Mt. Ashland LSR Project

Fire & Fuels Assessment

Final Report
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I. Introduction

This analysis will address issues and opportunities surrounding the restoration and maintenance of late-successional forest habitat within a portion of the Mt. Ashland Late Successional Reserve (LSR). The purpose of the Mt. Ashland LSR Project is to restore and maintain healthy forest ecosystems that provide habitat for late-successional forest wildlife species and reduce the threat of wildfires burning with intensity that kills large numbers of trees over large areas.

The project area encompasses Long John and Beaver-Grouse 7th field watersheds. Portions of the Deer-Beaver, Upper Cow and Headwaters of Cottonwood Creek 7th field watersheds are also included in the project area along the major ridges that border Long John and Beaver-Grouse. The proposed project area is located in an area of primarily federal lands with minimal amounts of private ownership. The private lands consist of small inholdings, mainly along the eastern boundary of the project area. Fuel characteristics inside and outside the project area presents a risk to the LSR.

The effects of drought, forest disease and pests, mortality from overcrowding, and years of fire exclusion have put this area at risk of a wildfire which would compromise the ability of the area to meet desired future conditions as specified in the Klamath National Forest Land and Resource Management Plan (KLRMP). There is a need to take action and reduce tree density, and fuel levels in the area.

II. Alternatives

A. Alternative 1 – No Action

No action would be taken to implement silvicultural or fuel treatments to alter the current stand and fuel conditions. Stand development and fuel dynamics currently occurring in the project area will continue.

Wildfire prevention activities would continue to occur under the No Action Alternative. Wildfire prevention is the informing, educating, and regulating of human behavior or activities that influence the various types of potential ignition sources within flammable vegetation. Efforts to educate the public on safe fire use would continue through personal contacts, interpretive programs, the use of posters and signs, radio and press releases. Under the No Action Alternative, no management activities for the purpose of fire hazard reduction would occur. The appropriate suppression response for a wildland fire would continue to be suppression. The Forest Service policy for fire suppression is to conduct fire suppression in a timely, effective and efficient manner, with emphasis on public and firefighter safety.

B. Action Alternatives Fuel Treatments

While the number of acres proposed for treatment varies between action alternatives, the suite of fuels treatment options is common to all action alternatives. Following is a brief summary of each fuels treatment considered in this analysis.

Whole tree removal is proposed as a fuels treatment in thinned stands with slopes less than 45%. This fuels treatment involves removing limbs and tops with the boles of trees that are thinned from the stand, which reduces the amount of fuel added to the forest floor during the thinning operation. The material is available for biomass utilization, or if not utilized, would be burned at disposal areas under wet conditions. Whole tree removal is an intermediate fuels treatment and will be followed up by a surface fuels treatment after the mechanical removal occurs.

Mastication is proposed as an additional fuels treatment in stands with slopes less than 45% where there is a substantial number of small diameter trees (less than 8"dbh). Thinning and reduction of the ladder fuels is accomplished through the use of equipment with a rotary drum or grinding head (masticator). This fuel treatment will result in a change in the surface fuel bed as small trees are shredded or chipped into small pieces. Mastication increases the amount of surface fuel available to burn as small trees are shredded into pieces. Although more fuel is placed on the surface, the fuel bed is fairly compact and generally burns with lower flame lengths and slower rates of spread when compared to similar quantities of unmasticated fuels.

Hand piling and burning of material is proposed in stands that will have a large number of small diameter trees remaining after the thinning has been accomplished. This treatment is proposed to reduce the risk of tree mortality that might be incurred during an underburn. Thinning out small trees and burning the piled material reduces the ladder and surface fuels and provides opportunities to underburn without incurring unacceptable levels of tree mortality. In many stands this fuels treatment will be followed by an underburn. Some stands are comprised primarily of smaller diameter trees, are small in size, or are not readily accessible. Hand pile and burn is the only fuels treatment prescribed in these stands.

Underburning is proposed as a fuels treatment in stands with slopes greater than 45%. Fires are intentionally lit under controlled conditions. Underburning reduces the surface fuels and ladder fuels by consuming fuel on the forest floor, killing smaller trees and pruning the lower limbs of larger trees.

Defensible Fuel Profile Zones (DFPZ) are a component of each action alternative. There are five zones identified along major ridges. The average width of the DFPZs is ¼ mile. The objective of the fuel modification within the DFPZ is to create zones that are resistant to crown fires. Active crown fires moving into these zones would drop to the round and become surface fires. The DFPZ is a zone where surface fuels are reduced to levels that generate low fireline intensity; ladder fuels are reduced to limit potential for spread into crowns; canopy fuels are reduced to limit potential spread between crowns and to maintain an overstory of large healthy trees, minimizing the potential for competition induced mortality and creation of snags. The DFPZs are designed to: (1) reduce the extent of wildland fire severity by limiting the amount of area affected by wildland fire; (2) create areas where fire suppression efforts can be conducted more safely and effectively; (3) break up continuity of fuels over a large landscape; and (4) serve as anchor points for further area wide fuel treatments such as prescribed burning. The prescription will be to thin from below, removing the smaller trees in the stand. Primarily trees less than 20" in diameter will be targeted for removal. Occasionally a tree 20" or larger would be removed. The circumstances where this would occur are: 1) when a tree shows obvious signs of insects, disease, or poor vigor which indicate that the tree is likely to die and become a snag; or 2) when removal of a larger diameter white fir provides growing space for a vigorous, more fire resistant Ponderosa pine or Douglas-fir.

C. Alternative 2 – Proposed Action

This alternative proposes to treat 4706 acres. Silviculture treatments include variable density thinning (of trees up to 20" in diameter) would occur in 134 stands (2174 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 73 stands (1701 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees (less than 9" diameter) is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel. The fuels treatments proposed in this alternative are listed in Table 1

Alternative 2 (Proposed Action)		
Fuels Treatment	**Stands**	**Acres**
Whole Tree Removal	67	1202
Masticate	51	809
Masticate combined with hand pile and burn	15	436
Hand pile and burn	76	980
Hand pile and burn, followed by underburn	42	979
Underburn	72	1502

Table 1

D. Alternative 4

This alternative proposes to treat 4209 acres. Silviculture treatments include variable density thinning in 101 stands (1762 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 68 stands (1616 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel. The fuels treatments proposed in this alternative are listed in Table 2

Alternative 4		
Fuels Treatment	**Stands**	**Acres**
Whole Tree Removal	48	989
Masticate	35	617
Masticate combined with hand pile and burn	11	353
Hand pile and burn	63	862
Hand pile and burn, followed by underburn	42	939
Underburn	67	1438

Table 2

E. Alternative 5

This alternative proposes to treat 4612 acres. Silviculture treatments include variable density thinning in 136 stands (2180 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 73 stands (1601 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel. The fuels treatments proposed in this alternative are listed in Table 3.

Alternative 5		
Fuels Treatment	**Stands**	**Acres**
Whole Tree Removal	62	1065
Masticate	48	745
Masticate combined with hand pile and burn	14	375
Hand pile and burn	76	997
Hand pile and burn, followed by underburn	42	959
Underburn	78	1536

Table 3

III. Description of Area/Affected Environment

A. Climate

The area is characterized as having a modified Mediterranean climate, combining maritime and continental weather influences. Winters are cool and moist, with most precipitation falling as snow at the higher elevations, lasting until early summer in protected locations. Summers can be hot and dry with intermittent thunderstorms, which may be wet or dry, accompanied by lightning. The Collins Baldy Remote Automated Weather Stations (RAWS) located across the Klamath River shows an average of 35 inches of precipitation per year. Wildfires generally occur from June through October.

Fires burn hottest when fuels are dry and relative humidity is low, conditions that normally occur during August and September

B. Fire Environment

1. Fire Regime

A fire regime is a generalized description of the role fire plays in an ecosystem. Agee (1993) defines a fire regime as the combination of fire frequency, predictability, intensity, seasonality and extent characteristic of fire in an ecosystem. There are multiple systems used to define the fire regime. The system used in this analysis is a combination of fire frequency and fire severity devised by the USFS, Interior Agencies, and the Nature Conservancy (Hann et. al., 2003). *"Natural (historical) fire regimes are classified based on average number of years between fires (fire Frequency) combined with the severity (amount of replacement) of the fire on the dominant overstory vegetation."*

The lower elevation mixed conifer stands are classified as Fire Regime I, defined by a fire frequency of 0–35 years and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced).

The higher elevation red fir dominated stands are classified as Fire Regime III, defined by a fire frequency of 35–100 plus years and mixed severity (less than 75% of the dominant overstory vegetation replaced). Several authors agree that red fir dominated forests such as in the upper reaches of the Mt Ashland LSR project area fall into a mixed severity fire regime (Agee 1993, 1998; Skinner and Chang 1996). A review of pertinent literature reveals that red fir forests are highly variable when it comes to fire return intervals (FRI). Many studies indicate a wide variation about the mean (as much as from 5 to 157 years), when it comes to FRIs (Agee 1998). Fire intensity and effects on stand structure are also highly variable in these stands. Patch sizes and tree ages will show great diversity due to the complexities of the relationship between fire occurrence, fire intensity, and stand structure at any point in time.

b. Fire Regime Condition Class

The Fire Regime Condition Class (FRCC) is a classification of the amount of departure from the natural fire regime (Hahn et al., 2003).The classification is based on a relative measure describing degree of departure from the historical fire regime. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure and mosaic pattern); fuel composition; fire frequency, severity and pattern; and other associated disturbances (e.g., insect and disease related mortality, grazing and drought). Three classes are used to define the degree of departure.

- Condition Class 1 – Landscape is within the natural (historic) range of variability of vegetation characteristics; fuel composition; fire frequency; severity; and pattern. Fire behavior, effects, and other associated disturbances are similar to those that occurred prior to fire exclusion. Composition and structure of vegetation and fuels are similar to natural (historic) regime.

- Condition Class 2 – There is a moderate departure from the natural (historic) fire regime. Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). Composition and structure of vegetation and fuel are moderately altered.

- Condition Class 3 – There is a high degree of departure from natural (historic) fire regime. Composition and structure of vegetation and fuels are highly altered.

This analysis includes an assessment of the degree of departure for both historic fire return interval, FRCC (FRI), and vegetative structure FRCC (VS). A detailed discussion of the methodology for determining FRCC can be found in the Fire Regime Condition Class Report (Creasy et al, 2006).

The fire regime characterizations, as defined by Hann et al. (2003), are consistent with the published fire history studies in the Klamath region. Fires were common in the Klamath and Siskiyou mountains. Lightning was the primary ignition source. A fire history study on Thompson Ridge (roughly 35 air miles to the west) determined that, prior to European settlement, the median fire return interval (the number of years between two successive fire events in a given area) was 14.5 years and the annual area burned was roughly 350 hectares (Taylor and Skinner 1998). Similar results were found in the Hayfork study area roughly 75 air miles to the south (Taylor and Skinner 2003). Fires burned with variable severity across the landscape, killing many trees in some stands and few in others. Fire severity patterns were influenced by aspect and slope position. Fires were generally less severe on lower slopes, particularly north and east aspects. Fires occurring on the upper slopes tended to have more high severity burned area, particularly on south and west aspects (Taylor and Skinner 1998, 2003). The cumulative effect of the variation in fire severity across the slopes suggests that forested stands with late-successional characteristics (e.g., multi-layered canopy, high density of large diameter trees, snags and downed logs) were more commonly found at lower slope positions as well as on north and east facing slopes. The upper slopes and middle slopes on south and west facing aspects were more likely to have a pattern of scattered older trees, and remnant patches of older trees mixed in with larger areas of younger trees where fires had previously burned at intensities severe enough to kill many of the trees in the stand (Taylor and Skinner 1998).

Current fire return intervals exceed historic averages; approximately 89% of the project area has not experienced a wildfire since 1910. Approximately 74% of the project area is characterized as severely departed (Condition Class III). Approximately 22% is characterized as moderately departed (Condition Class II) as defined by the FRCC (FRI) measure

2. Fire History

In order to accurately address fire history and fire risk, it is necessary to examine areas beyond the strict confines of the project area. Fire history is taken from the Klamath

National Forest (KNF) fire occurrence records from 1922 through 2004 and Oregon Department of Forestry (ODF) fire occurrence records from 1967 through 2003. A fire analysis area was chosen that represents both fire occurrence within and adjacent to the project area. The primary analysis area is the Beaver Creek 5th field watershed (69,710 acres) which encompasses the majority of the Mt. Ashland LSR project area. Two 5th field watersheds to the north and east of the project area were also analyzed to asses the potential threat of fire spread into the Mt. Ashland LSR project area. To the north, on the Rogue River National Forest, is the Little Applegate watershed (72,250 acres). To the east is the Cottonwood Creek watershed (63,500 acres). Part of the project (approximately 5% of the acres proposed for treatment) occurs within the Cottonwood Creek watershed along the ridge top fuel reduction zone that separates the Beaver Creek and Cottonwood Creek watersheds.

A small portion of the project area abuts the Bear Creek 5th field watershed (northeast of Mt Ashland). This watershed is over 200,000 acres and includes several communities in Jackson County. Much of the fire occurrence is associated with population density. This watershed was not considered in the analysis due to the abundance of human caused ignitions in the populated areas, and the size of this watershed in context to the minimal proximity to the project area.

There are 558 fires on record in the Beaver Creek watershed between 1922 and 2004. Lightning was identified as the cause for 80% of the recorded fires. Suppression efforts have been effective within the watershed, with 95% of all reported fires contained at less than 10 acres. Of the fires that do escape initial attack, 79% have been contained at less than 100 acres and two fires exceeded 5,000 acres.

Within the Beaver Creek watershed there are only 5 years with no ignitions during the 84-year fire history record. Most years, more than one fire was recorded. There are only 11 years with one fire recorded for the year. It is not uncommon for a single thunderstorm to cause several fires within the watershed. More than 10 fires were recorded in a given year for 20 of the 84 years on record. The highest frequency of ignition occurred in 1973 with 37 fires recorded.

Both of the adjacent watersheds have far fewer recorded fires. This can be partially attributed to the shorter fire history record. The Little Applegate watershed has a total of 172 recorded fires between 1967 and 2003. The KNF portion of the Cottonwood watershed has a total of 199 recorded fires between 1922 and 2004. Another 51 fires were recorded in the ODF database between 1967 and 2003. Table 4 displays the number of fires in each size class for each watershed.

Fire Frequency by Size Class			
Size at Containment	**Beaver Creek**	**Little Applegate**	**Cottonwood Creek**
less than10 acres	530	161	222
10–99 acres	22	6	15
100–299 acres	2	2	7
300–999 acres	2	1	3
1000–4999 ac.	0	1	1
greater than 5000 acres	2	1	2

Table 4

Due to the differences of the length of the fire history record between watersheds, no conclusions can be drawn regarding the actual differences in fire frequency. But, comparisons can be made regarding the cause of ignition and size at containment. Only 34% of the recorded fires in the Applegate watershed were caused by lightning. Within the KNF portion of the Cottonwood watershed, lightning caused 50% of the fires. For the portion of the watershed outside the Forest, only 12% of the fires were caused by lightning. Based on this analysis, it can be concluded that within the project area and surrounding Beaver Creek watershed, lightning is the most likely cause of ignition. But the threat of fire entering the project area from adjacent watersheds is just as likely to be from a human caused ignition.

Analysis of suppression effectiveness also shows marked differences between the watersheds. Within the Little Applegate watershed 94% of all fires were contained at less than 10 acres. Of fires that did escape initial attack a greater proportion grew to larger size when compared to Beaver Creek. Within the Cottonwood watershed only 87% of the fires were contained at less than 10 acres. Similar to the Little Applegate statistics, a greater proportion of fires grew to larger size prior to containment.

Further analysis of the fire history records contrasts containment size with seasonality. Three categories were identified to determine whether time of year had a bearing on suppression effectiveness. Ignitions during May through July were grouped as early season fires. Ignitions between August and October were considered late season fires. Fires that started between November and April were all grouped as ignitions that occurred outside fire season. Table 5 summarizes the results of this analysis.

Probability of Size at Containment Based on Time of Ignition									
Size	**Beaver Creek**			**Little Applegate**			**Cottonwood Creek**		
@ Containment (acres)	**Early (May–July)**	**Late (Aug.–Oct.)**	**Nov thru Apr.**	**Early (May–July)**	**Late (Aug.–Oct.)**	**Nov. thru Apr.**	**Early (May–July)**	**Late (Aug.–Oct.)**	**Nov. thru Apr.**
less than10	97%	95%	100%	94%	96%	92%	87%	86%	100%
Fires that escape Initial Attack*									
10–99	91%	79%		100%	33%	0	38%	69%	
100–299	0	7%			33%	0	31%	15%	
300–999	0	7%			17%	0	8%	15%	
1000–4999	0	0			0	100%	8%	0	
greater than 5000	9%	7%			17%	0	15%	0	

Table 5

*For those fires that are not suppressed at less than 10 acres, the probability of fire size based on historic records. Note: Cottonwood Creek late season ignitions do not equal 100% due to rounding errors.

While there are not a large number of large fires recorded, the probability analysis does show an increased likelihood of larger fires occurring during the latter part of the season when conditions are drier. In the Beaver Creek watershed, there is a slight (2%) reduction in the number of fires contained at less than 10 acres during the latter part of fire season. For the fires that exceed 10 acres, there is a noticeable difference in the probable fire size at containment. Late season fires have a greater likelihood of becoming larger if they escape initial attack.

In the Little Applegate watershed, there is a slight (2%) increase in the number of fires contained at less than10 acres during the latter part of fire season. But again, there is a noticeable increase in the likelihood that late season fires will become large if initial attack efforts are not successful.

The Cottonwood Creek watershed had somewhat different outcome. Although the ability to contain fires at less than 10 acres doesn't differ substantially between early and late fire season, there is a substantial reduction in suppression effectiveness (roughly 10% less) when compared to the other two watersheds. There is also a greater likelihood that fires will become larger. Of note in this watershed, the records indicate early season fires have had a greater likelihood of escaping initial attack and becoming large.

3. Fire Risk

Fire risk is defined as the statistical probability of a fire start occurring over a ten year period for a given thousand acre area. Fire risk is based on the fire occurrence records for an analysis area. Calculations based on the number of ignitions, number of years with recorded fire history, and the size of the analysis area are used to stratify the analysis area into one of three levels of fire risk.

- High Risk – At least one fire expected to occur per decade for every thousand acres in the area being analyzed.

- Moderate Risk – Between .5 and .99 fires expected to occur per decade for every thousand acres in the area being analyzed.
- Low Risk – Less than .5 fires expected to occur per decade for every thousand acres in the area being analyzed.

The Beaver Creek 5th field watershed was used as an analysis area for the Mt Ashland LSR project. Fire records indicate that the Beaver Creek watershed had 558 fires occur over 84 years. The risk value is thus:

$$R = \{(x/y)10\}/z$$

Where:
x = fire starts (558),
y = period analyzed (84 years),
z = acres analyzed (69,710 displayed in thousands = 69.7)
R = Risk rating
Thus – {(558/84)10}/69.7 = 0.9531 = 0.95 for the Risk Value

The Beaver Creek watershed falls into the Moderate Risk classification.

4. Fire Behavior

Fire behavior is influenced by a variety of factors. Understory structure, overstory structure, and average tree size can influence fire behavior. Ladder fuels (small trees and brush that allow fire to move from the ground into the tree crowns) increase the potential for a surface fire to move from the ground into the tree crowns. Conversely, the understory can develop to a point that fire behavior is reduced. As trees grow and the bottom of the crowns becomes higher, the opportunity for fire to reach the crowns is reduced.

Changing stand conditions cause changes in fuel characteristics, potential fire behavior, and fire effects. Litter, branch fall, and dead trees add fuel to the forest floor, while decomposition breaks fuels down. The amount and arrangement of surface fuels continually changes over time. Fuel loading increases when fuel accumulation exceeds the decay rate. As fuel loading increases, the likelihood of more intense surface fire (fire that burns on the forest floor) increases, meaning ground fires will burn hotter and kill more vegetation.

Changes in overstory structure will also influence fire behavior. Dense canopies may contribute to crown fire spread but also reduce the amount of wind reaching the surface and may contribute to an increase in fine fuel moisture due to the shaded conditions. Conversely, open stands may not allow fire spread between crowns, but could result in higher wind speeds at the surface and increased fine fuel moisture. Finally, as trees get larger, the probability decreases of fire killing them (wildfire-induced mortality). Stands that develop a greater proportion of larger trees will be less susceptible to mortality from fire. Regenerating stands are susceptible to high fire mortality due to the higher proportion of small diameter trees.

5. Fuels

Surface fuels within the Mt Ashland LSR project area vary. Conditions range from open areas with low amounts of combustible material to areas concentrations of heavy dead and down fuel loadings in stands that are severely impacted by tree mortality.

a. Fine Fuels

Fine fuels are the smaller fuels which are less than 3” in diameter and are the easiest to ignite. Fine fuels generally control surface fire rates of spread and are represented by 13 fire behavior fuel models established by Rothermel in 1972, and documented by Albini in 1976, for use in surface fire spread models. These standard fire behavior fuel models have been in use since that time, with a guide developed by Anderson (1982) commonly used for reference. The stands targeted for treatment vary but can be generally described as standard fire behavior Models 8, 9, 10, 11, 12 and 13. Fuel Model 8 represents closed canopy stands with compact litter layers and only occasional concentrations of heavier fuels. Fuel Model 9 represents closed canopy pine dominated stands. The litter layer is less compact, resulting in greater flame lengths and rates of spread than fuel model 8. Fuel Model 10 is typical of mature timber stands with moderate amounts of dead and down material. Fuel models 11, 12 and 13 are more representative of slash fuels, with greater loadings of fine fuels than other models, which can increase spread rates and flame lengths. Fuel Models 8 and 10 dominate the project area. Areas of wind damage or concentrated mortality are best represented by a Slash Fuel model 11. Descriptions of fuel loading and fire behavior fuel models found in the project area are based on fuels transect data and ocular estimates made during field visits Refer to Appendix A for a discussion of standard fire behavior fuel models.

b. Horizontally Oriented Coarse Fuels

The standard fire behavior fuel models do not explicitly capture the contribution of larger fuels (greater than 3 inches in diameter) to fire behavior and effects. Areas where densely grown trees are competing for resources, larger diameter material is being recruited into the fuel beds as stand mortality occurs and dead trees fall to the forest floor. These fuels do not contribute to the fire spread models; however when they fall to the ground they raise the fuel bed height, increasing flame heights and fire residence time. As these fuels shatter and decay they become fine fuels, adding to spread rates. Resistance to control by suppression forces is also increased as large fuels accumulate on the forest floor, adding time and difficulty to fireline construction by suppression forces. Pockets of this type of fuel exist throughout the project area.

c. Vertical Fuels

Vertical Fuels are standing vegetation, either live or dead, which can serve as links for ground fire to move into overstory canopies, initiating crown fires, which can be the most destructive and difficult to suppress. Many stands are overly dense, with low canopy base heights, making them highly susceptible to crown fire initiation. Standing dead trees (snags) are good receptors for embers. Embers from burning snags are also more easily carried by winds ahead of a fire, increasing spotting potential and adding to fire spread.

D. Vegetation Types

The vegetation has been classified by primary vegetation type and distribution of structural classes within each vegetation type. The vegetation classification is a step in the process of defining the Fire Regime Condition Class (FRCC). Review, validation and refinement of the historic fire regimes and reference conditions developed nationally has been undertaken by the Pacific Southwest Region (PSW) ecology program. In the Mt Ashland LSR project area, the classification was completed by the Province Ecologist using a process that is being applied consistently across the Pacific Southwest Region (Creasy etal. 2006). Potential Natural Vegetation maps, existing vegetation maps, gradient modeling, lithology, elevation and climate grids were all used to characterize the vegetation types (referred as biophysical settings by FRCC). The Vegetation Dynamics Development Tool (VDDT) was used to generate predictions of historic distributions of structural classes at the landscape scale, given the fire regime associated with the vegetation types that are present. The current landscape conditions are then contrasted with reference conditions to determine the degree of departure from historic (reference) conditions.

The project area consists primarily of mixed conifer forest. The lower elevation mixed conifer stands are classified as Fire Regime I, defined by a fire frequency of 0–35 years and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced.)

Mixed conifer is defined by two vegetation types. The dominant vegetation type is white fir mixed conifer (61% of the landscape). The white fir mixed conifer vegetation type occurs within areas where white fir is capable of becoming a dominant component within a stand. This vegetation type is found at higher elevations of the mixed conifer zone and lower on the slope on north and east aspects. The actual species composition within this vegetation type is influenced by fire frequency. More frequent fires result in a greater proportion of ponderosa pine, sugar pine and Douglas-fir conifer species. In areas where fire occurs less frequently, white fir can become established and develop to sufficient size to withstand low intensity fire. The second mixed conifer vegetation type is ponderosa pine mixed conifer (4% of the landscape). This vegetation type is found at lower elevations, particularly on south and west aspects. Jeffrey pine montane chaparral (rocky) is located in areas of serpentine parent material (2% of the landscape).

The upper reaches of the project area consist primarily of red fir/white fir forests (29% of the landscape). This vegetation type occurs at higher elevations, where fires occur with less frequency. The higher elevation red fir dominated stands are classified as Fire Regime III, defined by a fire frequency of 35–100 plus years and mixed severity (less than 75% of the dominant overstory vegetation replaced). Wet mountain meadows, also located at the higher elevations, account for another 2% of the landscape. Other vegetation types, including California grasslands, chaparral and red fir/western white pine, comprise the remaining 2% of the landscape.

This analysis will focus on the mixed conifer and red fir/white fir vegetation types, as they dominate the landscape and are also the vegetation types where the majority of the treatments are proposed. Refer to the Mt Ashland LSR Silviculture Report for a more detailed discussion of the vegetation condition.

As previously stated, Fire Regime Condition Class describes the degree of departure for vegetation, fire frequency and fire severity. For this analysis only the vegetation and fire frequency departure is described. While it may be presumed that a high degree of departure in vegetative composition and structure would translate to a departure in fire severity, there is not sufficient information relative to severity reference conditions to establish the degree of departure for fire severity.

1. Condition Class

The mixed conifer zone, which is Fire Regime I, has missed several fire return intervals. From a fire frequency standpoint (FRCC FRI), much of the project area is in a Condition Class 3 (severe departure). The higher elevation red fir/white fire, Fire Regime III, is characterized as Condition Class 2 (moderate departure) based on historic fire frequency..

The degree of departure for vegetation composition and structure is not as pronounced, with 55% of the project area characterized as Condition Class 2; 28% characterized as Condition Class 3; and the remaining 17% as Condition Class 1.

Condition Class is calculated at the 7th field watershed level. There are distinct differences between the 7th field watersheds. The analysis shows that Long John watershed is primarily Condition Class 3 in the lower elevation mixed conifer stands. The upper elevation true fir zone is primarily a mix of Condition Class 1 and 2 stands. The mixed conifer zone in the Grouse watershed is primarily Condition Class 2. The true fir zone is also a mix of Condition Class 1 and 2, but is skewed to a higher proportion of Condition Class 2.

The distribution of structural classes influences the Vegetative Condition Classes. The reference conditions are based on modeling assumptions of the fire severity at the landscape scale and its effect on the vegetation. Seral stage (structure class) distribution is defined by the reference condition modeler in VDDT based on the fire regime associated with each vegetation type. The general definitions for structure classes are:

A: post-fire often shrub forbs but includes sapling trees

B: mid-development, closed canopy (trees 5–20” dbh & greater than 40% canopy cover)

C: mid-development, open canopy (trees 5–20” dbh & less than40% canopy cover)

D: late-development, open canopy (trees greater than 20” dbh & less than40% canopy cover)

E: late-development, closed canopy (trees greater than 20” dbh & greater than 40% canopy cover)

The late development stands have a component of larger trees (20” dbh or larger) that were apparent during the typing of stand structure. Within the project area, although a component of larger trees is present; many of the stands characterized as late development are dominated by mid-development stand structure (i.e., the majority of the trees in the stand are less than 20” dbh).

The following graphs display the structural classes for the major vegetation types. Each graph displays the current acres; reference acres; and departure acres. The Reference Condition acres have a 15% error bar denoted on each column. This is done to acknowledge the probable error associated with these acres which have been derived from Region 5 or LANDFIRE Reference Condition models developed in VDDT.

Long John 7th Field Watershed

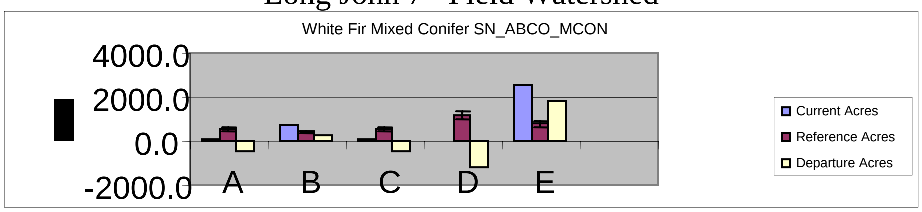

Figure 1

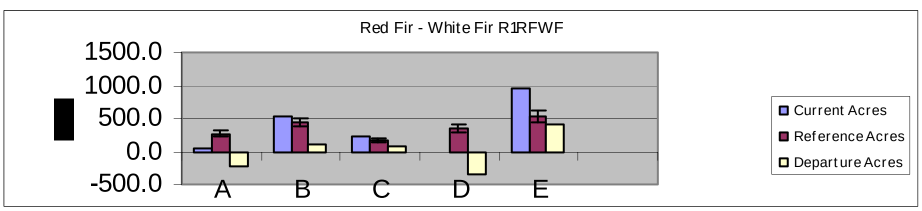

Figure 2

Beaver Grouse 7th Field Watershed

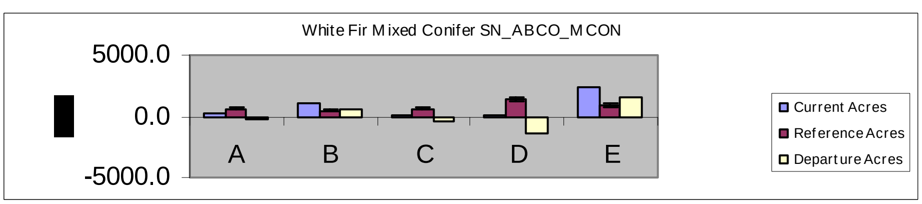

Figure 3

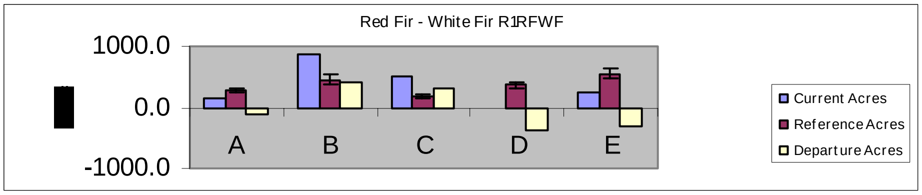

Figure 4

The FRCC analysis indicates the Project Area lacks late-development open stand structure and, to a lesser degree, post-fire shrub forbs vegetation. The FRCC analysis also displays an abundance of mid and late-development closed stand structure. Field verification indicates that much of the vegetation typed as late-development-closed stands, while containing a component of trees greater than 20" dbh, is predominantly comprised of trees less than 20" dbh and lacks the structural complexity to be characterized as late successional habitat. Refer to the Mt Ashland LSR Silviculture Report for a more detailed discussion of the current condition of the vegetation.

IV. Analysis Methods

Stand composition and structure will influence fire behavior, which in turns affects the post fire stand conditions. The analysis focuses on criteria that either influence fire behavior, determine how resilient a stand may be to the effects of a fire, and which influence suppression effectiveness. The stand attributes do not factor in topography and weather conditions, which also influence fire behavior and suppression capabilities

A. Surface fire intensity
B.

Fuels, topography and weather influence how a fire will burn. The fuel is the only component which can be influenced through management. For modeling purposes topography is maintained constant (50% slope) and weather is defined by very dry, or severe conditions (90th percentile weather) and dry, or moderate conditions (50th percentile weather). Table 6 displays the values used to depict severe and moderate conditions.

Weather Parameters

Moderate Conditions (50th Percentile Weather)		Severe Conditions (90th% Percentile Weather)	
1 hour fuel moisture	9%	1 hour fuel moisture	6%
10 hour fuel moisture	10%	10 hour fuel moisture	7%
100 hour fuel moisture	13%	100 hour fuel moisture	9%
1000 hour fuel moisture	25%	1000 hour fuel moisture	10%
Air Temperature	73º F	Air Temp.	85º F
20 ft wind speed	5 mph	20 ft wind speed	10 mph

Table 6

The intensity of the flaming front affects tree survival. Although different species have different survival rates, larger trees, with thicker bark, are less susceptible than small trees. In general, as intensity increases, survivability decreases for any given species of a given size. For trees that are not killed outright by the flaming front, the surface fire intensity affects the amount of crown scorch that occurs. This will reduce the amount of live crown available for photosynthesis and will increase the crown base height. Surface fire intensity also influences crown fire potential.

B. Ladder fuels

Ladder fuels consist of small trees and brush in the understory which enable a fire move from the surface to the crowns. The presence of small trees in the understory affects the canopy base height which is a measure of the height from the ground to the base of the tree crown. The method of measuring canopy base height is defined as the lowest height at which a 3-foot running mean is greater than 30 lbs/acre/foot (Scott and Reinhardt 2001). (The point in the stand where a 3-foot height increment has an average value greater than 30 lbs/acre/foot) Changes in canopy base height can be used as a measure of change in ladder fuel structure within a stand.

C. Canopy bulk density

The compactness of the tree crowns influences crown fire spread once a surface fire is able to move into the crowns. Canopy bulk density is an estimate of crown weight for a given volume (either kg/m^3 or lb/ft^3) that is used as a measure of the density of tree crowns within a stand. The methods for calculating canopy bulk density are also based on Scott and Reinhardt (2001). At higher densities a fire can be sustained and move through the crowns (defined as active crown fire). At lower densities, although a fire may be able to move into the crowns, it cannot be sustained and would result in single tree or group torching also referred to as a passive crown fire. Changes in canopy bulk density can be used as a measure of change in stand structure.

D. Species Composition and size

Fire affects tree species differently. Some species are relatively resistant to wildfires and will survive under a variety of burning conditions, while other species may be killed readily by low intensity burns. Size is also a factor. Smaller trees are generally more susceptible to fire and may be killed under conditions that would not kill larger trees of the same species. Changes in average stand diameter can be used as a measure of change in the proportion of small and large trees in the stand.

As stand conditions change over time the fuel characteristics; potential fire behavior; and fire effects will also change. Fuel dynamics are influenced by stand development. Litter and branch fall, as well as whole tree mortality, add fuel to the forest floor. At the same time decomposition is occurring which breaks fuels down. Over time there are continual changes in the amounts and arrangement of surface fuels.

When fuel accumulation exceeds decay rates, the result is an overall increase in fuel loading. As fuel loading increases there is a greater likelihood for an increase in surface fire intensity.

Changes in understory structure can increase fire behavior as ladder fuels develop increasing the potential for a surface fire to move into the crowns. Conversely, the understory can develop to a point that fire behavior is reduced. As the canopy base height increases, there may be less opportunity for a fire to reach the crowns.

Changes in overstory structure will also influence fire behavior. Dense canopies may contribute to crown fire spread, but also reduce the amount of wind that can reach the surface. Conversely, open stands may not allow fire spread between crowns but could result in higher wind speeds at the surface.

Finally as tree size changes, the susceptibility to wildfire induced mortality also changes. Stands that are developing a greater proportion of larger trees will be less susceptible to wildfire induced mortality. Stands that are regenerating through creation of gaps may be susceptible for longer periods due to the higher proportion of small diameter trees.

E. Potential Fire Behavior & Fire Effects

Treatments can be designed to reduce surface, ladder and canopy fuels to an established threshold which would result in acceptable fire behavior and post fire stand conditions in relatively short time frames if necessary.

Addressing changes in species composition and tree size is more problematic. Many of the stands proposed for treatment in the Mt. Ashland LSR project contain large numbers of small diameter trees. Although treatments can be designed to increase average stand diameter over time, they must account for the current stand conditions. Stands dominated by small trees may require time to reach a size which will readily survive a wildfire. Finally, tree health also influences opportunities. While tree size is a factor in of wildfire, tree health also influences survival. A larger tree in an already weakened condition may not survive any better than a smaller vigorous tree. Findings in burned white fir by van Mantgem and others (2003) indicate the frequency of trees killed by fire is at least partially dependent on the pre-fire stand conditions. They found that including pre-fire growth rates, along with the severity of fire caused damage, improved post-fire mortality predictions. They concluded that if tree growth is reduced by factors such as climatic change, increased forest density, or other stresses, there will likely be an increase in fire severity (number of trees killed), even when there is no change in fire intensity.

F. Suppression Effectiveness

In making decisions about suppression operations, Forest Service policy requires managers to minimize suppression costs and resource loss consistent with the resource management objectives for the values to be protected. The primary criteria for choosing fire suppression strategies and tactics are to ensure the safety of the public and firefighting resources while minimizing suppression costs, resource loss, environmental damage, and the threat of wildland fire escaping onto non-Federal lands. The selection of less aggressive containment strategies in areas of minimal potential negative impacts is appropriate if it is determined to be the safest and least cost alternative (Forest Service Manual 5130 2004).

Within the LSR, the goal of wildfire suppression is to limit the size of all fires. Once an LSR assessment has been completed, some natural fires may be allowed to burn under prescribed conditions (MA 5-37 of Klamath LMP, 1995). The Forest-wide LSR Assessment (1998) addressed fire as an ecological process. It is expected and even desirable to have low to moderate intensity fires burn in the LSR. Low intensity fires will reduce fine surface and ladder fuels, create a seedbed for a diversity of understory plants, and create a patchy understory open enough for spotted owl movements. Moderate intensity fires are desirable if they create small openings in the canopy of one to five acres in size. Burn openings are most desirable if they occupy only a small percentage (5–10%) of the stands providing habitat.

While wildland fire as an ecological process is desired within the LSR, suppression effectiveness as measured by flame length and rate of spread are important considerations when considering alternatives to immediate suppression. When conditions are favorable, decisions may be made to use less aggressive containment strategies consistent with agency policy, or allow a naturally ignited wildland fire to burn to achieve resource benefits.

The Forest-wide LSR assessment identified the desired fire behavior as flame lengths less than 4 feet and rates of spread less than 20 chains per hour (1320 feet per hour).

Flame lengths less than 4 feet allow for direct attack at the head and flanks of a fire with hand tools. Hand constructed line should be able to hold a fire in check. Rates of spread less than 20 chains per hour are within production capabilities of initial action resources. A five person engine crew (a standard configuration on the Klamath National Forest) is capable of constructing 20 chains of fire line per hour during an initial attack in the types of fuels found within the LSR.

G Measurable Indicators

For this analysis late successional habitat restoration stands were evaluated separately from DFPZ stands. The mixed conifer stands were grouped by watershed and aspect, the red fir/white fir stands were grouped and each DFPZ was addressed separately.

The FFE-FVS simulations were evaluated at four points in time to compare the effects over time. The current condition for each stand category provides a baseline for all treatment alternatives. Each alternative was evaluated for year 20 and year 40. It is anticipated that fuels treatment would occur within three to five years after the silviculture treatments are completed. In this analysis all fuels treatments were assumed to occur five years after the mechanical treatment. Each action alternative was evaluated post mechanical treatment prior to completing the surface fuels treatment; post surface fuels treatment; at year 20 and at year 40.

The fire and fuels assessment builds upon stand categories as defined in the vegetation report. Fuels transect data was also collected from representative stands. The Fire Fuels Extension of the Forest Vegetation Simulator (FFE-FVS) was used to model changes in horizontal and vertical fuel conditions, fire behavior and fire effects.

The modeled results are not intended to be absolute values, but display relative trends for each of the defined categories. The analysis of potential fire behavior and fire effects is based on the interpretation of the FFE-FVS results. Refer to Appendix A for further explanation of the FFE-FVS analysis process.

The following indicators were selected from the FFE-FVS simulations to measure changes in surface fire intensity; ladder fuel condition; canopy bulk density and species composition and size for each alternative. Each of the selected indicators is also sensitive to topography and weather parameters that influence fire behavior (slope, wind and fuel moisture).

- ***Surface flame lengths*** serve as a visible and measurable indicator of surface fire intensity.

- ***Fire Type*** is an indicator of whether a fire is likely to stay on the surface or move through the crowns, given the stand structure and defined burning conditions. Fire type is defined by the following categories:

    - ***Surface fire* –** The fire remains on the forest floor. The combination of surface fire intensity and ladder fuels are not sufficient to move a fire into the crowns under the defined burning conditions.

    - ***Passive crown fire* –** Individual tree or group torching occurs. The combination of surface fire intensity and ladder fuels allow for movement into the crowns under the defined burning conditions, but canopy bulk density is too low for fire to spread through the crowns under the projected winds speeds.

    - ***Active crown fire* –** The combination of surface fire intensity, ladder fuels and canopy bulk density allow fire to move into, and spread through, the crowns under the defined burning conditions.

    - ***Conditional crown fire* –** Canopies are dense enough to carry fire with the projected wind speeds, but the surface fire intensities and ladder fuels do not allow movement into the crowns. Crown fires may move into the stand from outside, but cannot be initiated from within the stand under the projected wind speeds.

- ***Potential Mortality*** is a measurable indicator of the percentage of basal area mortality that could be expected in a stand with a given species composition and structure under defined burning conditions.

Flame length has already been identified as a criterion of measurement. Potential rate of spread as modeled in BEHAVE Plus 3 is used to evaluate relative changes in suppression effectiveness.

- ***Rate of Spread*** **–** The speed at which a fire grows. Generally referred to in chains per hour. Rate of spread is influenced by the type of fuel that is burning, the topography, and the wind speed. Spread rates can be calculated for different areas of the fire. For this analysis the rate of spread is calculated for the head of the fire, which is the direction of primary spread.

Flame length, which directly correlates with fireline intensity, affects the choice of suppression tactics. Table 7outlines how flame length influences fire suppression actions as interpreted in Appendix B of the Fireline Handbook (NWCG 1998)

Suppression Interpretations

Flame Length (ft.)	**Fireline Intensity (BTUs/Ft/Sec)**	**Interpretations**
0-4	0-100	Fires can generally be attacked at the head or flanks be persons using hand tools. Handline should hold the fire.
4-8	100-500	Fires are too intense for direct attack on the head by persons using hand tools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8-11	500-1,000	Fires may present serious control problems, including torching, crowning and spotting.
11 and greater	1,000 and greater	Crowning, spotting, and major runs are common. Control efforts at the head of the fire are ineffective.

Table 7

Rate of spread is influenced by the type of fuel that is burning, the topography, and the wind speed. Spread rates can be calculated for different areas of the fire. For this analysis the rate of spread is calculated for the head of the fire, which is the direction of primary spread. FFE-FVS does not calculate spread rates. Potential rate of spread as modeled in BEHAVEPlus v3 is used to evaluate relative changes in suppression effectiveness. The Behave program has been used to model fire behavior since 1984. Rothermel's surface fire spread model (1972) is a fundamental component of BehavePlus. The 13 standard fire behavior fuel models as described by Anderson (1982) are used as inputs, along with historic weather parameters defined above in Table 6.

Fuel Model Description	Example
Fire Behavior Model 8 Closed canopy stands of short-needle conifers or hardwoods that have leafed out. Fire spreads through a compact litter layer, consisting mainly of needles, leaves and occasional twigs. Little undergrowth is present in the stand. Generally slow burning fires with low flame lengths, although occasional heavy fuel concentrations may occur causing the fire to flare up. Only under severe weather conditions, involving high temperatures, low humidities, and high winds do the fuels pose a fire hazard.	
Fire Behavior Fuel Model 9 Closed stands of long-needled pines and hardwoods. Fires run through the surface litter faster than model 8 and have longer flame length. Concentrations of dead and down woody material will contribute to possible torching of trees, spotting and crowning.	
Fire Behavior Fuel Model 10 Any forest type may be considered if heavy down material is present. The dead and down fuels include greater quantities of 3 inch and larger limb wood. Fires burn in the surface and ground fuels with greater intensity than other timber fuel models. Crowning, spotting and torching are more frequent in this fuel type, leading to potential fire control difficulties.	
Fire Behavior Fuel Model 11 A slash fuel model which can also represent stands with higher loads of fuel from wind damage and areas of high mortality. The arrangement of the fuel, shading from the overstory, or age of fine fuels can contribute to limiting fire potential. Fires are fairly active in the areas of concentrated fuels and understory vegetation intermixed with the dead fuels.	
Fire Behavior Fuel Model 13 Fire is generally carried by a continuous slash layer. Large amounts of material larger than 3 inches are present. Situations were the slash still has red needles, but total amount of fuels is less, can be represented because a fire to quickly become more intense and burn more rapidly. Fires spread quickly through the fine fuels and intensity builds more slowly as large fuels start burning. Active flaming is sustained for long periods and a wide variety of firebrands can be generated	

Figure 5

Rate of spread was evaluated under both moderate and severe conditions for four fire behavior fuel models, slope steepness ranging from 20–60%; and a range of canopy conditions. Fire behavior fuel models 8, 9, 10 and 11 were used to model rate of spread.

These fuel models represent the majority of the conditions found in the project area. Currently much of the area would be characterized as fuel model 8 and 10. There are also concentrated areas of recent mortality that would be best represented by a slash fuel model 11. After thinning, prior to surface fuels treatment, many proposed treatment stands would also be best represented by a slash fuel model. Fuel model 13 was selected, as it represents the heaviest fuel conditions. This fuel model would display worst case for fire behavior. With treatment fuel model 8 would be the most commonly occurring fuel model, with fuel model 9 occurring in pine dominated stands and fuel model 10 occurring to a lesser degree. Fuel Model 11 was used to depict post treatment conditions in masticated stands.

The range of canopy cover used for untreated stands ranges from 50–75%, as this represents the range of current and projected conditions with no action. With a variable density thinning prescription, as defined in the Forest-wide LSR Assessment (1998), the majority of the area within treated stands will be thinned from below, with minor reductions in overstory canopy. To achieve the habitat development goals, portions of the stands will be thinned heavily opening up the canopy and portions will be left untreated. This will result in a wide range of canopy cover values within treated stands. A range of 25–50% canopy cover was used to represent more heavily thinned areas for the treated stands, as this represents the possible range of conditions immediately after thinning.

H. Current Fire Behavior/Fire Effects

Currently the mixed conifer stands on the north and east aspects of Long John Creek are susceptible the effects of a wildfire under both moderate and severe conditions. The stands consist of large numbers of smaller trees and have low canopy base heights. Flame lengths just exceed direct attack capabilities with hand tools only. Under both moderate and severe conditions, fire will readily move into the crowns, with passive crown fire behavior, and there would be substantial levels of tree mortality within the fire perimeter.

The mixed conifer stands on the north and east aspect of Grouse creek consist fewer numbers of small trees and have higher canopy base heights. The differences in stand structure are projected to result in subtle differences in fire behavior. Fireline intensities are similar, with flame lengths that exceed direct attack capabilities. In Grouse creek the stand densities are capable of supporting an active crown fire under severe burning conditions, but would remain on the surface under moderate burning conditions. Similarly, mortality is projected to be near 100% under severe conditions, but is projected to be less than 25% under moderate burning conditions.

The sampled stands on the south and west aspects of Long John Creek and Grouse Creek are currently more resilient when compared with the north and east aspect stands. Currently there is no projected difference in fire behavior between the modeled stands in either drainage. Although a substantial component of smaller trees also exists in these stands, the combination of lower levels of surface fuels and slightly higher canopy base height indicate a greater resilience. It would require higher wind speeds to move a fire into the tree crowns. Few trees would be anticipated to die under similar burning conditions. Initially fireline intensities are within the desired less than 4 foot flame length for both moderate and severe burning conditions. Initially fire is not expected to move into the crowns under the defined burning conditions and mortality levels remain low.

With the current condition of the true fir stands, the flames lengths are at the desired four foot under both moderate burning conditions, and just exceed the desired flame length under severe burning conditions. A fire is projected to remain on the surface, and tree mortality is projected to remain at less than 25%, under both moderate and severe conditions.

The composition and structure of the stands in the Defensible Fuel Profile Zones (DFPZ) varies. As a result, the projected fire behavior is also varies. The Cow Creek, Doe Peak and Four Corners are dominated by mixed conifer stands. The projected flame lengths are near direct attack capabilities under severe conditions. Under moderate conditions the flame lengths remain at, or less than four feet. A fire is projected to remain on the surface under both moderate and severe conditions. The stand mortality for the Cow Creek and Four Corners DFPZ is projected to be less than 20% under moderate and severe burning conditions. While the fire behavior is similar in the Doe Peak DFPZ, the mortality is projected to be near 25% due to the higher component of small diameter trees.

Table 8 displays the projected flame lengths, type of fire and mortality for all stands in their current condition.

Stand Category		**Current Conditions**					
Mixed Conifer Stands		**90th Percentile Conditions**			**50th Percentile Conditions**		
Aspect	**Watershed**	**Flame Length**	**Fire Type**	**Basal Area Mortality**	**Flame Length**	**Fire Type**	**Basal Area Mortality**
North & East	**Long John**	6	P	99%	5	P	93%
	Grouse	6	A	100%	5	S	24%
South & West	**Long John**	4	S	23%	3	S	20%
	Grouse	4	S	23%	3	S	20%
True Fir Stands		5	S	21%	4	S	20%
Cow Creek		5	S	17%	4	S	16%
Doe Peak		4	S	27%	3	S	25%
Four Corners		3	S	17%	2	S	17%
Siskiyou Gap		4	P	45%	3	S	16%
Siskiyou Peak		5	A	100%	4	S	27%

Table 8

For the north and east aspect mixed conifer stands, the fire behavior modeled in the FFE-FVS simulations is best represented by Fuel Models 10 and 11. The stands on the south and west aspect are best represented by Fuel Model 10, with portions of the stands represented by a Fuel Models 8 and 12. The true fir stands are best represented by Fuel Models 10 and 11. The stands within the DFPZs are best represented by Fuel Models 8 and 10, with portions of the stands represented by a Fuel Model 11. The rates of spread projected for each of these fuel models are displayed in Tables 9 and 10.

Rate of Spread for Severe Conditions (90th Percentile Parameters)

Fuel Model	Rate of Spread in Chains per Hour					
	20% Slope 75% Cover	20% Slope 50% Cover	40% Slope 75% Cover	40% Slope 50% Cover	60% Slope 75% Cover	60% Slope 50% Cover
8	0.4	0.5	0.8	0.9	1.5	1.5
10	2.6	2.8	5.3	5.4	9.7	9.9
11	1.4	1.5	2.6	2.7	4.6	4.7

One Chain = 66 feet

Table 9

Rate of spread is influenced more by change in slope than by changes in canopy cover. As noted in the table above, a 25% reduction in canopy cover will result in a minimal increase in spread rate, while a 20% increase in slope will nearly double the rate of spread. Fuel Model 11 as a slash fuel depicts lower rates of spread when compared to Fuel Model 10 because the rate of spread for Fuel Model 10 is influenced by the low live fuel moisture the occurs during severe burning conditions. On the ground areas with heavier fuel loads more typical of a slash Fuel Model 11 and a live understory component will have rates of spread more typical of Fuel Model 10.

Currently, over the modeled range of conditions, the rate of spread does not exceed the line construction capabilities of a five person engine crew during initial attack. While the rates of spread remain within line construction capabilities, the fire line intensities (as displayed in Table 10) will limit the effectiveness of direct attack at the head of the fire without engines, dozers or aircraft support.

Rate of Spread for Moderate Conditions (50th Percentile Parameters)

Fuel Model	Rate of Spread in Chains per Hour					
	20% Slope 75% Cover	20% Slope 50% Cover	40% Slope 75% Cover	40% Slope 50% Cover	60% Slope 75% Cover	60% Slope 50% Cover
8	0.4	0.4	0.7	0.7	1.2	1.2
10	1.7	1.8	3.4	3.5	6.3	6.4
11	1.2	1.3	2.2	2.3	3.9	4.0

Table 10

Under moderate burning conditions, there is a decrease in rate of spread for the fuel models which represent much of the Project Area. The reduced rate of spread, combined with a reduction in flame length, increase the likelihood of being able to effectively suppress a fire with limited resources.

V. Analysis of Alternatives

A. No Action

With no action, the high density stands will continue to self thin and surface fuels will continue to accumulate. Increased amounts of surface fuels will result in increased fire line intensities, a higher occurrence of crown fire behavior and increased stand mortality.

There will be no change in road access for suppression resources. Therefore there would be no change in capabilities of ground resources to reach a fire in initial attack phase.

The FFE-FVS model scenarios after 20 years indicate a slow trend towards increasing flame length which will influence suppression capabilities and increase susceptibility to crown fire activity. Under 90th percentile conditions, all stands are projected to have flame lengths which limit direct attack suppression capabilities. A majority of stands within the project area would be susceptible to single tree and group torching. There is also a marked increase in wildfire induced mortality.

Under 50th percentile conditions, there is a slight increase in flame lengths over time, which will begin to limit suppression effectiveness. In the majority of stands, fire is anticipated to remain on the surface. Wildfire induced mortality is relatively unchanged from current conditions. Table 11 displays the modeled conditions for the No Action Alternative at year 20.

Stand Category		No Action – Projected Conditions at 20 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	6	P	99%	5	P	83%
	Grouse	6	A	100%	5	S	24%
South & West	Long John	5	P	94%	4	S	19%
	Grouse	5	P	42%	4	S	16%
True Fir Stands		6	A	100%	4	S	17%
Cow Creek		5	S	19%	4	S	13%
Doe Peak		4	P	97%	3	S	21%
Four Corners		5	P	97%	4	P	15%
Siskiyou Gap		4	P	15%	3	S	15%
Siskiyou Peak		5	A	100%	4	S	23%

Table 11

With no action, there would be an increased amount of area with fire behavior that would be best represented by fuel models 10 and 11. As a result, more of the project area would be represented by the higher rates of spread displayed in Tables 9 and 10. When combined with the increase in fire line intensity, there would be a further reduction in suppression capability and will increase the probability of large fire occurrence.

After a 40-year period, the trend continues. Under both severe and moderate conditions the projected fire line intensities could present serious control problems. Flame lengths would generally exceed direct attack capabilities with hand tools.

Most stands would experience crown fire activity under both moderate and severe conditions. Many stands would incur higher levels of mortality under moderate (50th percentile) conditions. Table 12 displays the modeled conditions for the No Action Alternative at year 40.

Stand Category		No Action – Projected Conditions at 40 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	8	P	99%	6	P	96%
	Grouse	7	P	99%	6	P	63%
South & West	Long John	7	P	97%	6	P	43%
	Grouse	6	P	93%	5	S	12%
True Fir Stands		6	A	100%	4	P	57%
Cow Creek		5	S	19%	4	S	13%
Doe Peak		6	P	98%	5	S	18%
Four Corners		7	P	97%	6	P	49%
Siskiyou Gap		5	S	14%	4	S	13%
Siskiyou Peak		6	A	100%	4	S	19%

Table 12

With projected increase in fire behavior, particularly under moderate burning conditions, there will be further limitations to suppression effectiveness. This could be particularly problematic during a multiple ignition lightning event, when initial attack resources may be limited. The likelihood of a large fire occurring within the project area will continue to increase.

The modeled results are consistent with observations of current stand conditions and general trends that can be expected in high density stands when left untreated. As stands reach maximum density, self thinning will occur resulting in mortality of less vigorous trees. As trees die and fall to the ground there will be accumulations of fuel on the forest floor, resulting in higher fireline intensities.

The initial stages of this process are already noticeable. Portions of the project area already have high levels of mortality and pockets of heavier fuel accumulations.

Indirect Effects

As fuel loading and fire hazard increase, the potential for fires that can escape initial attack will increase. This will have an indirect effect on the capability of the area to sustain late successional habitat characteristics.

The continued increase in stand density, combined with continued efforts to suppress fire, will result in stands that are vulnerable to other disturbance influences such as drought, insects or disease.

Cumulative Effects

As more areas develop into a higher fire hazard condition, with high levels of wildfire induced tree mortality, there will be a change in vegetative structure across the landscape if a wildfire occurs that cannot be contained at initial attack stage.

B. Alternative 2 (Proposed Action)

This alternative proposes to treat 4706 acres. Silviculture treatments include variable density thinning (of trees up to 20" in diameter) would occur in 134 stands (2174 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 73 stands (1701 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees (less than 9" diameter) is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel.

This alternative presents no substantive change to current access for suppression operations. A total of 9.3 miles of road are proposed for a change to year-round closure. Year round closure using a gate system (or similar removable barrier), would still provide access for ground resources. The proposed decommissioning of the 40S20 road (0.49 miles) would not negatively impact fire suppression efforts. Of particular importance from a fire suppression and fuels management perspective, is the proposal to place unauthorized road 40S06.2 (1.98 miles) on the transportation system. This ridge top road is located along a portion of the Doe Peak DFPZ. Addition of this road to the transportation system would maintain access along a key ridge system within the project area.

This alternative proposes use of 8.0 miles of current unauthorized roads as temporary road spurs to implement the proposed action. There effects of this action would positively influence the ability to treat hazardous fuels in a more cost effective manner if road access were maintained until the surface fuels treatments are completed

The range of fuels treatments proposed is based on site specific stand conditions. The size of the remaining trees in the thinned stands, topography, size of stand and proximity to control features (i.e., roads, streams and ridges) all factor in to the fuels treatment selection.

Table 13 displays the fuels treatments for the stands proposed for development of late-successional forest characteristics and stands within the Defensible Fuel Profile Zones in

Alternative 2. The following tables summarize modeled results for fuel treatments applied to various stand categories.

ALTERNATIVE 2						
Summary of Habitat Improvement Fuels Treatment Acres						
		North & East Aspect		**South & West Aspect**		
FUELS TREATMENT	**Total Acres**	**Grouse**	**Long John**	**Grouse**	**Long John**	**True Fir**
Masticate	503	20	101	40	226	116
Hand Pile Burn	217	59	33	56	33	37
Underburn	913	128	119	265	247	155
Hand Pile Burn & Underburn	472	95	66	118	80	113
Masticate and Hand Pile Burn	69	1	31	1	35	0
TOTAL	**2174**	**303**	**349**	**481**	**621**	**421**
Summary of DFPZ Fuels Treatment Acres						
Fuels Treatment Group	**Total Acres**	**Cow Creek**	**Doe Peak**	**Four Corners**	**Siskiyou Gap**	**Siskiyou Peak**
Masticate	236	54	67	57	26	32
Hand Pile Burn	122	58	16	10	38	0
Underburn	469	19	232	118	71	29
Hand Pile Burn & Underburn	507	57	178	45	193	34
Masticate & Hand Pile Burn	367	55	134	92	86	0
TOTAL	**1701**	**243**	**627**	**322**	**414**	**95**

Table 13

Post Thin Stand Conditions

After the stands are thinned, they will be more susceptible to the effects of a wildfire until the fuels treatment is complete. Generally fuels treatments will occur within three to five years after the mechanical treatments have been implemented. Based on past experience, there may be a lag time of between five and ten years before all fuels treatments are completed.

Under severe burning conditions all stands are projected to have flame lengths that exceed direct attack capabilities with hand tools. With the projected fireline intensity (greater than 8' flame length) in many of the stands, a wildfire would present serious control problems. Passive crown fire could be expected in the majority of stands. Wildfire induced mortality remains high until the surface fuels are treated.

Under moderate burning conditions, flame lengths still exceed the four foot flame length that is desired, but fire would remain on the surface in the majority of stands. Wildfire induced mortality would be comparable to current conditions.

Table 14 displays the modeled conditions for stands after thinning prior to the fuels treatment.

Stand Category		Stands >9' dbh - Post Thin Conditions (Prior to Fuels Treatment)					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	10	P	95%	8	S	22%
	Grouse	6	P	50%	4	S	14%
South & West	Long John	7	S	33%	6	S	13%
	Grouse	8	S	30%	6	S	14%
True Fir Stands		6	P	97%	5	S	15%
Cow Creek DFPZ		8	P	92%	7	P	31%
Doe Peak DFPZ		7	S	34%	6	S	20%
Four Corners DFPZ		7	P	95%	5	P	26%
Siskiyou Gap DFPZ		6	S	24%	4	S	12%
Siskiyou Peak DFPZ		9	P	99%	7	S	77%

Table 14

Whole Tree Removal

A total of 1202 acres are proposed for whole tree removal. This includes all stands proposed for thinning using ground based equipment. The removal of limbs and tops would reduce the amount of surface fuel accumulation during the thinning operation. Whole tree removal would reduce the susceptibility of the stands prior to implementation of the fuels treatments.

Masticated Stands

A total of 739 acres are proposed to be masticated. Mastication is proposed in stands with slopes <45% where there is a substantial number of small diameter trees (<8"DBH). Thinning and reduction of the ladder fuels is accomplished through the use of equipment with a rotary drum or grinding head (masticator). This fuel treatment will result in a change in the surface fuel bed as small trees are shredded or chipped into small pieces. Mastication increases the amount of surface fuel available to burn as small trees are shredded into pieces. Although more fuel is placed on the surface, the fuel bed is more compact and generally burns with lower flame lengths and slower rates of spread when compared to similar quantities of unmasticated fuels.

The choice of masticator heads can influence the size and arrangement of material after treatment. Anecdotal observations of wildfire behavior in masticated fuel beds noted low flame lengths and rates of spread. The observed fire behavior is considered to be a function of the compact fuel bed created by the equipment. Additionally, higher levels of mortality have also been noted, presumably due to the amount of residence time of the burning material. The FFE-FVS model scenarios do not readily account for the change in fuel bed structure resulting from this treatment.

Initial research into fire behavior in masticated fuel beds supports the anecdotal observations. A comparison of fire severity and intensity of spring prescribed burns in natural and masticated stands (Bradley etal., 2006) reported an average flame length of

29 inches in previously masticated plots. Mortality in overstory trees (>8” dbh) was between 16-49% and between 47 and 98% in understory trees (<8” dbh). The stands were burned six months after the mastication treatment when the fuel bed was still loosely arranged on the surface. The spring prescribed burn was implemented during a vulnerable stage of plant development when leaf, bud and cambium tissues were particularly susceptible to the heat released from the flaming front. Knapp etal (2006) reported similar, though less severe, results when masticated stands received a prescribed burning 2-3 years after mastication. This study reported flame lengths of 1-2 feet; rates of spread of 1-3 chains per hour; higher than predicted scorch heights; and as much as 30% tree mortality. The study also contrasted observed fire behavior with predicted fire behavior as modeled in BehavePlus. Flame length and rate of spread were adequately predicted by the model, but actual scorch height was two to four times the model predictions. The initial mortality appeared to be due to crown scorch which can be mitigated by adjusting firing techniques and burning when air temperature is low (Knapp etal., 2006)

The current research indicates that initial flame lengths and rates of spread as modeled in this analysis can be reasonably anticipated, while anticipated mortality levels are likely to be substantially underestimated. It should be noted that burning masticated stands is not proposed in this project. With the predicted flame lengths and rates of spread, a wildfire can be readily suppressed within masticated areas. The application of prescribed fire in the future would be appropriate, as the masticated fuel bed breaks down.

According to the models, after treatment the majority of stands (70%) are within the desired four foot flame lengths under severe burning conditions. Similarly, fire would remain on the surface in the majority of stands. Mortality levels are anticipated to be greatly reduced in all stands, with roughly 90% of the stands projected to incur <25% mortality.

Under moderate burning conditions, all stands are projected to be within the desired four foot flame length. Fire type is expected to remain as a surface fire. Wildfire induced mortality is projected to exceed 25% on <5% of the stands. As previously stated, the fire behavior predictions are likely to be similar to actual burning conditions, while tree mortality in masticated stands may be underestimated.

The FFE-FVS model scenarios depict the likely worst case scenario for mastication treatment. The models do not readily account for the change in fuel bed structure resulting from this treatment. The choice of masticator heads can influence the size and arrangement of material after treatment. Anecdotal observations of fire behavior in masticated fuel beds noted low flame lengths and rates of spread (personal conversation with Fire Managers observing wildfire behavior in masticated fuel bed on Squires fire on the Medford district of the BLM in 2002). The observed fire behavior is considered to be a function of the compact fuel bed created by the equipment. Additional higher levels of mortality have also been noted, presumably due to the amount of residence time of the burning material.

The models depict a slow trend towards increased fire behavior. Under severe (90th percentile) burning conditions at year 20 the masticated stands are projected to have flame lengths comparable to no action at the same time frame. But, a wildfire is anticipated to remain on the surface in a greater proportion of stands. Wildfire induced mortality is anticipated to be much lower, as the treated stands would consist of larger more resilient trees. Table 15 displays the modeled conditions for mastication treatments for the first five years after treatment.

Stand Category		Post Mastication of Thinned stands >9" dbh					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	11%	4	S	11%
	Grouse	4	S	13%	3	S	13%
South & West	Long John	4	S	12%	3	S	11%
	Grouse	5	S	13%	4	S	11%
True Fir Stands		4	S	15%	3	S	14%
Cow Creek		5	P	23%	4	S	16%
Doe Peak		4	S	17%	3	S	15%
Four Corners		4	P	28%	3	S	17%
Siskiyou Gap		4	S	12%	3	S	11%
Siskiyou Peak		5	P	37%	4	S	26%

Table 15

Under moderate (50th percentile) burning conditions the models depict a slight improvement over no action. In general, flame lengths are within the desired four feet. Fire would remain on the surface and wildfire induced mortality would be less than 25%.

As previously discussed, current fire behavior models do not readily address masticated fuels. Research is currently ongoing to determine how masticated fuel bed will burn, and establishing decay rates for masticated fuels. As with the immediate post treatment results, it is assumed that the mastication scenarios likely represent a more severe situation than what would be expected to occur. Table 16 displays the modeled conditions for the masticated stands twenty years after treatment.

Stand Category		Mastication Treatment @ 20 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	7	P	56%	5	S	9%
	Grouse	5	S	11%	4	S	11%
South & West	Long John	5	S	13%	4	S	11%
	Grouse	6	S	13%	4	S	10%
True Fir Stands		6	P	95%	4	S	12%
Cow Creek		5	P	63%	4	P	17%
Doe Peak		5	S	17%	4	S	13%
Four Corners		5	P	19%	3	S	17%
Siskiyou Gap		5	S	10%	3	S	10%
Siskiyou Peak		6	P	97%	4	S	25%

Table 16

Over time the masticated material continues to breakdown. There is projected to be limited additional fuel accumulation due to the health and vigor of the residual stands. Additional fuel accumulation would consist primarily of small branch and limb wood, contrasted with the self thinning that would continue to occur in untreated stands.

Under severe conditions flame lengths are still projected to remain at levels that make direct attack with hand tools difficult, but there is a slow trend toward reduced fire line intensities. The majority of the project area would experience surface fire and mortality levels are projected to be less than 25% in all but the true fir stands.

Under moderate conditions, much of the area is within the desired four foot flame lengths. A wildfire is project to remain on the surface and mortality levels are projected to be less than 25% in all masticated stands. Table 17 displays the modeled conditions for the masticated stands forty years after treatment.

Stand Category		**Mastication Treatment @ 40 Years**					
Mixed Conifer Stands		**90th Percentile Conditions**			**50th Percentile Conditions**		
Aspect	**Watershed**	**Flame Length**	**Fire Type**	**Basal Area Mortality**	**Flame Length**	**Fire Type**	**Basal Area Mortality**
North & East	**Long John**	6	S	8%	5	S	8%
	Grouse	5	S	8%	3	S	8%
South & West	**Long John**	5	S	12%	4	S	7%
	Grouse	5	S	8%	4	S	7%
True Fir Stands		6	P	77%	4	S	11%
Cow Creek		5	S	20%	4	S	13%
Doe Peak		4	S	12%	3	S	10%
Four Corners		4	P	17%	4	S	12%
Siskiyou Gap		5	S	9%	3	S	8%
Siskiyou Peak		6	S	22%	4	S	20%

Table 17

As previously stated, masticated fuels are not readily depicted by the model scenarios. It is likely that the fuel beds will be more compact, resulting in fire behavior that is much reduced from what is depicted in the models.

Hand Piled Stands

A total of 339 acres are proposed for hand pile and burn fuels treatment. Hand piling and burning of material is proposed in stands that will have a large number of small diameter trees remaining after the thinning has been accomplished and have slopes greater than 45%. This treatment is proposed to reduce the risk of tree mortality that might be incurred during an underburn. Thinning out small trees and burning the piled material reduces the ladder and surface fuels and provides opportunities to underburn without incurring unacceptable levels of tree mortality.

In many stands this fuels treatment will be followed by an underburn. Some stands are comprised primarily of smaller diameter trees, are small in size, or are not readily accessible. Hand pile and burn is the only fuels treatment prescribed in these stands. Under severe burning conditions roughly 75% of the stands are within the desired four foot flame lengths. A wildfire is primarily expected to remain on the surface. Less than 5% of the stands are expected to incur greater than 25% wildfire induced mortality.

Under moderate burning conditions, roughly 90% of the stands are within the desired four foot flame lengths. Fire is projected to remain on the surface in all stands. Wildfire induced mortality is projected to be less than 25% in all stands.

Table 18 displays the modeled conditions for hand pile treatments for the first five years after treatment.

Stand Category		**Post Hand Pile Burn of Thinned stands >9" dbh**					
Mixed Conifer Stands		**90th Percentile Conditions**			**50th Percentile Conditions**		
Aspect	**Watershed**	**Flame Length**	**Fire Type**	**Basal Area Mortality**	**Flame Length**	**Fire Type**	**Basal Area Mortality**
North & East	**Long John**	6	S	13%	4	S	11%
	Grouse	4	S	12%	3	S	12%
South & West	**Long John**	3	S	12%	2	S	11%
	Grouse	7	S	20%	5	S	13%
True Fir Stands		4	S	15%	3	S	14%
Cow Creek		4	S	20%	3	S	16%
Doe Peak		4	S	17%	3	S	15%
Four Corners		4	P	28%	3	S	17%
Siskiyou Gap		5	S	12%	4	S	12%
Siskiyou Peak		No acres of this treatment proposed in this category					

Table 18

With time the hand piled stands are projected to remain more resilient when contrasted with no action. Under severe conditions the majority of stands are projected to have flame lengths within the desired four foot. Under moderate conditions flame lengths in all stands are projected to be at, or below four foot. Under both severe and moderate conditions a wildfire is projected to remain on the surface and wildfire induced mortality is less than 25% in all stands.

Table 19 displays the modeled conditions for hand pile treated stands twenty years after treatment.

Stand Category		Hand Pile Burn Treatment @ 20 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	9%	4	S	9%
	Grouse	4	S	11%	3	S	11%
South & West	Long John	4	S	10%	2	S	9%
	Grouse	6	S	13%	4	S	10%
True Fir Stands		4	S	13%	3	S	12%
Cow Creek		3	S	16%	3	S	15%
Doe Peak		3	S	13%	2	S	13%
Four Corners		3	S	17%	2	S	15%
Siskiyou Gap		4	S	10%	3	S	10%
Siskiyou Peak		4	S	20%	3	S	19%

Table 19

After forty years the modeled scenarios indicate a slight trend upwards in fire line intensity. The majority of stands still remain within the desired four foot flame lengths under severe burning conditions. All stands are within the desired four foot flame lengths under moderate burning conditions. Under both severe and moderate conditions a wildfire is projected to remain on the surface. With the combination of low fireline intensities and increased growth of the trees in the treated stands, the anticipated wildfire induced mortality remains very low.

Table 20 displays the modeled conditions for hand pile treated stands forty years after treatment.

Stand Category		Hand Pile Burn Treatment @ 40 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	6	S	13%	4	S	11%
	Grouse	4	S	8%	3	S	8%
South & West	Long John	4	S	9%	3	S	7%
	Grouse	5	S	8%	4	S	7%
True Fir Stands		5	S	11%	4	S	10%
Cow Creek		4	S	14%	3	S	12%
Doe Peak		3	S	10%	2	S	10%
Four Corners		3	S	13%	3	S	12%
Siskiyou Gap		4	S	9%	3	S	8%
Siskiyou Peak		4	S	15%	3	S	15%

Table 20

The modeled scenarios for hand pile fuels treatment are comparable with what can be expected. Hand pile fuels treatments do not reduce currently existing surface fuels, except in areas where activity fuel is piled. As a result, it is reasonable for the higher flame lengths projected in the scenarios to occur. Additionally, since the stands proposed for hand pile treatment consist of higher numbers of small diameter trees, there would be high levels of mortality within those stands. Smaller trees are more susceptible to cambium kill and crown scorch which due to the thinner bark and low crowns.

Masticated & Hand Pile Stands

A total of 436 acres are proposed for a combination of mastication and hand pile burn fuels treatment. This includes stands which are predominately on slopes less than 45%, with steeper pitches where machinery cannot operate. Mastication will occur on the gentler slopes and the steeper portions of the stands will be hand piled and burned. The modeled scenarios for masticated stands and hand piled stands would apply to these acres, with a greater proportion of the area depicted by the mastication modeled scenario.
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Underburn Stands

A total of 1382 acres are proposed for underburn fuels treatment. Underburning is proposed in stands with slopes greater than 45%. Fires are intentionally lit under controlled conditions.

Underburn prescriptions are designed to implement a low intensity fire which will consume surface fuels while maintaining scorch heights at low levels, minimizing impacts to trees to be retained in the stand. Underburning reduces the surface fuels and ladder fuels by consuming fuel on the forest floor, killing smaller trees and pruning the lower limbs of larger trees. Underburning is proposed as the only fuel treatment in stands where there numbers of small diameter trees are fewer and the anticipated mortality incurred during the underburn is within acceptable levels.

After treatment, under severe burning conditions roughly 80% of the stands are within the desired four foot flame lengths. Fire is projected to remain on the surface in all stands. Wildfire induced mortality is projected to be less than 25% in all stands.

Under moderate burning conditions all of the stands are within the desired four foot flame lengths. Fire is projected to remain on the surface in all stands. Wildfire induced mortality is projected to be less than 25% in all stands.

Table 21 displays the modeled conditions for hand pile treatments for the first five years after treatment.

Stand Category		**Post Underburn of Thinned stands >9" dbh**					
Mixed Conifer Stands		**90th Percentile Conditions**			**50th Percentile Conditions**		
Aspect	**Watershed**	**Flame Length**	**Fire Type**	**Basal Area Mortality**	**Flame Length**	**Fire Type**	**Basal Area Mortality**
North & East	**Long John**	5	S	9%	4	S	9%
	Grouse	5	S	11%	4	S	11%
South & West	**Long John**	1	S	7%	1	S	7%
	Grouse	1	S	8%	1	S	8%
True Fir Stands		4	S	12%	3	S	12%
Cow Creek		1	S	10%	1	S	10%

Doe Peak	2	S	12%	2	S	12%
Four Corners	2	S	13%	2	S	13%
Siskiyou Gap	5	S	10%	3	S	10%
Siskiyou Peak	4	S	21%	2	S	21%

Table 21

With time the stands which receive an underburn treatment are projected to remain more resilient when contrasted with no action. Under severe conditions the majority of stands are projected to have flame lengths within the desired four foot. Under moderate conditions flame lengths in all stands are projected to be at, or below four foot. Under both severe and moderate conditions a wildfire is projected to remain on the surface and wildfire induced mortality is less than 25% in all stands.

Table 22 displays the modeled conditions for underburned stands twenty years after treatment.

Stand Category		**Underburn Treatment @ 20 Years**					
Mixed Conifer Stands		**90th Percentile Conditions**			**50th Percentile Conditions**		
Aspect	**Watershed**	**Flame Length**	**Fire Type**	**Basal Area Mortality**	**Flame Length**	**Fire Type**	**Basal Area Mortality**
North & East	**Long John**	5	S	8%	4	S	7%
	Grouse	5	S	9%	4	S	9%
South & West	**Long John**	3	S	6%	2	S	6%
	Grouse	3	S	7%	2	S	7%
True Fir Stands		4	S	11%	3	S	11%
Cow Creek		3	S	10%	2	S	10%
Doe Peak		3	S	11%	2	S	11%
Four Corners		2	S	11%	2	S	11%
Siskiyou Gap		4	S	9%	3	S	9%
Siskiyou Peak		4	S	20%	3	S	19%

Table 22

After forty years, similar to the modeled scenarios for other proposed fuels treatments, there is a slight trend upwards in fire line intensity. The majority of stands still remain within the desired four foot flame lengths under severe burning conditions. All stands are within the desired four foot flame lengths under moderate burning conditions. Under both severe and moderate conditions a wildfire is projected to remain on the surface. With the combination of low fireline intensities and increased growth of the trees in the treated stands, the anticipated wildfire induced mortality remains very low.

Table 23 displays the modeled conditions for underburned stands forty years after treatment.

Stand Category		Underburn Treatment @ 40 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	6%	4	S	6%
	Grouse	5	S	7%	3	S	7%
South & West	Long John	4	S	5%	3	S	5%
	Grouse	4	S	6%	2	S	6%
True Fir Stands		5	S	9%	4	S	9%
Cow Creek		3	S	9%	2	S	8%
Doe Peak		3	S	8%	2	S	8%
Four Corners		3	S	8%	2	S	8%
Siskiyou Gap		4	S	7%	3	S	7%
Siskiyou Peak		4	S	15%	3	S	15%

Table 23

The modeled scenarios are consistent with expectations based on experience. Underburn treatments provide a more uniform consumption of smaller diameter surface fuels which drive fire behavior. As a result the projected post treatment flame lengths are reduced and, with lower fireline intensities, tree mortality would be reduced.

Hand Pile & Burn Followed by Underburn

A total of 979 acres are proposed for a hand pile and burn treatment, followed by an underburn. The combined treatment is proposed in stands with a higher proportion of small diameter trees that occur within larger areas proposed for underburn fuels treatments. The hand pile and burn treatment will reduce the fuels to levels sufficient to allow an underburn to be completed without incurring unacceptable levels of mortality.

Under severe conditions roughly 65% of the stands proposed for the combined hand pile and underburn treatment would remain within the desired four foot flame lengths. Fire is projected to remain on the surface in all stands. Wildfire induced mortality is projected to be less than 25% in all stands.

Under moderate burning conditions all of the stands are within the desired four foot flame lengths. Fire is projected to remain on the surface in all stands. Wildfire induced mortality is projected to be less than 25% in all stands.

Table 24 displays the modeled conditions for hand pile combined with underburn treatments for the first five years after treatment.

Stand Category		Post Hand Pile & Underburn					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	8%	4	S	8%
	Grouse	5	S	10%	4	S	10%
South & West	Long John	1	S	8%	1	S	8%
	Grouse	1	S	8%	1	S	8%
True Fir Stands		4	S	11%	3	S	11%
Cow Creek		1	S	10%	1	S	10%
Doe Peak		3	S	15%	2	S	14%
Four Corners		3	S	12%	2	S	12%
Siskiyou Gap		5	S	9%	3	S	9%
Siskiyou Peak		3	S	21%	2	S	20%

Table 24

With time, these stands are projected to become more resilient. At 20 years roughly 95% of the stands have flame lengths within the desired four feet under severe burning conditions. Under moderate burning conditions all stands are projected to have flame lengths within the desired four feet. Under both severe and moderate conditions a wildfire is projected to remain on the surface and stand mortality is projected at less than 25% for all stands.

Table 25 displays the modeled conditions for hand pile combined with underburn treatments twenty years after treatment.

Stand Category		Hand Pile & Underburn @ 20 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	8%	4	S	8%
	Grouse	4	S	9%	3	S	9%
South & West	Long John	2	S	8%	2	S	8%
	Grouse	2	S	8%	2	S	8%
True Fir Stands		4	S	11%	3	S	11%
Cow Creek		2	S	10%	1	S	10%
Doe Peak		3	S	9%	2	S	9%
Four Corners		2	S	11%	2	S	11%
Siskiyou Gap		4	S	9%	3	S	9%
Siskiyou Peak		4	S	20%	2	S	19%

Table 25

After forty years there is minimal change. Between year 20 and year 40 only the true fir stands show an increase in flame length above four feet under severe burning conditions. Under moderate conditions the flame lengths are projected to be within four feet for all stands. A wildfire is projected to remain on the surface under both severe and moderate conditions. Wildfire induced mortality is remains under 25% under both severe and moderate conditions.

Table 26 displays the modeled conditions for hand pile combined with underburn treatments forty years after treatment.

Stand Category		Hand Pile & Underburn @ 40 Years					
Mixed Conifer Stands		90th Percentile Conditions			50th Percentile Conditions		
Aspect	Watershed	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
North & East	Long John	5	S	6%	3	S	6%
	Grouse	4	S	7%	3	S	7%
South & West	Long John	3	S	6%	3	S	6%
	Grouse	3	S	6%	2	S	6%
True Fir Stands		5	S	9%	3	S	9%
Cow Creek		3	S	9%	2	S	9%
Doe Peak		2	S	8%	2	S	8%
Four Corners		3	S	9%	2	S	9%
Siskiyou Gap		4	S	7%	3	S	7%
Siskiyou Peak		4	S	16%	3	S	15%

Table 26

Rate of Spread

The surface fire rate of spread is partially influenced by the amount of wind that can reach the flames at the surface (mid-flame wind speed). In the short term after treatment, the stands will be in a relatively open condition increasing the amount of wind that can reach the surface when compared with closed stand conditions.

A 20% slope represents the gentler topography in the Project Area. The steeper terrain is represented by 60% slope. Slope influences rate of spread far greater than canopy cover. A 50% canopy cover represents the denser stands. The more open stands are represented by 25% canopy cover. The canopy cover range represents the amount of overstory that could be anticipated immediately post treatment. As the remaining trees continue to grow and reoccupy the available growing space, there will be a slow trend towards increased canopy cover.

Fuel Model 13 represents the worst case fire behavior that could be expected after thinning, prior to completion of the fuels treatment. Fuel Models 8 and 10 best represent the fire behavior that could be expected after the fuels treatment is complete. Fuel Model 9 represents the fire behavior that could be expected in pine dominated stands. Fuel Model 11 best represents fire behavior that could be expected in masticated stands. Mastication will not occur on slopes greater than 45%, therefore post treatment rate of spread was not calculated for Fuel Model 11 on 60% slope.

The rates of spread projected for each of these fuel models are displayed in Tables 27 and 28.

Rate of Spread for Severe Conditions – 90th Percentile Parameters

Fuel Model	Rate of Spread in Chains per Hour					
	20% Slope 50% Cover	20% Slope 25% Cover	40% Slope 50% Cover	40% Slope 25% Cover	60% Slope 50% Cover	60% Slope 25% Cover
8	0.5	0.6	0.9	1.0	1.5	1.7
9	1.6	2.2	3.2	3.8	5.9	6.5
10	2.8	5.0	5.4	7.7	9.9	12.1
11	1.5	2.7	2.7	3.9	Not Modeled	Not Modeled
13	4.3	8.8	7.7	12.2	13.4	17.9

One Chain = 66 feet

Table 27

After the fuels treatment is accomplished, the projected rate of spread does not exceed the line construction capabilities of a five person engine crew during initial attack. Combined with the reduction in fire line intensities, a greater amount of the Project Area remains well within initial attack capabilities. The rates of spread for Fuel Model 13 combined with the fire line intensities will limit the suppression effectiveness in the short term. The Project Area would remain at higher susceptibility to loss until the fuels treatments are complete.

Rate of Spread for Moderate Conditions – 50th Percentile Parameters

Fuel Model	Rate of Spread in Chains per Hour					
	20% Slope 50% Cover	20% Slope 25% Cover	40% Slope 50% Cover	40% Slope 25% Cover	60% Slope 50% Cover	60% Slope 25% Cover
8	0.4	0.5	0.7	0.8	1.2	1.4
9	1.3	1.8	2.6	3.1	4.8	5.3
10	1.8	3.2	3.5	5.0	6.4	7.9
11	1.3	2.3	2.3	3.3	Not Modeled	Not Modeled
13	3.6	7.3	6.4	10.1	11.1	14.8

One Chain = 66 feet

Table 28

Under moderate burning conditions, there is a decrease in rate of spread for the fuel models which represent much of the Project Area. Prior to completion of the fuels treatment, stands within the project still remain susceptible to loss under moderate condition.

Once the fuels treatments have been accomplished the reduced rate of spread, combined with a reduction in flame length, increase the likelihood of being able to effectively suppress a fire with limited resources.

Additionally the reduction in fire behavior provides options for initiating an appropriate management response. Under an appropriate management response fire managers may be safely contain fires within boundaries of previously treated features, rather than take immediate suppression action.

Summary Conclusions

In summary, all fuels treatment options show a positive effect on reducing fire behavior and fire effects. All fuels treatments result in substantial reductions of wildfire induced mortality. The reduction in surface and ladder fuels also minimizes the potential for torching and crown fire activity. Although the models indicate that some treatments will exceed the desired four foot flame length under severe burning conditions, conditions are improved over no action for the same stand category at the same point in time.

With the distribution of stands and varied fuels treatments proposed under Alternative 2, much of the analysis area would be resilient to the effects of future wildfires. The proposed treatments provide options beyond immediate initial attack. Managers will have an increased capability of implementing an appropriate management response allowing fires to be contained within previously treated stands.

The condition of the Defensible Fuel Profile Zones (DFPZ) would increase suppression capabilities and minimize the suppression impacts. With the DFPZs at a level of reduced fuel, there would be increased flexibility in implement suppression tactics aimed at keeping a fire out of the project area. The impacts of the suppression activities could be reduced, as the conditions of the stands would allow for application of less impacting suppression tactics.

The model results are consistent with expectations for each proposed treatment. Stands will be more susceptible after mechanical treatments are completed prior to completion of the surface fuels treatment. Hand pile fuels treatments

C. Alternative 4

Alternative 4 implements the same array of fuel treatments. The differences between this alternative and alternative 2 are the acres of proposed treatments. The small diameter stands proposed for thinning and the stands proposed for underburn without mechanical treatment remain unchanged. The differences are in the number of acres proposed for thinning to promote late successional characteristics and defensible fuel profile zones. Changes in logging systems and access may also result in changes in proposed fuels treatments.

This alternative proposes to treat 4209 acres. Silviculture treatments include variable density thinning in 101 stands (1762 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 68 stands (1616 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel.

This alternative proposes similar road actions as alternative 2. There would be no difference in access for suppression ground resources.

Table 29 displays the fuels treatments for the stands proposed for development of late successional forest characteristics and stands within the Defensible Fuel Profile Zones in Alternative 4.

ALTERNATIVE 4						
Summary of Habitat Improvement Fuels Treatment Acres						
		North & East Aspect		**South & West Aspect**		
FUELS TREATMENT	**Total Acres**	**Grouse**	**Long John**	**Grouse**	**Long John**	**True Fir**
Masticate	**354**	7	96	14	181	57
Hand Pile Burn	**119**	42	1	51	2	23
Underburn	**880**	106	106	255	255	158
Hand Pile Burn & Underburn	**349**	84	38	115	52	59
Masticate and Hand Pile Burn	**60**	9	22	9	20	0
TOTAL	**1762**	**248**	**263**	**444**	**510**	**297**
Summary of DFPZ Fuels Treatment Acres						
FUELS TREATMENT	**Total Acres**	**Cow Creek**	**Doe Peak**	**Four Corners**	**Siskiyou Gap**	**Siskiyou Peak**
Masticate	**205**	54	30	57	32	32
Hand Pile Burn	**90**	58	0	10	22	0
Underburn	**438**	19	201	118	71	29
Hand Pile Burn & Underburn	**590**	57	182	45	272	34
Masticate & Hand Pile Burn	**293**	55	134	92	12	0
TOTAL	**1616**	**243**	**547**	**322**	**409**	**95**

Table 29

The effects of the fuels treatments in the tables presented in Alternative 2 are valid for the treatment categories for this alternative. The difference is in the amount of acres treated and the distribution of the treated stands.

In Alternative 4 there is roughly a 20% reduction in the total number of acres proposed for treatment to develop late successional habitat characteristics. Fewer acres are proposed for treatment in each stand category with the biggest reduction of acres occurring in true fir stands.

There is a 30% reduction in treated acres in the true fir stands. On the north and east aspect stands there is a 25% reduction of acres treated in Long John drainage and a 20% reduction of acres treated in Grouse Creek. On the south and west aspects there is an 18% reduction of acres treated in Grouse Creek and an 8% reduction of acres treated in Long John drainage.

Implementation of alternative 4 would result in the highest reduction of treated acres in the stand categories which appear to be currently least resilient to the effects of wildfire (refer to Table 8 under current conditions).

This will result with greater amounts of the project area that would be susceptible when a wildfire occurs. Treated stands are still well distributed throughout the watershed, providing options for containing a wildfire at smaller sizes than would be expected with no action.

The focus on treating a greater proportion of stands on the south and west aspects in the mixed conifer zone is consistent with moving stands towards conditions more typical of the fire regime of the area.

There is a 5% reduction in the number of acres proposed for treatment in the DFPZ. This is due to deferring treatment of stands in the Doe Peak and Siskiyou Gap DFPZs. Deferral of the treatment stand in the Doe Peak DFPZ should have a minimal impact on the DFPZ effectiveness, it occurs lower on the slope and much of the surrounding area is still proposed for treatment. The reduction of 5 acres in the Siskiyou Gap DFPZ is considered incidental to the effectiveness of its functioning capability.

D. Alternative 5

Alternative 5 implements the same array of fuel treatments. The primary differences between this alternative and Alternative 2 are the acres of proposed treatments within the DFPZ. The small diameter stands proposed for thinning and the stands proposed for underburn without mechanical treatment remain unchanged. The differences are in the number of acres proposed for thinning to promote late successional characteristics and defensible fuel profile zones. Changes in logging systems and access also result in minor changes in proposed fuels treatments.

This alternative proposes to treat 4612 acres. Silviculture treatments include variable density thinning in 136 stands (2180 acres) to promote development of late-successional forest characteristics. Thinning to reduce density and ladder fuels is proposed in 73 stands (1601 acres) as part of a defensible fuel profile zone strategy. Thinning of only small diameter trees is proposed in 47 stands (711 acres) to promote growth; reduce ladder fuels and reduce surface fire intensity. Two stands (120 acres) are proposed for underburning, without mechanical treatment, to reduce the amount of surface fuel.

Table 30 displays the fuels treatments for the stands proposed for development of late successional forest characteristics and stands within the Defensible Fuel Profile Zones in Alternative 4.

ALTERNATIVE 5						
Summary of Habitat Improvement Fuels Treatment Acres						
		North & East Aspect		**South & West Aspect**		
FUELS TREATMENT	**Total Acres**	**Grouse**	**Long John**	**Grouse**	**Long John**	**True Fir**
Masticate	**445**	9	102	14	200	111
Hand Pile Burn	**213**	58	32	58	32	34
Underburn	**981**	128	128	284	285	157
Hand Pile Burn & Underburn	**472**	94	66	118	80	113
Masticate and Hand Pile Burn	**69**	12	20	14	22	0
TOTAL	**2180**	**301**	**348**	**212**	**619**	**415**
Summary of DFPZ Fuels Treatment Acres						
FUELS TREATMENT	**Total Acres**	**Cow Creek**	**Doe Peak**	**Four Corners**	**Siskiyou Gap**	**Siskiyou Peak**
Masticate	**242**	54	67	57	8	56
Hand Pile Burn	**131**	53	16	0	62	0
Underburn	**435**	19	232	92	63	29
Hand Pile Burn & Underburn	**487**	57	178	45	207	0
Masticate & Hand Pile Burn	**306**	55	85	92	74	0
TOTAL	**1601**	**238**	**578**	**286**	**414**	**85**

Table 30

From a fire and fuels perspective this alternative is very similar to Alternative 2. Basically the same stands are proposed to be treated. Acreage adjustments are a result of changes in accessibility. The primary difference is 68 acres proposed for mastication in Alternative 2 are proposed to be underburned in this alternative. The effects of the fuels treatments in the tables presented in Alternative 2 are valid for the treatment categories for this alternative.

There is roughly a 5% reduction in acres treated within the DFPZs. Within each DFPZ, the reduction of treated acres is minimal. The majority of DFPZ treatment units that have been deferred are within Doe Peak and Siskiyou Peak, both of which are interior defense zones within the project area. The deferred portion of the Doe Peak DFPZ occurs on relatively gentle topography in the upper reaches of the watershed. The effects of deferring this portion of the DFPZ should be of minimal impact to future wildfire suppression or fuels treatment actions due to its position in the project area and proximity to other stands still proposed for treatment in this alternative.

This DFPZ was designed to stop short of the primary ridge due to its proximity to currently suitable late-successional habitat. This DFPZ has no effect on fire coming from outside the project area. The deferred portion of the Siskiyou Peak DFPZ occurs in the upper most reach of the treatment zone. Deferral of this additional segment of DFPZ will have little impact on future suppression or fuels treatment options within the remainder of the project area.

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