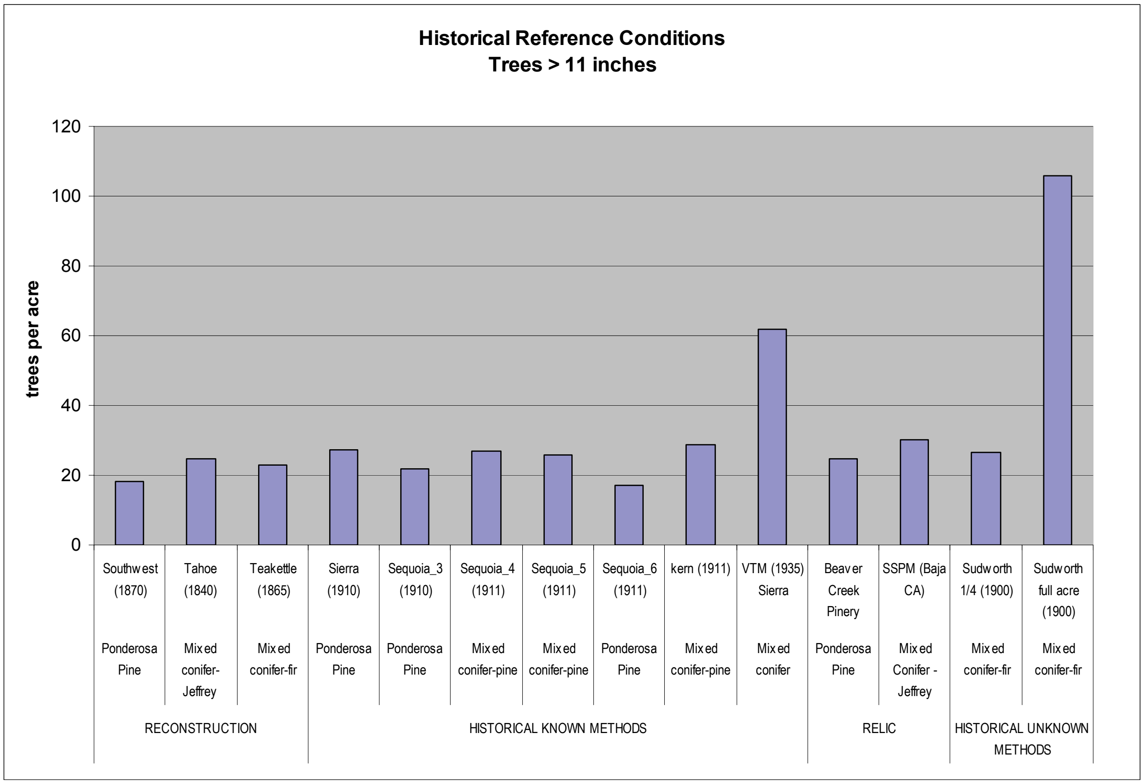


Figure 3-6 Trees per acre greater than 11inches are displayed for reconstructed forests, relic forests in the Sierra Nevada and Baja California, and historical data sets with known and unknown collection methods. These data sets indicate that historical forest structures had relatively few trees. They compare Sudworth's ¼ acre plots collected in 1900 to other data sets representing the historical condition. The comparison clearly shows that Sudworth's plots expanded to the full acre are not representative of the average historical condition.

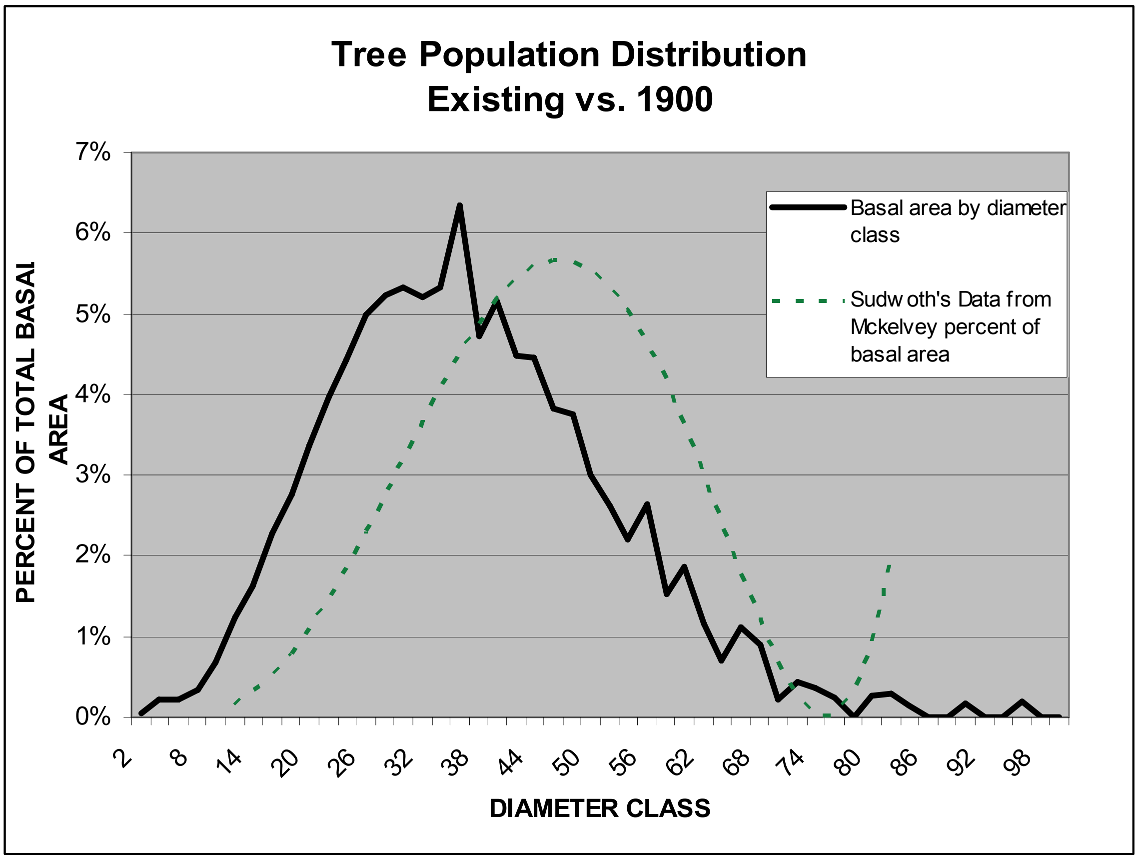
Historical data sets used in this analysis are those with both known and unknown methods of collection. Known methods include data from the 1930s for the Sierra Nevada and the transverse ranges of Southern California, and early 1900 data measured by Show and Dunning for the methods of cut studies (Hasel 1931). George Sudworth's ¼ acre plots from 1900 are a historical data set with unknown methods of collection (Mckelvey and Johnston 1992). Literature indicates these plots were likely biased and also that no clear understanding of the methodology used to collect them exists (Bouldin 1999, Stephenson 1999, Mckelvey and Johnston 1992). Stephens and Fiske (1998) narrowly describe the data at the full acre as representative of the sampled acres and not the broader Sierra. The analysis looked at the many other data sets to determine historical conditions and compared Sudworth's plots. This comparison of data by the most casual observation indicates that Sudworth's data expanded to the full acre does not represent the average historical forest vegetation structure. Figure 3-6 displays the various data sources on an equal basis and illustrates the difficulty with using Sudworth's 1900 ¼ acre plots.

Since Sudworth described the data as representative, observers are left with three options: expand the data to the full acre(Stephens and Fiske 1998), which is clearly not representative, only use tree population characteristics of his trees (Mckelvey and

Johnston 1992), or leave the data unexpanded (Sudworth 1900a). The third option is how Sudworth himself displayed a portion of his Southern Sierra data set in his USGS paper (Sudworth 1900b). His data was used at the population level and as unexpanded ¼ plots. Sudworth's data expanded to the full acre are shown for comparative purposes.

Figure 3-7 shows the percent of stem area occupied by diameter classes. The proportion of stem area (basal area) is displayed by diameter class for the population of measured trees in the Kings River Project's eight management units and those measured by Sudworth (1900a and 1900b) as analyzed by Mckelvey and Johnston (1992; 11J & 11L) representative of the Southern Sierra Nevada. The graph displays that the current Kings River Project area has more trees below 38 inches than were historically present in 1900.

Figure 3-7. Tree Size Distribution – Existing vs. 1900



General Character

Six conclusions about the pre-1850 historical forest prior to the influence of fire suppression and grazing can be made from available sources (Appendix A):

- The historical ponderosa/Jeffrey pine and mixed-conifer forests of the Kings River Project had relatively low tree densities
- Large trees dominated the historical forests of the Kings River Project with open stand conditions leading to the growth of very large trees (greater than 40 inches)
- The historical forest was greatly affected by frequent low intensity fire
- The historical forest had high heterogeneity within forest types and between forest types
- Historical forest stand structures were uneven-aged and found in groups that could be even-aged (Bonnickson and Stone 1982) or uneven-aged aged (North and others 2004)
- The historical mixed-conifer and pine forest had a lower frequency of shade-intolerant individuals than current forests

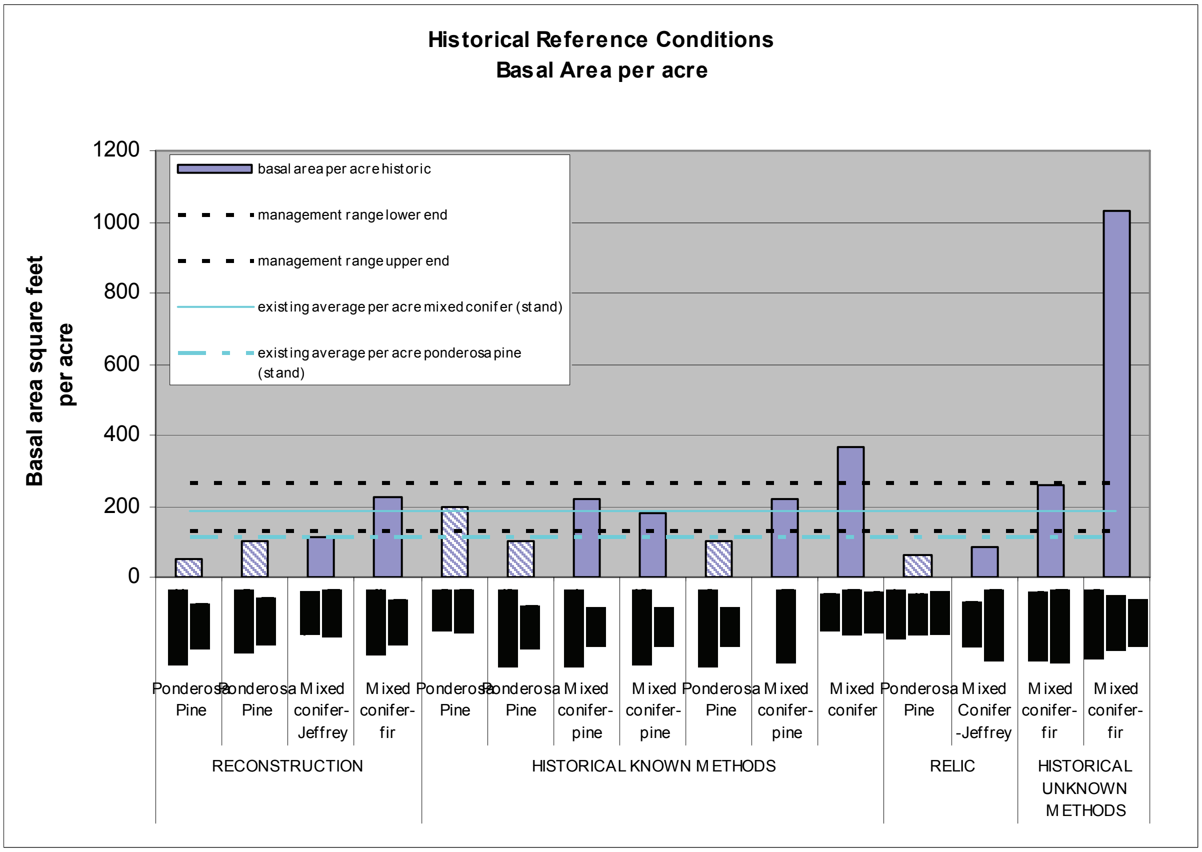
Current Condition vs. Historic Condition

Actions to achieve the desired condition would move the landscape distribution of trees closer to the historical distribution. No landscape data describing the distribution of tree sizes for the historical pre-1850 Kings River Project exist. McKelvey and Johnston (1992) described the distribution of trees measured in 1900 (Sudworth 1900b) for several ¼ plots in the Southern Sierra Nevada. Figure 3-7 displays the existing sample population of trees by percent of basal area across the project's eight management units and the population of trees described by McKelvey and Johnston (1992) of trees measured by Sudworth in 1900. Figure 3-7 indicates that trees smaller than those found in the historical forest dominate the growing space as measured in basal area and that an excess of trees below 38 inches exists compared to Sudworth's measured trees. The existing condition was determined from combining all plots and determining frequency by diameter class.

Figure 3-10 displays current conditions (tree numbers) for ponderosa pine and mixed conifer plots, proposed minimum and maximum range of trees per acre defined by an inverse J-shaped curve, reconstructed historical data sets, and relic forests. The figure shows that current conditions for pine exceed all historical, reconstructed, and relic forest structures. Mixed conifer stand data indicates that all but the Sudworth data at the full acre is currently exceeded.

Figure 3-8 displays the basal area management range for uneven-aged stands in the project area. The graph compares the existing average plot condition for ponderosa pine and mixed conifer stands in the Kings River Project's eight management units. The graph shows that the management range is higher than most of the historical data sets. The graph also shows that the current condition for ponderosa pine is higher than all but one of the historical data sets. This illustrates that while stem area remains similar to historical conditions stem numbers are much higher than historical conditions.

Figure 3-8. Historic Reference Conditions Basal Area per acre

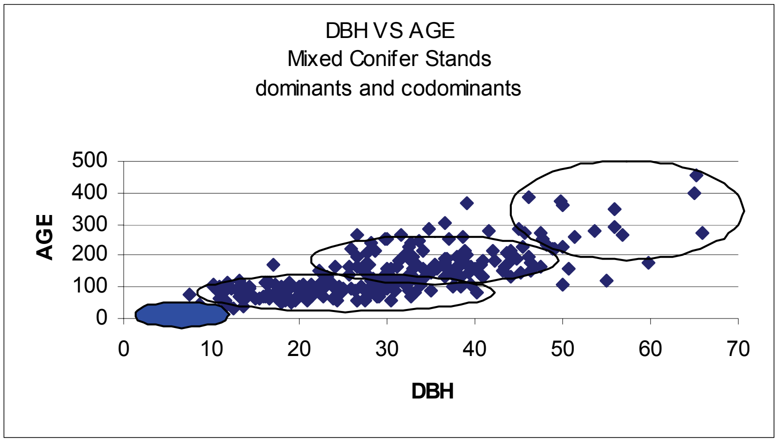


Basal area is displayed (for trees greater than 4”) of reconstructed historic forests, historic data sets with known and unknown methods, and relic forests of the Sierra Nevada and Baja California. The graph also displays the basal area management range for uneven-aged stands in the project area. In addition, the graph compares the existing average plot condition for ponderosa pine and mixed conifer stands, in the eight management units, to the reference data. The graph shows that the management range is higher than most of the historical data sets. The graph also shows that the current condition for ponderosa pine is higher than all but one of the historical data sets. This illustrates that while stem area remains similar to historical conditions stem numbers are much higher than historic conditions. (See Figure 3-10)

Comparisons of the basal area of the existing condition to several historic data sets indicate that existing basal area (stem area at 4.5 feet) varies by forest type. Current mixed conifer management units (Krew_bul_1, El_o_win_1, Glen_meadow_1, Krew_prv_1, and Bear_fen_6) contain about the same amount of basal area as the historical data sets, but with many more small trees than are represented in the historical data sets shown in Figures 3-8 and 3-10. Ponderosa pine-dominated management units (North_soaproot_2, Providence_1 and Providence_4) contain slightly more basal area than the historic data would indicate and also has more small trees.

Comparison of population level data shown in Figure 3-7 and stand level data in Figure 3-8 and Figure 3-10 would indicate that current conditions are denser than historic conditions. Management range is set some what higher than the historic condition. This is especially true for ponderosa pine. The higher range was adopted to meet canopy cover objectives for California spotted owl and Pacific fisher habitat.

Figure 3-9. Dbh vs. Age in Mixed Conifer Stands



The graph shows age vs DBH and the relative abundance of trees in the age sub-samples, with four cohorts represented, with the youngest age class a solid color.

Large Trees

Large trees dominated the historic Kings River Project landscape. Trees of all size classes were represented. Project alternatives that attempt to increase the dominance of large trees and maintain their persistence in the face of disturbances such as wildfire or insect attack attempt to maintain characteristics of the historic forest. Trees that are both large and old are important legacies. These large and old trees provide forest structure and have natural resistance to both fire and bark beetles. These trees occur at lower frequencies across the project area than in the historical forest.

The frequency distribution of sample trees indicates a decline in frequency with increasing size, as would be expected across such a large landscape as the Kings River Project area (O'Hara 1998). Figure 3-9 displays the age and size relationship in the project's eight management units. Trees over thirty-five inches, and certainly over forty inches, are both old (greater than 130 years) and occur at much lower frequencies than younger and smaller trees. A large cohort of sampled trees exist that are under thirty-five inches and greater than 30-inches in dbh and younger than 100 years. These trees have many replacements and have the potential to grow much larger with more growing space (Meyers 1938, Dunning 1942, Assmann 1970). The objective of the proposed action is to increase the dominance of trees over thirty five inches, by increasing the growing space available to them.

Data sets for Figure 3-10 indicate that historical forest structures had relatively few trees. They compare Sudworth's ¼ acre plots collected in 1900 to other data sets representing the historical condition. The comparison clearly shows that Sudworth's plots, expanded to the full acre, are not representative of the average historical condition.

Figure 3-10. Historical Reference Conditions Trees per acre

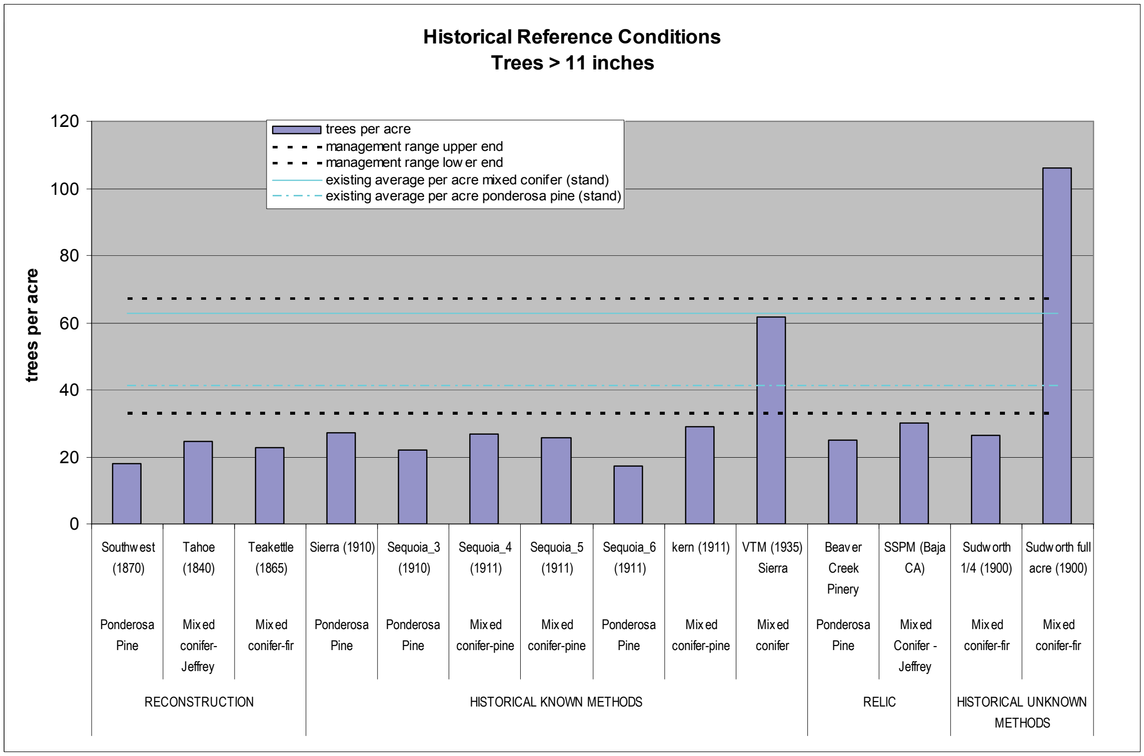


Figure 3-10 Trees per acre greater than 11 inches are displayed for reconstructed forests; relic forests in the Sierra Nevada; Baja, California; and historical data sets with known and unknown collection methods.

Measures used to compare effects of the project's alternatives are the numbers of trees removed from stands and the numbers of trees that remain. Comparisons are made at different diameter size classes for each alternative. Absolute numbers of trees do not reveal the relative dominance of trees. They can describe the direct effects of treatments on stand structure and large trees.

Tree Distribution

Creating uneven-aged stand structures that have a minimum of three age classes is an objective of the Kings River Project. Disturbance and succession drive all forests. The frequent low intensity disturbance of the 1850 forest also set the stage for stand initiation and understory re-initiation (Oliver and Larson 1996) and maintained stands in the stem exclusion phase. Stand initiation is caused by a disturbance that kills all large trees typically caused by fire or insects. That includes low intensity ground fire and occasional torching of crowns resulted in crown openings that provided a favorable environment for seedling establishment. Partial or low disturbance areas were left with an overstory which allowed for invasion of the understory or understory re-initiation. Understory re-initiation occurs when understories are invaded by shade-tolerant shrub or trees. This is the case in which disturbance leads to the regeneration of more shade-intolerant species (pines and oaks) and can result in an inverse J-shaped curve (Oliver 1995). However, other distributions are possible (Oliver 1995). Scale is important in defining distribution. A normal distribution may be found by looking at only one opening. One of many distributions including the inverse J-shaped curve may be found when looking at a portion of a stand with partial disturbance. Stands are more likely to produce an inversed J-shaped curve when both the opening and partially disturbed areas are looked at. Young trees invading the understory fill in the lower end of the inverse J-shaped curve and older trees left after a disturbance fill in the upper end. This pathway of frequent low intensity disturbance is the pathway associated with the silviculture strategy for the Kings River Project.

Table 3-4. Tree Size Distribution of Forest Conditions

Data type	Forest Type	Data Set	Distribution
Reconstruction	Ponderosa Pine	Montana	modal, flat
	Mixed conifer-Jeffrey	Tahoe	skewed modal
	Mixed conifer-fir	Teakettle	flat
Historical Known Methods	Ponderosa Pine	Sierra-methods of cut	inverse J-shaped
	Ponderosa Pine	Sequoia_3-methods of cut	inverse J-shaped
	Mixed conifer-pine	Sequoia_4-methods of cut	inverse J-shaped
	Mixed conifer-pine	Sequoia_5-methods of cut	inverse J-shaped
	Ponderosa Pine	Sequoia_6-methods of cut	inverse J-shaped
	Mixed conifer-pine	Kern-methods of cut	inverse J-shaped
	Mixed conifer	Sierra VTM (1935)	various mostly inverse J-shaped
	Mixed Conifer -Jeffrey	So Cal VTM (1932)	flat
	Mixed conifer-fir	So Cal VTM (1932)	inverse J-shaped
Relic	Ponderosa	Beaver Creek Pinery	skewed modal
	Mixed Conifer -Jeffrey	SSPM (Baja CA)	various mostly inverse J-shaped
Historical Unknown Methods	Mixed conifer-fir	Sudworth 1/4	skewed modal
	Mixed conifer-fir	Sudworth full acre	skewed modal

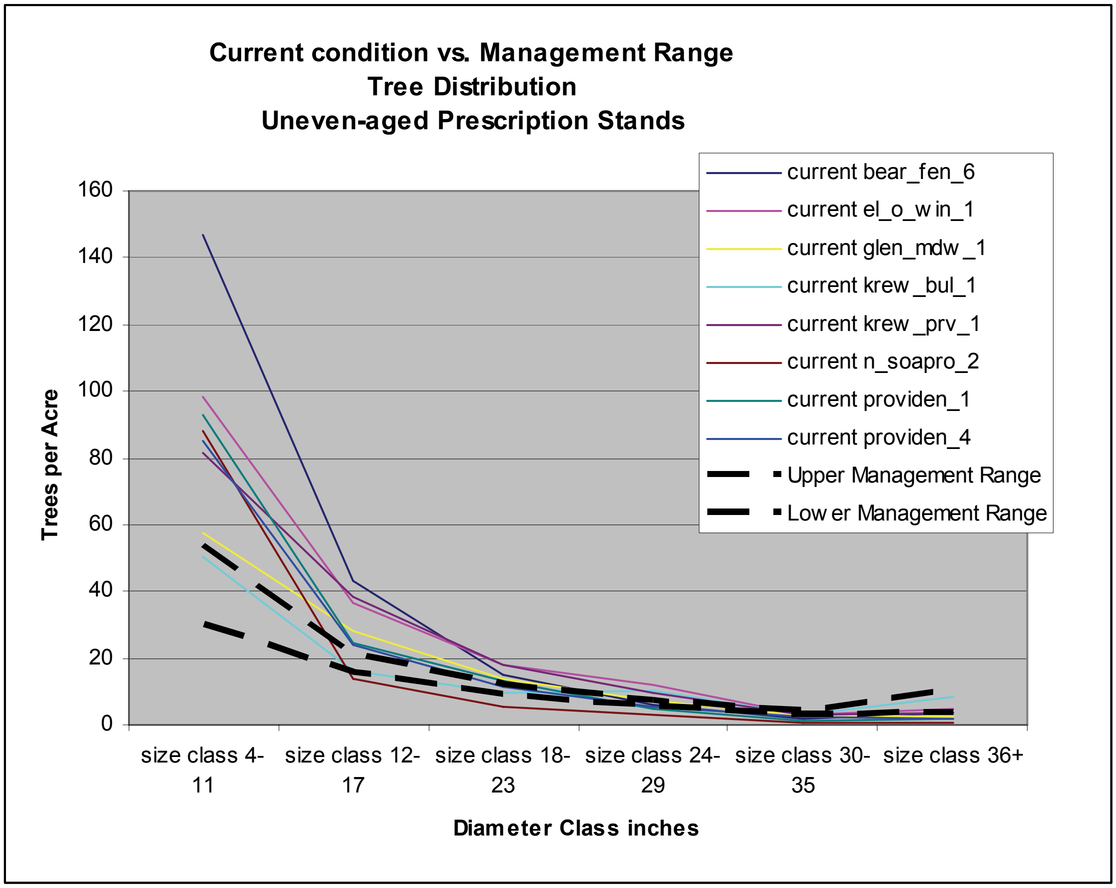
Distribution types of historic data prior to both effective fire suppression and logging

The Kings River Project proposes to use the inverse-J shaped curve for trees 11 inches dbh or greater as a tool to achieve uneven-aged stands. Uneven-aged stand conditions were prevalent in the historical 1850 Sierra Nevada forest (Bouldin 1999, Bonnickson and Stone 1981, North and others 2004). Several tree distributions have been suggested as representative of this historical condition. North (2005) has suggested the rotated sigmoid. Reconstruction of 1865 forest structures in the Teakettle Experimental Forest (adjacent to Krew_bul_1 management unit) indicates that a relatively flat tree distribution existed after the last major fire (North and others 2006).

Mckelvey and Johnston (1992) display data collected by Sudworth in 1900, showing a highly skewed distribution with more small trees than larger trees. Bouldin's (1999) review of the earliest sierra wide data set (VTM 1935) suggests that distributions with decreasing numbers with increasing size were dominant. Minnich's (1999) review of similar VTM data, in Southern California mixed conifer forest, showed flat and inverse J-shaped distributions. Data from un-harvested mixed conifer and ponderosa pine stands (c1910) on the Sierra Forest Reserve (Hasel 1931) indicate an inverse-J shaped distribution was prevalent. Data from relic forest in Baja California Sierra San Pedro Martir (Stephans and Gill 2004) indicate that the dominant tree distribution was inverse-J shaped. Relic ponderosa pine forest in the Sierra Nevada structures had a flat distribution following high intensity fire (Oliver 2001), and an inverse J-shaped distribution prior to high intensity fire (Knapp 2006). Ponderosa pine stands across the western United States also show this variability (Arno and others 1995, Covington and others 1997). Table 3-4 displays the tree distribution of several reconstructed forests, historical data sets with known data collection methods, and historical data with unknown methods. The table indicates that eleven of the fifteen data sets have an inverse-J shaped curve or a highly skewed distribution. That is, they exhibit a generally decreasing numbers of trees with increasing tree size, similar that proposed in the project's uneven-aged management strategy.

Current stand structures range from uneven-aged to even-aged. They are the result of past disturbance (harvests, wildfire, prescribed fire, and insects). Graphs that display the distribution of trees by 2-inch diameter class of each stand are found in the project file. Most stands exhibit declining numbers of trees with increasing tree size. Only a few stands exhibit balanced uneven-aged structures with trees found in each diameter class. Most stands exhibit a structure that has several diameter classes not represented. Several stands exhibit an even-aged distribution. Figure 3-11 compares tree distributions in each management unit to the desired management range.

Figure 3-11. Current Condition vs. Management Range



Current tree distribution for each management unit and the desired management range (minimum and maximum range of desired condition) are displayed. The desired condition for an individual stand is determined by aspect, slope, forest type, habitat objectives and fire allocation (defense, threat or DFPZ)

Landscape Variability

Canopy cover varies across the project landscape based on aspect, site quality, slope, forest type, and fire return interval (Appendix C). Determinations of historic canopy characteristics were made using potential natural vegetation; site quality; historical descriptions; early photographs of the project area; aerial photographs (1940); early cruise data from 1914 to 1926 (USDA 1926); and data collected in the early 1900s. These determinations were inherently subjective. The proposed action and alternatives are compared against the desired landscape canopy cover heterogeneity and the creation of uneven-aged stand structures. These two attributes (uneven-aged and heterogeneity) describe the heterogeneity between stands and within stands that was typical of the historic forest.

Information from Appendix C, on the variability of canopy cover for the historic forest, indicates that dense and moderately dense canopy cover dominated 33 percent of ponderosa pine forests; 65 percent of mixed conifer forests; and the remainder of each type in open or sparse conditions. Information from Bonnickson and Stone (1982) indicates that approximately 30 percent of the mixed conifer forest they analyzed was dominated by grass, bare ground, and shrubs with 70 percent in dense and moderately dense tree cover. Values of mixed conifer pine in the project area are similar to that of Bonnickson and Stone (1982). Current mixed conifer forest is 90 percent dense and moderately dense canopy cover. Current ponderosa pine forest types have approximately 80 percent dense and moderately dense canopy cover.

Heterogeneity is also been described for reconstructed historical Sierra Nevada forests (Taylor 2004, North and others 2004) as well as described by early observers (Dunning 1923, Meyers 1939). Heterogeneity is achieved in the project area by assigning variable residual canopy targets across the landscape that result in variable residual density and by creating single storied or multi-storied stands. In addition, the uneven-aged management strategy maintains trees in all size classes and tends to create heterogeneous forest structures (Oliver and Larson 1996).

Implications for Management

These conclusions have several implications for management. Regeneration should be in groups; uneven-aged stands should be promoted; and fewer shade-intolerant species and more species resistant to fire such as pines should be favored. Growth should be concentrated on large trees. Regeneration should occur episodically rather than continuously. Variability across the landscape should be promoted. Very large trees, greater than 40 inches occurred often and developed in open stands. Management to create open stand conditions can lead to the growth of these very large trees. Frequent fire should be utilized as an important process to maintain historical forest structures. Open and moderately dense canopy cover should dominate across the landscape.
Simply imposing an inverse J-shaped curve does not create uneven-aged structures or restore the historical condition. Uneven-aged structures, as discussed above result from partial disturbance and the inclusion of different age classes after disturbance. The inverse J-shaped curve, as defined by the BDQ method, is a tool. Field application of the uneven-age silviculture prescription requires choices between species, crown position, age class, tree vigor, and size (Guldin 1995). Crown position requires the recognition of different cohorts (age classes) in the matrix so that suppressed and intermediate trees are not retained. This also results an accentuated age class division in the matrix or allowing layering in other areas. Minimum basal area retention is required to maintain structure and disperse removals across the stand. The desired diameter distribution implies removal or retention targets, by diameter class. Regeneration groups are applied to accentuate existing openings, or cohort groups, were they exist. The resulting stand is one that conforms to an inverse J-shaped curve that accentuates the age classes that currently exist and creates additional age classes in small openings, consistent with the historical forest.

The uneven-aged management strategy uses the desired diameter distribution for trees between 11 inches and 30 inches to 35 inches in diameter, depending on the alternative, and regeneration in groups, to promote heterogeneity and homogeneity, were appropriate. Prescribed fire is then applied where appropriate, and functions as a tool to reduce fuel accumulations, kill small trees (mostly fir and cedar) and shrubs, and reinitiate frequent fire. Fire is important to the project's uneven-aged management strategy because it tends to suppress the number of small trees. An important note is that planted openings are protected from prescribed fire by fire lines or by planting after the initial burns or both. Application of the inverse J-shaped curve does not explicitly manage trees below 11 inches, tree removal based on spacing and fire determine the desired trees below 11 inches. Trees in these lower diameters are managed to remove fuels ladders or provide layering for wildlife.

Current Landscape Activities

Current landscape activities are those actions in the Kings River Project area that have current decisions or ongoing activities that contribute to cumulative effects on vegetation. These current projects include plantation maintenance, underburning, roadside hazard tree removal, and power line maintenance. Residential development, timber harvesting and vegetation management is carried out on private land holdings inside the project area. Please see the section on past, present, and reasonably foreseeable projects near the beginning of Chapter 3 for a complete description.

Approximately 10,106 acres of plantations exist across the project area. Approximately 2,319 acres have ongoing treatments with current decisions. Current plantation activities include: thinning, hand release, chemical release, and planting.

The South of Shaver fuel hazard reduction thinning project completed harvest in 2006 and is now undergoing steps to further reduce fuels with the use of prescribed fire. Tree sizes removed were generally less than twenty inches in diameter. Four stands removed trees up to a maximum diameter of thirty inches.

The Wildlife Habitat Improvement project, currently underway, has resulted in 125 acres of shrub piling in Blue Canyon.

The proposed action would treat 1,321 acres of plantations in 2006, 2007 and 2008. An additional 2,578 acres of plantation maintenance are planned for treatment in other decision documents. The remaining plantations are planned for future activities and are not yet included in NEPA decisions.

Roadside hazard projects are used to abate the hazards posed by damaged, dead, or weakened trees found along roads. Commercial timber sales are used to abate hazardous trees. Removal may take place within 300 feet of a road surface. The distance of tree removal is dependent on the likelihood of trees to strike roads or block traffic. Tree removal is focused on weakened or dead trees. Roadside hazard removals treated approximately 90 miles of road in 2003 and 2004 and removed 1,734 trees from the project area. Rot or mortality is the primary causes for tree removal. Trees larger than 24 inches in diameter are often removed. Trees with excessive rot or those with no commercial value are felled and left in place.

The Helms/Gregg 230 kV Transmission Line right-of-way runs across the southern boundary of the project area. The right-of-way for this transmission line occupies approximately 371 acres. Maintenance of vegetation within this right-of-way includes spraying herbicides to reduce large vegetation, felling of hazard trees, and cutting vegetation. Vegetation objectives for the transmission line are to maintain a cover of low-growing vegetation that provides soil cover and early seral stage wildlife habitat. Hazard tree removal, and right of way clearing in 2006 has removed over 500 trees less than 10 inches, 324 trees from 10 inches to 29 inches, and 206 trees over 30 inches. Herbicide spraying, shrub cutting and tree cutting occurred on 399 acres underneath the power line in 2005 and 2006.

Southern California Edison and several private individuals own approximately 15,000 acres of land within the project boundary. Southern California Edison lands are managed using an uneven-aged silvicultural system that conforms to California's Forest Practice Act. Grand Bluffs and Twin Ponds properties are owned by private individuals. Grand Bluff property owners have a cooperative fuel reduction grant from the Forest Service and the State of California. Landowners are coordinating fuel reduction activities with the Forest. Grand Bluff's Private holdings are adjacent to the Power 1 thinning and Krew_prv_1, and Providen_4 projects.

Approximately 1,500 acres are harvested each year from Southern California Edison lands, yielding approximately five million board feet annually. Harvesting occurs across all diameter classes. Tree removal has no size limit. Typical prescriptions remove about thirty percent of the standing stem area. However, requirements for the protection of "old-growth" are part of timber harvest plans. Tree removal is accomplished using tractor logging on slopes less than 40 percent, and helicopter logging on steeper slopes.

Development on private lands (Wildflower Village) will create single-family homes across 160 acres. This area has been logged in the past. Home site construction will permanently remove trees from forest cover. Adjacent forests are typically left intact following construction.

Environmental Consequences of Current Landscape Activities Common to All Alternatives

Plantation treatments reduce shrub cover below 20 percent through directed spray of an herbicide containing glyphosate; hand release; tractor piling; and mastication. Thinning is accomplished using hand cutting and machines. Plantations younger than 15 years have slash lopped and scattered. Older plantations have thinned material piled, shredded, or removed from the site. Current decisions remove plantation trees less than 55 years old. Spacing ranges from 18 feet to 24 feet in older plantations. Canopy cover is reduced in all plantations. However, since canopy cover is composed largely of trees less than 12 inches changes would not affect meeting the fisher canopy goal of 50 percent cover in CWHR size trees 4 and 5. The Bretz and Power 1 thinning projects remove trees as large as 20 inches in diameter. These two plantation projects include reductions in tree density from sixty percent to 45 percent in CWHR size 2 and 3. The effects of treatments are to accelerate tree growth. Trees grow larger, but do not contribute to the pool of trees over 30 inches during the thirty year analysis period. The effects of severe fire are reduced due to lower surface fuel resulting from fuel treatments, lower shrub cover, and increased space between trees. This increased space improves tree vigor and increased resistance to insect attack. Plantation treatments move stands along a growth trajectory that accelerates tree size. Larger trees are consistent with the historic condition.

Experience with the Kings River Project's underburning program indicates that prescribed fire would tend to reduce surface fuel loading after two burns. Few medium or large size trees would be removed; however, the many small trees removed could increase insect habitat and result in pockets of insect mortality. The reintroduction of fire into the ecosystem through the 17,300 acre burn program is consistent with the goal of restoring more resilient forest conditions.

Hazard tree removal results in the removal of approximately 250 trees greater than 30 inches each year. The scattered nature of these weakened or unstable trees produces no measurable effect on canopy cover. Trees typically are removed in groups of one to three trees. The net effect, on trees greater than 30 inches, is a reduction of less than 0.01 trees per acre. Hazard tree removal does remove large fuel from the roadside that could increase fire intensity; however, the overall effect on potential fire mortality is small due to the few trees removed. The removal of hazard trees would not lower tree density or remove disease vectors sufficiently to lower or increase the resistance to insect attack. The removal of large old trees that may contain rot moves the landscape further from the historic condition. The effect across the landscape on the historical condition is low since so few trees are removed.

The largest private landowner in the project area is Southern California Edison (SCE). The effect of implementing the SCE uneven-aged silvicultural system is to reduce canopy cover. Canopy cover typically remains above fifty percent. Private landowner treatments should not reduce the number of acres meeting the fisher goal. Reductions in surface fuel, ladder fuel, and more open canopy density would reduce fire severity across approximately 1,500 acres each year. The entire SCE property should be treated in 10 to 15 years. Reduced tree density would increase tree vigor and tend to reduce successful insect attacks. The uneven-aged management strategy used by SCE should increase the acres that meet the historic condition.

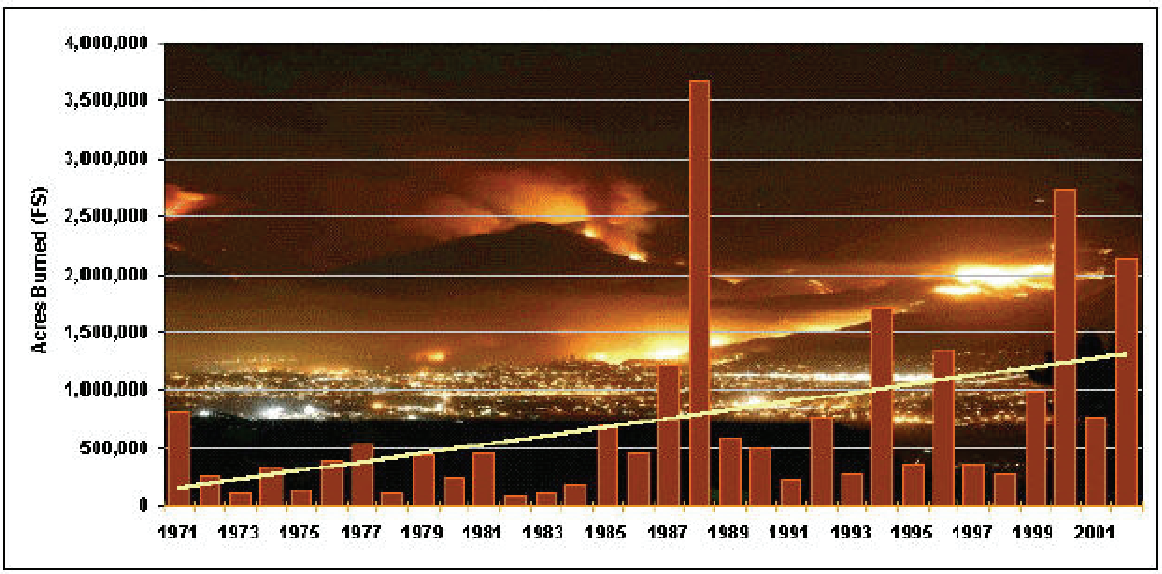
Power line treatments would continue to keep these areas dominated by early shrub and grass. Power lines reduce the number of acres available to grow large trees and meet historic forest conditions.

The South of Shaver fuel reduction project applies thinning from below to reduce tree density. Treated stands should remain below the imminent risk of insect attack threshold. No regeneration of openings occurs in this project; however, the prescription favors pine and oaks over incense cedar and white fir. Treated stands should experience small increases in pine and oak species; significant reductions in tree numbers (from more than 600 to less than 200 trees per acre); and increased resistance to severe fire effects over time. Underburning and tractor piling would be used to lower shrub cover.

Fuel – Fire Behavior

Wildfires have increased in both number and severity on California forest land, often killing trees over extensive areas, well in excess of historic patterns. Striking changes in structural and functional components of Sierran ecosystems have occurred since 1860, largely due to alternations in the pre-Euro-American settlement fire regime. Today, unnatural fuel accumulations occur in many fire-dependent forest ecosystems along with associated increases in forest stand densities. Changes in fire regime characteristics have come with these shifts. Changes include large stand-destroying fires (Caprio and Graber 2000). Successful fire exclusion over the past 60 to 70 years coupled with prolonged drought and epidemic levels of insects and diseases have coincided to produce extensive forest mortality and increases in forest fuel. Increased stand densities and fuel have led to an increase of crown fire potential (Mutch and Cook 1996). The occurrences of severe large fires are well outside the natural range of variability and thus considered detrimental to Sierra Nevada ecosystems (Weatherspoon and Skinner 1995). According to Scott Stephens (2005), annual wildfire acres in the western United States have increased in the last 60 years, where California has experienced the highest amount of acres burned from 1940 to 2000.

Figure 3-12. Escalating Wildland Fire Acres Burned (Forest Service Only) (www.fireplan.gov, 2004)



"The best general approach for managing wildfire damage seems to be managing tree density and species composition with well-designed silvicultural systems at a landscape scale that includes a mix of thinning, surface fuels treatments, and prescribed fire with proactive treatments in areas with high risk to wildfire," (Graham and others 1999) and the maintenance of those treatments.

Species composition has changed from fire-adapted to fire-intolerant. Fire intolerant species tend to form unhealthy stands prone to large-scale wildfires, as well as to increased outbreaks of disease and insects (Graham and others 1999). Dry site, low elevation ponderosa pine forests in the Sierra Nevada are classified as fire regime. A natural fire regime is classified as the role fire would play across a landscape in the absence of modern human mechanical intervention and is a generalized description of the fire's role within a vegetation community. Three condition classes are described for each fire regime and are based on a relative measure describing the degree of departure from the historical natural fire regime I; mid-elevation mixed conifer forests are typically fire regime III; and high elevation true fir forests are characterized as fire regime IV. Seventy-two percent of the project area is classified as Condition Class 2 and 3, with uncharacteristic conditions that are moderately or highly-departed from the natural fire regime (see Table 3-5).

The historic low-severity fire regime which dominates the project area was one of high frequency – low intensity fire in the ponderosa pine forest, transitioning to mixed severity in the mixed conifer forest and to one of low frequency – mixed intensity in the true fir forest (Brown and Smith 2000). Fire suppression efforts in the last century have changed the landscape and the historic fire regime. Fire history and tree ring studies in the Kings River Project suggest a historical fire return interval of every 3 to 5 years (Drumm 1996, Phillips 1998). The Kings River Project has missed several fire entries, possibly as many as 20 low intensity fires. The project area has become overstocked with fire-intolerant trees and shrubs due to the lack of frequent low-intensity fires, converting it to a fire-susceptible forest type in which high-intensity fires are prevalent.

Table 3-5. Current Fire Regime Condition Class

Fire Regime	Condition Class	Acres	Percent land area
I	1	3731	2%
I	2	38288	22%
I	3	74419	44%
III	1	15767	9%
III	2	20331	12%
III	3	8	0% (.004%)
IV	1	17065	10%
IV	2	823	1%
IV	3	0	0

The risk of ignition is increasing within the WUI with the intensified development of private land adjacent to and within the forest and the project area. Dense stands of trees, choked with an understory of fire-intolerant thickets of incense cedar, fir and manzanita exist within feet of homes in the WUI (see property layer - district files). The radiation and heat exposure from a wildland fire in the WUI would threaten homes and increase their likelihood of becoming a fuel source. Cohen identifies homes as potential fuel and indicates the distance between the wildland fire and the homes is an important factor for structure ignition (Cohen 1999, Cohen and Stratton 2003). We have no control over the ignitability of homes in the WUI; however, we can change the landscape directly adjacent to homes in the WUI and influence the resulting fire behavior in the event of a wildfire.

Fire and Fuel Existing Condition

Existing vegetation – Ponderosa pine (28 percent) and Sierra mixed conifer (43 percent) are the dominant vegetation types within the project's eight management units. Types that occur less frequently include chaparral (5 percent), montane chaparral (2 percent), montane hardwood (8 percent), montane hardwood conifer (3 percent), red fir (3 percent), barren (7 percent), and other CWHR types (32 percent). Shrubs are a dominant component. This is especially true in ponderosa pine and Sierra mixed conifer stands. Mixed conifer stands average 24 percent shrub cover, in ponderosa pine stands shrub cover ranges from 0 to100 percent with approximately half the plots containing greater than fifty percent shrub cover.

Fire Behavior – Ponderosa Pine Type **-** This vegetation type occurs primarily in the Providence_1, Providence_4, and North_soaproot_2 Management Units. Small pockets also occur in the Bear_fen_6 Management Unit. One or more of these management units could burn on any hot windy summer day.

Figure 3-13. Ponderosa Pine/Shrub

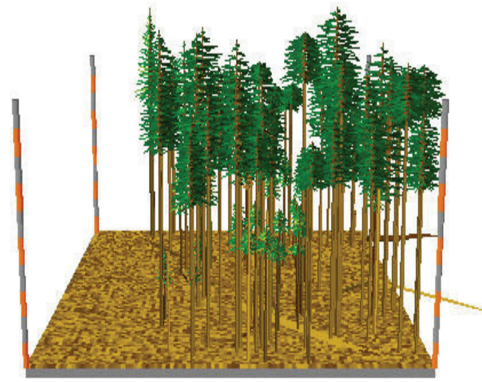
Existing Condition

Figure 3-14. Providence_1

Existing Condition

Figure 3-15. Ponderosa pine/Shrub Thinned

Figure 3-16. Ponderosa Pine/Shrub Year 2025



Figures 13-16 are examples of treated and untreated ponderosa pine stands in Providence_1, Providence_4, and North_soaproot_4. 28 percent of the project area is represented in stands like this.

Heavy surface fuels (about 16 to 50 tons per acre) coupled with dense shrubs (bear clover and manzanita) provide for a continuous fuel bed in ponderosa pine. Large shrubs (white leaf manzanita and deerbrush) and dense pockets of sapling-sized incense cedar and white fir make up the understory vegetation. This dense understory canopy (ladder fuel) and the crown base height ranges from 0 to 5 feet. Ponderosa pine and black oak dominate in the overstory with canopy cover ranging from 30 to 70 percent.

Fire behavior can be characterized by high intensity surface fires in untreated stands. Torching of trees (passive crown fire) is likely with some active crowning possible depending on wind conditions. Fires of this type would result in mixed to lethal mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 10 to 95 percent in both moderate and severe fire weather conditions. Potential fire behavior in this vegetation type was modeled using Behave (surface fires), FlamMap (crown fire risk) and in the Fire and Fuels Extension of FVS (surface and crown fires). All three models use established published methodologies for computing crown bulk density, fire behavior, predicted scorch, and mortality. Flame lengths range from 2 to 24 feet in height when fine fuel moistures are at three percent; mid-flame (eye level) wind speeds range between 8 to14 miles per hour (with gusts to 20 mph); and rates of spread ranged from 22 to 93 chains (surveyor's chain of 66 feet) per hour. Modeling showed passive to active crown fire possible under severe fire weather conditions (97th percentile). This fire behavior is likely to occur over 80 percent of the time during the summer months (Fire Family Plus *Mountain Rest weather station*).

Two recent wildfires within the same vegetation type on the Sierra National Forest have exhibited these outcomes. Both wildfires occurred in August 2001 under 90th percentile (high fire weather) conditions in the WUI. The Musick Fire started on August 17 and the

North Fork Fire on August 21, 2001. Weather conditions for August 17 and 21 matched the historical 90th percentile conditions for the Mountain Rest weather station. The vegetation type for both fires was ponderosa pine with a shrub understory, very similar to ponderosa pine types in the Kings River Project area. The Musick Fire experienced 80-foot flame lengths after the humidity dropped to below 12 percent with no wind at 3:00 A.M. on the morning of August 18. Active and rapid crown fire spread made suppression of the fire hazardous and all crews were pulled from the line (personal communications). The North Fork fire became an active crown fire within minutes of ignition and was greater than 100 acres in size within an hour. One home was lost and hundreds were threatened over the several days the fire burned (Moore, 2001). High fire intensity levels were experienced over 27 percent or 1,106 acres of the fire area. Tree mortality was severe in these areas. Strong hydrophobic conditions (soil water repellency) were also created in the high intensity burn areas. The consequences of this high intensity fire are the loss of habitat; the potential for strong overland water flows; and debris slides in the South Fork of Willow Creek and in Peckinpah Creek (Roath and Prentice, 2001). Similar consequences are predicted in the Kings River Project if a fire were to start under similar conditions.

Figure 3-17. North Fork fire, 08/01

Rick Moore

Figure 3-18. North Fork Fire 12/18/01

Mike Pasillas

Fire behavior can be characterized by low intensity surface fire in treated stands. Torching of trees is infrequent and only where fuels were left untreated for topological reasons or habitat concerns. Fires of this type may result in low to mixed mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 0 to 30 percent loss in both moderate and severe fire weather conditions. Flame lengths range from 0 to 7 feet in height when fine fuel moistures are at three percent; and mid flame (eye level) wind speeds range between 8 to 14 miles per hour (with gusts to 20 mph); rates of spread ranged from 0 to 4 chains per hour. Modeling showed surface to passive fires possible under severe fire weather conditions (97th percentile).

Fire Behavior – Sierra Mixed Conifer

Sierra mixed conifer occurs primarily in the Krew_prov_1, Glen_meadow_1, Elo_win_1 and Bear_fen_6 Management Units. One or more of these management units could burn on any hot windy summer day.

Figure 3-19. Sierra Mixed Conifer Condition

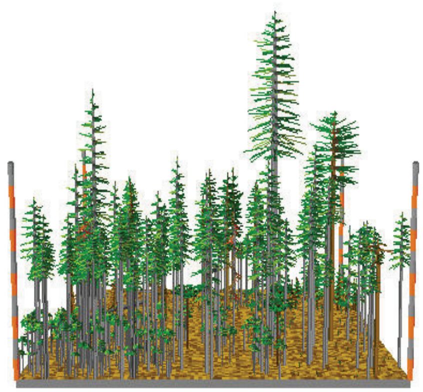


Figure 3-20. Bear_fen_6 Existing

Figure 3-21. Sierra Mixed Conifer Thinned

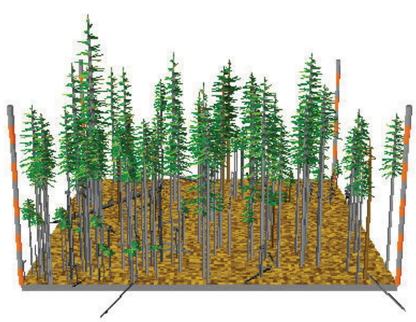
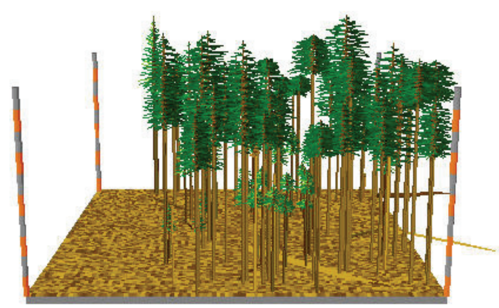


Figure 3-22. Sierra Mixed Conifer Year 2025



Figures 19-22 through 3-34 are examples of treated and untreated Sierra mixed conifer stands in Krew_prv_1, Glen_meadow_1, Elo_win_1 and Bear_fen_6. 43 percent of the project area is represented in stands like this.

Heavy surface fuel (16 to over 50 tons per acre), coupled with moderate shrub growth, provide for a continuous fuel bed in Sierra mixed conifer; large shrubs (greenleaf manzanita and whitethorn) and dense pockets of sapling size incense cedar and white fir, dominate the understory and openings. Crown base height ranges from 0 to 5 feet. The overstory canopy is a mix of white fir, incense cedar, ponderosa pine and sugar pine with canopy cover ranging from 10 to 70 percent.

Fire behavior can be characterized by high intensity surface fires in untreated stands. Torching of trees (passive crown fire) is likely with some active crowning possible depending on wind conditions. Fires of this type may result in mixed to lethal mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 6 to 60 percent loss in moderate fire weather conditions and 6 to100 percent loss in severe fire weather conditions. Flame lengths range from 7 to 66 feet in height when fine fuel moistures are at three percent. Mid-flame (eye level) wind speeds range between 8 to15 miles per hour (with gusts to 22 mph), and rates of spread ranged from 66 to 118 chains per hour. Modeling showed passive to active crown fires possible under severe fire weather conditions (97th percentile).This fire behavior is likely to occur over 90 percent of the time during the summer months (Fire Family Plus *Fence Meadow weather station*).

The Rock Creek fire started on August 18, 1981 in the upper portions of the Dinkey Creek drainage in mature mixed conifer forest. The fire narrative states that winds were upslope at 15 to 20 miles per hour. Relative humidity was less than 20 percent and the temperature was 80 degrees Fahrenheit. These conditions are a near match for 97th percentile at the Dinkey Creek weather station (Temp-81F, Rh (min), 13 percent, winds at 15 mph). The rate of spread exceeded 80 chains per hour when district personnel arrived. The fire was crowning in mature timber and spotting up to ¾ miles ahead of the main front (District Records). The fire grew to over 1,000 acres in the first day. The final fire size was 1,155 acres. No records exist of the severity or the tree mortality but personal observations, revealed over 90 percent of the area had 100 percent mortality.

Figure 3-23. Rock Creek Fire area 20 Years Later (2001)

Fire behavior can be characterized by low intensity surface fire in treated stands. Torching of trees is infrequent and only where fuels were left untreated for topological reasons or habitat concerns. Fires of this type may result in low to mixed mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 0 to 24 percent loss in both moderate and severe fire weather conditions. Flame lengths range from 0 to 7 feet in height when fine fuel moistures are at three percent; mid flame (eye level) wind speeds range between 8 to15 miles per hour (with gusts to 22 mph); and rates of spread ranged from 0 to 4 chains per hour. Modeling showed surface to passive fires possible under severe fire weather conditions (97th percentile).

Fire Behavior – Red Fir

Red fir occurs primarily in the Krew_bul_1 Management Unit. This unit is the least likely to experience burning on a hot windy summer day.

Figure 3-24. Red Fir Existing Condition

Figure 3-25. Krew_bul_1 Existing Condition

Figure 3-26. Red Fir Thinned

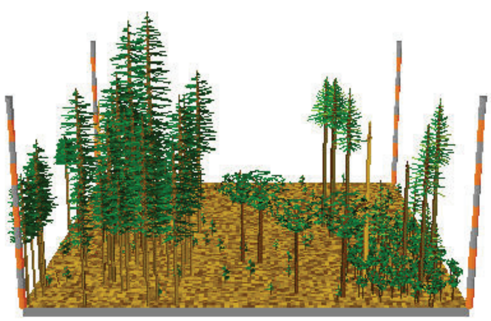
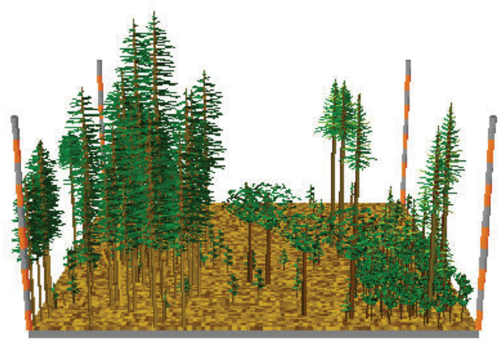


Figure 3-27. Red Fir Year 2025



Figures 24-27 above are examples of treated and untreated red fir stands in Krew_bul_1 3 percent of the project area is represented in stands like this.

Moderate to heavy surface fuels (16 to over 34 tons per acre) exist within this management unit. The shrub understory is light compared with the other management units. Whitethorn and some greenleaf manzanita exist. The crown base height ranges from 4 to 40 feet. The overstory canopy is predominately red fir, with canopy cover ranging from 10-60 percent.

Fire behavior can be characterized by high intensity surface fire in untreated stands. Torching of trees (passive crown fire) is likely. Active crown fire is possible but unlikely. Fires of this type would result in mixed to lethal mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 10 to 20 percent loss in moderate fire weather conditions and 10 to100 percent loss in severe fire weather conditions. Flame lengths range from 1 to 4 feet in height (up to 78 feet possible if passive crown fire occurs) when fine fuel moistures are at three percent; mid flame (eye level) wind speeds range between 8 to15 miles per hour (with gusts to 22 mph);and rates of spread ranged from 80 to 118 chains per hour. Modeling showed surface to passive crown fires possible under severe fire weather conditions (97th percentile).This fire behavior is likely to occur over 50 percent of the time during the summer months (Fire Family Plus *Fence Meadow weather station*).

Fire behavior can be characterized by low intensity surface fire in treated stands. Torching of trees is infrequent and only where fuels were left untreated for topological reasons or habitat concerns. Fires of this type would result in low to mixed mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 8 to 55 percent loss in both moderate and 37 to 99 percent in severe fire weather conditions. Flame lengths range from 0 to 20 feet in height when fine fuel moistures are at three percent; mid flame (eye level) wind speeds range between 8 to15 miles per hour (with gusts to 22 mph); and rates of spread ranged from 0 to 4 chains per hour. Modeling showed only surface fires possible under moderate and severe fire weather conditions (97th percentile).

Fire Behavior – Chaparral/Montane Chaparral/ Montane Hardwood/Montane Hardwood Conifer

Chaparral/Montane Chaparral/ Montane Hardwood/Montane Hardwood Conifer occur in the North_soaproot_2 Management Units. Two stands occur in the Providence_4 Management Unit.

Figure 3-28. Chaparral/Hardwood Existing Condition

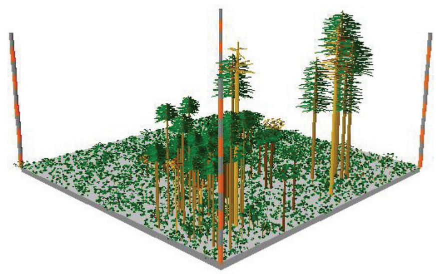


Figure 3-29 - Providence_4 Existing Condition

Figure 3-30. Chaparral/Hardwood Thinned

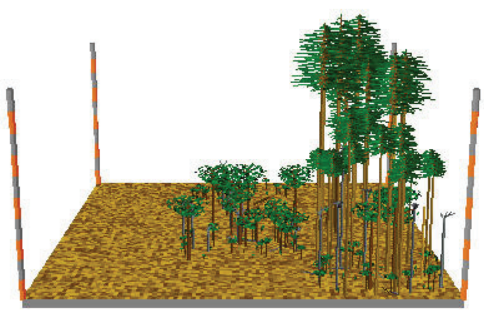
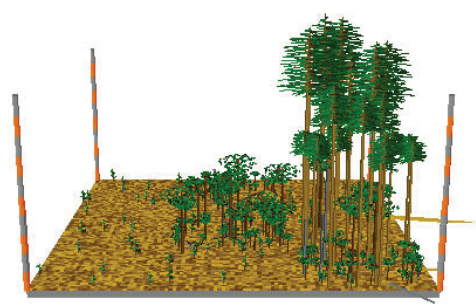


Figure 3-31. Chaparral/Hardwood Year 2025



Figures 28-31 above are examples of treated and untreated chaparral/hardwood stands in North_soaproot_2 and Providence_4. 17 percent of the project area is represented in stands like this.

Surface fuel loading is light (0 to15 tons per acre) in chaparral/hardwood stands. Shrub fields in the North_soaproot_2 and the Providence_4 are dominated by a complex of shrub species: deerbrush, whiteleaf manzanita, bear clover, whitethorn, gooseberry, and greenleaf manzanita. These shrub fields are generally classified as chaparral or montane chaparral. The crown base height (no appropriate term for shrub fields exists) ranges from 0 to 2 feet. The overstory canopy is a light scattering of ponderosa pine (conifer dominated stands are discussed under ponderosa pine) or black oak.

Fire behavior can be characterized by high intensity surface fires in untreated stands. Torching of single or groups of trees (passive crown fire) is likely. Crown fires cannot exist where no continuous crown canopy is present. Fires of this type would result in mixed to lethal mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 0 to 60 percent loss in moderate fire weather conditions and 0 to 100 percent loss in severe fire weather conditions. Flame lengths range from 4 to15 feet in height when fine fuel moistures are at three percent; mid flame (eye level) wind speeds range between 8 to14 miles per hour (with gusts to 20 mph); and rates of spread ranged from 22 to 60 chains per hour. Modeling showed surface to passive crown fires possible under severe fire weather conditions (97th percentile).This fire behavior is likely to occur over 90 percent of the time during the summer months (Fire Family Plus using data from *Mtn. Rest weather station*).

Fire behavior can be characterized by high intensity surface fires in untreated stands. Torching of single or groups of trees (passive crown fire) is likely. Crown fires cannot exist where no continuous crown canopy is present. Fires of this type would result in mixed to lethal mortality in both moderate and severe fire conditions. Modeling estimates percent basal area loss ranges from 0 to 66 percent loss in both moderate and severe fire weather conditions. Flame lengths range from 0 to 8 feet in height when fine fuel moistures are at three percent; mid flame (eye level) wind speeds range between 8 to14 miles per hour (with gusts to 20 mph); and rates of spread ranged from 0 to 4 chains per hour. Modeling showed surface to passive fires possible under severe fire weather conditions (97th percentile).

Fuels – Crown Bulk Density

Affected Environment

Crown bulk densities (CBD) in the Kings River Project range from 0.240 to 0.004 kg/m^3 and mid-flame winds used to predict surface fires range from 10 to12 miles per hour. Crown, or canopy, bulk density is the mass of foliage and stem biomass, measured by weight per unit area, commonly in kg/m^3. Given existing crown conditions and wind speeds, crown fire spread rates would range from 22 to118.6 chains per hour. Crown fires caused by excessive fuel accumulations are generally considered the primary threat to ecological and human values. Crown fires are the primary challenge to fire managers. Such fires kill large numbers of trees; damage soil; increase erosion; impair air quality; and degrade or destroy species habitat (Graham and McCaffrey 2003).

Assessing crown fire potential requires reasonably accurate estimates of canopy fuel characteristics. The three main characteristics of canopy fuels are canopy bulk density, canopy base height, and foliar moisture content. Crown (canopy) bulk density is the mass of available canopy fuel per unit canopy volume (Scott and Reinhart 1999). Decreased fire frequencies have resulted in a build-up of forest fuels creating “fuel ladders” for wildfire to climb up to the tree tops and where overstory trees are densely packed, the fire spreads quickly from tree to tree in a phenomenon known as crown fire or “crowning”.

Crowning and torching is a source of firebrands that have the potential to start spot fires ½ - 2 miles ahead of the main fire, and ignite homes in the WUI. The creation of firebrands, by torching trees, was a significant source of home ignition in the Siege of 2003 in Southern California (CDF and USDA 2004a). Firebrands, tree torching, and crown fires ignited and destroyed 17 percent of the 794 homes in the 2003 Haymen Fire, (Cohen and Stratton 2003). Treatments to alter forest structure can be designed to influence fire behavior, burn severity, and spotting potential (Cohen and Stratton 2003, Cohen 1999).Additionally, thinning designed to reduce tree crown density would tend to reduce the probability that trees are killed or severely burned (Graham and McCaffrey 2003) . Current CBD levels in the Kings River Project, coupled with severe drought, weather/fuel characteristics of the 97th percentile, would produce scorch heights of over 164 feet tall and have flame lengths over 16 feet tall. Modeling of forest inventory data shows that canopy base heights are close to zero in the current condition, and in the event of a wildfire, no wind is necessary to drive the fire up into the canopy of the forest (torching index) and a wind as low as only 6 miles per hour (crowning index) would be all that's necessary to initiate an active crown fire (FVS-FFE modeling 2006). Foliar moisture content, of course, varies with the short and long term weather patterns.

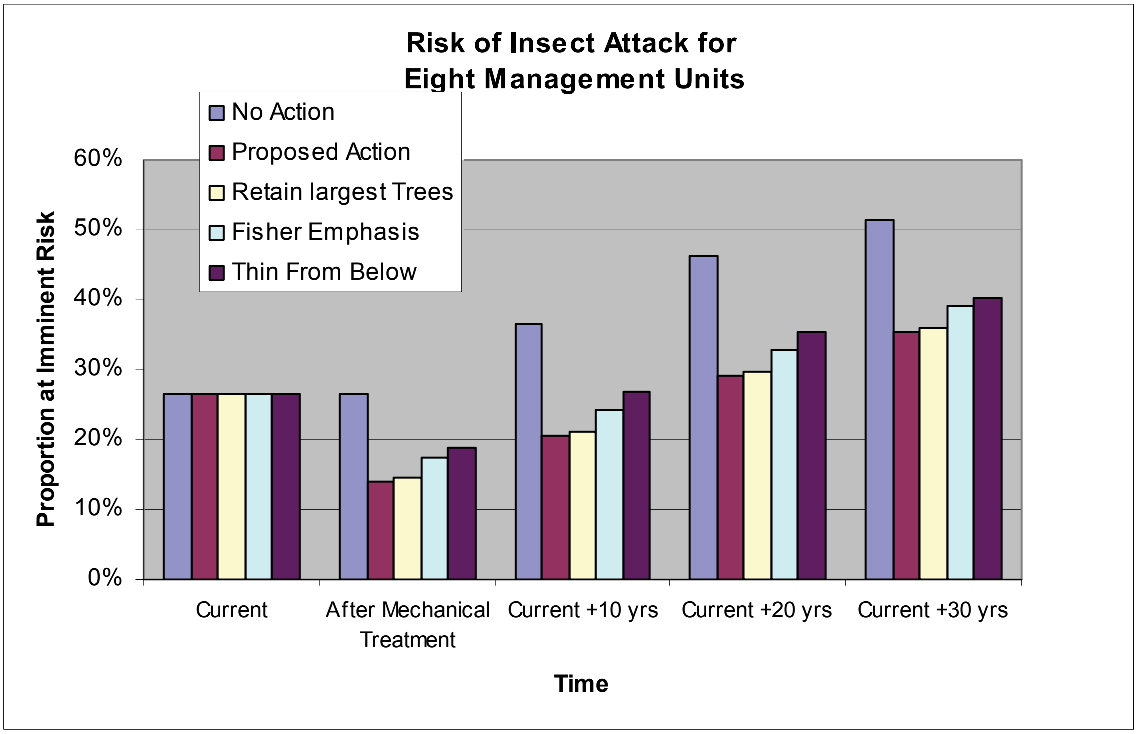
Vegetation, Fuels, and Fire Behavior Effects

Direct, indirect, and cumulative effects to forest structure and composition are described including aspects of fuel conditions that affect fire behavior. Clear links exist between density measures, diameter distributions, species composition, canopy cover, and fire behavior. The following text will attempt to characterize each criterion separately, but some overlap may occur.

Direct effects are analyzed on the basis of how treatments change existing conditions on approximately 13,700 acres. Indirect effects are those effects that occur as a result of growth or mortality (later in time). Cumulative effects are those that occur as a result of past, present, and reasonably foreseeable activities. The time frame for analysis of indirect and direct effects is 30 years. This time period was used as the more easily detected effects of the set of alternatives would no longer be discernible.

Alternative 1 - Proposed Action

Figure 3-32. Risk of Insect Attack



Displays the proportion of plots that exceed the imminent (epidemic) threshold for insect attack and thus experience lower tree vigor. (Phase III model results)

Vegetation

Forest Structure and Composition - The goal of increasing resilience would be fostered by tree removal from 13,757 acres. Factors that describe the effects are Stand Density Index value (SDI), diameter distribution, species distribution, and canopy cover.

Stand Density Index (SDI) - Proposed treatments would increase growing space for favored trees, increasing the probability that they would persist in the face of multi-year droughts and wildfire threats. Treatments would reduce the risk of insect-related mortality by increasing available growing space for individual trees, especially during the periodic multi-year droughts (Figure 3-32). Stands with SDI levels above approximately 60 percent of maximum SDI are at imminent risk for insect-related mortality (Oliver 1995, Oliver and Uzoh 1997). Lower SDI values provide a growth environment that favors tree resistance to bark beetles; improve access to soil moisture and nutrients; and sustain more fully-developed crowns essential to maintain tree vigor. Tree removal would be primarily focused on small to medium trees from lower crown classes. Remaining larger trees would benefit from treatment.

Treatments would not eliminate endemic insect/pathogen-related mortality. Fifteen percent of treated plots would remain at imminent risk. A non-peer reviewed article by Black (2005) reviewed literature on the effects of logging to control insects. Blacks review indicates that tree removal can increase tree vigor but is not effective in controlling infestations once a bark beetle outbreak occurs. Fourteen cited papers in Black (2005) show a positive effect of thinning on preventing bark beetle attack and mortality of residual trees. Benefits of reducing tree density and increasing resistance to insect attack is supported by studies that look at the stand structures that lead to insect attack in California (Oliver 1995, Oliver and Uzoh 1997) and studies that look at tree vigor (Miller and Keene 1960, Furniss and Carolin 1977, Larsson and others 1983).

Bark beetles may continue to play a role in shaping stand structure. A study that compared thinned and un-thinned stands of ponderosa pine demonstrated an increased resistance to insect attack from thinning over a 32-year study period (Kolb and others 1995). Stands would be generally more open and dense portions would still exist (see Figure 3-32). Insects may cause mortality, creating snags and snag-related habitat. This mortality is consistent with what has been observed in mixed conifer stands. Open mixed conifer stands that continued to experience low intensity fire similar to what occurred in the historical forest had low insect activity. Insect activity tended to kill large old trees. Old trees are less vigorous even though they are well established and have access to water held deep in the soil or bedrock.

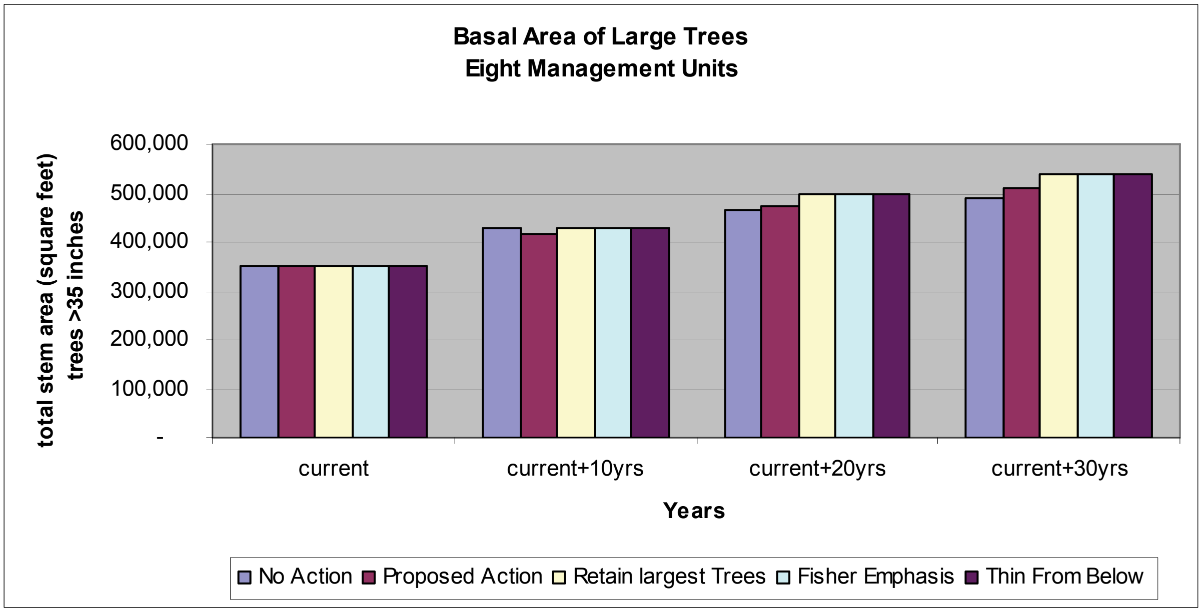
The intended trend toward a resilient forest requires time. Reducing stand-replacing fire would enhance the likelihood that this resilience would develop. Reducing trees meets several objectives including reduced potential for crown fire; increased resistance to insect attack; and increases in the number of larger trees. Increased growing space allows for tree diameter and crown expansion. Stand density and trees size are inversely related. Trees grown in low-density stands tend to be larger (Oliver and Larson 1996). Research by Poage and Tappeiner (2002) would indicate that open stand conditions might be necessary to grow the large trees. In addition, more recent research by Hoage and others 2007 indicate that thinning around old large pine can result in increase vigor and growth however, prescribed fire and drought can reduce or eliminate gains in growth.

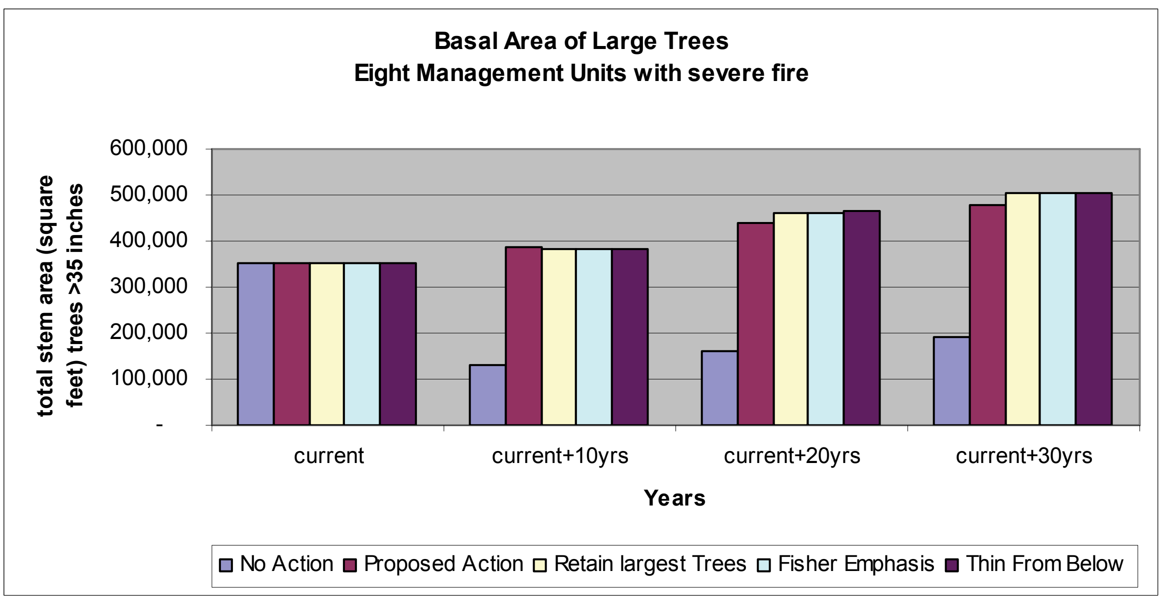
The indirect effect of the proposed action is to provide fewer trees that occupy greater growing space after a period of growth. Model results at both the landscape scale (phase II) and the stand level (phase III) indicate that thinning would result in more stem area in large trees. This is true for scenarios with wildfire and without wildfire. Management units in these alternatives maintain more stem area in larger trees following wildfire than the No Action Alternative. Figures 3-33 and 34 display the change in stem area of large trees. All action alternatives have similar amounts of large tree stem area. All of the action alternatives maintain more acres with large trees in the face of severe wildfire than the No Action Alternative.

Plantations and regeneration groups benefit from thinning in the California Spotted Owl Study (CSOS) by allowing for increased diameter growth and conditions suitable for restoration of historical conditions.   Regeneration of historical forest occurred over a prolonged period. Trees grew at low densities with little competition for water, nutrients and light. After timber harvest or disturbance young stands may develop with high tree density with similar ages and considerable self-thinning. The results suggest that tree removal is needed in dense young stands where the management objective is to speed development of old forest characteristics (Tappeiner and others 1997).

Stand density increases in all management units with each growing season. Reducing the number of trees, especially when this reduction is adjacent to favored trees, focuses growth potential on those trees and more directly meets goals for larger and more resilient trees. While the annual growth rates would increase or be sustained by thinning, as decades pass, stand density eventually returns to the pre-treatment level. SDI levels would meet or exceed current levels in this alternative in about 20 years, given the degree of change proposed.

Figure 3-33&34. Stem Area of Large Trees





Displays the total stem area for trees larger than thirty-five inches for eight management units without a wildfire and with simulated wildfire over the thirty year analysis period

Plot level analysis of stand density was conducted for all plots in the project's eight management units. Results indicated that thinning in the CSOS and the uneven-aged management strategy units would reduce stand density and increase tree vigor.

The cumulative effect of this reduction in tree density is to increase resistance to insect attack on about 19 percent of the forested portion of the landscape. This should increase resilience at the landscape scale.

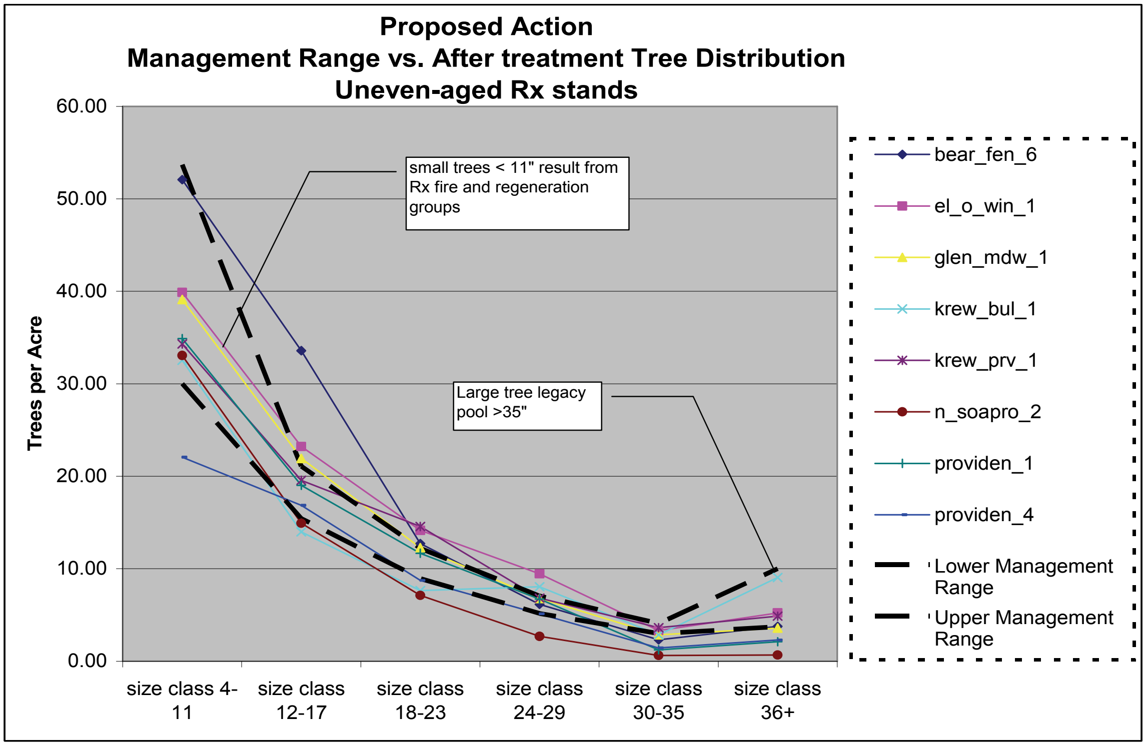
Diameter Distribution - Diameter class distributions would shift toward greater numbers in larger size classes. Treated areas would have higher numbers of trees with thick, fire-resistant bark and enhanced access to soil moisture and sunlight, providing an advantage when faced with wildfire and multi-year drought.

Tree densities would be lower in all diameter classes over the 30-year analysis period. The greatest difference in tree numbers between the No Action and action alternatives occurs in the smaller diameter classes.

Figure 3-35 displays tree distributions by management units for stands managed using the uneven-aged management strategy. The graph compares post-treatment tree distributions to the upper and lower management ranges. This graph indicates that management units generally follow the management range zone. The current condition displayed in Figure 3-35 shows current distributions well outside these ranges.

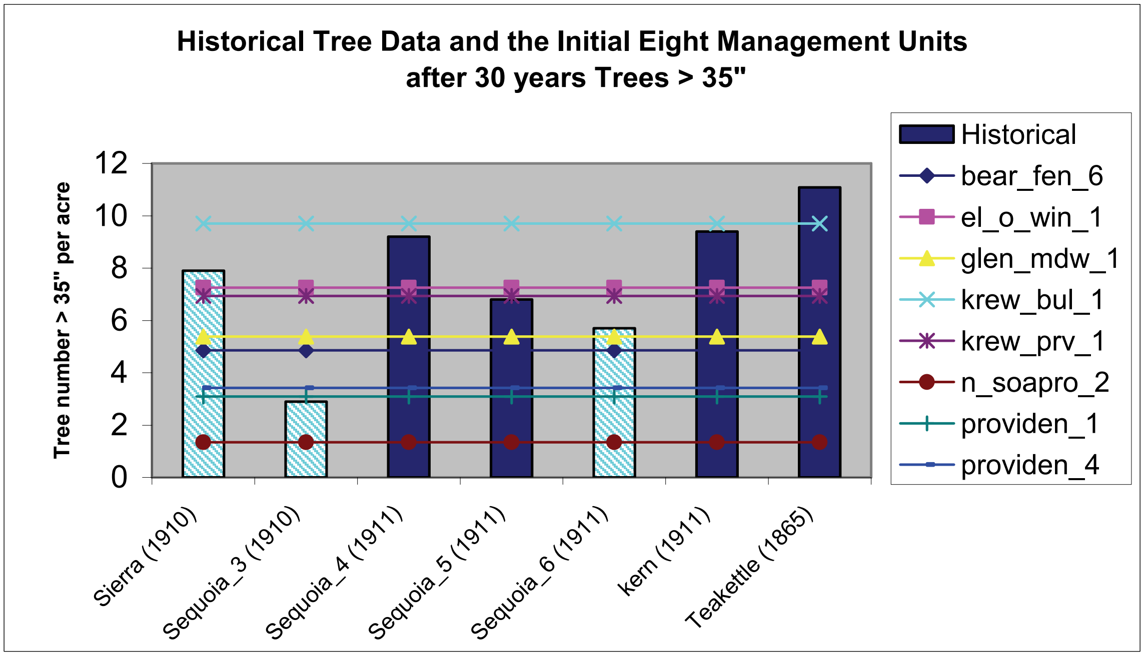
Figure 3-35 portrays how specific diameter classes would be altered by treatment. For example, of the 145 stands treated, 67 stands would remove 0 to 1 tree per acre from the 30 to 35 inch diameter class range. Further, more than 5 trees per acre from the 0 to 10 inch diameter class would be removed in 121 stands.

Figure 3-35. Tree Distribution Following Treatment



Large trees are an important characteristic of a resilient forest (North and others 2005, Taylor 2003, Mckelvey and Johnston 1992). Large tree dominance is maintained even with severe fire. This alternative maintains approximately sixty-percent more large tree stem area than the No Action Alternative even after wildfire. Given the more favorable growth environment, the numbers of large trees increase over time. The proposed action creates approximately four percent more trees greater than thirty-five inches than the No Action Alternative. However, large tree numbers remain below those shown in historical data sets with known methods (Hasel 1931) and reconstructed stands in the Teakettle Experimental Forest adjacent to the Krew_bul_1 Management Unit (see Figure 3-36).

Figure 3-36. HistoricTree Data



Historical data from the southern Sierra Nevada and reconstructed historical forest at the Teakettle experimental forest are shown in bars. Hatch bars represent ponderosa pine and solid bars represent mixed conifer types. Lines represent average tree number larger than 35 inches at the end of the thirty year analysis period. While large tree numbers increase they are generally less than the historical data represented. N_soapro, Prov_1 and Prov_4 are ponderosa pine dominated. Other management units are mixed conifer.

The historic forest was highly variable (North and others 2004). This variability existed at a fine scale. Literature indicates two dominant tree arrangements were found in the Kings River Project area. They were either arranged in even-aged, even-sized groups (homogenous) (Bonnickson and Stone 1982), or in many ages and sizes (heterogeneous) (North and others 2004). Even-aged regeneration groups and planted openings represent homogenous structures. Leaving large trees in regeneration groups creates heterogeneous structures. The application of an uneven-aged management strategy at the stand level, results in variable structure. Landscape variability is achieved by varying two management parameters, basal area, and maximum diameter. Eight different residual basal area levels and two maximum diameters are used in developing stand prescriptions. The residual basal area and maximum tree diameter were assigned based on forest type.

Figure 3-38 compares the range in opening or gap sizes found in the historical forest (Stephenson 1996) to past regeneration groups and planted openings. Regeneration groups would be placed in existing openings first then in areas of higher canopy density or disease. Comparison indicates that regeneration groups would have somewhat larger openings than the historical forest.

The uneven-aged strategy proposes to increase pine through reforesting groups and retaining pines that exhibit characteristics of good growth potential. These "good growers" would more rapidly grow into larger trees. Group regeneration objectives are subordinate to maintaining trees over 35 inches and leaving additional trees for heterogeneous structures.

The application of low intensity underburns creates additional variability. Since fire intensity and mortality vary resulting structures would also vary. Fires tend to kill small trees and change the final distribution of trees. Figure 3-35 displays the tree distribution for each management unit and the upper and lower management range.

Selected trees greater than 20 inches dbh would be removed when applying the uneven-aged management strategy in the proposed action and for Alternatives 3 and 5. North and others (2006) indicates that the thinning from below treatments removed many trees need for the “next generation of large old trees”. Simulations indicate that the uneven-age management strategy provides sufficient medium size trees to provide for this next generation. Action alternatives show improvements in the dominance of large trees over the No Action Alternative.

Trees in all diameter classes would be reduced. Those larger than thirty inches would only be reduced by approximately one percent across the landscape. For perspective, current hazard tree, residential development, and power line maintenance treatments remove approximately one thousand trees greater than thirty inches across a 72,000-acre forested landscape. The effect of growth in the project’s eight management units and the expected results of present activities is an increase in large tree numbers after thirty years. The South of Shaver fuel reduction project and plantation maintenance do not remove trees over thirty inches.

Forested lands owned by Southern California Edison reduce trees larger than thirty-five inches, when needed to meet the landowner objectives. While it is unclear how much these treatments on private lands would reduce large tree numbers, typical prescriptions can remove as much as one third of each tree size. The cumulative effect of all these treatments would likely be less than a one percent change in large tree numbers within the analysis area.

The proposed action and the action alternatives would make substantial reductions in the number of small understory trees. Notable changes occur in trees less than 24 inches in diameter.

Tree distribution across the landscape experiences change as a result of uneven-aged prescriptions. The proposed action, the reduction of harvest tree size alternative, and thin from below alternative make dramatic changes in the numbers of small trees in the understory of the project’s eight management units and would be expected across the landscape. Notable changes occur in trees less than 24 inches in diameter.

<u>Diameter Distribution</u> - The proposed action and alternatives 3 and 4 would reduce overstory canopy cover. This would result in increased resources for remaining trees and understory shrub production. Studies in the project area indicate that shrub production is related to both the amount of overstory tree canopy cover and the amount of understory shrub volume (Kie 1985). Equations developed by Kie (1985) indicate whitethorn (Ceanothus) shrub growth would increase by 35 percent for reductions in canopy cover,

from 60 percent to 40 percent. Ceanothus species growth would increase by 200 percent in regeneration groups. Increases in growth and cover of manzanita, bear clover and other shrub species can be expected following the creation of groups or the reduction of overstory canopy cover with thinning. Site preparation and release treatments planned for the project area have proven effective in the control of competing vegetation that developed in groups. Maintenance of understory shrub cover in defensible fuel profile zones (DFPZs) would be accomplished through repeated burning. Site preparation, release treatments, burning, and DFPZ maintenance would create conditions suitable for the invasion of plants that do well in disturbed sites or open canopies. These plants that arrive following disturbance include grasses (including cheat grass) and other noxious weeds (McDonald and Fiddler 1989, McDonald 1986, Larson and Schubert 1969, Keeley 2001). Treatments reduce the cover of competing plants, enhancing the growth environment for conifers (McDonald and Fiddler 1995).

Regeneration groups and plantations would contain scattered trees larger than 24 inches dbh. Planted seedlings, given treatments that reduce competing plants during the first few years, would be expected to capture site resources to an extent that they would reduce the development of shrub and grass species. Reforested montane shrub fields would be single-storied even-aged stands. Existing 5 to 15 year old plantations would continue to be single-storied. Older plantations with 30 to 45 year old trees found in the Providence_1, Providence 4, and Bear_fen_6 Management Units would have regeneration groups. This would create a second or third age class and begin to move these older single-storied plantations into an uneven-aged condition. Species composition would include a mix of planted conifers (ponderosa pine, Jeffrey pine, sugar pine, white fir, and red fir) with natural regeneration. Natural regeneration would also include incense cedar and oaks. Stand development from early shrub dominance to conifer dominance would be faster than unmanaged plant succession, due to the intentional suppression of competing plants during establishment.

The successful establishment of desired vigorous conifer species and stocking level is dependent on the availability of site resources, especially during the first few years. It is expected that plants like bearclover (*Chamaebatia foliolosa)*, and various species of *Arctostaphylos* and *Ceanothus* would offer strong competition to both planted and natural regeneration. Suppression of this competition would provide the timely development of the desired structure and composition within areas created to establish young forests.

Bearclover is a common and aggressive competing plant. The root system consists of an extensive network of roots and rhizomes 4 to 16 inches below the soil surface with sinker roots that often extend to depths of 6 feet. After fire or other disturbance, the plants resprout from adventitious buds at nodes along the rhizomes, and produce a dense stand (McDonald and Everest, 1996). Based on an extensive and sustained effort to evaluate alternative treatment techniques, herbicide application is the most effective treatment approach. Herbicides containing glyphosate are effective. Hand, fire and mechanical methods are not effective control treatments (Tappenier and Radosevich 1982, McDonald and others 2004). Treatments such as the winged subsoiler and repeated fire, at the time of flowering, have been suggested to control bearclover. Fire, hoeing, and machines have been used on the Sierra National Forest to remove the aboveground portion of bear clover. Survival of planted seedlings is commonly well below desired stocking levels. Herbicide application has proven the only effective means to control bear clover on the Sierra National Forest. These results agree with reforestation research that indicates that, after three years, only 13 percent of planted conifers were alive in a study area with bearclover cover of less than 40 percent (Tappenier and Radosevich 1982). This contrasts with 71 percent survival in areas with temporary control of bearclover. Only nine percent of the trees planted in an area with no vegetation control survived over a 19-year span. Growth of the surviving seedlings is also impacted. The same study showed that three-year-old seedlings, with no bearclover competition, were twice as tall as seedlings with no vegetation control. A review of bear clover control measures by McDonald and others (2004) also indicate that treatments such as herbicides, that kill bear clover rhizomes, are the only effective control measure, while other treatments have been failures.

Arctostaphylos (manzanita) *and* *Ceanothus* (whitethorn and deer brush) - Experience on the Sierra National Forest has shown that large plants, 2 to 6 feet tall, can not be controlled using hand methods due to the size of their root system. Seedling whitethorn has been successfully controlled using hand methods; however, once growth of aboveground whitethorn plants exceeds two feet, root systems are beyond the effectiveness of hand tools. In addition, the removal of deerbrush and whitethorn commonly result in a shift to dominance of grasses and forbs, that also compete with planted conifers for site resources. These same results have been observed on other National Forests, where repeated hand release treatments have resulted in limited control of *Ceanothus* seedlings; impractical control of well established (greater than two feet tall) *Ceanothus*; and ineffective control of plants that establish from burls or roots (Click and others 1994, McDonald and Fiddler 1996).

One ponderosa pine study, in the middle of a deerbrush and manzanita shrubfield, had diameter and height growth of 60 to 90 percent, when compared to trees free to grow from competing shrub species (Oliver 1979; McDonald and Oliver 1984). Also, the influence of competing vegetation was strongest at wider tree spacing, where the collective influence of shrubs was greatest. Another study showed conifers are at a disadvantage in capturing adequate resources and establishing dominance without release from deerbrush. McDonald and Fiddler (1989) noted that the average height of deerbrush was 184 percent greater than that of conifer seedlings in the control plot (without vegetation management). Although seedlings may persist under a canopy of *Ceanothus*, growth would be very slow. Local experience controlling deerbrush has been consistent with published information. Hand and mechanical means failed to control deerbrush in stands within part of the Big Sky Timber Sale and Big Creek Fire Recovery. Forest stands were killed by wildfire, selected dead/dying trees were removed, seedlings planted, and then released from competing plants (by hand tools) in the Big Creek Recovery treatment. Areas that received hand release treatments are dominated by sprouting *Ceanothus* species, with more than 50 percent cover in shrubs. Planted seedlings, and natural seedlings do not meeting stocking standards. Large deerbrush shrubs (greater than four feet tall) were cut with chainsaws in the Big Sky treatment. Observations in the following year showed *Ceanothus* sprouts to be two and three feet tall.

Deerbrush and whitethorn are usually found on sites that are more mesic than manzanita sites. *Ceanothus* and manzanita have many morphological and physiological adaptations that allow them to capture resources, growing rapidly after disturbance. One adaptation is the ability for some *Ceanothus* species to fix nitrogen. Soil nitrogen is beneficial for seedling growth and varies beneath Sierra Nevada vegetation gaps (Erickson and others 2005). Most of the nitrogen is used by the shrub that fixes it. Shrub cover removes soil moisture needed for seedling survival (Gray and others 2005). While shade-tolerant conifers, such as white fir, incense cedar and red fir, are able to germinate and persist within shrubfields, the, overall growth benefit for these species was undetermined by Erickson and others (2005). Results from the Teakettle Experimental Forest suggest that reductions in shrub cover may benefit tree establishment, but increasing understory light and decreasing surface soil moisture through canopy cover reductions may not. The effect of increased growth with shrub removal may be different for pine and fir after conifer establishment.

Greenleaf manzanita (*Arctostaphylos patula*), like the *Ceanothus* species, sprouts from the root system in response to disturbance. Manzanita in shrubfields, openings, and plantations exceeds three feet in height. The size of these plants makes hand removal impractical. Manzanita and *Ceanothus* competition were responsible for a 58 percent reduction in growth in a 20 year old Sierra Nevada ponderosa pine stand (Oliver 1990). Manzanita seedlings can rapidly occupy a site after disturbance.

The use of an herbicide, containing glyphosate as an active ingredient, is necessary to achieve the desired survival and vigor of seedling conifers within reforestation groups when mechanical methods (mastication and tractor piling), hand methods (chainsaw cutting and hoeing), or underburning are not effective.

The purposeful creation of younger age classes, combined with the shifts in age/size classes in older stands, by thinning, provides for long-term landscape-scale heterogeneity and resilience. The scale of changes proposed in the proposed action is relatively small, but definitively establishes a first step toward meeting this goal. Notable indirect or cumulative effects are absent or minimal.

<u>Species Composition</u> - The selective reduction of some incense cedar and white fir is planned to favor other species. California black oak, disease-free ponderosa pine, and sugar pine would be retained. Pines would remain at levels higher than desired in stands where pines, as well as incense cedar and white fir, already dominate. The landscape-scale distribution of the more fire-resilient species is expected to be enhanced.

The establishment of pine seedlings, in gaps created by insect, pathogen, or fire related mortality, would increase the amount of fire-resilient conifers. Additional numbers of these shade-intolerant and fire-resilient species would be established when gaps are created. The proposed action may result in a slight increase of approximately four percent in the dominance of pine, as compared to no action, over a 30 year analysis period.
The growth environment for oaks would be improved, providing for crown expansion and increased vigor. This improvement would lead to larger sizes and an increased presence on the landscape.

Shifts in species can be expected to persist for several decades. Shifts are less dramatic and less prolonged in treated areas where incense cedar and white fir remain. Natural regeneration would continue to provide for their persistence in the stand. Wildfire would likely reduce some natural regeneration; however the extent of this effect is unknown.

Cultural treatments in planted areas would reduce competing plant density and size, favoring the development of preferred species. Mechanical, hand tool, and/or herbicide application would have fairly immediate effects by increasing available soil resources (primarily water) to remaining trees. Treatments that physically remove competing plants would provide for a sustained advantage to remaining trees. These treatments would provide for successful establishment and relatively rapid growth rates that favor both the desired species shift and the development of thicker bark, yielding an advantage when confronted with fire. Long-term landscape-level changes to non-tree vegetation are unlikely as extensive unaffected areas exist and are capable of continual expansion.

Species composition shifts would be significant at the stand scale. The cumulative change to species composition across the analysis area would be small. The stem area within the eight management units would increase by small amounts of less than four percent. Similar or smaller changes would occur as the result of reasonably foreseeable actions. Plantation treatments would cause little change in tree composition. Thinning on private and federal lands would favor pine. Stands currently dominated by fir would continue to accumulate stem area and favor the reproduction of incense cedar and fir.

The proposed action favors pine and black oak over fir and incense cedar. This action results in approximately a three percent increase in ponderosa pine stem area after 30 years compared to the No Action Alternative. This small difference between the No Action and action alternatives is due to the time it takes for small seedlings to accumulate stem area. This difference is also due to the high proportion of overstory shade-intolerant species across the landscape. Species composition does not make large shifts toward pine species within the analysis time frame. The continued persistence of species more susceptible to fire such as fir and incense cedar would lower resilience. The proposed action maintains slightly more stem area in ponderosa pine than Alternative 3 (less than one percent).

Lilieholm and others (1990) found that ponderosa pine was not present under a heavy overstory in unmanaged stands in a comparison of the composition of seedlings. These mixed conifer unmanaged stands were less than 30 years of age, growing on highly productive sites in northern California. However, active management to favor shade-intolerant species in small openings did allow ponderosa pine (intolerant) and sugar pine (intermediate) to persist in stands having an 8 to12 year re-entry cutting cycle. This finding indicates that some active management is needed to encourage recruitment of shade-intolerant species for future stand development where relatively high stocking is retained on highly and moderately productive sites. The direct effect of the regeneration strategy proposed in the proposed action is to create an environment suitable for the establishment and growth of shade-intolerant species.

The cumulative effect of the projected changes in species composition across the landscape would be small, but would provide a positive shift toward a more resilient balance of tree species.

Canopy Cover - Thinning from below, up to a maximum diameter of 20 inches within the California Spotted Owl Study (CSOS), and to 35 inches within the Kings River Project uneven-aged management strategy management units, would increase growing space and reduce fuel ladders. Large numbers of smaller trees would be removed in order to provide more growing space for the larger trees. Reductions of canopy cover would result. Site competition for these resources has to be reduced in order to provide for increased availability of site resources. Canopy cover values are an inevitable consequence. Some of the removed trees are from the codominant crown class. The vast majority of trees would come from suppressed and intermediate crown classes. Trees in these crown classes are already subordinate to trees being retained. Reductions in canopy cover provide for deeper penetration of sunlight into the forest canopy, reducing the shade-related loss of needles and leaves that occurs when branches of neighboring trees overlap each other. This provides for higher crown ratios that are better able to sustain individual tree vigor.

Projected changes in canopy cover changed stands from moderate and dense canopy cover to open and moderately dense. While closer to the historic pre-1850 forest conditions described for the Kings River Project (Appendix A), they would remain above most of those characterizations. Exceptions to this projected reduction include stands in spotted owl PACS, old forest linkages, and Class I Stream Management Zones. These stands would generally remain moderately dense.

Overall canopy cover as defined by CWHR canopy closure categories within mixed conifer forests, moved from approximately 90 percent dense (greater than 60 percent) and moderately dense (40 to 59 percent) canopy cover to approximately 80 percent dense and moderately dense canopy cover after mechanical treatments. Ponderosa pine forests moved from approximately 80 percent dense and moderately dense canopy cover to approximately 70 percent dense and moderately dense canopy cover after mechanical treatments. These values are closer to those described as historical conditions in Appendix C and by Bonnickson and Stone (1982).

Phase I and II modeled results from FVS are used to display changes in canopy cover (Figure 3-37). These results include changes that occur as a result of the uneven-aged management strategy, prescribed fire, and thinning in the CSOS.

Canopy cover values change with each passing growing season. The distance between trees decreases and canopy cover increases as trees grow each year. These increases would vary from slight change in stands composed of larger, older trees to easily detected changes in stands with multiple canopy layers and younger trees that are still exhibiting juvenile (rapid) growth rates.

Figure 3-37. Treatment Effects to Canopy Cover

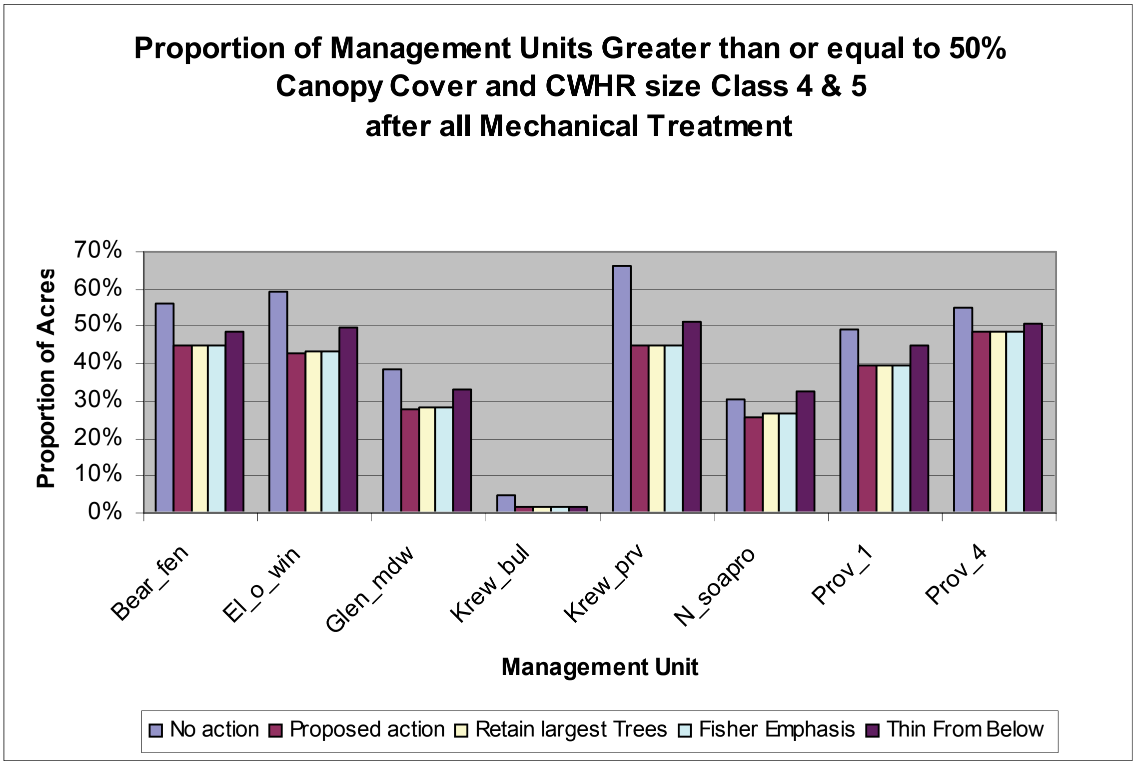


Figure 3-37.The above graph displays the proportion of management units that meet the fisher habitat goal. The fisher goal is across the landscape; however, data is presented here by management unit to compare direct effects between management units.

Figure 3-38. Regeneration Groups and Openings

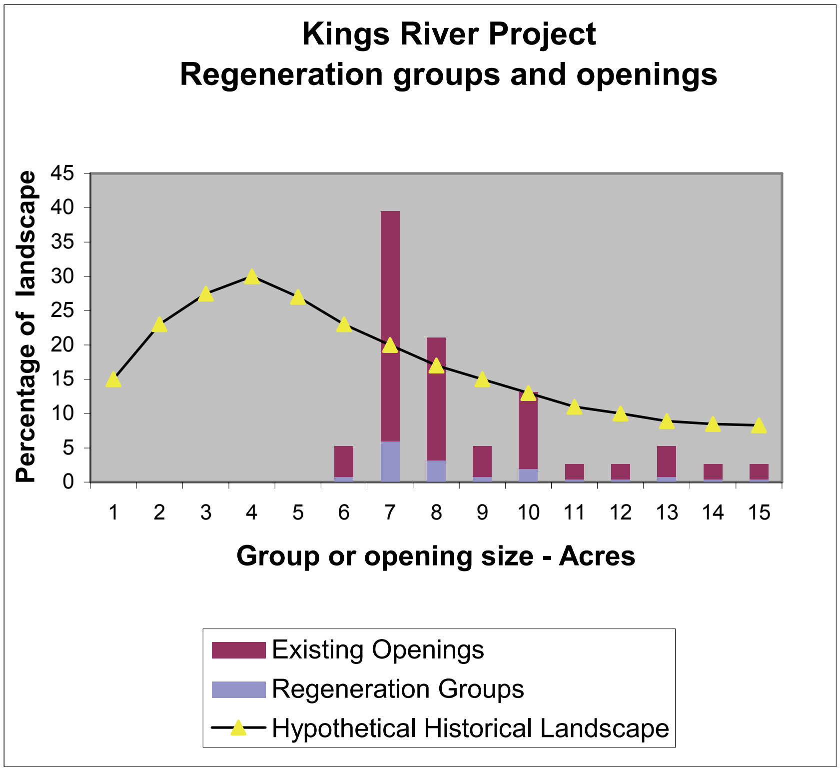


Figure 3-38 displays the estimated canopy gaps for mixed conifer forest proposed by Stephenson (1996) and the size and frequency of regeneration groups created by the uneven-aged silviculture system in the Kings River Project. Groups smaller than .7 acres occur, but these groups were not planted. Groups larger than 5 acres occurred but were created by fires or even-aged management. Bars represent existing openings and created regeneration groups.

The cumulative effect of projected changes in canopy cover would make a step toward the desired condition; however, the amount of acres where these changes occur is limited. Detecting any landscape-level change may be difficult.

Fuel and Fire Behavior

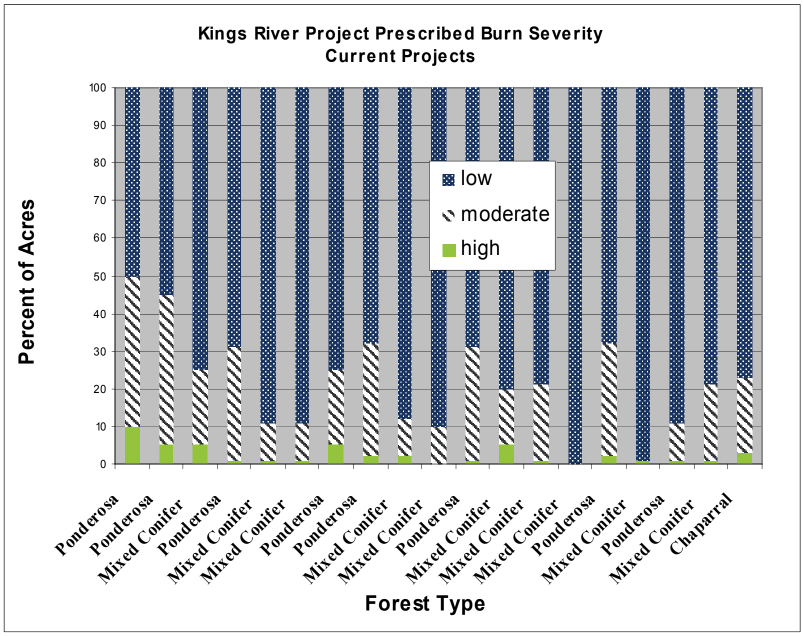
Forest structure and composition effects affect fire behavior. The following discussion focuses on prescribed fire, potential fire types, and canopy bulk density. This discussion expands previous conclusions to estimate fuel level and wildfire potential effects. Actions that reduce fuel levels increase the extent of a resilient forest environment by affecting potential fire behavior. Reductions in tree density reduce the ability of fire movement from crown to crown. Removal of trees from suppressed and intermediate crown classes lift crown base heights, reducing the likelihood of fire spread from the forest floor to tree crowns. This shift toward larger trees increases the number of trees with bark thickness sufficient to insulate the living cambium layer from heat damage during a fire. Species composition shifts toward greater numbers of pines, especially larger individuals. This shift provides for a more fire-resistant forest. Canopy cover reduction reduces fire spread within the canopy.

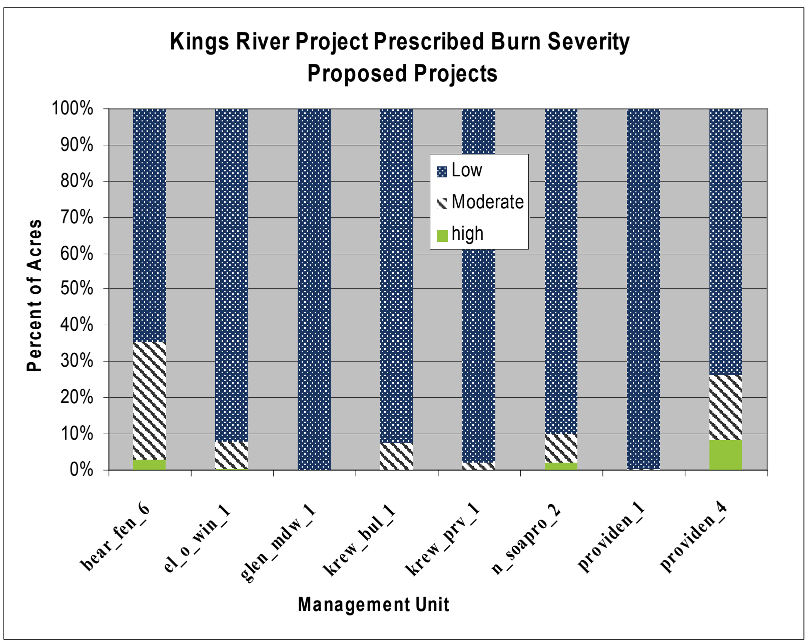
Prescribed Fire - Prescribed fire is widely regarded as the most valuable treatment available to reduce surface fuel levels. Underburning, broadcast burning, and pile burning all reduce surface fuel and decrease fuel hazards. Prescribed fire directly alters fuel levels by consuming most of the smaller material as well as portions of both living and dead woody plants.

Prescribed fire may injure trees and lead to successful bark beetle attack and mortality. The majority of research-based evidence is associated with wildfire (Mitchell and Martin 1980). Miller and Keen (1960) described the relationship between crown damage from fire and insect mortality. Generally, a greater level of crown damage leads to a greater level of associated mortality. This relationship between crown damage and attacks by western pine beetle has been described by others (McHugh and others 2003, Wallin and others 2003). Proposed underburns are expected to result in limited patches of high severity fire and would reduce tree numbers. Model results indicate the loss of trees greater than 24 inches dbh to be less than one per two acres. Losses were observed to be less than 1/10 of a tree per acre in local underburns (Ballard 1999).

Proposed prescribed burns would be designed to be low intensity fires. Flame heights should be less than four feet high. Underburning would occur alone or after harvest material is removed from project stands, and slash is piled or masticated.

Figure 3-39&40. Prescribed Burn Severity





Displays the severity of previous individual underburns by forest type. Each bar represents a single underburn in the forest types displayed in the X axis. Figure b (lower) displays the severity of underburning simulated in the eight management units for the action alternatives. Burn severity is based on the change in basal area. 0-10%=low, 10-50%=moderate, and 50-100%=high severity.

Several stand structure components are affected by prescribed burning including, overstory trees, understory trees, shrubs, snags, and logs. Direct effects of underburns on trees have been monitored for the Kings River Project. Monitoring for this project has been extensive. Fuel management personnel classified fire severity (high, moderate, low) across underburns with plots measuring the amount of tree and shrub mortality. Proposed action treatments are designed to have similar fire behavior as previous underburns across the project area. Fire severity classes represent direct effects from prescribed fire. Effects associated with bark beetle-related mortality were not included. Crown scorch and basal area loss was used as the measure of fire severity. Scorch heights measuring the direct effects on vegetation should fall within the range of severity experienced during the last eight years of operational treatments.

Modeled results indicate that underburns would kill less than one 30-inch or greater tree per 10 acres. Currently, the Kings River Project area has approximately 17,000 acres in an underburning program. Treatments have been accomplished in ponderosa pine, Sierran mixed-conifer, montane hardwood conifer, montane hardwood, and montane chaparral CWHR types. Fire severity examined in terms of tree and shrub mortality has been monitored intensively on one burn. Severity has been categorized for other burns in the project area using scattered monitoring plots and observations from burn bosses. Severity is divided into low, medium, and high direct effects of fire mortality. Low fire severity is characterized by fire scorch less than fifteen feet tall. Most trees taller than fifteen feet would survive. Low severity areas would experience less than ten percent reduction in basal area. Dominant tree crowns over fifteen feet would appear green or unburned. Medium severity fire would result in fifteen to fifty foot scorch height. Ten to fifty percent of existing basal area may be lost. Many trees would have brown needles. High severity areas would have scorch height greater than fifty feet. More than fifty percent of the basal area would be lost. High severity areas would have blackened and/or browned crowns.

A detailed examination of mortality experienced during the Barnes Mountain Burn in ponderosa pine type forest indicates that 53 percent of existing shrubs were killed during burning (Ballard 1999). Tree mortality was largely confined to trees less than 5 inches in one portion and 11 inches in another. One tree over 43 inches died as a result of both fire and insect activity. Kings River Project underburn severity is in contrast to severity experienced during prescribed fire at neighboring Sequoia and Kings Canyon National Park. Intensive monitoring of one prescribed fire indicated that as much as ten percent of dominant trees were killed by both fire and insects (Mutch and Parsons 1998). The character of fire severity differs between the Sierra National Forest and neighboring National Parks for two reasons:

- Park objectives are often to create openings and remove trees taller than fifteen feet in height and up to thirty inches in diameter, while Sierra National Forest objectives are to consume ground fuel and remove small trees and shrubs
- Park objectives drive prescribed fire prescriptions with flame lengths over two feet, while Sierra National Forest objectives drive fire prescriptions with flame lengths of less than one foot. (In project planning, burn prescriptions plan for 4 foot flame lengths, but typical projects frequently result in lengths less than one foot, shorter flame lengths reduce fire intensity and subsequent tree mortality)

Observations of severity from previous underburns and modeled proposed underburns are displayed in Figure 3-39. Results displayed in Figure 3-40 indicate that past underburns result in high severity on less than 10 percent or the area. Medium severity is more variable.

Indirect effects result from subsequent western pine beetle attack. The severity experienced from the underburning program in the project area is consistent with modeled results for the proposed action. Results of past underburns (Figure 3-39) indicate that some management units experience high understory mortality and little overstory mortality. Other management units experience some pockets of moderate overstory mortality. This moderate mortality could be seen as small pockets of less than one acre of dead trees scattered across burn areas. Larger pockets rarely would result from the combination of both insects and fire.

Modeled results that show acres of high, moderate, and low severity resulting from underburns are displayed in Figure 3-40. Most management units tend to fall within the range of severity experienced in previous burns. However, modeled underburns in the Bear_fen_6 Management Unit resulted in mortality and changes in stand structure not experienced during actual burning completed in Bear_fen_6 (Oak Flat burns). Model results indicate that white fir severity is higher than project monitoring data indicates. This is likely due to underlying model equations that attempt to mimic the greater level of susceptibility of fir trees and the high amount of fir in the Bear_fen_6 unit. Model results for all management units fall with in the range of results experienced across previous underburns in the project area. Underburns tend to be of low severity for overstory trees; kill most of the trees less than eight inches; and remove high proportions of aboveground woody shrub stems. Monitoring results of the Barnes South and Barnes North Underburns indicate that less than three overstory trees (larger than 20 inches) were killed over several thousand acres.

Broadcast burning is conducted to consume shrubs that have been crushed in chaparral stands. Broadcast burning is designed to create large holes in chaparral stands and change the age class of the shrub field. The direct effect of broadcast burning is to remove aboveground portions of chaparral species. Most of these species sprout after fire or aggressively germinate from seed.

Figure 3-41. Effects of Fire on Canopy Cover

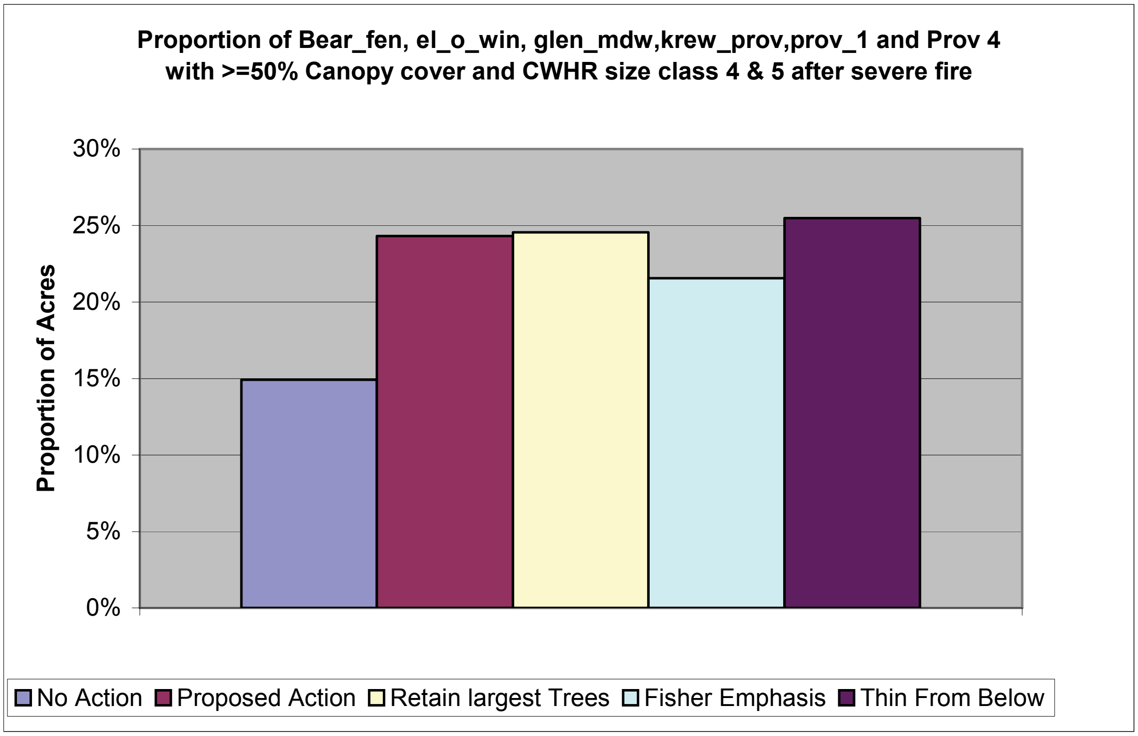


Figure 3-41 displays the effects of severe fire on canopy cover across all eight management units

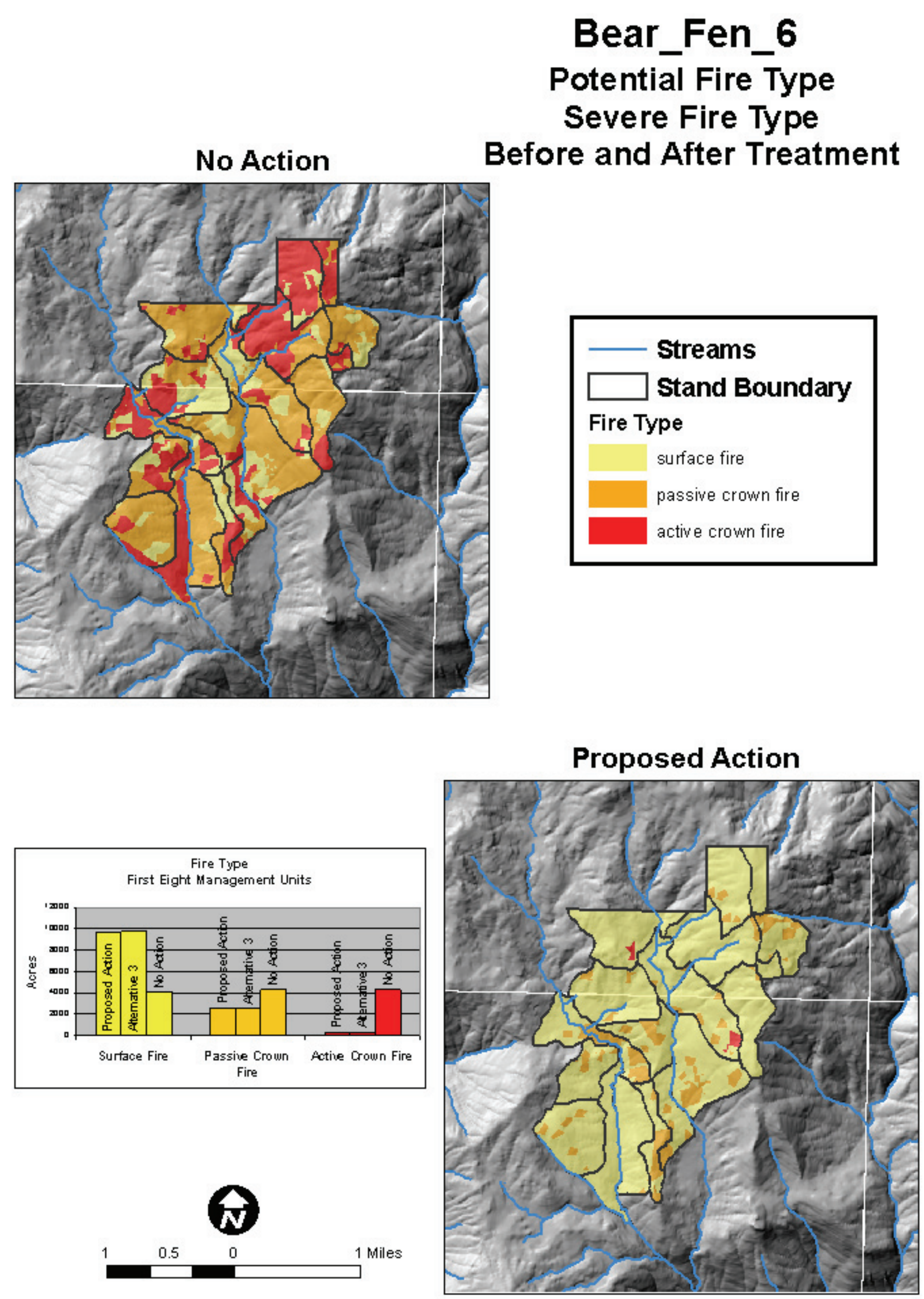
The cumulative effect of projected prescribed burning treatments would increase the proportion of the landscape where adverse wildfire effects are unlikely to occur during the next decade or so. The extent of influence on fire effects is limited to the location of treatments.

<u>Potential Fire Type</u> - Recent research has found that prescribed burning and mechanical thinning can lower fire spread rates and intensities within the treated area (Graham and McCaffrey, 2003), (Perry and others, 2004), (Agee and Skinner, 2005), (Stephens and Moghaddas, 2005). Modeling of vegetation treatments (FVS) and fire behavior (FlamMap) show that thinning effectively reduces flame length and change fire type where treatments occur, as indicated in Figure 3-42 and 3-43 below. Not all stands in each management unit would be treated. A range of results is expected.

The combination of proposed treatments would reduce flame lengths and the potential for passive (torching) and active crown fires. A passive crown fire is also called torching or candling. A passive crown fire is a fire where individual or small groups of trees begin to burn but solid flame is not consistently maintained in the canopy. An active crown fire is also called a running or continuous crown fire. An active crown fire is a fire where the entire surface/canopy fuel complex is burning. Fire in tree crowns remains dependent on heat from surface fuels for continued spread. Fire behavior values were derived by using FVS-FFE and FlamMap. The year of treatment was modeled in 2007 and the year of probable wildfire was 2017, after all initial treatments were completed. Figure 3-42 displays a comparison of the acres of potential fire type for the proposed action and the

No Action Alternative. Figure 3-42 shows the change in fire type for the proposed action compared to the No Action Alternative. Krew_prv_1 and Bear_fen_6 Management Units are shown as examples. The charts in Figure 3-42 shows the total acres of fire type changes for selected alternatives.

Figure 3-42. Fire Type



Active crown fire potential decreases from 834 acres (under no-action) to 167 acres of active crown fire as a result of the proposed action. Surface fire acres increase from 7,092 acres under no action to 10,614 acres under the proposed action. Only North_soaprooot_2 shows an overall change in fire type. The hottest potential fire type in the proposed action is a passive crown fire. Not all stands in every management unit would be treated. A full range of fire types including surface fire to active crown fires would still present in each management unit. (Please refer to the Fire-Fuels Analysis for a full presentation of changes in fire type by each management unit).

Stands would become less sheltered from wind. Stands would be modified by understory thinning and fuel reduction activities, including the removal of shrub and surface fuels. Mid-flame wind speeds would increase. Surface rates of spread would increase in the presence of light flashy fuels. Wildfire flame lengths would be reduced due to the treatment of surface and understory fuels in all management units. Flame lengths in treated, less-sheltered stands with a grass and bear clover understory would produce shorter flame lengths than stands with dense shrubs and trees. Table 3-6 shows the change in flame lengths between the proposed action and the No Action Alternative (Bear_fen_6 and Krew_prv_1 are used as examples). Figures 3-43, 3-44, and 3-45 compare flame length changes across the first three alternatives for Krew_prv_1.

The removal of surface fuel, slash, and shrubs, through thinning and piling coupled with an increase in crown base height dramatically alters post-treatment fire behavior and fire types in forest stands. The increase in height to live crown (crown base height) dramatically increases the torching index in all management units. Torching index values were derived by using FVS-FFE (the year of treatment was modeled in 2007 and the year of probable wildfire was 2017 after all initial treatments were completed). Actual recorded winds during severe fire conditions have only been recorded to 35 mph. Figures used are an index of the potential for torching to be initiated. Crowning and torching indexes are based upon wind speed necessary to initiate that type of fire characteristic. A low number means that even low wind speeds are sufficient to initiate torching (passive crown fire) or an active crown fire.

Table 3-6. Results of Wildfire Simulation

Management Units	Fire Type	Flame Length			Torching Index		
	PA NA %Δ	PA	NA	%Δ	PA	NA	%Δ
Bear_ fen	Surface to Active 0	6	41	85	373	31	92
El_o_win	Surface to Active 0	8	48	83	274	24	91
Glen_mdw	Surface to Active 0	13	31	58	150	32	78
Krew_prv	Surface to Active 0	11	29	61	341	115	66
Krew_bul	Surface to Active 0	5	42	87	231	116	50
N_soapro	Surf to Act Surf-Pass	7	7	11	231	116	50
Prov_1	Surface to Active 0	6	13	56	515	102	80
Prov_4	Surface to Active 0	8	11	30	384	221	42

Numbers given are the average of the plant aggregations within each MU.
PA = Proposed Action
NA = No Action
%Δ = Percent change

Figure 3-43. Flame Length and Fire Condition

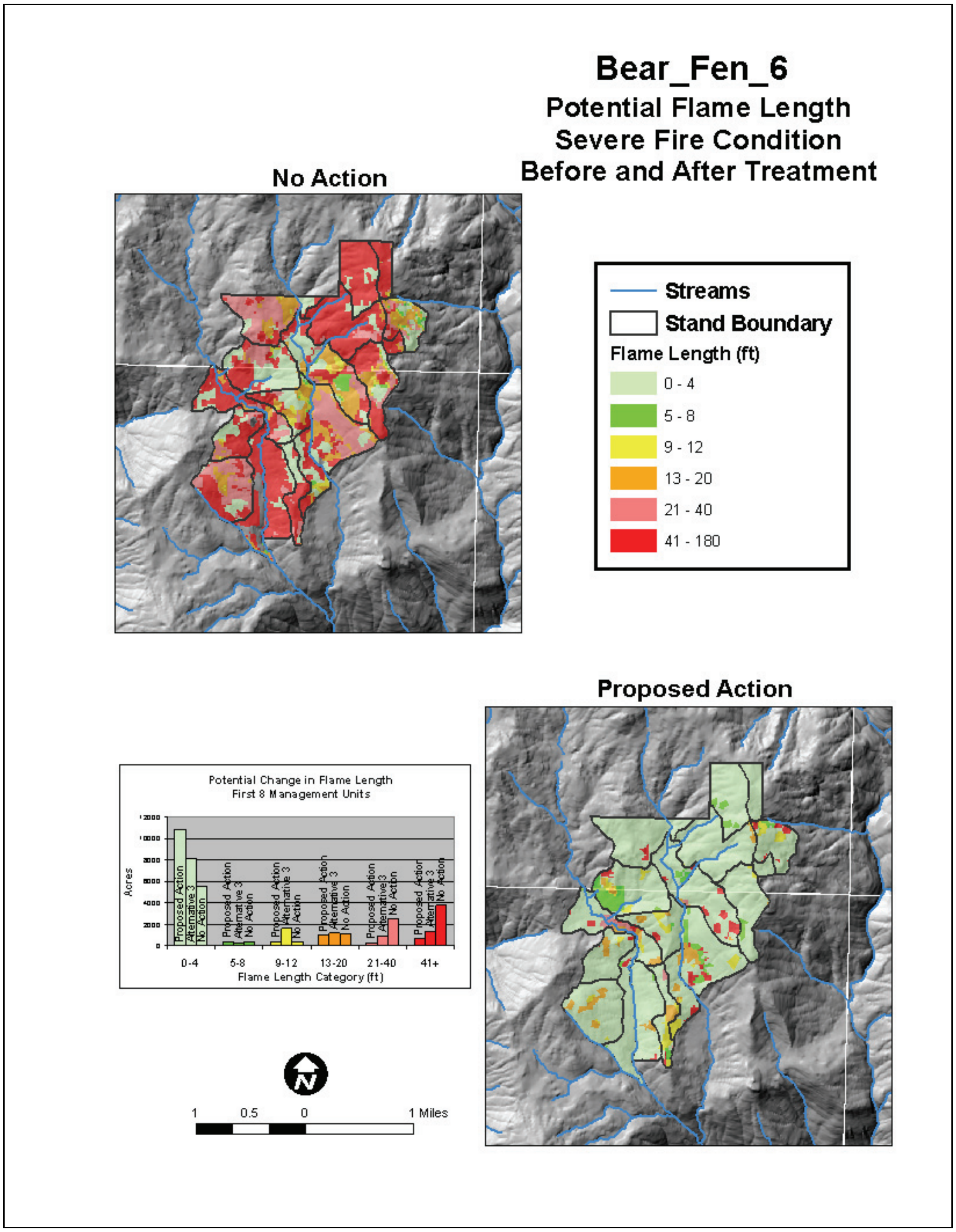


Figure 3-44. Flame Length and Fire Condition

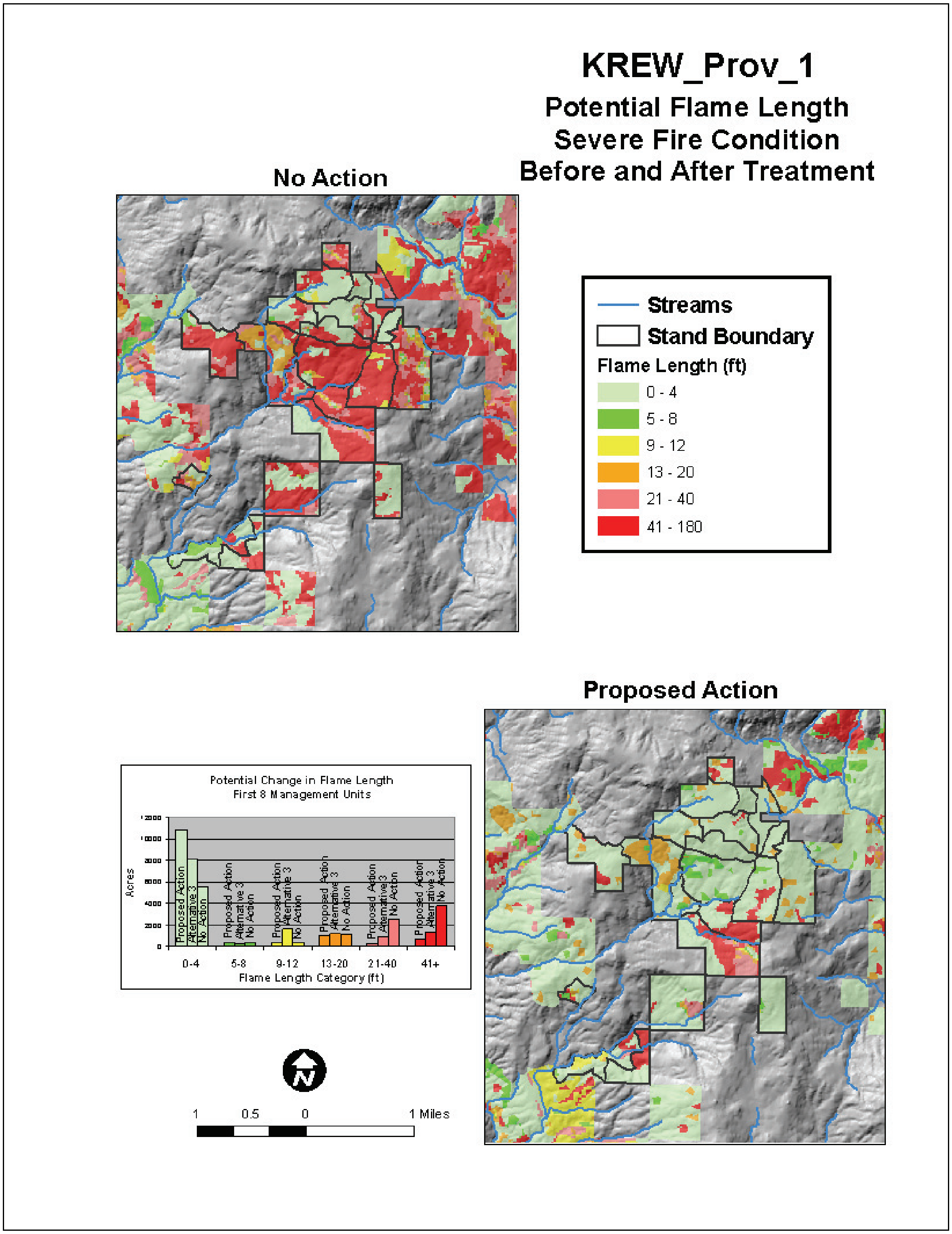


Figure 3-45. No Action Flame Length

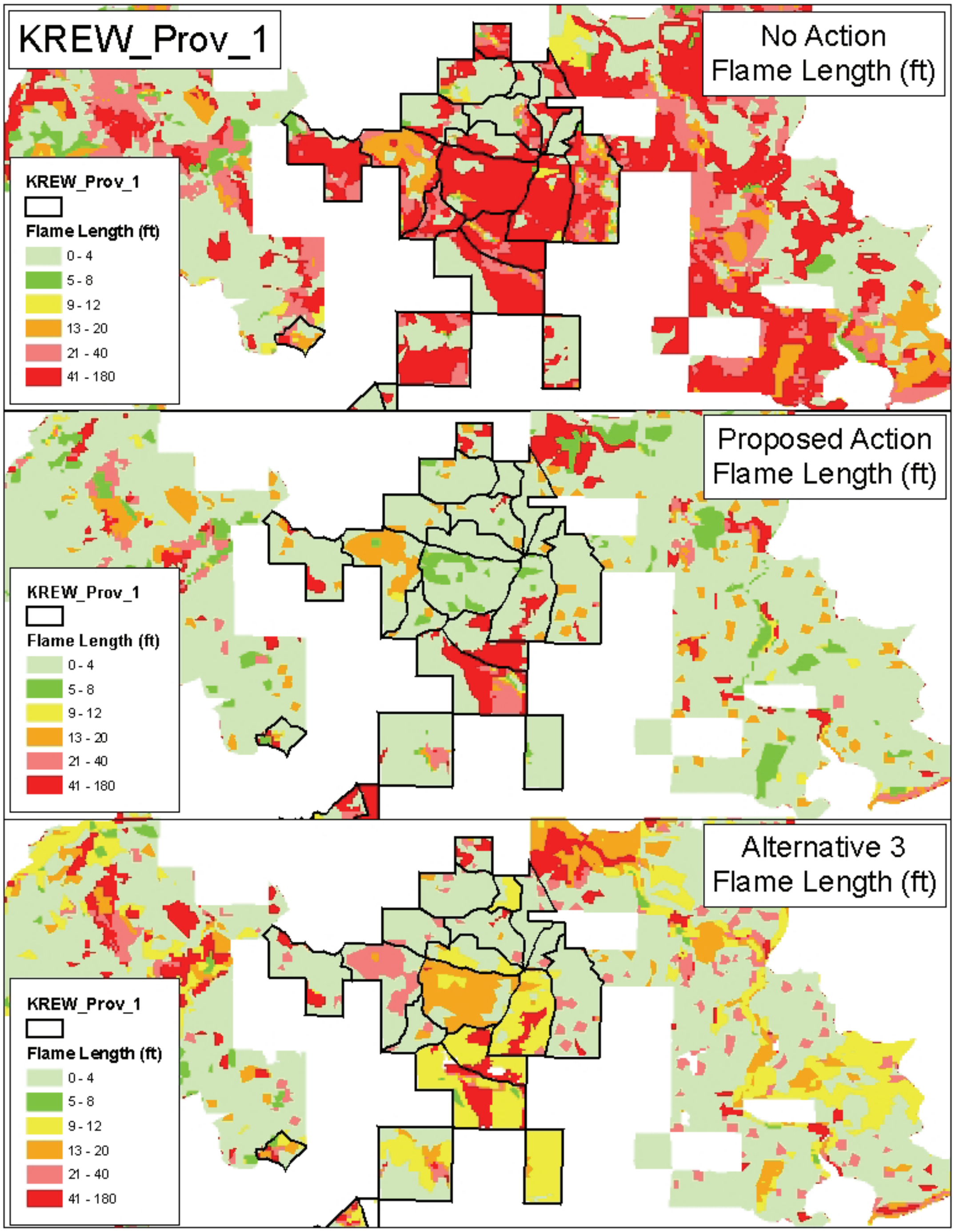


Figure 3-45 demonstrates a spatial comparison of the flame length changes using the Krew_prv_1 management unit as an example. Differences between the proposed action (Alternative 1) and Alternative 3 include canopy bulk density, canopy base height, and fuel model differences between the two alternatives.

The biomass of slash remaining after thinning would have a significant impact on fuel loading and greatly impact wildfire behavior if left untreated (Pollet and Omi 2002, Omi and Martinson 2002). This alternative is designed to thin trees (crowns) 11 inches and greater in diameter; treat surface fuel and slash; remove encroaching shrubs; increase crown base heights (height to live crown); and clean up the created slash through piling, mastication, and underburning. Maintenance of the desired condition would be accomplished through repeated treatment activity including underburning, herbicide spraying, and/or hand thinning. Maintenance would reduce encroaching shrubs and the accumulation of dead and down fuel.

Treated areas burn at lower intensities and at slower rates of spread compared to untreated areas, reducing damage to the treated stands from wildfire. An indirect effect is that adjacent untreated stands also benefit, including private property and communities in the WUI. Wildfires enter untreated stands at lower intensities and rates of spread, reducing mortality in adjacent areas as well. The effectiveness of treatment on fire behavior outside treated areas is assumed to have a 2:1 ratio (USDA 2001a), for every two acres treated. One acre of untreated vegetation would benefit from a reduction in fire behavior. Maintenance burning; herbicide spraying; or hand cutting and piling would be required to maintain desired fire behavior and keep sprouting and re-growth of shrubs at a desired level.

A cumulative effect is expected due to the past, present and reasonably foreseeable future activities of the High Sierra District in and around the Kings River Project area in addition to the direct and indirect effects of Alternative 1. The combination of vegetative and fuel conditions would contribute to an increased level of resiliency across the landscape.

Past and present private landownership activities include vegetation management programs with any combination of harvesting or thinning, masticating, piling and burning. These landowners include Southern California Edison Company (1500 acres annually); Grand Bluffs Demonstration Forest (80 acres completed and 160 acres proposed); and Wildflower and Granite Ridge Housing developments (160 acres). These vegetation management activities can contribute to desirable changes in fire behavior outcomes. Cumulative effects include further reductions in surface fuel loadings and shrub layers that reduce the potential for high intensity wildfires; reduce flame lengths; and reduce the potential fire type from one of active or passive crown fire to surface fire. Vegetation management activities on federal lands can include any of the following activities: dead tree removal; thinning; hand release of competing vegetation; tree planting; prescribed fire; or herbicide spraying. Projects include Plantation maintenance (3640 acres), Roadside Hazard Tree Removal (4400 trees in 3000 acres along 90 miles of road), Prescribed Underburn Program (17,300 acres), Hazardous Fuels Reduction projects – 10S18 (1,647 acres), Jose 1 (1263 acres), South of Shaver (1813 acres), and the Teakettle research burn (60 acres). All but hazard tree removal contribute to desirable fire behavior results within these projects.

Plantation maintenance, hazardous fuel reduction, and prescribed fire projects clear unwanted vegetation and reduce the potential for high intensity wildfires. The 10S18 and South of Shaver Fuels Reduction Projects, Jose 1 Project, and the on-going prescribed fire program (Table 3.7) would have altered vegetation conditions at various levels of density and risk.(The Jose 1 Project is outside of the project area, but is included as it may be considered when analyzing fisher habitat.) Implementation of the South of Shaver project (scheduled to start summer 2006) would take four to five years to reach its initial desired condition in mechanically treated stands. Stands treated with prescribed fire alone would take three to four entries over the next 20 years to reach the desired condition. The cumulative effect is to produce a more fire resilient forest with low surface fuel loadings; to increase height to live crowns; to reduce encroachment of shrubs in pine and mixed conifer stands; and to reduce flame lengths in combination with private landowner projects and the activities proposed in Alternative 1. Wildfire rates of spread could increase where the forest canopy becomes more open and heavy surface fuel loading and dense shrub is replaced with grass and bear clover (flashy fuels). Slash created from hazard tree removal adds surface fuels in the vicinity of the sale. Slash is piled and subsequently burned whenever clumps of trees are removed, leaving no effect to potential fire behavior. Minimal amounts of slash are lopped and scattered where individual trees are removed. This increase in surface fuel loading is considered negligible.

Other projects, Bretz, completed in 2005, and Power 1, completed in 2006, include commercial thinning of older plantations. Both projects reduced surface fuel loading and the height to live crown value. They also thinned the canopy, reducing fire hazard, including reduced potential for severe wildfire-related mortality. Current vegetation management/plantation projects include the Nutmeg, Lost, Men, Flat, Progeny Site, 10S18, and Fence plantations. Only thinning portions have any potential to change fire behavior, either positively or negatively within proposed and on-going plantations. Thinning trees removes a portion of the canopy, reducing the potential for fire to carry through the crown of young trees. Residual slash would increase surface fuel loading for about three years. Activity created slash from plantation thinning is generally masticated or piled, reducing the potential flame length but not the heat per unit area. Overall the cumulative effect of plantation treatments has a positive effect on fire behavior making plantations more resilient to severe fire by increasing the height to live crown; removing encroaching shrubs; treating activity created slash; and opening the canopy to reduce the potential for torching and crown fires.

The fire behavior effects of completed timber sales are considered part of the current condition. The Reese and Indian Rock Timber sale are part of the existing Prescribed Burn Program of Work and are currently in either the initial phase of underburn treatments (Indian Rock) or in maintenance status (Reese). The Reese Timber Sale has reached the desired condition, in terms of fire behavior, after thinning, mastication, and multiple entry underburn treatments. Based on the results of these treatments, the modeled potential fire type would be a low intensity surface fire, a mimic of the historic condition under severe wildfire conditions. The Indian Rock Project is part of the district DFPZ network and has not been completed. All thinning and mastication work is completed. The project is undergoing an initial underburn entry. The Indian Rock Project would experience a low to moderate intensity surface fire under severe wildfire conditions. Some torching would be possible in areas that have been thinned and masticated, but not yet burned. Burn treatments are scheduled to be completed in 2006/2007.

The Helms-Gregg 230 kV Transmission Line Right-of-way (PG&E) is currently undergoing widespread reestablishment (started in 2005). This power-line extends from

Courtright Reservoir west to the Sierra National Forest boundary. Various clearing activities create slash underneath the transmission line. The depth of the previously live fuels has been compacted although surface fuel loading increases, alleviating the potential for contact between high voltage lines and vegetation underneath. Potential flame lengths from a wildfire are reduced, reducing the potential for wildfire damage to the transmission lines and for the transmission lines to start a wildfire.

Table 3-7. Prescribed Burn Program

Prescribed Burn	Management Unit	Year of next entry	Year of last entry(s)	Prescribed Burn acres
I-rock	Irock_1	2007	2007	920
Barnes South	N_lost_1 N_lost_2	2006	1997	1185
10S18N Unit 5	N_up_big_3	2006		475
Haslett	Bear_fen_1	2007	1994/1998	900
Rush	N_soapro_1	2007	1998	215
Virginia's	N_duff_1 N_duff_2	2012	2008	1360
Turtle B2	N_ross_2	2007	1999	470
Turtle B1	Bear_ fen Bear_fen_7	2012	1996/2002	418
Turtle B5	N_turtle_3	2009	1999	523
Turtle B6	N_turtle_1 N_poison_1	2009	1999	418
Turtle B7	N_turtle_1 N_turtle_2 N_turtle_3 N_turtle_4	2009	1999	1692
Dinkey Unit 1	N-ross_1 N_ross_2	*	1999	883
Dinkey Unit 2 & 3	Bear_ fen	*	Unit 2-2000	1454
Dinkey Unit 4	N_ross_4	*	1998	571
Dinkey Unit 5	N_ross_1	*	1999	632
Oakflat	Bear_ fen_	2012	1996/2002	125
Poison	N_poison_1			539
Reese	Reese_1 Reese_2 N_410_1 Exchequer_5	2012	1999/2002	922
10S18	10S18 n_duff_1	2011	2001	590
10S18North	Ten_S_18 N_summit_1 N_up_big_1 N_up_big_3	2014	2004	1071
Carls	N_carls_1 N_ross_2	2009	1997/1999	1024
Clarence	Ten_s_18 Providen_1 Providen_4 Providen_4 N_duff_2	2008	2001	889
Barnes North	N_duff_3	2015	2005	767

Prescribed Burn	Management Unit	Year of next entry	Year of last entry(s)	Prescribed Burn acres
Bear Creek	N_bearcr_1	Not scheduled**	2000	395
Little Rush	N_soapro_1 N_soapro	2010	2002	288

*Under cooperative agreement with SCE and CDF, ** Mitigation unit for PG&E Lost Canyon rupture

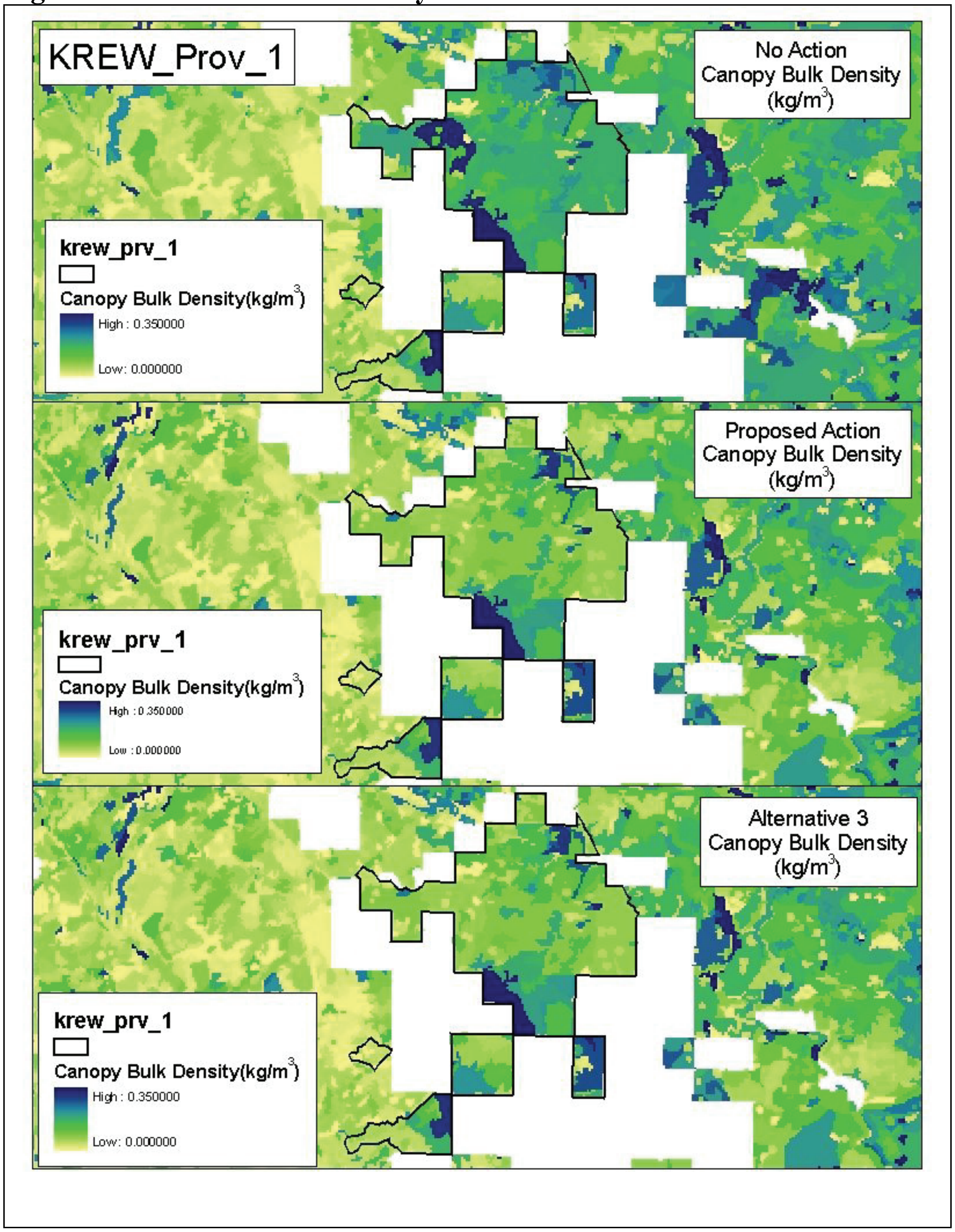
The cumulative effects of changed surface fuel levels are the more widespread presence of areas where the potential for high intensity wildfires is reduced. Low surface fuel loadings, increased height to live crowns, reduced encroachment of shrubs in pine and mixed conifer stands, and reduced flame lengths expands the extent of fire-resilient forests.

<u>Canopy Bulk Density</u> - Recent research has found that thinning to reduce tree crown density would tend to reduce the probability that residual trees would be killed or severely burned (Graham and McCaffrey 2003).

Low intensity underburning would result in incidental mortality of overstory trees (less than 10 percent of trees greater than five inches dbh) because of the accumulation of duff around the base of trees. Trees (one to four inches dbh) in the understory would be killed. This incidental mortality would occur across all stands. The predicted mortality of trees from a wildfire is less than expected in the No Action Alternative. A reduction of basal area occurs in all management units for the project's proposed treatments. This reduction is shown in Table 3-9.

Canopy bulk density (CBD) values represent the average of the plant aggregates in each management unit. CBD values were estimated by the FVS-FFE. Crowning index values were derived by using the FVS-FFE and FlamMap modeling programs. Treatments were modeled to occur in 2007, with a wildfire in 2017, after all initial treatments were completed. These values represent the expected crowning index for the average CBD. The crowning indexes represent the wind speed necessary to initiate that type of fire. The crowning index increases for all management units, except the North_soaproot_2 (refer to Tables 3-8 for Crown Bulk Density after Treatments). North_soaproot_2 is a hardwood and chaparral unit. FVS modeling under-represents changes to stand dynamics in shrub-only stands or where shrubs predominate.

Figure 3-46. Crown Bulk Density



Spatial comparison of the canopy bulk density changes for three alternatives using the Krew_prv_1 management unit as an example. Outcomes are expected to be similar in the other management units. The canopy bulk density values, in kg/m3, were derived by the FVS-FFE and were part of the data layers that were used in FlamMap to model fire behavior across the Kings River Project landscape.

Thinning and follow-up treatments would reduce canopy bulk density to levels between 0.076 –0.011 kg/m^3 (refer to Table 3-8). This reduction in crown fuel moves toward openness and a lack of canopy connection, both horizontally and vertically. This openness results in a very low probability of crown fire initiation. Current direction recommends canopy bulk densities in the wildland urban intermix be between 0.05-0.15 kg/m3 for the prevention of crown fire spread (SNFPA ROD 2004).

Figure 3-46 shows the results of simulating a wildfire's effects on tree canopy after treatments under the proposed action. Figure 3-46 compares wildfire's effects on the tree canopy with the No Action Alternative. Crowning index is an estimate of the wind speed necessary to initiate an active crown fire, with lower values representing higher hazards (see Table 3-10). Also, the basal area mortality estimate represents the amount of basal area that would be killed by the modeled fire.

Table 3-8. Crown Bulk Density after Treatments, by Alternative (in kg/m3)

Management Unit	No Action	Proposed Action
Bear_fen	0.103	0.072
El_o_win	0.090	0.062
Glen_mdw	0.081	0.056
Krew_bul	0.095	0.076
Krew_prv	0.094	0.066
N_soapro	0.014	0.011
Prov_1	0.036	0.026
Prov_4	0.023	0.018
All Units Combined	0.062	0.044

Table 3-9. Average Basal Area Mortality after Treatments, by Alternative

Management Unit	No Action	Proposed Action
Bear_fen	77	44
El_o_win	57	36
Glen_mdw	64	41
Krew_bul	24	26
Krew_prv	59	35
N_soapro	53	43
Prov_1	56	40
Prov_4	50	37
All Units Combined	57	39

BA- Basal Area

Table 3-10. Average Crowning Index after Treatments, by Alternative

Management Unit	No Action	Proposed Action
Bear_fen	31	56
El_o_win	36	59
Glen_mdw	38	60
Krew_bul	35	53
Krew_prv	32	54
N_soapro	67	68
Prov_1	59	74
Prov_4	74	90
All Units Combined	48	65

Crowning Index: wind speed necessary for a sustained running crown fire

Reducing existing canopy bulk density would decrease crown fire spread. The overall reduction in expected fire behavior and fire severity usually outweighs changes in fire weather factors such as wind speed and fuel moisture, where thinning is followed by sufficient treatment of surface fuels (Weatherspoon, 1996). A decrease in crown fuel allows more moisture and sunlight to reach the forest floor. Residual trees become more resistant to bark beetle attack and resultant mortality when this decrease in crown fuel is coupled with reduced competition for resources.

No cumulative effects associated with changes in crown bulk density would occur in the project's eight management units. The geographic extent of effects is limited to the general area where changes have occurred.

Past timber sales in the project area (such as Patterson, Deer, Snow Corral and Hall Meadow) that have finished all treatment activities (thinning, piling, and burning), are analyzed as part of the current condition in relation to fire behavior and canopy density. The effects of these projects are not expected to add significantly to those projected to occur with the proposed action. The Reese and Indian Rock Timber sale are currently part of the Prescribed Burn Program of Work and are currently in either the initial phase of underburn treatments (Indian Rock) or in maintenance status (Reese). The Reese Timber Sale has reached the desired condition in terms of fire behavior and under severe wildfire conditions through thinning, mastication and multiple entry underburn treatments. The Reese Timber Sale would experience a low intensity surface fire, a mimic of the historical condition. The Indian Rock Project is part of the district DFPZ network and has not been completed. All thinning and mastication work is completed, and initial underburn entries are underway. The Indian Rock Project would experience a low to moderate intensity surface fire under severe wildfire conditions. Some torching would be possible in areas where thinned and masticated treatments have not yet been burned. Burn treatments are scheduled to be completed in 2006/2007.

The South of Shaver Fuels Reduction Project; on-going prescribed fire program plantation management programs; private land management activities and the treatment of the Helms-Gregg transmission line would have beneficial cumulative effects similar to those described above. All projects listed would have altered vegetation conditions. Implementation of the South of Shaver project (scheduled to start late 2005) would take four to five years to reach its initial desired condition in mechanically-treated stands. Stands treated with only prescribed fire would take three to four entries over the next 20 years to reach the desired condition.

Alternative 2 – No Action

Vegetation

Stand Density Index - The annual growth of forest trees increases tree density. The extent and degree of inter-tree competition also increases. The No Action Alternative would eventually result in declines in stocking as bark beetles, pathogens, wildfires, and other influences kill trees without disturbance. The timing of these potential changes is impossible to predict. Changes could be dramatic over time. The reductions that occur via these mechanisms are not likely to mimic patterns intended with the other alternatives. Favorable inter-tree competition levels may occur if wildfire-related mortality removes only smaller and less fire-resistant trees. The same may occur if other forces somehow manage to remove the neighbors of the most valued larger trees. This more optimistic scenario would not be expected to be widespread. The purposeful selection of trees to remove, via management action, provides the highest level of certainty that the trees regarded as most valuable are retained and provided with the growing space they need to meet project objectives.

Observed epidemic bark beetle mortality, in the late 1980s exceeds modeled density-induced mortality within the analysis area. Since 1930, each decade has seen significant occurrences of bark beetle mortality within the Kings River Project area. Existing simulation models are not capable of accurately modeling potential outcomes of western pine beetle attacks in ways that fire behavior models predict fire effects. Nevertheless, the historic record of drought in California, combined with documented outbreaks and resultant mortality, seems to point to future epidemics that would adversely affect individual trees and stands of trees currently regarded as valuable resources.

Predicting fire-related mortality is aided by simulation models that can depend on basic physical principles as well as comparisons to recent fires. For example, the Big Creek Fire occurred on the High Sierra Ranger District in 1994 and burned 5,600 acres of chaparral, ponderosa pine, mixed conifer and red fir forest types similar to those found in project area. The Big Creek fire resulted in an eighty-four percent mortality in high intensity areas; a fifty percent mortality in moderate intensity areas; and a seven percent mortality in low intensity areas. The fire resulted in a mosaic burn pattern, with half the conifer stand receiving moderate or high mortality. Half the stands in the Big Creek Fire would have been classified as high mortality using the Kings River Project's severity classes. Model results for the No Action Alternative indicate that areas of high mortality vary from fifty percent to as much as seventy percent. The 200 acre Musick Fire burned in August of 2001 and resulted in thirty percent high mortality. Again, model estimates are consistent with measured mortality from similar stands on the High Sierra Ranger District that have been subjected to severe fire. Structural changes observed from both modeled results and observed changes from local fires are consistent with published results from several untreated stands subjected to wildfire in 2000 (Omi and Martinson 2002). The indirect effect of growth and severe wildfire is that management units under the No Action Alternative have a potential for dramatic stand structure changes during the analysis period.

Density estimates indicate that 25 percent of the stands exceed the upper stocking level benchmark, 60 percent of maximum stand density index. More than 50 percent of the project's eight management units are at stand densities that fully occupy the site, with insect-related mortality imminent by the end of the thirty year analysis period. Individual stress and disease would weaken trees and increase their susceptibility to bark beetle-related mortality when stands begin to exceed benchmark densities for imminent mortality (35 percent of stand density index). While the death of individual trees would provide some increased growing space for neighboring trees, desired trees are not always the survivors, nor is the extent and magnitude likely to match project objectives.

Historical weather data indicates that the Sierra Nevada experiences periodic droughts (SNEP 1996, North and others 2005). Lack of soil moisture, in below normal precipitation years, would weaken the trees defense mechanisms and allow bark beetles to begin killing trees.

Resilient forest characteristics require time to develop, especially the number of large trees. The No Action Alternative maintains trees in dense stands providing limited growing space for diameter and crown expansion. Stand density is highest under the No Action Alternative with many stands that exceed fifty percent cover and have many small stems. The No Action Alternative retains slightly more trees across the project's eight management units than the action alternatives. This is true for all diameter classes including those larger than 35 inches. Modeled growth of forested stands would increase the number of trees larger than 35 inches, in the absence of wildfire, although growing space, and resilience, is lowest in this alternative.

Small to medium CWHR size classes (3 and 4) and canopy density classes greater than 40 percent dominate the project's eight management units. Understory vegetation may be reduced and large snags may increase if low intensity wildfire and minimal insect attack occur. However, modeled outcomes for wildfire point to a high intensity disturbance instead.

The current dominance of mixed conifer stands by white fir and incense cedar continue under the No Action Alternative. This difference between the No Action Alternative and the proposed action is largely due to reductions of fir in the proposed action and the continued dominance of fir in the No Action Alternative.

The No Action Alternative continues the trend away from resilient forest conditions. This is true for both scenarios, with severe wildfire and without. Management units in the ponderosa pine and mixed conifer types continue to increase stand density and canopy cover. These increases are out of character with the open nature of the historical forest. Reconstructed Sierra Nevada forest structures (North 2004, Taylor 2004); similar forests under repeated low intensity fire (Stephens and Gill 2004); descriptions of the project's landscape in the early 1900s (Sudworth 1900a , Flintham 1904); and historical photos of the project area all indicate that stand structures varied across the landscape by forest type and topography. Open canopy conditions dominated ponderosa pine stands, while mixed conifer stands varied from open to dense.

However, existing stand density is greater than the historical forest of the 1850s (Bouldin 1999, North and others 2005). Stands dominated by trees would continue to increase in density across all the project's management units, while shrub fields would remain dominated by shrubs. Growth would occur on many small to medium size trees. Increases in stand density, continued dominance of small trees, and shrubs would perpetuate a forest condition vulnerable to bark beetle attack and unusually susceptible to stand-replacement wildfire.

Large trees persist in scenarios without wildfire or drought; however, these scenarios seem highly unlikely based on past weather and fire risk as previously described. The No Action Alternative accumulates and maintains large amounts of small trees that result in the persistence of ladder fuels. Increasing stand densities above the imminent threshold for insect attack indicate that resistance to insect attack would decrease during the analysis period. Lower resistance to insect attack would result in more tree mortality. This mortality would eventually find its way to the forest floor and result in more accumulation of fuels. Accumulations of fuels and small trees result in wildfire conditions that could kill many large trees over hundreds of acres. The No Action Alternative promotes structures that are driven by high severity events, such as wildfire and stand-replacing bark beetle attack, in contrast to resilient forest structures which were driven by repeated low severity fire.

The No Action Alternative makes conditions less favorable for the establishment of shade-intolerant species. Conditions suitable for the establishment of shade-tolerant species persist and increase as stands across the landscape become denser. Pine and mixed conifer forest types that were historically dominated by pine species continue to be dominated by incense cedar and fir.

<u>Diameter Distribution</u> - Based on the effects of recent wildfires, wildfires in the project area would kill significant numbers of trees. Most of the smaller stems would be lost, regardless of their crown position. Indications are that the acreage of stand-replacement fire would be extensive, where even the largest trees are killed. The desired distribution of tree sizes would be difficult to achieve over large areas. More of the mid and large-sized trees would also be killed given the current pattern of wildfire-caused changes. Bark beetles typically overwhelm even healthy trees and all sizes are affected during multi-year droughts.

Areas unaffected by disturbance would slowly change as lower crown classes continue to decline and upper crown classes add an annual increment to their diameter. Inter-tree competition would define the pace of these changes, with those that have greater growing space being able to more rapidly increase in size.

Modeling results indicate that, following severe wildfire, Alternatives 1, 3, 4, and 5 maintain approximately sixty percent more trees greater than thirty five inches than the No Action Alternative. Severe fire is not likely to enter all eight management units at once; however, the total number of large trees remaining after a simulated fire serves as and indicator of resistance to fire for each alternative.

Species Distribution - The establishment of pine seedlings in gaps created by insect, pathogen, or fire-related mortality, would lead to increases in the amount of fire-resilient conifers. Additional numbers of shade-intolerant and fire-resilient species would be established when gaps are created. The proposed action results in a slight increase (approximately 4 percent) in the dominance of pine compared to no action over the 30 year analysis period.

The proposed action favors pine and black oak over fir and incense cedar. This action results in approximately a three percent increase in ponderosa pine stem area after 30 years compared to the No Action Alternative. This small difference between the No Action and the action alternatives is due to the time it takes for small seedlings to grow and accumulate stem area. This small difference is also due to the high proportion of overstory shade-intolerant species across the landscape. This characteristic of the project area overwhelms the design to favor the retention of pines and oaks during treatments. The species composition does not make large shifts toward pine species, as measured by basal area within the analysis time frame. The continued persistence of species more susceptible to fire such as fir and incense cedar would lower resilience. The proposed action maintains slightly more stem area in ponderosa pine than Alternative 3 (less than 1 percent).

Wildfire and bark beetles would likely create openings in the forest canopy. No planting of these openings or existing openings created earlier from unplanned events would occur. Reforestation would rely on natural regeneration. These openings would likely be dominated by shrubs, similar to untreated stands examined in research (McDonald and Fiddler 1995). McDonald and Fiddler (1995) found that Sierra Nevada forest areas dominated by shrub species required treatment to return conifer dominance. McDonald and Fiddler (1997) found in another study that areas that lacked treatment to reduce manzanita or *Ceanothus* had changes in the dominance of shrub species through time, but shrubs continued to dominate and increased in dominance over 31 years. Many studies have shown clearly that shrub competition slows the growth of conifers (Tappeiner and Radosevich 1982, McDonald and Fiddler 1990, McDonald and Fiddler 1995, McDonald and Fiddler 1997, McDonald and Fiddler 2001, McDonald and others 2004, Powers and others 2005). Conifers that could become established in the No Action Alternative could be up to two times shorter and thinner when competing with bear clover, ceanothus, and green leaf manzanita (Tappeiner and Radosevich 1982, McDonald and Fiddler 1997, McDonald and Fiddler 2001).

Conifer establishment would result in very sparse numbers of trees and openings dominated by bear clover, manzanita, or *Ceanothus*. High tree density would occur in openings that favor conifer establishment (McDonald and Reynolds 1999). New conifer establishment would continue to be dominated by shade-tolerant species including incense cedar and white fir. Conifer growth in these small openings would be slow (McDonald and Reynolds 1999) but dependent on site factors. Conditions that promote the establishment of shade-intolerant and lower fire resistant incense cedar and fir would continue. The growth of these shade-intolerant trees would be slow due to shrub and high tree density.

The current dominance of mixed conifer stands by white fir and incense cedar continue under the No Action Alternative. This difference between no action and the proposed action is largely due to reductions of fir in the proposed action and the continued dominance of fir in the No Action Alternative.

Canopy Cover - Canopy cover changes would follow the pattern described in the Stand Density Index discussion above.

Growth would result in stand canopy cover increases for conifer-dominated stands in the absence of unplanned events, such as fire or insect attack. Modeled growth results indicate that crown canopy continues to increase for the 30-year analysis period. Acres of canopy cover greater than 50 percent for CWHR size class 4 and 5 trees continue to increase for the analysis period. The fisher habitat goal, to achieve 50 percent of the landscape in canopy cover greater than 50 percent in size Class 4 and 5, and habitat canopy cover objectives for spotted owl, are sustained for the analysis period.

Unfortunately, a wildfire is a reasonably foreseeable event and can be expected to burn one or more of the management units. Stands with dense and moderate canopy cover of greater than 50 percent could suffer severe damage. Wildfire effects are most pronounced in Bear_fen_6 and El_o_win_1 Management Units. Management units that may be struck by wildfire under the No Action Alternative would contribute little to accomplishing the fisher goal and owl or goshawk PACs could be severely damaged.

Fuel and Fire Behavior

Prescribed Fire - Prescribed fire would not occur as part of the Kings River Project; however, it would as part of the ongoing High Sierra ranger District's program of work.

Potential Fire Type - Potential fire types are described for the No Action Alternative in the discussion characterizing the effects of Alternative 1.

Communities and recreation resorts within the project area would not benefit from hazardous fuels reduction treatments. The forest habitat and urban communities would remain at risk from severe stand-replacing fires created by excessive fuel loading, and the dense tree and shrub growth that exists.

Forest conditions necessary for the creation of a resilient forest would be reduced or eliminated with widespread stand-replacing wildfire. A surface fire was modeled to occur with surface flame lengths averaging 39 feet and an overall flame length of 27 feet (tree crown included) that would affect approximately 87 to 100 percent of stands. Modeling provides one measure of assessing the potential loss in habitat from an unplanned wildfire event; however, comparison using actual fire data is more illustrative. The Big

Creek fire occurred on the Pineridge District in 1994 and burned 5,600 acres, which resulted in mortality rates of eighty four percent in high intensity areas; fifty percent in moderate intensity areas; and seven percent in low intensity areas. The fire burned in a mosaic pattern across conifer stands. Fifty percent received moderate or high mortality. The Musick fire burned in August of 2001 and burned 200 acres. Mortality rates for conifers ranged between 55 and 81 percent. By comparison, modeling results for the South of Shaver stands indicate that a wildfire of moderate to high intensity could affect up to 81 percent of standing basal area. Modeling estimates are consistent with measured mortality from similar stands on the High Sierra Ranger District.

August 21, 2001, the North Fork Fire burned 4132 acres and started in the urban intermix of North Fork on the Sierra National Forest. Table 3-11 shows the results of simulating this event during the first three hours of ignition using BEHAVE. The modeled fire has flame lengths over 11 feet in length. Hand crews and engines are limited to flame lengths less than 4 feet tall. Dozers are limited to operating with less than 6 foot flame lengths. Only indirect attack and aerial fire fighting resources would be effective on this fire.

Table 3-11. Fire Simulation within Initial 3 hours

FIRE VARIABLE	FIRE OUTPUT
Flame Length	11.8-feet
Rate of Spread	43.3 chains/hour
Fire Area - 1 hour	37.4 acres
- 2 hours	149.5 acres
- 3 hours	336.3 acres
Scorch Height	Average 270 feet
Torching Index	0 mph (all stands)
Crowning Index	6.3-441.2 mph

Weather conditions for August 21st are similar to the historical 97th percentile conditions for the Fence Meadow weather station. The vegetation type (ponderosa pine with a shrub understory) is very similar to lower elevations of the high risk/high hazard area of the Kings River Project. The North Fork Fire became an active crown fire within minutes of ignition. The fire's progression exceeded 100 acres in one hour with observed flames lengths and spread rates in excess of modeled flame lengths and fire behaviors (Moore 2002). Fire intensity was high in 27 percent of the area. Mortality in conifer stands was severe and caused a portion of spotted owl habitat in a home range area core to be lost. Furthermore, hydrophobic conditions were created in the high intensity burn areas leading to the potential for overland water flows and debris slides in the South Fork of Willow Creek and Peckinpah Creek (Roath and Prentice 2001). Similar fire behavior and intensities would be predicted in the Kings River Project under these conditions.

Canopy Bulk Density - Any changes in canopy bulk density would generally follow the changes that occur in tree density. Mortality would decrease this value and the magnitude of the change would be linked to the magnitude of changes in tree numbers. Conversely, it would continue to increase in areas unaffected by wildfire or other density-reducing forces. Changes in this aspect are reflected in the potential fire type discussion above, as higher levels are generally supportive of crown fires.

Alternative 3 – Retain Largest Trees – Uneven-aged Strategy

Vegetation

Forest Structure and Composition - The goal of increasing resilience would be fostered by tree removal from 13,715 acres, as described in Alternative 1, remains. This alternative is very similar, in almost all effects, to Alternative 1. The primary distinction between the proposed action and this alternative is the placement of a 30 inch upper limit for tree removal. The following discussion is limited to those aspects that differ from Alternative 1.

Stand Density Index - The number of 30-35 inch DBH trees that are proposed for removal in Alternative 1 is relatively small. While the most significant reduction in inter-tree competition occurs with the removal of a neighboring peer, the presence of multiple trees of this size, and greater, generally indicates that they have developed together and have found the essential resources to coexist. In a more specific case, trees that have been coexisting for decades, even centuries, may now begin to experience competition levels that may lead to a decline in vigor. The number of individual trees that are in this condition is not known, however it is unlikely that all of the trees in the 30-35 inch DBH range are easily coexisting with peers, especially when competing with substantially larger trees. In the case where the 30-35 inch DBH trees are not attempting to share the same resources, it is likely that they are the desired trees and that smaller trees would be removed to favor them.

Cumulative effects would be essentially the same as described in the proposed action. The difference between this alternative and the proposed action is spatially-limited and unlikely to have any discernable distinctions.

Diameter Distribution - The landscape effect of this scale of change would be negligible. As described in Alternative 1, diameter class distributions would shift toward greater numbers in the larger size classes.

This alternative removes approximately 10 percent of the trees between twenty-five and thirty inches. This action results in approximately 0.5 trees per acre removed and keeps approximately 4.5 trees per acre (25-30 inches dbh) after harvest. This alternative removes approximately sixty percent of trees less than eleven inches.

The number of trees larger than thirty-five inches ten years after mechanical treatment is less than two percent more in this alternative, as compared to the proposed action. Following severe fire, the eight management units would have approximately two percent more trees over thirty five inches remain, as compared to the proposed action.

Additional measures too protect large trees and structures important for Pacific fisher are implemented in this alternative. The identification and protection of clumps of trees that potentially provide fisher resting sites is implemented in this alternative. This would have the result of limiting the acres available for tree removal compared to the proposed action. As a result this alternative would keep more large trees than the proposed action. Since fisher rest site structures are the result of on the ground evaluation and scoring, no fixed number of these trees can be determined prior to implementation.

As described in Chapter 2, this alternative also eliminates the creation of small gaps (approximately 90 acres) that would increase the number of small trees to the landscape. Regeneration efforts would be limited to existing forest openings. Given the uncertainties related to the nature and extent of wildfire and drought, it is difficult to quantify the effect of this change. Certainly, the obvious effect, given little or no change, is the reduction of pine species.

Cumulative effects would be essentially the same as described in the proposed action. The difference between this alternative and the proposed action is, like above, spatially-limited and unlikely to have any discernable distinctions.

Species Distribution - A small number of shade-tolerant species, not available for removal, due to their size between 30 and 35 inches, would remain. Likewise a small number of pines would not be established, due to the reduced acreage of reforestation planned with this alternative.

Cumulative effects would be essentially the same as described in the proposed action.

Canopy Cover - As portrayed in the preceding Alternative 1 discussion, Figure 3-46 displays an estimate of the extent of canopy cover values greater than, or equal to 50 percent, by management unit. The difference between Alternative 1 and 3 is not significant.

Cumulative effects would be essentially the same as described in the proposed action.

Fuel and Fire Behavior

Prescribed Fire - Effects described in the Alternative 1 discussion are the same for Alternative 3.

Potential Fire Type - Effects described in the Alternative 1 discussion are the same for Alternative 3. The direct, indirect, and cumulative effects of Alternative 3, on fire behavior, are nearly identical to those of Alternative 1. See Table 3-12 for a comparison of the No Action Alternative to Alternative 3.

Table 3-12. Wildfire after Treatments (Alt 3 vs. Alt 2)

Management Units	Fire Type			Flame Length			Torching Index		
	alt3	NA	%Δ	alt3	NA	%Δ	alt3	NA	%Δ
Bear_fen	Surface to Active		0	6	41	85	389	31	92
El_o_win	Surface to Active		0	8	48	83	279	24	91
Glen_mdw	Surface to Active		0	13	31	57	155	32	79
Krew_prv	Surface to Active		0	11	29	62	347	115	67
Krew_bul	Surface to Active		0	5	42	87	232	116	50
N_soapro	Surf to Act/ Surf-Pass			7	7	12	236	116	51
Prov_1	Surface to Active		0	6	13	56	526	102	81
Prov_4	Surface to Active		0	8	11	29	387	221	43

Numbers given are the average of the plant aggregations within each MU.
PA = Proposed Action; NA = No Action; %Δ = Percent change

Canopy Bulk Density - Effects described in the Alternative 1 discussion are essentially the same for Alternative 3.

The direct, indirect, and cumulative effects of alternative 3 are nearly identical to the direct, indirect and cumulative effects of the proposed action. Refer to the effects section on canopy bulk density in Alternative 1 and Table 3-13 below. Table 3-13 shows the results of simulating a wildfire after treatments under Alternative 3 and compares it to a wildfire under the Alternative 2 (No Action).

Table 3-13. Canopy Bulk Density

Management Units	Canopy Bulk Density			Crowning Index			Percent Basal Area Mortality		
	Alt3	NA	%Δ	Alt3	NA	%Δ	Alt3	NA	%Δ
Bear_fen	.065	.145	-124	51	26	50%	34	83	59
El_o_win	.069	.132	-93	48	27	43%	32	83	61
Glen_mdw	.081	.118	-45	42	32	22%	46	68	33
Krew_prv	.075	.115	-53	43	30	30%	38	62	39
Krew_bul	.072	.175	-142	41	24	42%	23	64	64
N_soapro	.016	.018	-11	128	131	-8%	65	72	9
Prov_1	.035	.047	-35	81	67	17%	44	68	35
Prov_4	.023	.032	-38	78	89	-17%	57	67	14

PA = Proposed Action; NA = No Action; %Δ = Percent change

Alternative 4 – Fisher Emphasis

Vegetation

Forest Structure and Composition - The focus of this alternative differs significantly from Alternative 1 and 3. While the project area remains the same, effects vary considerably. The remaining acres differ in important ways. The following discussion is limited to those key aspects.

Stand Density Index - The focus on retaining clumps of large trees, with the associated mid-sized trees, results in no real reduction in stand density. The premise is that the larger trees have developed to this point by exploiting soil resources (primarily moisture) unique to the specific position they occupy. No assurance can be made that this competitive advantage would be sustained over any specific timeline. Trees that exhibit indications of at least moderate vigor are likely to persist. Associated trees of lesser stature, especially those that developed during the period of effective fire suppression, may not have any competitive advantage and may actually exert competitive stress to their larger neighbors.

Stocking would be reduced within the matrix surrounding these clumps. Individual tree vigor would increase; however, the significance of this increase is hard to assess. The relatively small addition of growing space would probably not alter the status of the matrix forest, with regard to density management thresholds. Annual growth would return treated stands to current conditions more quickly than in Alternatives 1 and 3.

Reductions in stocking would be less than Alternative 1 and 3, as higher stocking levels are desired. Hazards are higher with this alternative, as compared to 1 or 3 when bark beetle-related mortality hazard is viewed on a continuum. Cumulative effects of this alternative include an increased susceptibility of insect/pathogen-related mortality across the landscape.

Diameter Distribution - Changes in the population of larger trees can be expected to be minimal. As in Alternative 1 and 3, substantial numbers of trees less than 20 inches would be removed. Trees within the 20-30 inch size class would be maintained at higher levels than in previously described alternatives. An additional aspect of this alternative is the retention of smaller understory trees. Project design would allocate approximately 10-15 percent of the treated area to maintain existing levels of small trees. While the nature of these patches would be expected to vary considerably, the growth of these trees may be favored by area-wide density reduction, and yield both short-term habitat benefits, as well as provide for sustained growth into larger size classes.

Species Distribution - Limited changes would be made in the population of the larger shade-tolerant tree species. Following with the above statements, substantial reductions of understory white fir and incense cedar would occur. However, limited change would be made to increase the landscape-scale extent of dominant pines and oaks.

Canopy Cover - Project design would yield post-treatment canopy cover values much higher than the proposed action or Alternative 3. Most of the treated stands would have values of 50 percent, while even higher levels (60 percent or more) would occur in the vicinity of the clumps described above. For context, in typical Sierra Nevada forests, thinning projects, where increasing the growing space for the larger trees is the primary goal, post-treatment canopy cover is commonly within the 35-45 percent range. Few portions of treatment areas would be within this range.

Fuel and Fire Behavior

Prescribed Fire - Effects described in the proposed action discussion are about the same for Alternative 4. Some increase in associated torching may occur, due to the presence of higher levels of understory vegetation. The extent of this, however, is related to the specific placement of this fuel, relative to potential ladder fuel.

Potential Fire Type - Effects described in the proposed action discussion are about the same for Alternative 4. The removal of most of the ladder fuel, combined with surface fuel treatments, would likely yield about the same outcomes. Overall fire type, flame length, and torching index values, at the management unit scale, would be similar to those displayed in Table 3-6. The effects of increased understory fuel as discussed above would apply here also.

Canopy Bulk Density - Alternative 4 effects are significantly different than the proposed action and Alternative 3. The retention of clumps of larger trees would maintain current values and allow for even higher values over time. Some reduction would occur within the matrix, with values that would likely vary widely. The variation would be the most important characteristic, as continuity of higher values can reduce the effectiveness of surface and ladder fuel treatments.

Environmental Consequences

Alternative 4 is specifically designed to address the Pacific Southwest Research Station's (PSW) strategies that recommend an emphasis on restoration of ecological processes while reducing short term effects to fisher. The PSW recognizes recently discovered fisher den sites and the certainty of undiscovered den sites and then provides extensive protection. Alternative 4 provides for the full treatment of all eight Kings River Project management units; uses Cedar Valley suggestions for greater retention of canopy cover in habitat classified as CWHR 5D; and applies the limited operating period (LOP) of March 1 through June 30 to all treatments within the project's management units. The project's management units reside in an area identified by Conservation Biology Institute (CBI) that contains fisher.

The full scale implementation of a Limited Operating Period (LOP) to all management units curtails the application of prescribed fire as a method of treating slash and surface fuels in the project area during cooler seasonal period that provide for low intensity burns. This LOP restricts the use of management ignited prescribed fire (underburns, jackpot burn, and broadcast burns) in the Bear-fen_6, El-o-win_1, Krew_bul_1, Krew_prov_1, Providence_1 and Providence_4 Management Units to hotter dryer periods of the year. The Glen_meadow_1 Management Unit does not call for this type of prescribed burn. The North_soaproot_2 unit lies outside of the range of fisher habitat identified by CBI; therefore, these management units are not discussed further.

Prescribed underburns are allowed during the LOP providing burn prescriptions to be implemented are designed to retain high levels (70-90%) of the large diameter (greater than 24 inches dbh) hardwoods, logs and snags. Burning proposed within occupied 700 acre fisher den buffers has even higher retention standards (over 85-95%) due to the desire to not affect occupied den trees. If spring underburning prescriptions cannot meet retention guidelines, pile burning may be the preferred method or prescribed fire would be limited to time frames outside of the LOP.

The primary season for prescribed burning in ponderosa pine and mixed conifer forests on the High Sierra District has typically been late winter through early summer (February to Mid-June). Prescribed burning is used to remove dead and down woody debris that is both naturally and activity created, to thin out dense stands of undergrowth (young trees and brush) that create ladders for fire to move into the crowns of mature trees.

Direct Effects to Prescribed Burning - The limited operating period shifts the use of prescribed fire from early season (February through June) to late season (July through October). Current weather variables (prescriptions) used in early season prescribed burns are compared to variables that exist during the months July through October. September and October are months of poor air quality and higher fire activity. Burn windows are generally not available until late October. Project analysis focuses on conditions found in July and August. See 3-14 below for a comparison of the weather variables

Table 3-14. **Comparison of Weather Variables (used for current prescribed burn program as compared to potential hot season burn)**

Weather Variables	**Cool Season Burn Parameters (Feb-June)**	**Hot Season Burn Parameter (July-August)**
Slope	5-40%	5-40%
Temperature (degrees)	50-80 ^{o}F	50-90 ^{o}F
Relative Humidity (%)	60-20%	60-15%
Mid-Flame Wind Speed (mph) Slope winds	0-10	0-15
Dead Fuel Moisture 1Hr. (%)	9% -5%*	9% - 3% *
10 Hr. (%)	10% -6% *	10 % - 4 % *
1000 Hr. (%)	20% -8% *	20% - 5 % *
Transport Wind Direction	North to Southwest	North to Southwest

Higher moisture contents occur earlier in the year, fuel moisture drops as the season progresses.

July and August in the Sierra Nevada become hot and dry, effectively drying out surface fuels and limiting the amount of moisture in brush and grass. Live woody vegetation generally drops to below 80 percent moisture content in late July or early August (Live Fuel Moisture Sampling records – district files). Once chaparral reaches the critical level of 80% moisture content they ignite and burn readily as if they were dead. The current weather parameters used in the High Sierra districts underburn program (Table X above) is compared to a probable prescription that might be necessary under the LOP if undesired or unexpected impacts are observed, and modifications in the effective dates for the fisher LOP, types of permitted activities, and/or extent of permitted activities were to be made This probable prescription is used to show the reader how season variables change and how these changes affect the resultant fire behavior.

The computer program Fire Family Plus was used to summarize historical weather data from 1987 to 2007. Averages, ranges, median and mean values were characterized by Fire Family plus for the period of July through October to determine weather variables that would be used to conduct a hotter (summer) season prescribed burn program. Weather variables used to model fire behavior are dry bulb (degrees Fahrenheit), relative humidity (percentage), wind (miles per hour), 1-hour fuel moisture (percentage) and 10-hour fuel moisture (percentage). Variables are then modeled in Behave Plus, a fire behavior prediction program used to model basic surface fire spread behavior in terms of flame length (feet), rate of spread (chains per hour) scorch height (feet) spotting distance (miles) and probability of ignition (percentage). The current cool prescription used by the High Sierra District has been in use since 1994 and was developed through years of actual prescribed fire experience in the Big Creek and Dinkey Creek drainages.

An analysis was conducted to determine the occurrence of days in July through October that would meet cool prescription parameters and allow managers to ignite. The number of days meeting cool prescription parameters ranged from 0 to 46 days in the four month period July through October. This prescription was analyzed from 20 years of weather records. Managers would be able to ignite an average of 27 days out of 120 under a low (cool) intensity. The number of days within prescription for a hot burn was classified using Fire Family Plus – Event Locator for the same months (July through October). The number of days managers would be able to ignite jumps to 70 days out of 120 under the probable hotter prescription designed to allow for more burn days, but with hotter and drier parameters. This only applies to the rules that allow fire managers to put fire on the ground. Forest Service Manual Chapter 5142.1 – Fire Use states that a prescribed fire manager must be within prescription parameters to put fire on the ground (ignite). Parameters include weather variables set in a site specific, signed, approved Prescribed Fire Plan as outlined in the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide. All ignitions must stop and fire put in to a holding pattern if conditions are outside of the prescription.

Table 3-15. Fire Behavior comparison of Cool and Hot Season Burn Parameters

Fire Behavior Characteristics *	Cool Season Fire Behavior (Feb-June)	Hot Season Fire Behavior (July - October)
Flame Length (feet)	2.9	4.5
Scorch Height (ft)	13.0	28
Forward Rate of Spread (ch/hr)	3.9	9.2
Backing Rate of Spread (ch/hr)	0.4	0.4
Spotting Distance (miles)	0.0	0.3
Probability of Ignition (%)	<64	<87%

* Fuel Model 11 was used to run fire behavior. Model 11 is a light slash timber model

Table 3-15 above compares the resulting fire behavior of the current burn program to a hotter season burn program, if the LOP was instituted for an entire fisher occupancy range greater than 15 percent in this alternative. Conditions can become much hotter and dryer as day-to-day conditions change once a burn is ignited and moves around the burn unit. Lower moisture content in live and dead fuels and well as increased air temperature allows fuels to burn hotter and to ignite more readily. Experience shows that spotting from fire brands becomes a problem once the 10-hour fuel stick parameter drops to six percent moisture content or below. Spotting distance increases from 0 miles in a cool prescription to 0.3 miles under a hotter prescription. This indicates that burns can spot up to 1,500 feet away, starting new fires. Spotting coupled with the percent probability of ignition in the hot prescription means that a greater risk exists that the burn would escape. An 87 percent probability of ignition means that 87 out of 100 firebrands would start a new fire. Spotting does not readily occur in the cool underburn prescription. Prescribed burns can be used as a tool to reduce surface and ladder fuels, even in the WUI. Fire managers may choose to forego the use of underburns due to the unacceptable risk of escape under the hot prescriptions.

The use of prescribed fire in hotter conditions increases flame lengths and scorch heights; the consumption of live brush; the consumption of dead and down woody debris; and the consumption of small seedlings and saplings. Table 3-16 below compares the changes in fire behavior and consumption between cool and hot prescriptions for all management units in the Kings River Project that have prescribed burn activities.

Table 3-16. Comparison of Fire Behavior and Consumption between Cool and Hot Burn Prescription

	Flame Length (feet)		Scorch Heights (feet)		Consumption (tons/acre)	
Management Unit*	**Cool Rx**	**Hot Rx**	**Cool Rx**	**Hot Rx**	**Cool Rx**	**Hot Rx**
Bear_fen	2.4	5.0	10.4	41.3	9	19
El_o_win	1.6	3.5	5.9	24.8	9	20
Krew_bul	0.6	1.1	1.1	2.2	8	16
Krew_prov	1.7	3.0	6.5	19.1	10	19
N_soapro	4.4	9.3	27.1	114.3	3	6
Prov_1	2.7	3.8	11.9	26.9	7	16
Prov_4	3.2	5.9	15.9	54.6	6	14

* Analysis was conducted at the stand level.

Direct Effects on Wildfires - No change in fire behavior would occur for the Glen_meadow_1, El-o-win_1, Krew_prv_1, Krew_bul_1, Providence_1, North_soaproot_2, Bear_fen_6 and Providence_4 Management Units. Slight changes in canopy cover as a result of retention of larger trees in CWHR 5D habitat would not change enough of any stand in any management unit to produce a noticeable change in overall wildfire behavior in the event of a wildfire.

Indirect and Cumulative Effect to Prescribed Burning - The indirect effects of a hotter prescribed burn include increased potential for passive crown fire or torching trees in a stand. The lower moisture content in live and dead fuels and well as increased air temperature allows fuels to burn hotter and to ignite more readily (as described above). This causes increases in flame length and scorch heights which directly relate to how easily a fire would move through ladder fuels into the crowns of trees, allowing for passive crown fire, or torching individual trees or pockets of dense trees. The forest vegetation simulator (FVS) program models the amount of crown consumption of foliage and small branches and displays it as average of percent of trees crowning. FVS also models the amount of large woody debris consumed by fire (in this case by prescribed burning). Shown below (Table 3-17) is a comparison the average percent of trees crowning (passive crown fire or torching) between cool and hot prescriptions, and a comparison of the amount of large woody debris greater than 12 inches consumed in tons per acre by management unit.

Table 3-17. Comparison of Average Percent of Crowning Trees Per Acre and Large Debris Consumed between Two Prescribed Burn Prescriptions

Management Unit	Avg. % Crowning per acre		Large Woody Debris Consumed (tons per acre)	
	Cool Rx	Hot Rx	Cool Rx	Hot Rx
Bear_fen	1	2.3	0	24
El_o_win	0	1.7	0	6
Krew_bul	0	0	1	4
Krew_prov	0	0	1	8
N_Soapro	0	0	0	0
Prov_1	0	0	0	0
Prov_4	0	0	0	6

Indirect effects also occur when additional fire resources are required to accomplish prescribed burns under hotter conditions. Prescribed burns conducted in July and August would take over twice the amount of fire resources. The cost would be approximately $2,300 per day to burn under a cool prescription. Under the hot prescription the cost would jump to $7,600 per day.

Indirect and Cumulative Effects of Wildfire - Indirect and cumulative effects of this alternative are the same as for Alternative 3. Treatments do not change for any management unit. Management units remain at risk of severe stand replacing fires created by excessive fuel loading, dense trees and brush growth until implementation is started on any.

Crown Bulk Density

Direct, Indirect and Cumulative Effects to Prescribed Burning - Indirect effects of a hotter prescribed burn include increased potential for passive crown fire or the torching of trees in a stand. The lower moisture content in live and dead fuels as well as increased air temperature allows fuels to burn hotter and to ignite more readily (as described above). This causes increases in flame length and scorch heights which directly relate to how easily a fire would move through ladder fuels into the crowns of trees, allowing for passive crown fire or torching of individual trees or pockets of dense trees. This has a direct effect on trees. Indirect effects are those trees that succumb to the stress and die later on. Stress caused mortality may be caused by either cooking the cambial layer which is caused by an increase in fire intensity, or severe loss of foliage. Both the direct and indirect mortality of trees have a cumulative effect on stands and can result in the loss of crown canopy. The retention of patches for understory cover and habitat could be compromised in a hotter prescription when these retention patches fall within a prescribed underburn area. The loss of cover, and the potential crown loss coupled with the loss of large down woody debris may cause detrimental changes to species habitat (CWHR 5D). Further discussion of effects to vegetation can be found in the vegetation section of the supplement.

Direct, Indirect and Cumulative Effects on Wildfire - The direct, indirect and cumulative effects of this alternative are the same as for Alternative 3. Project treatments do not change for any management unit. Please refer to the Effects section on crown bulk density in Alternative 3 for further discussion.

Alternative 5 – Thin from Below

Vegetation

Forest Structure and Composition - The focus of this alternative differs significantly from the proposed action and Alternative 3, but is most similar to Alternative 4. The most significant difference between Alternative 4 and this alternative is the design specification that limits tree removal to 20 inches. As in previous alternative discussion, the following discussion is limited to key differences.

Stand Density Index - Reductions in stocking would be less than Alternative 1, 3, and 4, as restricting removal to trees less than 20 inches generally eliminates any likelihood of effective density reductions. Favored larger trees would not significantly benefit from the removal of trees this much smaller than themselves. If one assumes that the most valued trees are those that exceed, approximately 30 inches, only the removal of competing trees greater than 20 inches would offer significant growing space enhancements and expanded access to site resources. The removal of trees less than 20 inches, especially as they are already exist in subordinate crown classes, are not trivial, yet they can offer little in respect to biologically important resources. Potential mortality due to forces previously discussed would be higher than Alternatives 1,3, and 4.

Diameter Distribution - As in Alternative 4, in concert with the above description, the changes in the population of larger trees can be expected to be minimal. As in Alternative 1, 3, and 4, substantial numbers of trees less than 20 inches would be removed.

Species Distribution - As compared to Alternative 4, there would be even fewer changes made in the population of the larger shade-tolerant tree species. Reductions of understory white fir and incense cedar would likely be somewhat less than Alternative 4 and even fewer changes would be made to increase the landscape-scale extent of dominant pines and oaks.

Canopy Cover - Project design would yield post-treatment canopy cover values even higher than Alternative 4. While not limited to the same canopy cover specifications as Alternative 4, the limitation on harvest tree size would have a similar effect.

Fuel and Fire Behavior

Prescribed Fire - Effects described in the Alternative 3 discussion are about the same for Alternative 5.

Potential Fire Type - Effects described in the Alternative 4 discussion are about the same for Alternative 5. The removal of most of the ladder fuel, combined with surface fuel treatments, would likely yield about the same outcomes. Overall fire type, flame length, and torching index values at the management unit scale would be similar to those displayed in Table 3-6.

Canopy Bulk Density - Alternative 5 effects are significantly different than the proposed action and Alternative 3 and yield even higher values than Alternative 4. Like Alternative 4, the retention of clumps of larger trees, combined with the additional trees above 20 inches, would maintain current values and allow for even higher values over time. Reductions would occur, but as the primary source of CBD values is from trees greater than 20 inches, so this change is minimal, especially in the context of the landscape.