Appendix E: Risk Reduction Salvage in Late Successional Reserves

Full Report Submitted to the Regional Ecosystem Office on July 12, 2015

Proposed Activities in Late Successional Reserves
Westside Fire Recovery Project

Klamath National Forest

Introduction

In August, 2014 multiple lightning fires burned together to create three large fires on the west side of the Klamath National Forest collectively known as the Westside Fires. The Westside Fire Recovery Project was developed in response to the conditions created by these fires. The Westside Fire Recovery project is composed the Beaver Fire, Happy Camp Complex, and the Whites Fire of the July Complex. The Beaver Fire, Happy Camp Fire, and Whites Fire burned a total of 183,200 acres, including 162,300 acres of National Forest System lands and 20,800 acres of private land. See Table 1.

Table 1
General Fire Information

Project Area	Fire	Fire Start Date	Containment Date	Acres Burned: Forest Service	Acres Burned: Private	Total Acres Burned
A	Beaver Fire	July 30, 2014	August 30, 2014	14,600	17,800	32,400
B	Happy Camp Complex Fire	August 12, 2014	October 29, 2014	114,800	2,100	116,900
C	Whites Fire	July 31, 2014	September 25, 2014	32,900	900	33,800
Total of All Fires (acres)				162,300	20,800	183,100

Approximately 56,400 acres of the Seiad Late Successional Reserve (LSR) lies within the Happy Camp Complex. Approximately 24,800 acres of the Eddy Gulch LSR lies within the Whites Fire area. Overall, approximately 81,200 acres of the LSR land allocation were within the boundaries

of the Westside Fires. Table 2 provides an overview of fire severity in each LSR and an overall total.

Historical Stand Conditions in the Klamath Province

It is important to understand the fire history of the Klamath Province and the context of the Klamath Province in the area of the NWFP. Most of the area of the NWFP lies in the Oregon and Washington Cascades and Coast Ranges. There is often a mistaken presumption that the conditions described for those forests apply to forests of the Klamath Province as well. Key old-growth structural attributes of the Coast Range and Oregon and Washington Cascades include large live old trees, a large number of snags of various ages, a multilayered canopy, and moderate to high accumulations of logs or coarse woody debris on the forest floor (Franklin, 1981).

The fire regime of old-growth Douglas fir dominated forests of the Klamath Mountains differs from more mesic old-growth Douglas fir forests of Oregon and Washington (described in Franklin et al. (1981)) in fire frequency, fire severity, and structural attributes such as amount and persistence of snags and coarse woody debris (Taylor and Skinner 1997). The characteristic fire regime of the Klamath Mountains is actually one of frequent low to moderate intensity fire with low to moderate severity effects (Skinner et al. 2006), not "stand-replacement or mixed" that is typical in the Coast Range and western Oregon and Washington Cascades. In a study from a late successional reserve just north of the Happy Camp Complex, Taylor and Skinner (1998) reported fires prior to Euro American settlement burned on average every 14.5 years. Fire return intervals were shorter on south and west facing aspects than on north and east facing aspects, but the average was 16.5 years or less on all aspects. Wills and Stuart (1994) reported pre-settlement fire to occur every 10 to 17 years in the Hotelling Ridge area, and wrote that fire return intervals in the southern portion of the range of Douglas fir are considerably shorter than those found in southern or west-central Oregon. In the southern-most portion of the Klamath Mountains, fire return intervals (fires scarring two or more trees over the study area) as short as 4 to 7 years have been reported (Fry and Stephens, 2006). With frequent fire, surface fuels are maintained at low levels – too low for intensity sufficient to produce much stand-replacement fire, except under unusual circumstances.

Even though fire suppression has since altered the fire regime and produced an unnatural accumulation of surface fuels in many areas, fire in the Klamath Mountains still generally burns with predominantly low to moderate severity effects today. Odion et al. reported that only 12% of their study area within the 1987 fires burned at high severity, with 59% of the area burning at low severity and 29% burning at moderate severity. Using somewhat different fire severity categories for remotely sensed satellite data for all fires from 1987 to 2008 and constraining the data to only forested areas, Miller et al. (2012) reported an average of 15.8% high severity, with the remainder burning at low to moderate severity. The reason for predominantly low to moderate severity effects can be explained by the topographic complexity of this landscape. With mountains and deep river canyons, smoke from large fire events tends to become trapped under inversions when atmospheric conditions are stable, leading to conditions that cause fires to burn at low intensity despite the steep slopes and added fuels of the fire suppression period (Skinner et al. 2006, Miller et al. 2012). The current elevated fuel conditions do sometimes lead to fires of higher intensity and severity. Such fires most frequently occur on upper slopes above where such inversions set up, but also occur at lower elevations when inversions break and the atmosphere destabilizes, or can be caused by a wind event (Skinner et al. 2006). Both of these conditions

combined with record drought and high fuel loads contributed to the relatively high severity of the 2014 Westside Fires. As stated in Skinner et al. (2006),

"The extent of recent high-severity burns appears to be different than historic burning patterns. More area is burning at higher intensity, and this is related, in part, to higher quantities and more homogeneous fuels caused by accumulation during the fire-suppression period."

The percentage of historical high severity is not known, but the lower fuel loading and continuity in times of frequent fire likely led to an amount of high severity fire considerably less than the contemporary percentage of 15.8% reported by Miller et al. 2012. For comparison, the moderate / high severity percentage of the 2014 Westside Fires was 25 -35%, with high severity patch sizes that exceed 1,000 acres in many locations. These metrics are well outside of the typical natural fire regime of the Klamath Province (Figures 4, 5, 6).[1]

In a fire regime dominated by low to moderate severity effects, tree mortality with wildfire is by definition generally low. In the Klamath Mountains, patches of moderate to high severity fire, when they did occur historically, were more likely on upper slope positions and on south and west-facing aspects (Skinner et al. 2006). Patches of high severity would produce a pulse of snags and then eventually down logs, until those logs were consumed by subsequent fires. Because frequent low-moderate severity fires consume wood, it is unlikely that coarse woody debris accumulated to levels seen in more mesic old-growth Douglas fir forests of Oregon and Washington (Taylor and Skinner 1997). In the Klamath Mountains snags and logs were likely clustered in time and space, with long intervals and large areas where dead wood was sparse (Skinner 2002).

Under historical conditions, an event with the amount, large patch size and geographic extent of high severity fire that occurred in the Westside Fires would have been highly unlikely to occur because there would have been substantially less surface fuel, less fuel continuity and lower stand density compared to contemporary conditions. The limited surface fuels and discontinuous canopy that existed prior to the fire suppression era made it more likely that fire would burn on the ground rather than traveling into the tree canopy. Under historical conditions, there would have also been much less dead wood (both snags and down logs), with large areas on upper slopes and south and west aspects where there would have been little dead wood. The late successional stand structure under historical conditions would have been shaped by frequent low to moderate intensity fire that consumed most of the dead and down wood on upper slopes, and created a patchy stand structure with complex mosaics of age, size and structure (Wills et al. 1994). Large dead and down wood would have been present on lower slope positions, but at much lower densities than today.

2014 Westside Fire Severity in the Late Successional Reserves

Beardsley and Warbington (1996) noted that

[1] Since this data was collected, significant post-fire mortality has occurred in the moderate (50-75%) severity class from drought and subsequent insect attacks. Field observations indicate many of the areas inventoried as moderate severity burn in 2014 (50-75% mortality) are now high severity (75-100% mortality). Moderate and high severity burn areas are combined for this assessment because of this trend.

"*Fire suppression has altered the forest structure and created a buildup of fuels to such an extent that a natural fire in such an unnatural situation might put any remaining old growth forests at risk."*

Monitoring of the NWFP has verified these trends. Since the mid-1980s, the frequency and intensity of high severity wildfire in the range of the northern spotted owl has increased (Miller et al. 2009, cited in Davis et al. 2011). Moeur (2011) noted similar findings related to the loss of late-successional and old-growth forests favored by northern spotted owls.

The fifteen-year monitoring report for the Northwest Forest Plan (Davis et al. 2012) noted that:

Although the relationship between wildfire frequency and severity on owl demography is not fully understood, habitat loss is the primary reason for the owl's decline and subsequent listing as "threatened" under the Endangered Species Act (USDI 1990). The habitat monitoring results presented in chapter 3 (this report) identified wildfire as the leading cause of current spotted owl nesting and roosting habitat loss (3.4 percent) and its future recruitment on federal lands. This was also the finding in the 10-year monitoring report (Davis and Lint 2005), and since completion of that report, several more large wildfires have occurred within the owl's range and more nesting/roosting habitat has been lost. Thus, loss of habitat to wildfire remains a significant concern for the management and conservation of the spotted owl.

The 2011 Recovery Plan for the northern spotted owl also noted habitat loss or degradation from stand-replacing wildfire as one of the most important range-wide threats to the northern spotted owl (USFWS 2011). Davis et al. (2012) mapped areas prone to future large stand-replacing fires, noting the Klamath Province as one of the geographic areas most likely to experience large (>1,000 acres) stand-replacing fires in the future. The recently released 20 year monitoring report of NSO habitat in the area of the NWFP verified this prediction (Figure 1) (Davis et al. 2015). Figure 1 shows that the largest losses of spotted owl habitat to stand replacement fire have occurred in the LSRs of the Klamath Province of California (Davis et al. 2015).

In the wildfires that occurred in the 2014 Westside Fire Recovery project area (Beaver, Whites, and Happy Camp fires) over 7,000 acres of functioning nesting-roosting habitat and 9,600 acres of foraging habitat were lost to stand-replacement (i.e. high severity) fire. Thus, it is well established that stand-replacing, high intensity wildfire negatively affects northern spotted owl habitat within the Klamath Province and that the potential for future habitat losses in the Klamath Province is high. Given probable climate change scenarios, the rate of habitat loss from stand-replacement fire is likely to increase. From this, it follows that land managers should consider opportunities to reduce the probability of future large stand-replacement fires. That is the objective of risk-reduction salvage harvest in the Westside Fire Recovery project.

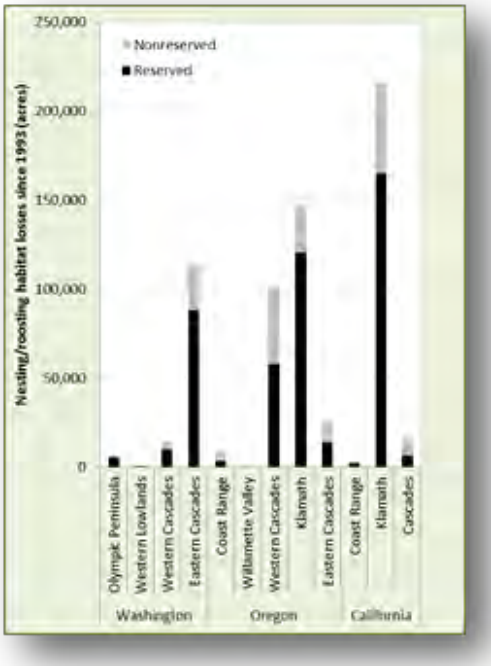


Figure 1: NSO Habitat Losses to Stand Replacing Fire in the Area of the NWFP

In many areas of the KNF, and in much of the high severity burn areas in the Westside Fire Recovery Project, there has been no recorded fire because of fire suppression since the establishment of the KNF in 1905. Most of the high severity fire that occurred in the LSR land allocation in the 2014 Westside Fires was in areas that have not had a recorded fire in the history of the Forest (See Figure 2 and 3). A contributing factor to abnormally high severity on portions of the Happy Camp Complex was heavy fuels that were created by the 1987 fires that had not been treated. Fire suppression has resulted in surface fuel buildup and increasing fuel continuity. These factors were likely drivers of the abnormally high fire severity experienced in the 2014 Westside Fires (FEIS Chapter 3 Fuels).

Remote Assessment of Vegetation Condition after Wildfire (RAVG) was used to measure the fire severity of the 2014 Westside Fires. In the 2014 Westside fires, approximately 82,800 acres burned within the LSR land allocation of which approximately 25,000 acres were moderate to high severity fire where tree mortality ranged from 50 to 100 percent. In many parts of the high-severity burns, patch sizes with near - total stand mortality are in the multiple hundreds of acres to over one thousand acres. Table 2 provides a breakdown by fire severity class for each LSR. Figures 4, 5 and 6 show a breakdown for each LSR and total LSR acres. This is based on vegetation-based fire severity RAVG data from October, 2014. Since this data was collected, substantial post-fire mortality has occurred in the moderate (50-75%) severity class from drought and subsequent insect attacks. Field observations indicate most of the areas inventoried as moderate severity burn in 2014 (50-75% mortality) are now high severity (75-100% mortality). Moderate and high severity burn areas are combined for this assessment.

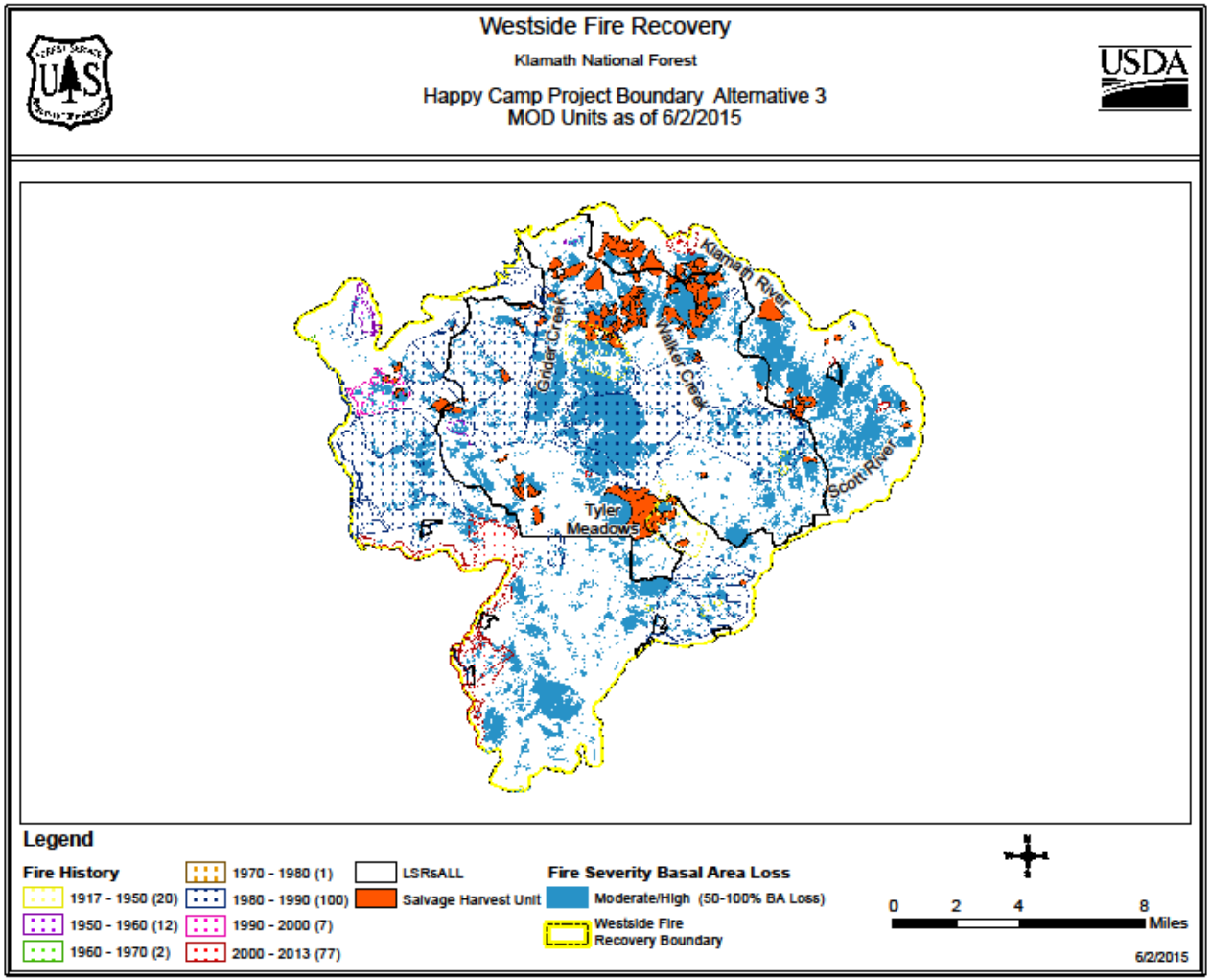


Figure 2: Fire History and Proposed Risk-Reduction Salvage Units, Happy Camp Complex

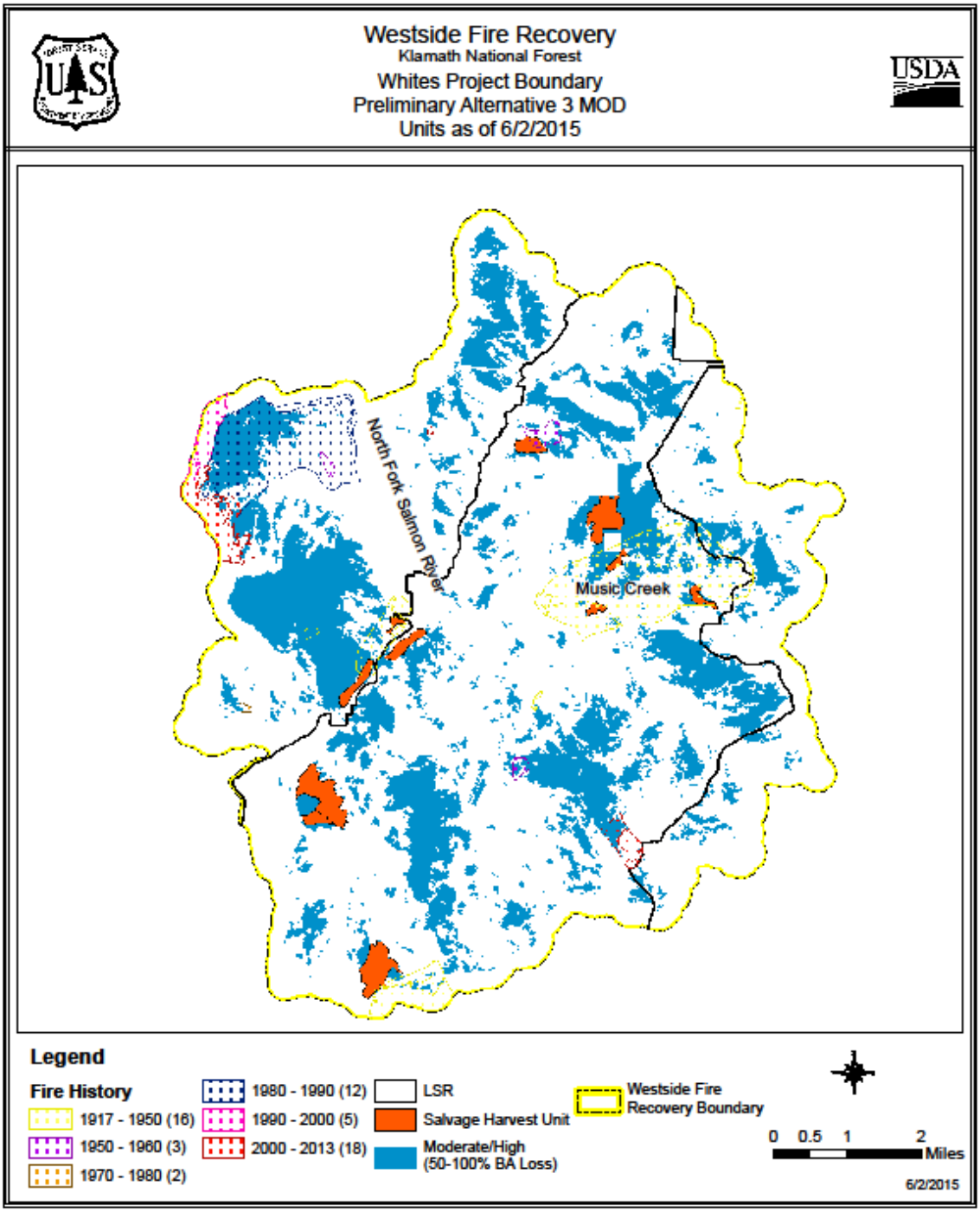


Figure 3: Fire History and Proposed Salvage Units, Whites Fire

Table 2
Fire Severity by LSR (Acres)

LSR	Very Low 0-25% Mortality	Low 25-50% Mortality	Moderate 50-75% Mortality	High 75-100% Mortality	Grand Total
Seiad LSR - Happy Camp Complex	33,418	4,517	3,385	15,092	56,412
Eddy Gulch LSR - Whites Fire	16,998	1,446	1,067	5,292	24,804
Grand Total	50,417	5,963	4,452	20,384	81,216

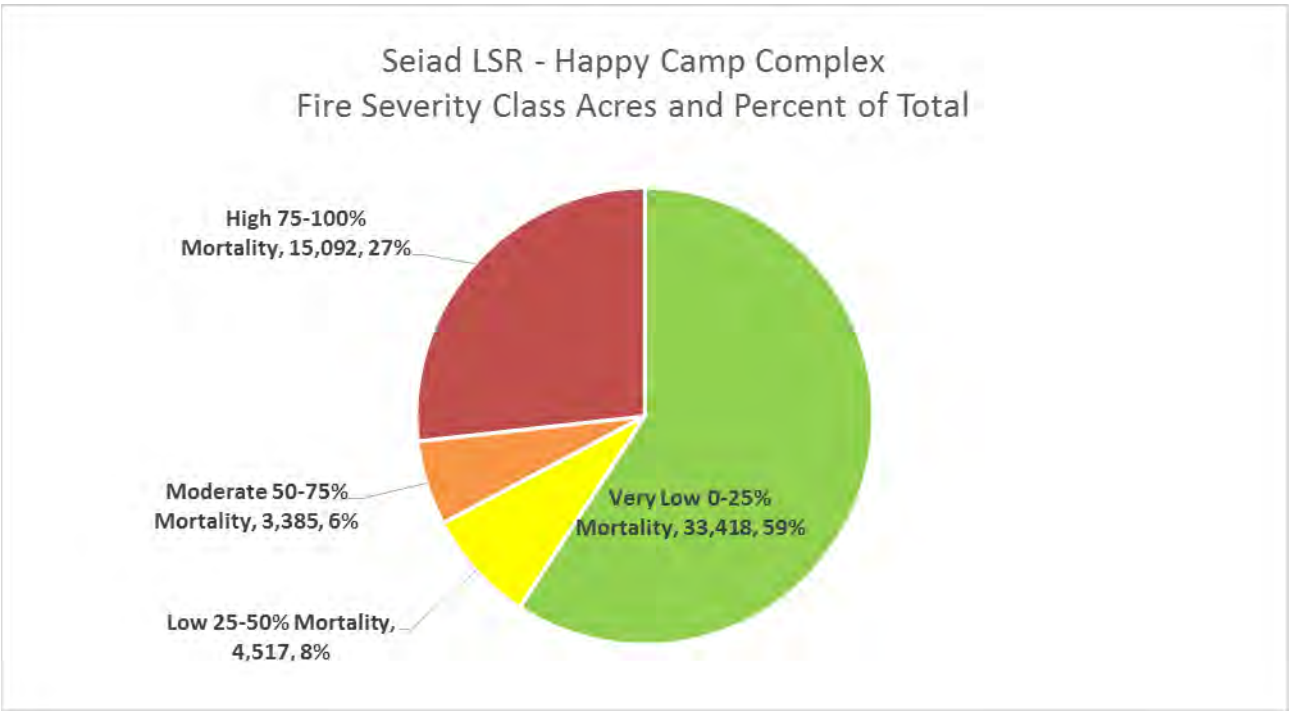


Figure 4: Fire Severity Class by Acres and Percent of Total Acres in the Seiad LSR

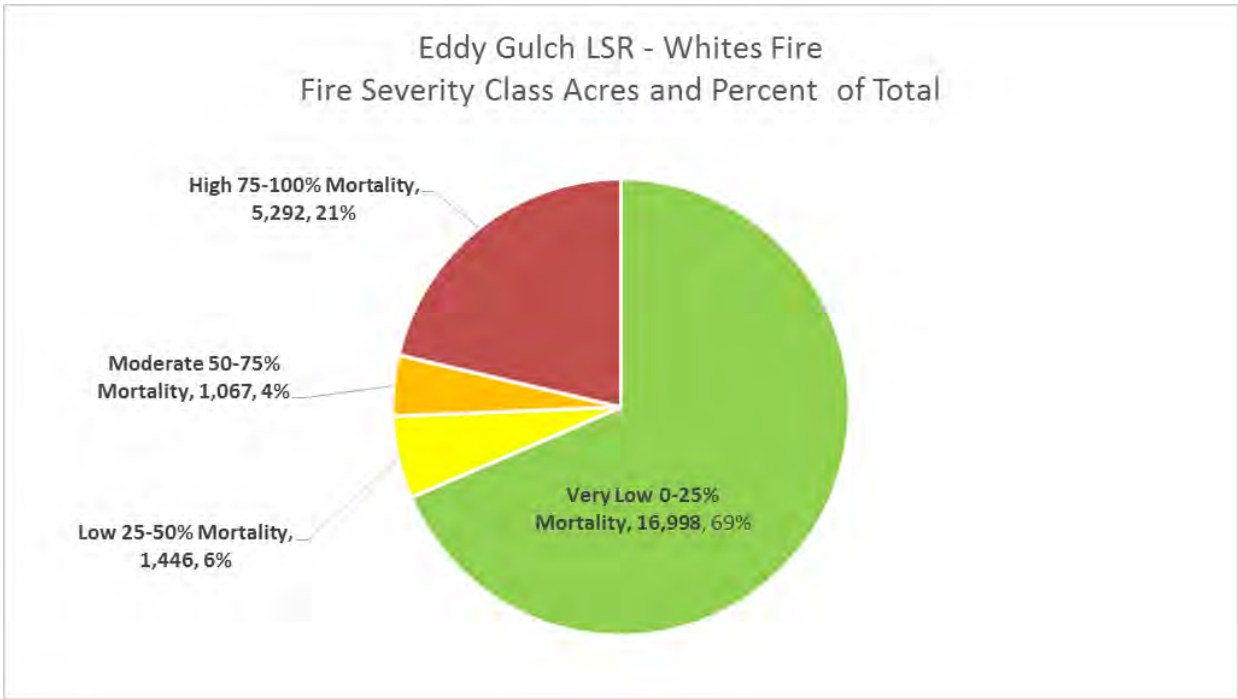


Figure 5: Fire Severity Class Acres and Percent of Total Acres in the Eddy Gulch LSR

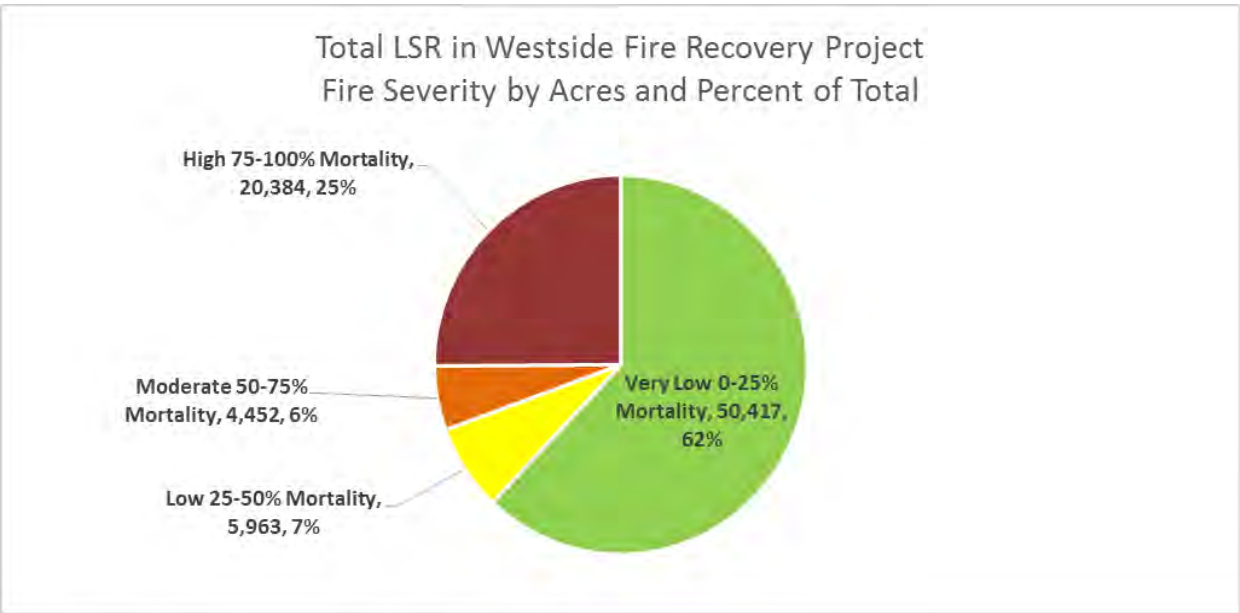


Figure 6: Fire Severity Class Acres and Percent of Total Acres Combined in the Eddy Gulch and Seiad LSRs

Risk of Future Stand-Replacement Fire from Fuels Created by the 2014 Westside Fires

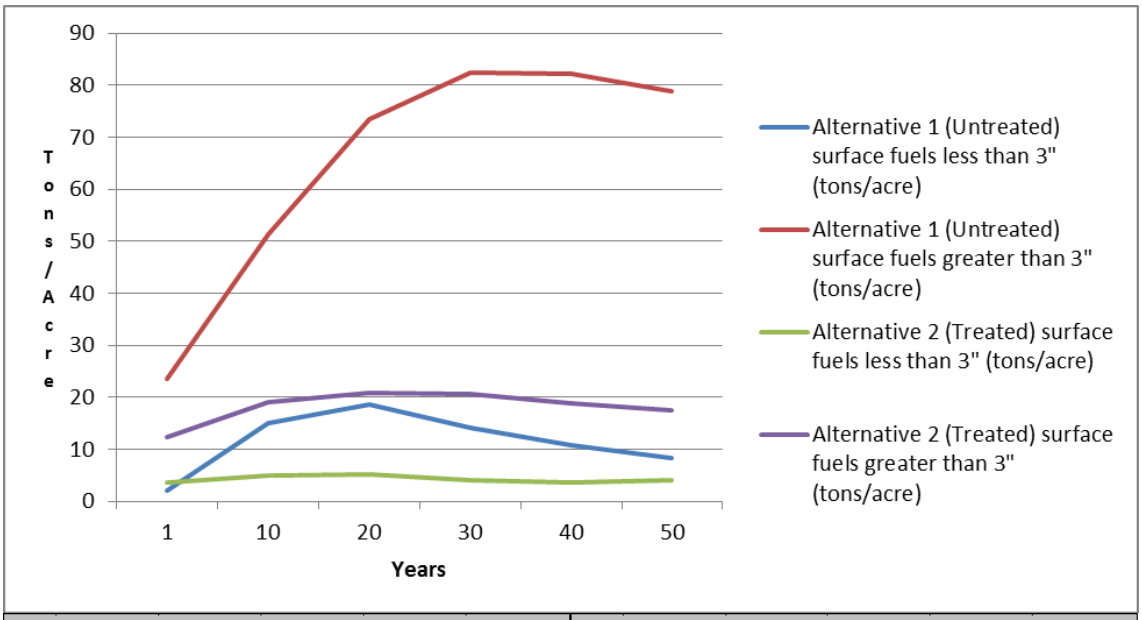
Criteria for salvage in LSRs include an allowance for actions that reduce the risk of future large scale disturbances that would inhibit the development of late successional stand conditions. The intended purpose of salvage of fire-killed trees is to reduce future fuel accumulation that would cause high-severity fires.

Approximately 60,000 acres of the 2014 Westside fires burned at high severity where most of the trees were killed. These patches of dead trees range from a few acres to large patches that span several thousand acres. When these snags begin to fall down, they become ground fuels. Knapp (2015) found that:

Dry dead wood is also combustible and too much can contribute to extreme fire behavior. While larger diameter dead wood loses moisture slowly, climate in the western US is characterized by long periods with relatively little precipitation, and both snags and CWD are generally readily consumed in wildfires. Burning snags can loft embers, and the common management practice prior to the 1970s was to fell snags in order to reduce fire hazard (Show and Kotok, 1924; Oliver, 2002). Once on the ground, dry dead wood provides a receptive surface for embers to ignite. The long burnout time and amount of heat released from combustion in large woody fuels can lead to torching and crown fire (Brown et al., 2003). Large numbers of snags and down logs are an issue for management or control of fire and safety of firefighting personnel working in proximity (Page et al., 2013). Concerns have also been raised about the negative effects to soil resources when excessive amounts of CWD are burned (Monsanto and Agee, 2008).

This tension between dead wood as habitat and dead wood as fuel has raised the question of how much wood is appropriate in fire-dependent forested ecosystems (Brown et al., 2003; Ucitel et al., 2003; Lehmkuhl et al., 2007; Scheller et al., 2011; Ritchie et al., 2013). Because wood is readily consumed by fire, one likely consequence of fire exclusion in unlogged forests where fire was historically frequent is an excess of coarse woody debris (Skinner, 2002). This is particularly true for heavily rotted wood, which is most readily consumed by fire (Kauffman and Martin, 1989; Skinner, 2002; Stephens and Moghaddas, 2005; Uzoh and Skinner, 2009). Historically, frequent fire would have likely resulted in rotten wood being maintained at relatively low levels (Stephens and Moghaddas, 2005).

The density of fire-killed trees per acre in the Westside fires area is much higher than the density of trees that existed naturally in the pre-suppression era (Beardsley and Warbington, 1996: 5; Skinner 2006). As noted by Knapp (2015), this material is all potential fuel, and can increase future fire severity. Since the density of trees per acre is significantly higher than historical levels because of fire suppression, it follows that the amount of heavy fuel created by these dead trees will be much higher than historical levels, and can cause elevated fuel levels for more than 40 years (Peterson et al. 2015; See also Figure 7). The Fuels Report in chapter three of this EIS provides an in-depth analysis of the fuel loading and predicted resistance to control that will result from fire killed trees under the no-action and action alternatives. Figure 7 shows a graph of the typical fuels accumulation from the Tyler Meadows area of the Westside fires. Similar graphs are provided for other parts of the fire area in FEIS Chapter 3-Fuels and the Fuels Report.



Walker Creek Stand ID 050552ABCD0292						Walker Creek Stand ID 050552ABCD0292					
Year	Surface Fuel < 3" dbh (tons/acre)	Surface Fuels > 3" dbh (tons/acre)	Intensity (btu/ft/sec) 26 ch/hr	Intesity (btu/ft/sec) 40 ch/hr	Resistance to Control	Year	Surface Fuel < 3" dbh (tons/acre)	Surface Fuels > 3" dbh (tons/acre)	Intensity (btu/ft/sec) 26 ch/hr	Intesity (btu/ft/sec) 40 ch/hr	Resistance to Control
1	2.10	23.61	87	87	Low	1	3.62	12.28	69	69	Low
10	14.95	51.34	5379	8213	Extreme	10	5.00	19.10	1901	2902	Moderate
20	18.57	73.51	7199	10991	Extreme	20	5.28	20.90	2046	3124	Moderate
30	14.20	82.47	6902	10537	Extreme	30	4.08	20.65	1821	2781	Low
40	10.81	82.30	6291	9605	Extreme	40	3.52	18.92	1630	2489	Low
50	8.21	78.92	5650	8626	Extreme	50	4.06	17.42	1645	2512	Low

Figure 7: Fuel Accumulation from Fire Killed Trees in No Treatment Areas (left) and Salvage (right)

As shown in Figure 7 and the accompanying analysis, fire-killed trees from the 2014 Westside fires are likely to create a significant fire hazard in the next 10-30 years as snags fall to the ground. Once ignited, these heavy fuels may significantly increase the resistance to control and severity of future fires.

Proposed Recovery Actions in Late Successional Reserves

In response to the 2014 Westside Fires several recovery actions were proposed. A draft EIS was published in March 2015. Alternative 2 was the Proposed Action. In the course of consultation with the US Fish and Wildlife Service, Alternative 3 with modifications has become the Preferred Alternative. Alternative 3 Modified removed all salvage harvest units from the Beaver project area. Additional salvage units were dropped in the Happy Camp and the Whites project areas after the initial Wildlife Biological Assessment was submitted. Alternative 3 Modified is intended to strike a balance between the need to reduce long-term risk of stand replacement fire and the current needs of northern spotted owls and Pacific fishers in a post-fire environment. All units were reevaluated by the Forest Service and removed from treatment if they did not contribute to the overall fuels strategy and if they were within northern spotted owl core areas classified as having moderate or higher potential for owls to remain on site, reproduce, and contribute to the

demographics of the population of the area. Units were also removed from treatment if they were no longer economically viable. Acres were adjusted after units were dropped within each project area. Alternative 3 Modified still meets the Project objectives though at a lesser scale than the original Proposed Action.

These actions are summarized for Alternative 3 Modified below, and summarized in Table 3. See the Map Supplement for maps of these actions.

- **Risk-Reduction Salvage:** This action would remove dying and fire killed trees greater than 14 inches in diameter by a combination of helicopter, skyline and tractor yarding. The objective of this action is to reduce heavy surface fuel loads that would otherwise be created by fire-killed trees as they break or fall to the ground. Approximately 3,900 acres of risk-reduction salvage is proposed within the LSR land allocation. Where live trees occur within units, they are marked for retention. Virtually all of the proposed LSR risk-reduction salvage is in RAVG Class Four stands that have greater than 75% mortality. This action is discussed in detail in following sections.
- **Site-Preparation and Planting**: This action restores existing conifer plantations that burned severely and replants areas where risk-reduction salvage occurs. Because Late-Successional Reserves have been established to provide high quality habitat for species associated with late-successional forest conditions, management following a stand-replacing event should be designed to accelerate or not impede the development of those conditions (NWFP C-14; LSRA 1-24). Site preparation and planting is intended to increase the likelihood and speed by which burned forested areas are restored to coniferous forest and late successional habitat. Approximately 3,480 acres of site preparation and planting in existing plantations and natural stands, and 3,900 acres within salvage units within the LSR are proposed (Table 3). This action is consistent with the LSRA and is not further discussed in this document. Approximately 65% of the high severity burn area in the LSRs will not be replanted and will go through an early seral phase that may last decades in large burn patches.
  More rapid and successful reforestation is accomplished by reducing fuel loading and creating openings for safe planting. This will create some pockets of established coniferous forest more quickly, providing habitat and creating some heterogeneity particularly in some of the very large burn patches. Careful evaluations were made to prioritize treatment units likely to support successful reforestation. Units within the project area are highly variable, so criteria differ slightly for determining site-preparation needs within natural units versus existing plantations. For the purposes of this project, reforestation needs were stratified into three categories for field evaluation: 1) burned conifer plantations; 2) conifer units proposed for salvage harvest; and 3) conifer units not proposed for salvage harvest for which there is a need to reforest with conifer species. Planting prescriptions are site-specific and are intended to achieve an open stand structure stocked with about 100 trees to the acre with variable spacing typical of a frequent low to moderated fire severity environment. Site prep and plant units are shown in the Map Supplement prepared for this document. Areas were considered for site preparation, planting and release if they:
  - Were identified as areas determined to have been historically dominated by conifers, as determined by the 1945 Wieslander Vegetation mapping (Kelly, M.B. et. al 2005) in addition to visual cues based upon Forest Service professional judgment;
  - Had successful vegetation growth before the 2014 fire;
  - Had evidence that, prior to the fire, conifers were successfully re-establishing, and competing vegetation (brush and hardwoods) were not dominating the site;

- Had little availability of natural seed source within seed distribution distances;
- Had favorable site class, aspect, slope position, and elevation for artificial regeneration; and,
- Had favorable regeneration potential by prioritizing areas based on site quality and moisture availability and avoiding areas with a history of repetitive high severity burns if likely to re-burn before a stand reaches a level of fire resilience.

- **Fuels Treatments:** Fuels treatments include construction of fuel management zones (FMZs or fuel breaks) along strategic roads and ridgelines, understory prescribed fire and WUI understory fuel treatments (Table 3). These actions are intended compliment and support risk reduction salvage actions, and should be viewed as parts of the overall fuels reduction strategy of the Westside Fire Recovery Project. See the EIS, Chapter 3 - Fuels for a more complete description of these actions. These actions are consistent with the LSRA and Klamath National Forest LRMP and are not further discussed in this document. Fuel treatments are summarized in Table 3 and shown in the map supplement for this document. These actions include:
  - **Wildland Urban Interface Fuels Reduction (WUI)**: This action would reduce ladder fuels and surface fuels within the WUI by cutting and piling trees less than 12 inches in diameter that create ladder fuels, and piling dead surface fuels. A combination of hand treatments, mastication and machine piling would be used as appropriate for ground conditions. Activity fuels created would be piled and burned. The objective of these prescriptions is to reduce surface and ladder fuels sufficiently so that underburns could be accomplished in the future to return selected areas to a low to moderate fire severity regime. Approximately 480 acres of WUI fuels reduction is proposed in LSRs in the Westside Fire Recovery Project.
  - **Fuels Management Zones (FMZ)** These are shaded fuel breaks that extend 250 feet either side of strategic ridgelines used to contain the 2014 fires as well as existing fire lines from previous large fires within the project area. Most of these control lines are already in place and partially cleared. The treatments aim to maintain existing control lines by removing all dead vegetation including snags, brush greater than two feet tall and thinning live conifer trees less than 12 inches in diameter at breast height to approximately 20 foot spacing. Hardwoods would be retained. Retained conifers will be pruned up to seven feet above the ground within these zones to increase canopy base height, and reduce ladder fuels and the potential for crown fire initiation. Activity-generated fuels will be disposed of by a variety of methods. A combination of mechanical, mastication, and hand work is proposed. Where hand thinning is proposed, lopping and scattering of fuels, piling and burning, and/or chipping will be used to reduce fuels. Mechanical or mastication equipment may be used to pile activity slash within these areas in addition to, or in lieu of, hand work. Hanging branches will be removed if they hang below seven feet above ground level. Approximately 2,280 acres of LSR would be included in this action.
  - **Roadside Fuels**: Roadside treatments identified as strategic for fuels reduction will assist with future locations to hold a planned or unplanned fire within the project area. Roadside treatments outside of identified strategic road systems will include hazard tree removal of activity-generated fuels to provide for access for fire suppression resources responding to future unplanned ignitions. Activities similar to those described above within fuels management zones will be used to treat roadside fuels. Roadside fuels are further split into “hot slope” (south and west aspects and upper slopes) and “cool slope” (north and east aspects and lower slopes).

- "Hot Slope" or complete—complete understory treatments are proposed in areas of higher solar radiation, including upper slope positions and westerly and southerly aspects. Treatment spacing will average 20 to 25 feet between leave trees. Leave trees will contain a mixture of hardwood and conifer species with good color and vigor. Approximately 920 acres within the LSR are included in this action.
- Cool Slope" or modified—modified understory treatments are proposed in areas with important wildlife habitat elements and areas of low solar radiation, including treatment: Cool Slope (northerly and easterly slopes and lower slopes all aspects. Leave tree spacing will average 15 feet. Leave trees will be retained in mosaic pattern, incorporating clumps of at least ¼ acre in size, which will be interspersed throughout areas proposed for modified understory WUI and roadside fuels treatment and will cover 10 to 20 percent. Preference for retention will be hardwoods located away from areas identified as strategic for fuels reduction (e.g. future locations to hold fire line for planned or unplanned fire within the project area). Approximately 1,390 acres within the LSR are included in this action.

- **Understory Prescribed Fire:** This action will occur 2-10 years in the future as small fuels created by the Westside Fires begin to die and fall to the forest floor. Understory burning is intended to reduce current fuel loading to the historic fuel loads typical of the Klamath Province. Implementation will occur under cool weather conditions which promote low intensity fires. A mosaic post-burn condition will exist with isolated pockets of tree mortality, and burned and unburned understory vegetation. Second-entry burns in units identified for prescribed burning will be used to maintain surface fuel loading and increase heterogeneity of forest structure and vegetation by consuming surface fuels and small understory vegetation. A mosaic burn is anticipated where some areas fully consume surface fuels and other areas are partially burned or unburned. Many of the prescribed burning locations will use existing control lines established in recent large fires within the project area. Line construction activities will occur around the perimeter of the fire and will include using dozers to re-scrape control lines to mineral soil; where control lines are inaccessible for equipment, hand-line construction to mineral soil will occur. Removal of understory vegetation along control lines will include cutting brush and conifer trees less than 12 inches in diameter to facilitate holding operations during prescribed fire implementation. Approximately 5,700 acres within LSR are included in this action.

- **Roadside Hazard Removal:** In addition to these actions, dead and fire damaged trees resulting from the Westside Fires need to be removed from system roads to provide for public and forest worker safety. This action consists of cutting and removing dead and dying trees that pose a hazard to the road. In areas of low and very low fire severity (1-50% mortality) hazard tree removal is widely scattered. In areas of moderate to high fire severity not in salvage units hazard tree removal is more concentrated. Hazard tree removal as proposed is provided for in Guidelines for LSRs and is not further addressed in this document. Approximately 1,640 acres of scattered roadside hazard removal and 800 acres of concentrated roadside hazard reduction would occur within the LSR. See Table 3 for a summary of roadside hazard removal acres.

Table 3
Westside Fire Recovery Project Actions in LSR (Acres)

Treatment Type	Happy Camp Complex Non-LSR	Seiad LSR, Happy Camp Complex	Happy Camp Complex Total	Whites Fire Non-LSR	Eddy Gulch LSR, Whites Fire	Whites Fire Total	Total LSR in Westside Fire Recovery Project	Total, All Land Allocations
Risk Reduction Salvage								
Risk-Reduction Salvage Gross Acres	2,164	4,020	6,208	63	624	687	4,645	6,895
Hydrologic Riparian Reserves and Snag Retention Areas	N/A	648	N/A	N/A	124		773	1,155
Net Risk Reduction Salvage	N/A	3,372	N/A	N/A	500		3,872	5,740
Site Preparation and Planting								
Site Prep and Plant	1,999	2,919	4,918	0	556	556	3,475	7,367
Fuels Reduction								
Fuels Management Zone	1,000	1,696	2,695	194	581	775	2,277	5,004
Roadside Complete	837	831	1,668	294	87	381	918	2,549
Roadside Modified	1,479	901	2,380	19	487	506	1,388	3,085
Understory Prescribed Fire	1,269	276	1,544	3,757	5,436	9,194	5,712	11,183
WUI	1,305	152	1,457	219	327	546	478	2,628
Treatment Type	Happy Camp Complex Non-LSR	Seiad LSR	Happy Camp Complex Total	Whites Fire Non-LSR	Eddy Gulch LSR	Whites Fire Total	Total LSR in Westside Fire Recovery Project	Total, All Land Allocations
Roadside Hazard								
Roadside Hazard Scattered	NA	1,268	2,075	NA	368	423	1,636	2,838
Roadside Hazard Concentrated.	NA	681 (170 > 24”)	845	NA	119 (70 > 24”)	130	800 (240 >24”)	1,330

Many of these treatments overlap, so acres would not add up to a total footprint. For example, roadside hazard removal, and roadside fuels reduction may overlap a salvage unit. Broadcast burn and WUI acres overlay all actions that occur within those areas.

Risk Reduction Salvage in Late Successional Reserves

The Klamath National Forest (KNF) Land and Resource Management Plan (LRMP) describes land allocations, goals for management of the Forest, and provides management direction (Guidelines) to accomplish those goals (LRMP Chapter 4). The 2014 Westside Fires created areas of fire-killed trees that in the future will become areas of continuous high fuel loading as dead trees break or fall and become surface fuels. In future fires, areas of continuous, high fuel loading have a high probability of burning with high severity (Figure 7, FEIS Chapter 3 – Fuels). This condition conflicts with the Forest-wide Goals for Fire Management (KNF 4-8) which state:

Reduce unacceptable fuel buildups and potential acreage of future high intensity wildfires.

The primary reason that salvage harvest is proposed within the LSR is to reduce the risk of future stand-replacement fire from heavy fuel accumulations that will result from trees killed in the 2014 Westside Fires. This section addresses how the proposed salvage of fire-killed trees in the Westside Fire Recovery project would contribute to LRMP goals for fire management (LRMP 4-8) and be compatible with LRMP direction to protect and enhance late-successional ecosystems within the LSR land allocation (LRMP 4-83). Late Successional Reserves are described in the Record of Decision (ROD) for the NWFP and are part of Management Area (MA) 5 in the KNF LRPMP. The objective of Late-Successional Reserves is to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl (NWFP Standards and Guidelines C-9; KNF LRMP 4-83).

Reducing risk by salvaging fire killed trees has a long term positive impact because it reduces fuels and reduces the probability of large stand-replacement fire. It also provides additional protections for areas where snags are retained such as hydrologic Riparian Reserves by reducing adjacent fuels. When combined with strategic fuel breaks along watershed boundaries, salvage of fire-killed trees helps increase the probability that large fires could be contained without affecting multiple watersheds (FEIS Chapter 3 Fuels).

Approximately 3,900 acres of risk-reduction salvage harvest would occur within the Late Successional Reserve (LSR) land allocation as part of the Preferred Alternative in the proposed Westside Fire Recovery project. This represents about 13% of the acres that burned at moderate to high severity within the LSR land allocation and about 5% of the total LSR acres within the Project area. See Figure 8, 9 and 10 for a breakdown proposed risk-reduction salvage in the LSR land allocation by LSR and total LSR acres. Figure 11 shows the land status of moderate and high severity burn areas and the net salvage proposed. Figure 12 shows the diameter classes of total Project acres in LSR, areas that burned at greater than 50% mortality and net acres of proposed salvage Eddy Gulch and Seiad LSR combined.

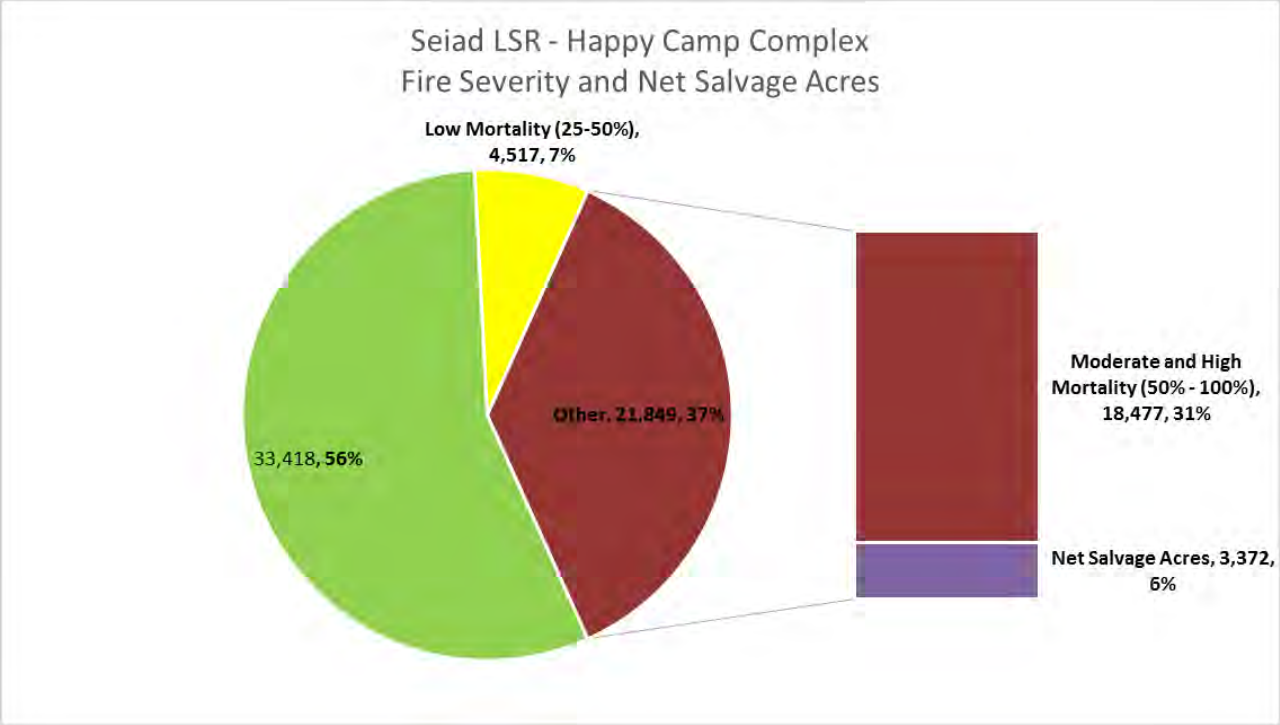


Figure 8: Fire Severity and Proposed Salvage Acres and Percent of Total Acres in the Seiad LSR. Moderate (50-75%) and High Severity (75-100%) are combined because of ongoing secondary mortality in the moderate severity burn areas.

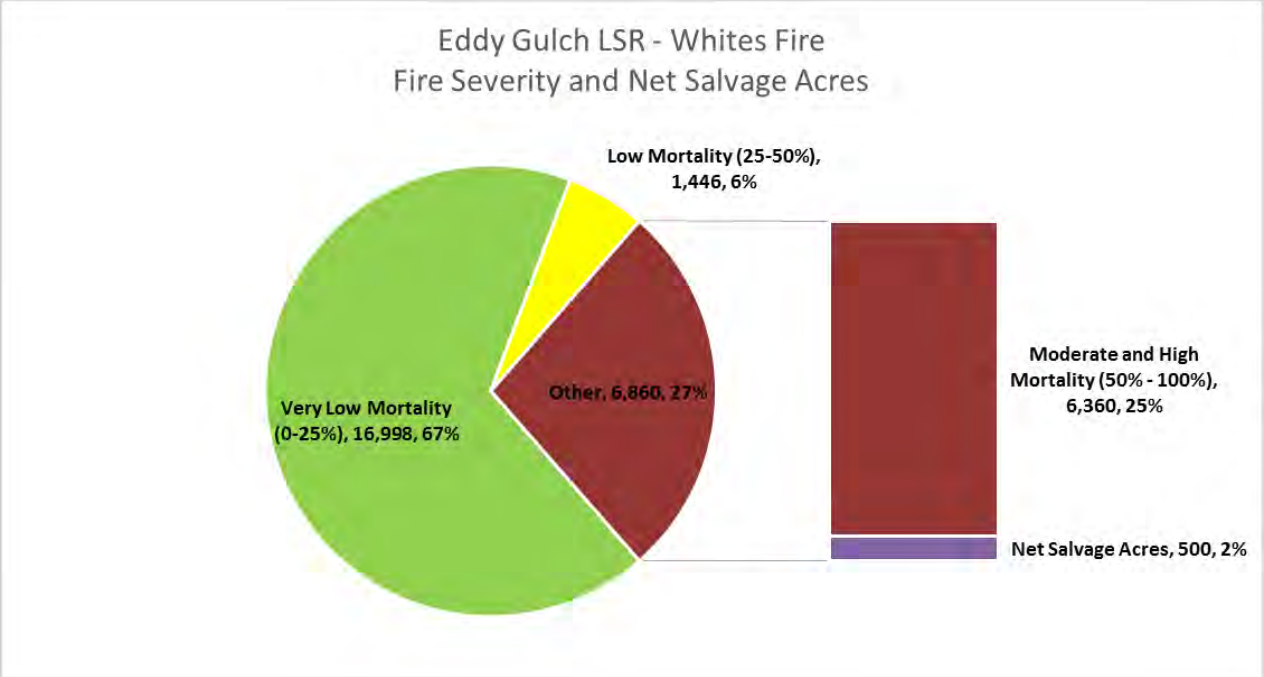


Figure 9: Fire Severity and Proposed Salvage Acres and Percent of Total Acres in the Eddy Gulch LSR. Moderate (50-75%) and High Severity (75-100%) are combined because of ongoing secondary mortality in the moderate severity burn areas.

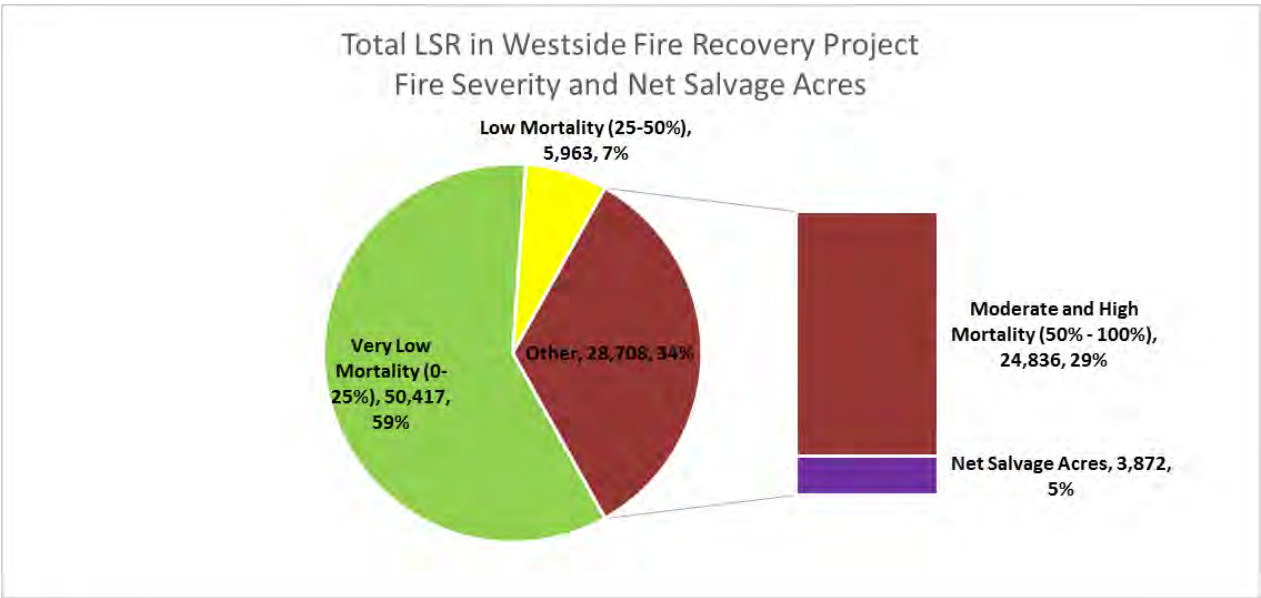


Figure 10: Fire Severity and Proposed Salvage Acres and Percent of Total LSR Acres in the Eddy Gulch and Seiad LSRs. Moderate (50-75%) and High Severity (75-100%) are combined because of ongoing secondary mortality in the moderate severity class.

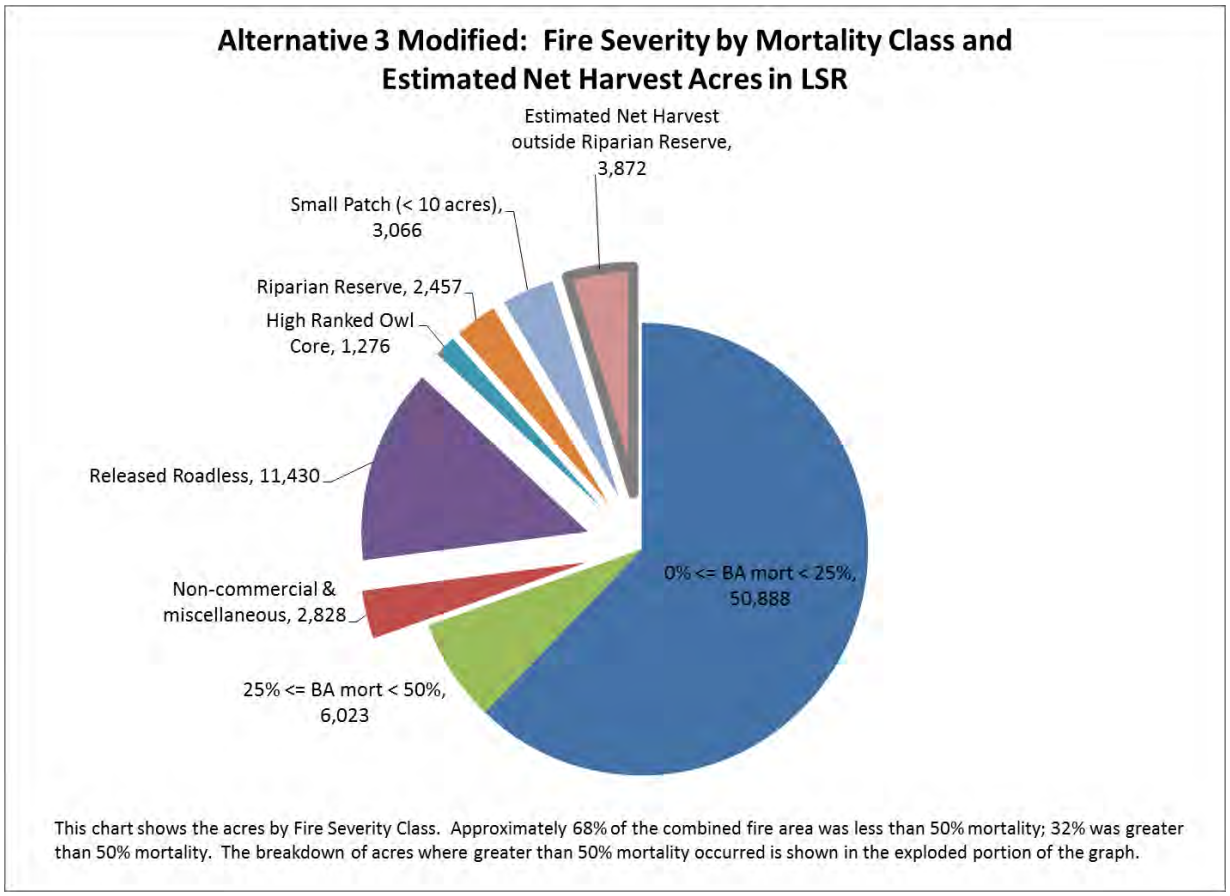


Figure 11: Acres by diameter class, fire severity and proposed salvage in the combined Eddy Gulch and Seiad LSRs

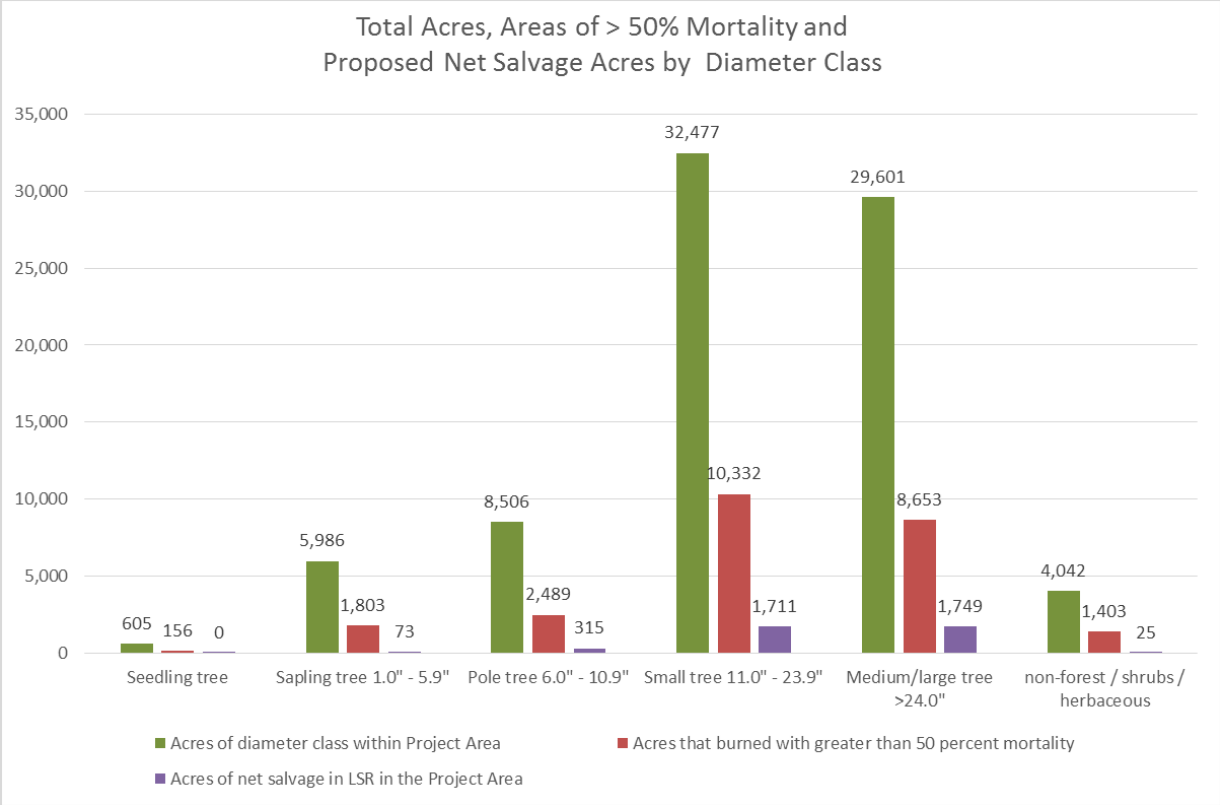


Figure 12: California Wildlife Habitat Relationship (CWHR) Diameter classes of total Project acres in LSR, areas that burned at greater than 50% mortality and net acres of proposed salvage Eddy Gulch and Seiad LSR combined.

Using California Wildlife Habitat Relationship (CWHR) data, Figure 12 shows that of the 29,600 acres of stands with a quadratic mean diameter (QMD) greater than 24 inches in diameter in the LSRs, in all burn severities, 1,750 acres (6% of the size class) would be removed by the Westside Fire Recovery project in salvage harvest units. An estimated additional 240 acres of stands greater than 24 inches QMD would be removed in roadside hazard cleanup (Table 3) in moderate – high severity burn areas. With salvage units and roadside hazard combined, approximately 2,000 acres of stands with a QMD greater than 24 inches would be removed within the Eddy Gulch and Seiad LSRs from moderate – high severity burn areas. Of stands with a QMD greater than 24 inches, this represents about 23 percent of the 8,650 acres of moderate - high severity burn acres and about seven percent of the of that diameter class in all burn severities in the LSRs. Of the stands where the QMD is greater than 24 inches that are in moderate to high severity burn patches, 77 percent would be retained. Overall, over 90 percent of the stands with a QMD greater than 24 inches in the Seiad and Eddy Gulch LSRs would be retained.

As described in the fuels analysis in the FEIS, the majority of the areas that burned at high severity in the 2014 wildfires exhibited unnaturally high levels of surface fuels, fuel continuity and stand density due to decades of fire suppression and / or accumulated fuels from previous high severity fires (FEIS Chapter 3 Fuels). The high tree densities that existed prior to the 2014 fires means that in the post-fire environment, there will be more snags and future down wood within severely burned areas than would have existed naturally. Over the next 10-30 years, most of the fire killed trees from the 2014 fires will break off or fall and become ground fuels (Figures

7, 11). In a recent study in Black's Experimental Forest on the Lassen National Forest, eight years after the Cone Fire, most of the ponderosa pine snags had fallen. Only 16% of pine snags between 30 and 45 cm and 41% greater than 45 cm were still at least partially intact (Ritchie et al, 2012). In their snag fall model, Harrod et al. choose 45 years as the time when all snags have fallen, which they term as "generous". The literature summarized by Harrod et al. 1998 shows most snags, even the large ones, don't last more than 20-25 years. Occasionally, very large snags in sheltered locations may persist until the next stand is producing large material, but this is exceedingly rare in the frequent fire environment of the Klamath.

Elevated surface fuels can constitute a significant risk to the succeeding stand (Agee and Skinner, 2005) and present a challenge and safety risk to fire crews in any subsequent burn of these areas (Ritchie et al. 2012). This dead wood contributes to heavy fuel loading and increases the likelihood and risk of future high severity fire (Figure 7; Knapp 2015; see also Fuels Report and FEIS Chapter 3- Fuels). Since the 2014 Westside Fires created large, continuous, or nearly continuous areas of fire-killed trees, those same areas would, in the future, become areas of high surface fuel loading as snags fall and become ground fuels.

Peterson et al. (2015) observed that:

"Post-fire logging can serve as an effective tool for managing fuel loadings in forests regenerating after high severity wildfires. By strategically applying and varying post-fire logging treatments within landscapes, post-fire logging could reduce woody fuels and help reduce threats to human health, property, and ecosystem services from unacceptable future wildfire behavior and effects. If applied using best management practices and with consideration for possible environmental impacts and meeting other management objectives, post-fire logging could serve as an effective option – along with mechanical thinning, prescribed fire, and managed low to mixed severity wildfires – for reducing fuels and restoring low and mixed severity fire regimes in dry coniferous forests of western North America and other fire-prone forest types."

Creating adequate breaks in the continuity of heavy fuels using timber salvage, constructed fuel breaks, fuels management zones and Wildland Urban Interface (WUI) fuels reduction provides an opportunity to reduce the risk, acreage and intensity of future fires (FEIS Chapter 3 – Fuels). These actions would contribute to accomplishing the Goal for Fire Management to "Reduce unacceptable fuel buildups and potential acreage of future high intensity wildfires" described in the LRMP on page 4-8. Proposed fuel breaks, salvage harvest units and WUI fuels reduction areas are shown in the Map Supplement for this document. These integrated actions would provide additional protection to communities while increasing options for suppression and managing planned ignitions in the future.

Figure *13*: Fire-killed trees in the Seiad LSR. Over time, fire killed trees break or fall and become surface fuels or block roads that provide needed administrative access.

As noted in the report of the Forest Ecosystem Management Assessment Team (FEMAT II-18) salvage harvest of dead trees provides an economically feasible method to reduce the heavy fuel loads that would otherwise result from fire-killed trees.

Risk reduction salvage units have been proposed because of their location relative to private lands, communities at risk, important access / ingress / egress roads and proposed ridgetop fuel breaks. Proposed salvage units reduce fuels within the area salvaged and are part of a larger strategic risk-reduction strategy (see Fuels Report) that includes creation of fuels management zones (FMZ) along key ridgelines and road systems and integrated fuels reduction within the Wildland Urban Interface (WUI). Reducing fuels by salvage harvest in concert with fuels management zones and WUI fuel treatments creates effective fuel breaks and reduces the risk of future high severity fire that would delay the development of late successional stand conditions. Creating large blocks where fuel loads have been reduced in concert with ridgetop fuel breaks also provides control points for fire suppression, and increases the likelihood that large fires could be contained along watershed boundaries. This reduces the risk of large, stand replacement fire occurring in multiple watersheds in one event as occurred in the 2014 Westside fires. While only a small proportion of affected LSR acres that burned at moderate or high severity are included in this proposal, these are the most important areas from a strategic fuels reduction viewpoint (FEIS Chapter 3 – Fuels). Approximately 13% of the LSR acres of fire killed trees in moderate or high severity burn areas are proposed for risk reduction salvage. Approximately 84% of the moderate or high severity burn areas have no proposed salvage units because of the need to strike a balance between risk reduction and resource protection for northern spotted owl habitat, Pacific fisher connectivity and other resources. The integrated risk reduction strategy of salvage and strategic fuel breaks, fuels management zones and WUI fuels treatments provides additional protections from high severity fire for these resources because it breaks up the continuity of heavy fuel.

Without fuels reduction, areas of high-severity fire from the 2014 fires will likely go through several cycles of stand-replacement fire until surface fuels are reduced enough to allow a low to moderate intensity fire regime to return (Attachment 1 FVS Analysis; FEIS Chapter 3-Fuels;

Fuels Report). Each time a stand replacement event occurs, early seral stand conditions will be reestablished, further delaying creation of desired late-successional stand conditions.

Forest Plan and LSR Assessment Provisions for Risk Reduction by Salvage Harvest in Late Successional Reserves

The question of risk reduction by salvage harvest of dead trees in LSRs was anticipated in the development of the NWFP and was addressed in the NWFP ROD. The report of the Forest Ecosystem Management Assessment Team (FEMAT) provided the basis for the NWFP. FEMAT considered salvage with three different prescriptions, ranging from Prescription 1 - no salvage, to Prescription 3 - salvage with minimum guidelines. The NWFP ROD adopted Prescription 2, (FEMAT II-18) which provided for limited salvage in LSRs. The FEMAT report describes the rationale for Prescription 2 as follows:

*Valuable trees that are dead can be used for commercial purposes with the attendant employment and economic benefits. ...**Increased fire danger or risk to insect and disease resulting from large accumulations of dead trees** (emphasis added) can be reduced in an economically feasible fashion. Avoided are the perceptions of economic waste if patches of dead trees are not salvaged (FEMAT II-18).*

The topic of salvage in LSRs was addressed in the NWFP ROD. Public comments on the Draft of the NWFP opined that salvage should be restricted only to Adaptive Management Areas. The Secretaries of Agriculture and Interior, the signing officials for the NWFP, noted their logic for allowing salvage in LSRs in the Response to Comments:

Salvage is not required to be beneficial, but is designed to permit recovery of a timber volume in those instances where catastrophic events clearly kill more trees (resulting in more snags and down logs in the short and long term) than are needed to maintain late successional conditions (NWFP ROD: 66).

The ROD for the NWFP provided Guidelines to Reduce Risks of Large-Scale Disturbance (NWFP ROD C-12, 13). The Klamath NF LRMP incorporated, and is consistent with, management direction contained in the NWFP. Guidelines from the KNF LRMP (4-87) to reduce the risks of large scale disturbance in LSRs are set forth below in Table 4, as is a short description of how the project will meet the guideline. A more detailed discussion of the project's consistency is provided in the discussion below as noted.

Table 4
LRMP Guidelines to Reduce Risks of Large-Scale Disturbance

Guideline	Implementation
MA5-27 Certain risk management activities, if properly planned and implemented, may reduce the probability of major stand-replacing natural events such as fire.	Salvage harvest units would reduce the threat of future stand replacement fire by removing heavy fuels. Salvage activities are integrated with fuel breaks in a cohesive fuels reduction strategy that reduces the risk of future stand replacement fire. Severely burned areas where risk-reduction salvage is proposed do not meet the definition of suitable habitat. Legacy components have been retained within proposed units where they exist.
MA5-28 Silvicultural activities aimed at reducing risk shall focus on younger stands in LSRs. The objective will be to accelerate development of late-successional conditions while making the future stand less susceptible to natural disturbances. **Salvage activities should focus on the reduction of catastrophic**	

Table 4 LRMP Guidelines to Reduce Risks of Large-Scale Disturbance	
insect, disease and fire threats. Treatments should be designed to provide effective fuel breaks wherever possible. (Emphasis added). However, the scale of salvage and other treatments should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions.	
MA5-29 In some LSRs in these provinces, management that goes beyond these guidelines may be considered. Levels of risk in those LSRs are particularly high and may require additional measures. Consequently, management activities designed to reduce risk levels are encouraged in those LSRs even if a portion of the activities must take place in currently late-successional habitat. While risk-reduction efforts should generally be focused on young stands, activities in older stands may be appropriate if**:** **(1) the proposed management activities will clearly result in greater assurance of long-term maintenance of habitat,** **(2) the activities are clearly needed to reduce risks and** **(3) the activities will not prevent the LSRs from playing an effective role in the objectives for which they were established.** Such activities in older stands may also be undertaken in LSRs in other provinces if levels of fire risk are particularly high.	Future risk levels that would result from large, high severity burn patches are addressed below, and in depth in the Fuels Report and EIS Chapter 3 – Fuels. Risk-reduction salvage harvest is appropriate in older stands where stand-replacement fire occurred because: 1. Management activities result in in greater assurance of long-term maintenance of habitat because reducing heavy fuels in large blocks in concert with strategically placed ridgetop FMZs provides substantial reduction in risk of large-scale stand replacement fire. This also provides a foundation to reintroduce fire and reestablish a low to moderate fire severity regime that would allow late-successional stand conditions to develop. 2. Activities are clearly needed to reduce risk because of the proximity to WUI in Walker, Grider Scott River and North Fork Salmon drainages. There is also a need to reduce the risk that would otherwise be created by large areas of heavy fuels from fire-killed trees outside of the WUI. 3. The LSR network is intended to be robust able to absorb impacts and still function (Dr. Jerry Franklin, public comment letter). Proposed activities would not affect LSR function in the short term because over 90% of the stands of larger trees (>24 inches QMD) would be retained. Using California Wildlife Habitat Relationship (CWHR) data, Figure 12 shows that of the 29,600 acres of stands with a quadratic mean diameter (QMD) greater than 24 inches in the LSRs, in all burn severities, 1,750 acres (6% of the size class) would be removed by the Westside Fire Recovery project in salvage harvest units. An estimated additional 240 acres of stands greater than 24 inches QMD would be removed in roadside hazard cleanup (Table 3) in moderate – high severity burn areas. With salvage units and roadside hazard combined, approximately 2,000 acres of stands with a QMD greater than 24 inches would be removed within the Eddy Gulch and Seiad LSRs from moderate – high severity burn areas. Of stands with a QMD greater than 24 inches this represents about 23 percent of the 8,650 acres of moderate - high severity burn acres and about seven percent of that diameter class in all burn severities in the LSRs. Of the stands where the QMD is greater than 24 inches that are in moderate to high severity burn patches, 77 percent would be retained. Overall, over 90 percent of the stands with a QMD greater than 24 inches in the Seiad and Eddy Gulch	

Table 4 LRMP Guidelines to Reduce Risks of Large-Scale Disturbance	
	LSRs would be retained. Removal of less than 25 percent of the stands with a QMD of > 24 inches the in the moderate - high severity burn area is not expected to prevent the LSR from functioning in the short term because most (77%) of the acres in of moderate –high severity burn this diameter class would not be harvested and components of late-successional forest (legacy trees, snags, down wood) are retained according to LRMP Guidelines (See Tables 7 and 8). Overall, in all burn severities, over 90% of the stands with a QMD >24 inches would be retained. In the long term, untreated areas of high severity fire are likely to go through a decades-long cycle of reburns because of heavy fuel loads created by the 2014 Westside Fires. This puts remaining old-growth forest at risk (Beardsley and Warbington 1996) and will likely delay reestablishment of late successional forest in these areas for multiple decades. The treated areas where salvage harvest occurs are likely to become late successional forest sooner than untreated areas because the risk of future stand replacing fire is reduced where salvage harvest occurs, and those areas are replanted (See Figure 7 and FVS-1).

The primary objective of proposed salvage harvest in the LSR is risk reduction (FEIS Chapter 3 – Fuels). However since salvage harvest could potentially affect LSR objectives, the Westside Fire Recovery Project should also demonstrate compliance with Guidelines for salvage to ensure LSR objectives are met.

Guidelines for salvage harvest in LSRs were provided in the NWFP ROD (C14-15) and were adopted in the KNF LRMP (4-87). These same guidelines for salvage harvest also appear in the KNF LSR Assessment. These guidelines are set forth below in Table 5 as is a short description of how the project will meet the guideline. For several of the guidelines, a more detailed discussion of the project's consistency is provided in the discussion below as noted.

Table 5 KNF LRMP and LSRA Guidelines for Salvage in Late Successional Reserves	
Guideline for Salvage	Project Design
MA5-30-1 The potential for benefit to species associated with late-successional forest conditions from salvage is greatest when stand-replacing events are involved. Salvage in disturbed sites of less than 10 acres is not appropriate because small forest openings are an important component of old-growth forests. In addition, salvage should occur only in stands where disturbance has reduced canopy closure to less than 40%, because stands with more closure are likely to provide some value for species associated with these forests.	Only openings greater than 20 acres with moderate to high severity burn would be included as salvage units. Mortality in most units is nearly 100% and in all cases, canopy closure is less than 40%.

Table 5 KNF LRMP and LSRA Guidelines for Salvage in Late Successional Reserves	
MA5-30-2 Surviving trees will provide a significant residual of larger trees in the developing stand. In addition, defects caused by fire in residual trees may accelerate development of structural characteristics suitable for associated species. Also, those damaged trees that eventually die will provide additional snags. Consequently, all standing live trees should be retained, including those injured (e.g., scorched) but likely to survive. Inspection of the cambium layer can provide an indication of potential tree mortality.	Only dead trees and those trees 70% or greater probability of mortality and not likely to survive with would be included in salvage units. Green trees (those with less than 70% chance of mortality) would not be included. Heavy secondary mortality has been observed in trees with 70% or greater probability of mortality because of drought conditions.
MA5-30-3 Snags provide a variety of habitat benefits for a variety of wildlife species associated with late-successional forests. Accordingly, following stand-replacing disturbance, management should focus on retaining snags that are likely to persist until late-successional conditions have developed and the new stand is again producing large snags. Late-successional conditions are not associated with stands less than 80 years old.	Approximately 1,800 snags greater than 14 inches in diameter and 700 snags greater than 20 inches in diameter in any given 100 acre area will be retained. This meets or exceeds the LSRA description of snag levels in late-successional forests in the KNF and Guidelines for snag retention. Project consistency with this guideline is discussed in detail below. See also Attachment 2, Snag Retention.
MA5-30-4 Following a stand-replacing disturbance, management should retain adequate coarse woody debris quantities in the new stand so that in the future it will still contain amounts similar to naturally regenerated stands. The analysis that determines the amount of coarse woody debris to leave must account for the full period of time before the new stand begins to contribute coarse woody debris. As in the case of snags, province-level specifications must be provided for this guideline. Because coarse woody debris decay rates, forest dynamics, and site productivity undoubtedly will vary among provinces and forest types, the specifications also will vary. Province-level plans will establish appropriate levels of coarse woody debris and decay rates to be used. Levels will be "typical" and will not require retention of all material where it is highly concentrated, or too small to contribute to coarse woody debris over the long timeframes discussed. This standard and guideline represents one item to be considered and may indeed result in no salvage following windthrow in low density stands. As for other management activities, it is expected that salvage standards and guidelines will be refined through the implementation and adaptive management processes.	The project provides for retention of levels of coarse woody debris found in late-successional forests as provided in the LSRA (Table 6) and KNF LRMP (Table 7 and 8). Consistency with this guideline is discussed in detail below.
MA5-30-5 Some salvage that does not meet the preceding guidelines will be allowed when salvage is essential to reduce the future risk of fire or insect damage to late-successional forest conditions. This circumstance is most likely to occur in the California Cascades Province and somewhat less likely to occur in the California Klamath Province. It is important to understand that some risk associated with fire and insects is acceptable because they are natural forces influencing late-successional forest development. Consequently, salvage to such risks should focus only on those areas where there is high risk of large-scale disturbance.	Proposed salvage harvest is designed to reduce the risk of future stand replacement fire. The analysis clearly shows that there is a high risk of future large-scale disturbance in stands where fuels are not reduced. Salvage within some fuel management zones may not fully meet preceding standards and guidelines because of WUI considerations, or ridgetop fuel break design. Consistency with this guideline is discussed in detail below.

Table 5 KNF LRMP and LSRA Guidelines for Salvage in Late Successional Reserves	
MA5-30-6 Removal of snags and logs may be necessary to reduce hazards to humans along roads and trails, and in or adjacent to campgrounds. Where materials must be removed from the site, as in a campground or on a road, a salvage sale is appropriate. In other areas, such as along roads, leaving material on site should be considered. Also, material will be left where available coarse woody debris is inadequate.	The project design is consistent with this direction. Material will be left along roads so long as it does not compromise fuels objectives. Fuel management prescriptions have been adapted to reflect slope position and aspect.
MA5-30-7 Where green trees, snags, and logs are present following disturbance, the green-tree and snag guidelines will be applied first, and completely satisfied where possible. The biomass left in snags can be credited toward the amount of coarse woody debris biomass needed to achieve management objectives.	Project design features are consistent with this direction.
MA5-30-8 These basic guidelines may not be applicable after disturbances in younger stands because remnant coarse woody debris may be relatively small. In these cases, diameter and biomass retention guidelines should be developed consistent with the intention of achieving late-successional forest conditions.	Younger stands are not included in this proposal.
MA5-30-9 Logs present on the forest floor before a disturbance event provide habitat benefits that are likely to continue. It seldom will be appropriate to remove them. Where these logs are in an advanced state of decay, they will not be credited toward objectives for coarse woody debris retention developed after a disturbance event. Advanced state of decay should be defined as logs not expected to persist to the time when the new stand begins producing coarse woody debris.	Down wood that was present on the forest floor and was not consumed by the fire will not be removed.
MA5-30-10 The coarse woody debris retained should approximate the species composition of the original stand to help replicate preexisting suitable habitat conditions.	Coarse woody debris retained will be consistent with the direction in the LSRA and would meet this S&G. See Table 8
MA5-30-11 Some deviation from these general guidelines may be allowed to provide reasonable access to salvage sites and feasible logging operations. Such deviation should occur on as small a portion of the area as possible, and should not result in violation of the basic intent that late-successional forest habitat or the development of such habitat in the future should not be impaired throughout the area. While exceptions to the guidelines may be allowed to provide access and operability, some salvage opportunities will undoubtedly be foregone because of access, feasibility, and safety concerns.	We are not aware of any circumstance where this is applicable.

Forest Wide Late Successional Reserve Assessment

The NWFP required completion of an LSR Assessment prior to initiating projects that may impact late-successional habitat. The Klamath National Forest completed an LSR Assessment (LSRA) in 1999. The Regional Ecosystem Office (REO) reviewed the KNF LSRA and found

that it provided adequate direction for salvage harvest and other management activities proposed in the Westside Fire Recovery Project. The REO concluded that actions that were consistent with the LSRA, including salvage, did not need further review; however because of the size and complexity of this project, the Forest has requested review by the REO. While an LSRA is not a decision document and does not provide enforceable standards and guidelines as does the LRMP, it serves to inform decisions concerning activities in the LSR land allocation. Management Recommendations established in the LSRA for salvage were as follows:

To remove dead trees in order to capture volume following a stand-replacing event. The effect on the LSR must be neutral. Salvage should have a long- term positive effect on late-successional habitat and should not diminish habitat suitability now or in the future. Salvage should focus on long-range objectives, which are based on desired future condition of the forest. Management following a stand-replacing event should be designed to accelerate or not impede the development of late-successional characteristics (LSRA 4-24).

Section 3 of the LSRA makes recommendations for achieving the Desired Condition as described in the LRMP. Desired future condition for LSRs, as described in the LRMP, state that characteristics of individual areas will vary according to the primary vegetative species, site class, topography and other site factors. Table 6 summarizes snag and CWD debris metrics by stand type and aspect from Tables 3-1, 3-2 and 3-3 of the KNF LSRA. The levels and ranges of various attributes should allow for long term viability of late-successional characteristics (LSRA 1-3). The desired amounts of snags and down logs are within the ranges described in the Forest LRMP. The recommended amounts shown here have been adapted for 3 vegetation types and reflect Forest data obtained from the 1992 old growth inventory (Beardsley and Warbington 1996). It must be understood that values represented in this study reflect 60-80 years of fire suppression. These values likely overstate historical snag and down wood numbers.

Snags larger than 15 inches DBH should count toward meeting the guideline in late-successional stands. Coarse woody debris should be in a variety of decay classes; logs 15" in diameter and 10 feet in length count towards meeting the guideline for late-successional stands, but larger down logs (i.e.>20") are preferable. The values shown in Table 6 represents a minimum average for a landscape or treatment area; i.e., 100 acres. Numbers of snags and down logs can vary on any particular acre. **It is desired to exceed this minimum figure, but not to a point that will create the likelihood of a stand replacing event (LSRA 1-3)** (emphasis added)**.** The Westside Fire Recovery Project uses a target level of ten tons / acre of residual fuels to meet project objectives except on lower slopes and areas of larger trees where up to 20 tons / acre of residual fuels could be retained (Chapter 3 - Fuels).

Table 6
Snag and Coarse Woody Debris Guidelines

		Snags >15 Inches DBH	CWD Pieces > 15 inches diameter and 10 feet long
Douglas fir	North and East Aspects	4	12
	South and West Aspects	3	8
Mixed conifer	North and East Aspects	6	10
	South and West Aspects	4	7
True fir	All Aspects	11	15

Source: Tables 3-1, 3.2 and 3.3, KNF LSRA, pages 1-5 and 1-6. The descriptions represents a minimum average for a landscape or treatment area; i.e., 100 acres. Numbers of snags and down logs can vary on any particular acre.

Snag and CWD metrics suggested in the LSRA shown in Table 6 are similar to those described in the LRMP (Table 7 and 8; see also following discussion).

Guidelines for Snag Retention and Coarse Woody Debris

Snag and down wood are essential parts of late successional forest stands. There is however a tension between leaving enough snags and coarse woody debris for habitat needs and leaving so much dead wood that fuel loads are unacceptably high (Knapp 2015). The LSRA, in describing Desired Condition, noted that minimum amounts of snags and CWD could be exceeded, but not to the point that they were likely to create the likelihood of a stand-replacing event (LSRA 1-3). Skinner et al. (2006) observed that:

"Quantities of large woody material for standards and guidelines were developed from contemporary old-growth forests that had experienced many decades of fire suppression. These quantities of woody material were probably unusually high compared to typical pre- fire suppression values. Consequently, a management emphasis on meeting or exceeding standards and guidelines for dead woody material has and will increase fire hazard over time and threatens the very habitat the standards and guidelines were designed to improve."

As noted by Knapp (2015):

While the importance of woody detritus to the ecological health of many forested ecosystems is undeniable, it is also recognized that in seasonally dry forests a balance is necessary so that excessive fire hazard does not result (Brown and See, 1981; Brown et al., 2003; Lehmkuhl et al., 2007). A substantial proportion of lighting- ignited fires start in snags (Komarek, 1968). Burning snags, particularly ones that are highly decayed, are also a prolific source of embers that propagate spot fires, contributing to rapid fire spread (Barrows, 1951). In addition, the instability and unpredictability of burning snags are a serious safety issue for fire management personnel (Page et al., 2013). While a greater proportion of the dead wood biomass in coniferous forests is typically found in CWD than in snags (Harmon et al., 1986), consumption of both standing snags and CWD increases fire-line intensity, contributing to extreme fire behavior and more severe fire effects (Page et al., 2013). <u>With CWD, Brown et al. (2003) speculated that an optimum quantity for warm and dry ponderosa pine and Douglas fir forest types of the western U.S. that would provide for wildlife, nutrients and other ecological benefits, without contributing to excessive risk of an uncharacteristically severe wildfire, would fall within the range of 11.2–44.8 Mg ha-1 (5–20 tons ac-1), with the higher fuel loading acceptable if the CWD was comprised of larger pieces.</u> (Emphasis added).

In the Westside Fire Recovery Project, we address this balance between habitat and fuel accumulation by utilizing landform, slope position and aspect to determine snag and coarse woody debris amounts and distribution. All snags and coarse woody debris are retained in hydrologic Riparian Reserves and designated snag retention areas which are generally associated with hydrologic Riparian Reserves or pockets of larger trees and lower slope positions. This mimics the natural fire pattern because fires burned with lower severity in riparian areas particularly on lower slope positions where riparian areas are wider and denser. Historically even in a frequent fire environment there would tend to be more snags in these areas. Coarse woody debris is retained as specified in the KNF LRMP, but in amounts that vary with slope position (See LSRA recommendations in Table 6).

The Klamath NF LRMP provided guidelines for retention of snags (LRMP 4-30) and coarse woody debris (LRMP 4-25). Guidelines for snag retention in the LRMP are reproduced here in Table 7.

KNF LRMP 8-25: Use Table 4-4 (Reproduced as Table 7 below) as guidelines in ecosystem analysis and project-level planning. The relative numbers of hard and soft snags in various size classes show the habitat needs of the different cavity-association Forest wildlife species. The number of snags on a given acre will vary, depending on the site and on the number of snags within the landscape.

Table 7
Numbers of Snags Required per 100 acres to support "Good" Quality Habitat for Primary Cavity-Association Species ( )= Number of Snags per 100 acres

Snag Diameter (DBH)	Hard Snags	Soft Snags	Total Snags by diameter class
11+		Downy (16)	(16)
15+	Red Breasted / Black Backed (45	Hairy / White hd. (225)	(270)
20+	Vaux's Swift(200)		(200+)
24+	Pileated(14)		(14)
Total Snags			(500)

The LRMP direction does not require that these snag metrics be met on every acre; the LRMP requires that within any 100-acre area, the appropriate number of snags be retained. This allows project design to mimic the natural snag distribution described by Skinner (2002) and Taylor and Skinner (1996) with concentration of snags in time and space, and intervening areas where snags would be relatively sparse or would not occur. Attachment 2 provides documentation that snag retention standards described in the LRMP would be met.

To meet the snag standards of the LRMP shown in Table 7, the following project design features would be implemented:

- Within harvest units, all snags are retained in hydrologic Riparian Reserves, which include inner gorge areas and additional snag retention areas associated with hydrologic Riparian Reserves. Based on GIS mapping and field layout, there are an estimated 770 acres of hydrologic Riparian Reserves and snag retention areas within the LSRs where snags would be retained within proposed harvest units in the Preferred Alternative (Table 3). Using plot data from the Westside Fire Recovery project, there are on average, 55 trees per acre in salvage units. Most of these trees are dead. Thus, hydrologic Riparian Reserves and inner gorge areas and associated snag retention areas within salvage units in the Preferred Alternative have approximately 42,000 green trees or snags that would be retained within salvage harvest units in the LSR land allocation. These green trees and snags are most likely to persist on the landscape if the surface fuels around them have been reduced because reducing surface fuels reduces the severity of future fires. Salvage harvest and follow-up activity fuel treatment would accomplish the objective of reducing future surface fuel loading (Figure 7.). To further verify that the Guidelines in Table 7 were met, 30 randomly generated 100 acre areas were evaluated for snag retention using plot data for hydrologic Riparian Reserves and GIS data for fire severity and size class. Based on this assessment, approximately 1,800 snags greater than 14 inches in diameter and 700 snags greater than 20 inches in diameter are retained per 100 acre area within the fire areas. This meets or exceeds the LRMP and LSRA metrics for snags shown in Table 7. See Attachment 2, Snag Retention Analysis.

- Within hydrologic Riparian Reserves in salvage units, surface fuels would be treated by broadcast burning at the time that activity fuels within units are burned. This reduces surface fuels, and increases the probability that retained snags would survive future fires.
- Green trees and lower-severity fire areas where most of the trees survived will be retained as they occur and are not "included timber" in proposed salvage harvest areas even if they occur within salvage unit boundaries. Over time, these green trees contribute to snags and coarse woody debris. Trees with less than 70% probability of mortality would be maintained. An estimated 8,500 live trees and legacy trees within units in the LSR have been marked for retention (Attachment 2).
- Large, fire-resistant legacy live trees, legacy trees killed by the fire and trees that were dead at the time of the fire are retained where they occur within salvage units. If these pose a safety hazard, they would be felled and left to provide large woody debris.
- Additionally there are 6,600 acres of moderate or high severity fire within the LSR land allocation that were originally proposed for salvage harvest that have been dropped from the project to meet the needs of habitat for northern spotted owls or because of feasibility concerns.

The KNF LRMP also provides Guidelines for coarse wood debris (CWD) (KNF LRMP 6-16: 4-25). These are shown in Table 8, which includes a brief discussion of implementation.

Table 8
Guidelines for Coarse Woody Debris

Guideline	Implementation
6-16 Until standards are developed as described above, the following guidelines apply in areas of regeneration harvests and other vegetation manipulation:	No additional standards have been developed for CWD. The standards provided in the LRMP will be implemented.
a) Manage to provide a renewable supply of large down logs well distributed across the matrix landscape in a manner that meets the needs of species and provides for ecological functions. Develop models for groups of plant associations and stand types that can be used as a baseline for developing prescriptions.	Green trees have been retained wherever they occur. Reforestation will contribute to down logs in the future.
b) Maintain 5 to 20 pieces of CWD per acre in various states of decay. The specific amount of materials specified for retention on individual projects shall be determined by the project ID team. At a minimum, the ID team should consider the amount of materials existing on site, the amount of material needed to provide for nutrient cycling and site productivity, the denning needs of wildlife species, and the fire risk as a result of fuel material on site. Attempt to maintain these levels of CWD on site throughout the life of the project or throughout the rotation (if timber harvest is planned.) Leave large logs, conifer and hardwood, sound and cull of at least 20 inches in diameter and about 40 cubic feet in volume when they are available. Most of the logs should be in Decay Class 3, 4 and 5 (defined in the USDA Handbook 553, page 80) with at least 2 logs per acre in decay Class 1 or 2. Do not count logs less than 12 inches in diameter or stumps as CWD. This guideline may be waived in strategic fuelbreak areas or for documented safety reasons. Down logs should reflect the species mix of the original stand. In areas of partial harvest, the same basic guidelines should be applied, but they should be modified to reflect the timing of stand development cycles where partial harvesting is	CWD in these amounts and size classes will be retained. See Table 6 for specific recommendations by forest type and aspect developed in the LSRA. On upper slopes and south and west aspects, fewer pieces (~5 pieces > 15 inches diameter and 10 feet long - the lower range) would be retained because historically, frequent fires consumed down wood in these locations. On north and east aspects and on lower slopes, relatively more pieces (up to 20 pieces - the upper range) will be retained because historically, these areas burned less frequently, or burned with less severity. Snags in clumps, and green trees within units may count towards these targets. These values are consistent with those recommended by Brown et al. (2003) and cited by Knapp (2015). Fuel modeling (Figure 7) shows that salvage harvest followed by activity fuel treatment would accomplish the LRMP goal of reducing fuel concentrations that would contribute to future high-intensity fire (LRMP 4-8). Areas of snag retention would provide large pulses of dead wood as that material breaks and falls to the

Table 8 Guidelines for Coarse Woody Debris	
practiced.	ground.
c) CWD already on the ground should be retained and protected to the greatest extent possible from disturbance during treatment (e.g., slash burning and yarding) which might otherwise destroy the integrity of the substrate.	All CWD that is currently on the ground will be retained.
d) Down logs should be left within forest patches that are retained under green-tree retention guidelines in order to provide the microclimate that is appropriate for various organisms that use this substrate.	All CWD within patches of standing trees will be retained.

Fuels Reduction and Reestablishment of Coniferous Forest Habitat

Because Late-Successional Reserves have been established to provide high quality habitat for species associated with late-successional forest conditions, management following a stand-replacing event should be designed to accelerate or not impede the development of those conditions (NWFP C-14; LSRA 1-24). Research has shown that the quickest way to reestablish a coniferous forest after stand replacement fire is by active reforestation (Zhang et al. 2008). Research has also shown that plantations established in areas with high slash loadings burned severely, while those where residual slash had been adequately treated burned with much less severity and intensity or not at all (Thompson, Spies and Ganio, 2007; Weatherspoon and Skinner, 1995; Omi and Kalabokidis 1991).

Forest Vegetation Simulation (FVS) modeling (Attachment 1) shows that reforestation will establish forested conditions more rapidly by treating surface fuels and planting trees than by natural succession. It also shows that where surface fuels have been treated by salvage logging and site preparation, the ensuing stand is more resilient to fire than untreated areas. If surface fuels are treated, the risk of future stand replacement fires would be reduced, increasing the probability that planted conifers can persist into the future. In the FVS model, planted stands where fuels had been reduced began to show late-successional stand conditions typical of the Klamath Province with 40% canopy closure and 18 inch DBH trees in 90 years compared to over 200 years for untreated stands to reach the same stage.

Without planting, trees will slowly become reestablished over a period of 10-50 years in severely burned areas, but the probability of a late-successional coniferous forest becoming established is low because of probable reburns. It is probable that areas where fuels are not treated will go through several cycles of stand replacement fire until surface fuels have been reduced to the point that a low to moderate fire severity regime has been reestablished. This would maintain areas where fuels have not been reduced in semi-permanent brush fields for decades rather than accelerating the development of late-successional stand conditions.

The planted trees in areas where fuels have been successfully reduced are expected to provide “islands” of coniferous forest in a sea of brushfields perpetuated by reburns where fuels have not been reduced. This would provide a measure of vegetative diversity that would not otherwise be present on the landscape. These planted stands have a much higher probability of achieving and sustaining the desired late successional stand condition for the LSR than do unplanted areas as shown in the FVS modeling (Attachment 1).

Summary

Every stand cannot, and should not attempt to meet some target for snags and down wood Stephens (2004). Heterogeneity i.e. concentrations of dead wood in some areas with other areas where dead wood was sparse as described by Skinner (2002) would be an indicator of a healthy ecosystem (Knapp 2015). Homogenous or "average" conditions on every acre would not occur naturally in the frequent fire environment of the Klamath. Thus, to reestablish the natural late-successional post-fire environment typical of the Klamath Province, the Westside Recovery Project seeks to replicate the patterns described by Skinner (2002), Taylor and Skinner (1996), and Knapp (2015) where snags and down wood are concentrated in time and space, with intervening areas where concentrations of snags and down wood in time and space are sparse. Retaining snags in hydrologic Riparian Reserves and designated snag retention areas and varying amounts of down wood by slope position and aspect would accomplish this objective. Generally, the largest trees occur within hydrologic Riparian Reserves, which are retained.

Guideline MA5-30-3 states:

"*Snags provide a variety of habitat benefits for a variety of wildlife species associated with late-successional forests. Accordingly, following stand-replacing disturbance, management should focus on retaining snags that are likely to persist until late- successional conditions have developed and the new stand is again producing large snags."*

Because of fire frequency this requirement is difficult to meet in the Klamath Province without reducing fuels. As previously noted, retaining all of the fire-killed trees currently on the landscape is likely to create future surface fuel loading that would increase the probability of future high severity fire that would consume snags and down wood (Skinner et al. 2006; Figure 7; Fuels Report – Chapter 3). Also, as noted by Taylor and Skinner (1997) and Skinner (2002), dead wood in the Klamath province rarely lasts long enough to actually decompose because snags and down logs are receptive to embers, and once partially rotted, are easily consumed by fire. The Westside Fire Recovery Project seeks to meet the objective described in Guideline MA 5-30 by

- Retaining large green "legacy" trees wherever they occur. By virtue of their location and / or inherent resistance to fire, large green trees are most likely to persist until the next stand can develop large structures.
- Retaining snags in Riparian areas. This has the effect of retaining the larger trees, on average on the landscape, in locations that historically burned with less severity or less frequently. Very few, if any snags will persist until the next stand develops large snags (Harrod 1998) but their longevity can be increased by reducing the continuity of adjacent fuels and the probability of consumptive reburns.
- Designating additional snag retention areas in association with hydrologic Riparian Reserves (see map packet) or in pockets of larger trees. Emphasis for additional snag retention areas was placed on lower slopes that historically have burned with lower severity.
- Reducing fuels around hydrologic Riparian Reserves and snag retention areas by salvage harvest and follow-up activity fuel treatment. By reducing surface fuels, the risk of future high severity fire consuming remaining snags and down wood is reduced (Figure 7).

While the risk of loss of snags and down wood from future fires cannot be eliminated, implementation of these measures would provide a higher probability of retaining surviving green

trees, snags and down wood similar to the patterns described by Skinner (2002) and Taylor and Skinner (1996) typical of the Klamath Province, than leaving areas completely untreated.

These measures would meet short term LSR objectives because very little of the Westside Fire Recovery Project area is actually in salvage units (Figures 8, 9, 10, 11, and 12) and because snags and coarse woody debris are maintained in sufficient amounts to meet LSR standards described in the LSRA (Table 6) and the KNF LRMP (Table 7 and 8) where salvage does occur. Using California Wildlife Habitat Relationship (CWHR) data, Figure 12 shows that within the Eddy Gulch and Seiad LSRs:

- Of the 29,600 acres of stands with a quadratic mean diameter (QMD) greater than 24 inches, in all burn severities, 1,750 acres (6% of the size class) would be removed by the Westside Fire Recovery project in salvage harvest units. An estimated additional 240 acres of stands greater than 24 inches QMD would be removed in roadside hazard cleanup (Table 3) in moderate – high severity burn areas.
- With salvage units and roadside hazard combined, approximately 2,000 acres of stands with a QMD greater than 24 inches would be removed within the Eddy Gulch and Seiad LSRs from moderate – high severity burn areas.
- Of stands with a QMD greater than 24 inches, this represents about 23 percent of the 8,650 acres of moderate - high severity burn acres and about 7% of the medium / large tree diameter class in all burn severities in the LSRs.
- Of the stands where the QMD is greater than 24 inches that are in moderate to high severity burn patches, 77 percent would be retained. Overall, over 90 percent of the stands with a QMD greater than 24 inches in the Seiad and Eddy Gulch LSRs would be retained.

Components of late-successional forests (legacy trees, snags, down wood) are retained within harvest areas in amounts specified in the Klamath National Forest LRMP. Long term LSR objectives would be met in salvage units because legacy trees, green trees (to the degree they exist) that can provide future snags and coarse wood and larger trees in hydrologic Riparian Reserves, would be retained. Risk-reduction salvage in concert with ridgetop FMZs would increase the probability that snags and CWD retained would persist within treatment units because these actions would reduce the amount of surface fuels, and thus reduce future fire severity (Figure 7). These measures would also increase the effectiveness of future wildland fire use and understory controlled burns by providing large areas of treated fuels with ridgetop fuel breaks to use for control lines. This would facilitate reintroduction of low to moderate intensity fire to the LSR which is key to protecting remaining late successional and old growth stands and developing late successional stand conditions in the future (Taylor and Skinner (1997; See also FVS Modeling, Attachment 1).

Based on this assessment, we conclude the actions proposed within the Seiad and Eddy Gulch LSRs in Westside Fire Recovery Project are consistent with the recommendations of the LSRA and the Klamath National Forest LRMP as amended.

The areas that are least likely to meet long-term LSR objectives are those areas where no fuels reduction occurs because extensive areas of heavy fuels created the 2014 Westside Fires will likely contribute to repeated high severity fires in the future that would delay the establishment of late-successional stand conditions.

Forest Vegetation Simulator-Westside Fire Recovery

Forest Vegetation Simulator in conjunction with the Fuels and Fire Extension and the Stand Visualization System was used to model the effects of the action alternative and the no action alternative on the relative length of time for a stand to achieve late seral characteristics. The objective was to model the development of a Late Successional Reserve in a fire ecosystem. The two key parameters selected to determine when a stand reached this desired condition for Late Successional Reserves were a canopy closure of forty percent or greater and 15 or more trees per acre greater than twenty inches in diameter at breast height. These parameters were derived from the Klamath Forest-Wide LSR Assessment which described the current condition of the Mixed Conifer zone for Mid and Late Successional stands on the Klamath NF. The Dense stands were classified as having greater than 40% canopy closure. The average number of trees per acre over 20" DBH for those stands was 15 or greater (pages 2-5 and 2-6). The modeled stands were determined to have met the conditions for LSR development when they had met both conditions.

The FVS model is designed to predict stand development relative to other modeled treatments and not predict actual stand development times. In this case the action and no action alternatives were compared based upon equal starting conditions and site characteristics. Table 1 shows a comparison by year and by management action.

Table 1. Under the management action alternative, late seral character becomes present in year 2087, or 70 years after initial reforestation efforts. Under the no action alternative, canopy cover greater than 40% is not achieved until the end of the 200 year analysis period.

	Action Alternative		No Action	
Year	Trees per acre greater than 20" DBH	Canopy Cover %	Trees per acre greater than 20" DBH	Canopy Cover %
2007	47.9	86.49	47.9	86.49
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2027	0	9.15	0	0.44
2037	0	22.7	0	2.86
2047	0	46.8	0	6.95
2057	0	23.43	0	4.25
2067	0	33.11	0.4	7.25
2077	11.7	42.12	1.4	11
2087	19.5	40.9	2.8	9.57
2097	28.6	48.08	6.7	13.2
2107	37.7	55.71	8.4	17.14
2117	44.5	57.25	9	15.98
2127	49.1	63.89	9.3	19.95
2137	50	70	11.4	24.21
2147	47.7	70.38	12.1	23.26
2157	47	74.17	14.8	27.02
2167	45.6	76.89	15.9	30.97
2177	43	75.27	15.7	30.52
2187	40	75.19	16.2	34.29
2197	37.3	74.22	16.5	37.89
2207	34.8	71.79	16.7	37.51
2217	33.3	72.27	17.5	41.1

Stand data from the Walker Creek area was used for the analysis. The stand identifier is shown as 050552ABCD0292 in the images below. The data in Table 1 corresponds to the images generated below using the stand visualization system. The inventory conditions (Image 1) reflect the year the data was collected. For this stand, data was collected in 2007. We simulated a stand replacing fire in 2014 to represent the Happy Camp Complex (Image 2). Image 3 shows the post fire mortality. The first 3 images are identical for both the Action and No Action Alternatives and therefore not duplicated. For the Action Alternative, salvage logging occurs in year 2016 (Image 4, left) followed by a prescribed broadcast burn to reduce fuels and prepare the site for planting (Image 5, left). Images 4 and 5, right, show the amount of standing dead material for the No Action alternative for the years 2016-2017. Artificial regeneration (tree planting) takes place in year 2017 for the action alternative (no image provided). In the year 2020, a pulse of natural regeneration was simulated in both alternatives. Using Shatford's research in the Klamath-Siskiyous (Shatford, Hibbs, and Puettmann, 2007), we estimated that at an average of 350 meters from the nearest seed source, 100 conifer seedlings per hectare would be established, or approximately 40 conifer seedlings per acre (Image 6). For both alternatives, wildfires were simulated on a 30 year cycle followed by a pulse of natural regeneration 5 years after each fire. The first wildfire was simulated in 2047 with a pulse of natural regeneration in 2052. A second fire was simulated in 2077 with a pulse of regeneration in 2082. We continued this pattern until the end of the simulation period of 200 years. Image 7 shows the stand condition in 2047 prior to the wildfire and Image 8 shows the fire spreading through the seedling stand. Images 9 through 11 show how the stand progresses under each alternative at 50 year intervals. Image 12 shows the stand at the end of the analysis period in the year 2217.

While the stand that developed without treatment (no action) may be appropriate on upper SW facing slopes, it does not meet the basic stand conditions necessary to meet the criteria for tree size and canopy closure until year 200 which delays development by 130 years, or almost three times the duration of the salvaged and planted stands.

Image 1

Stand=050552ABCD0292 Year=2007 Inventory conditions

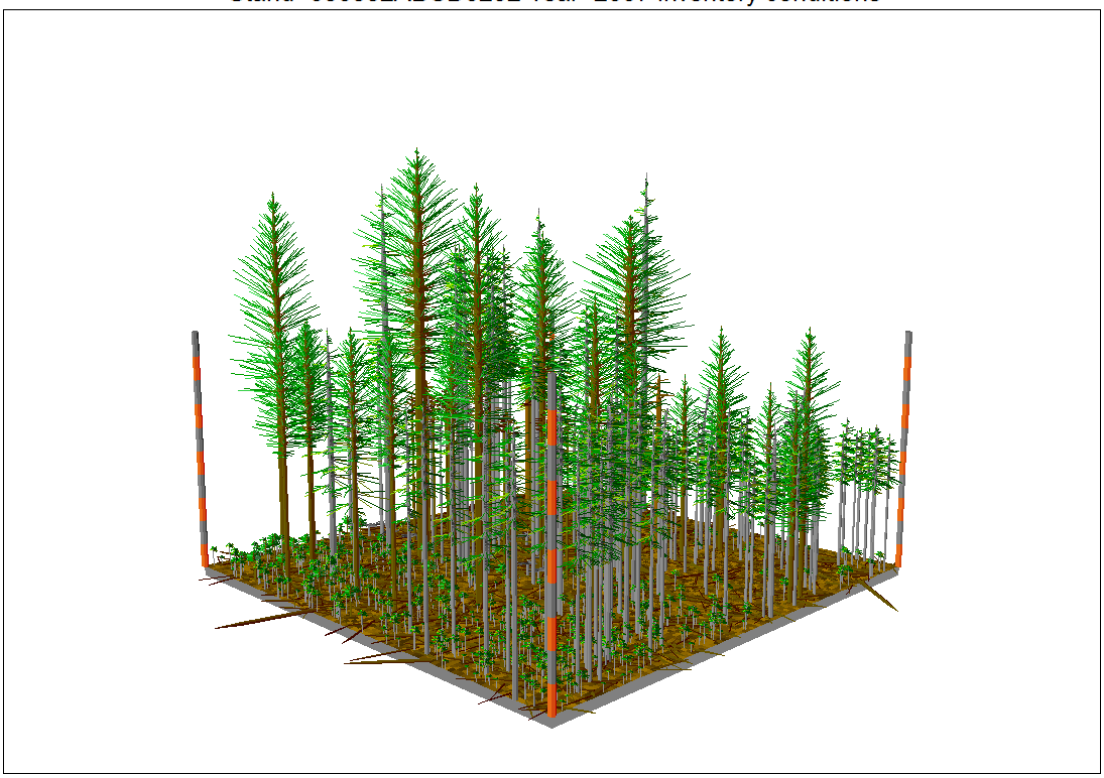


Image 2

Stand=050552ABCD0292 Year=2014 Beginning of fire (01/03)

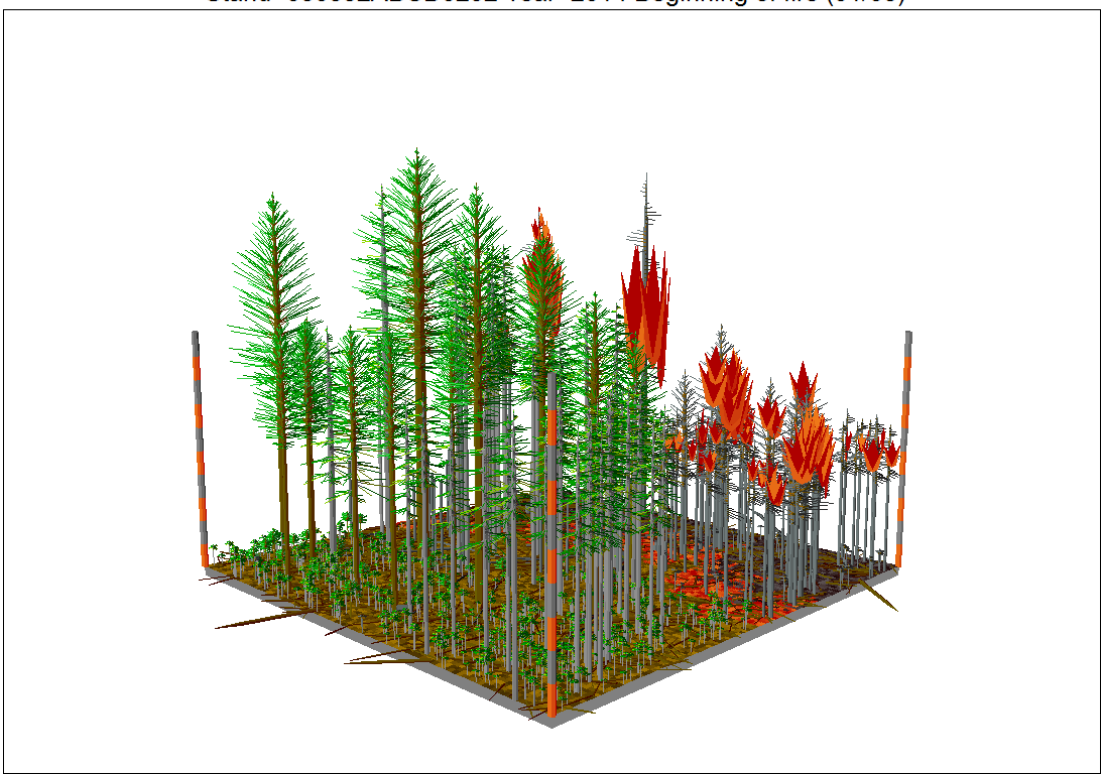


Image 3

Stand=050552ABCD0292 Year=2014 After the fire (03/03)

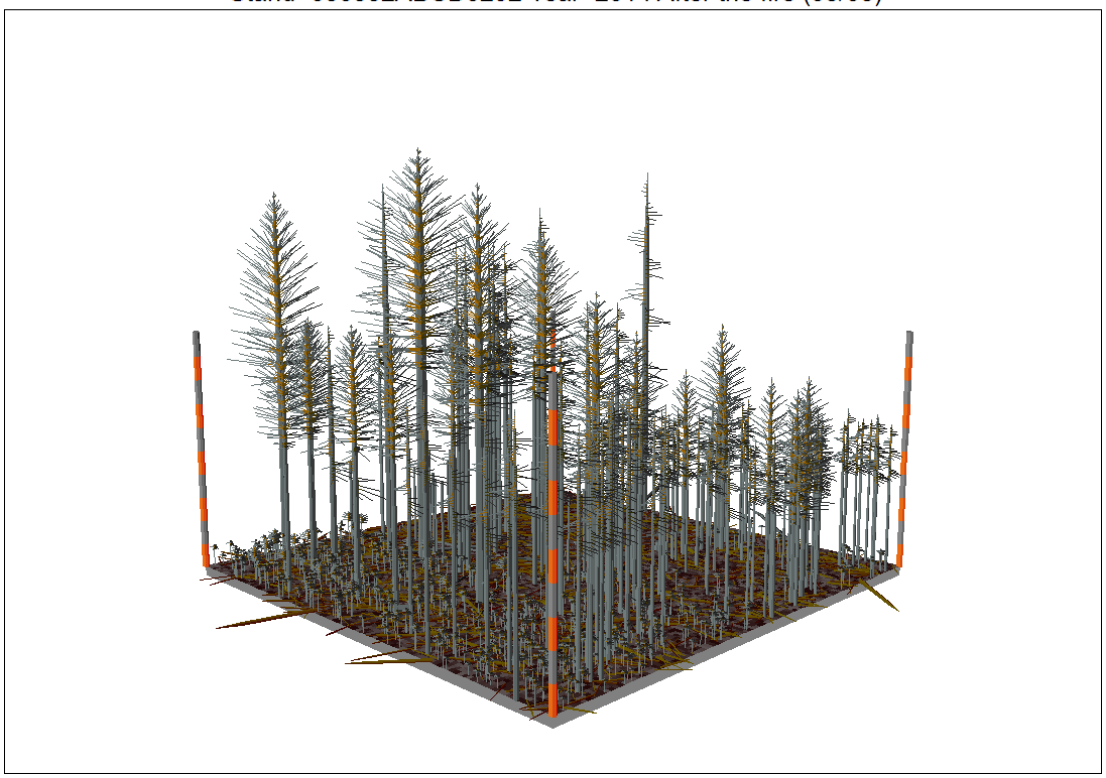
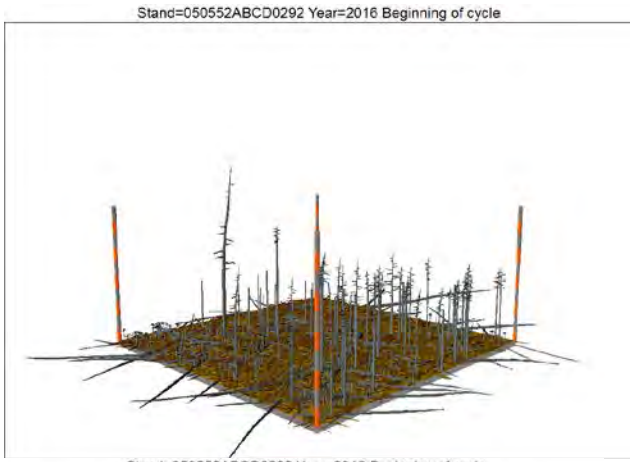


Image 4



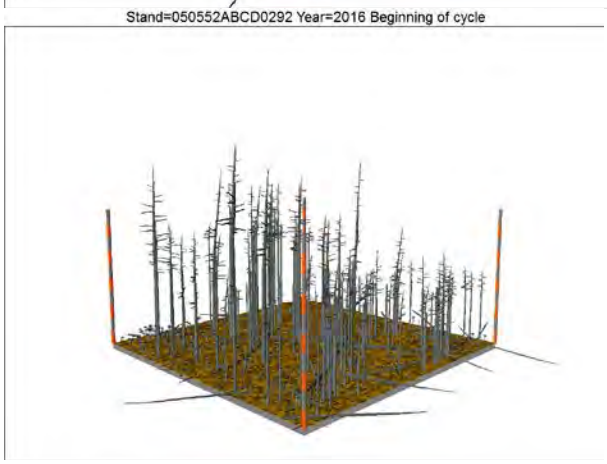
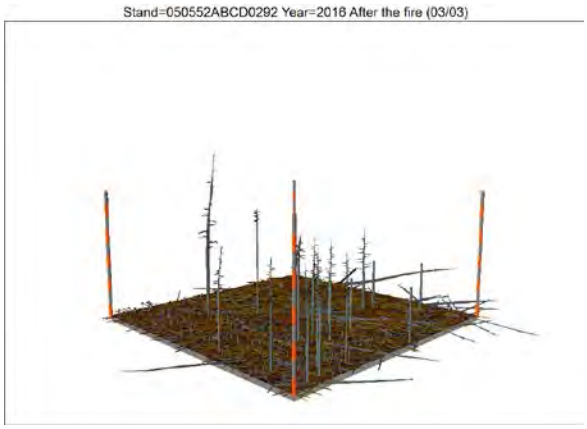


Image 5



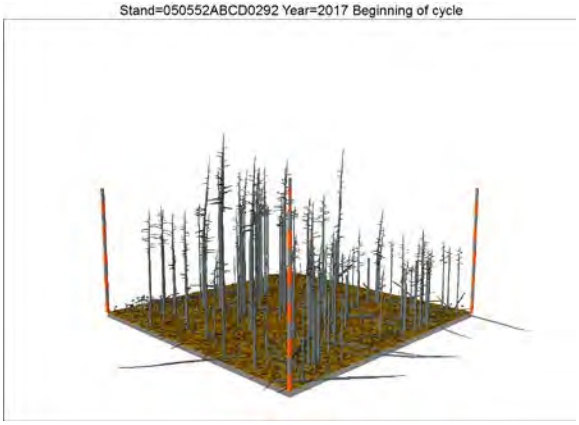


Image 6

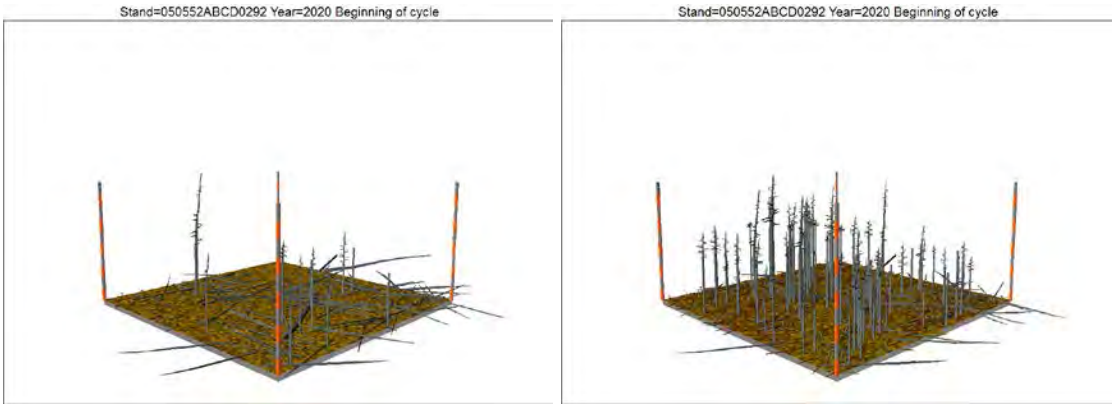


Image 7

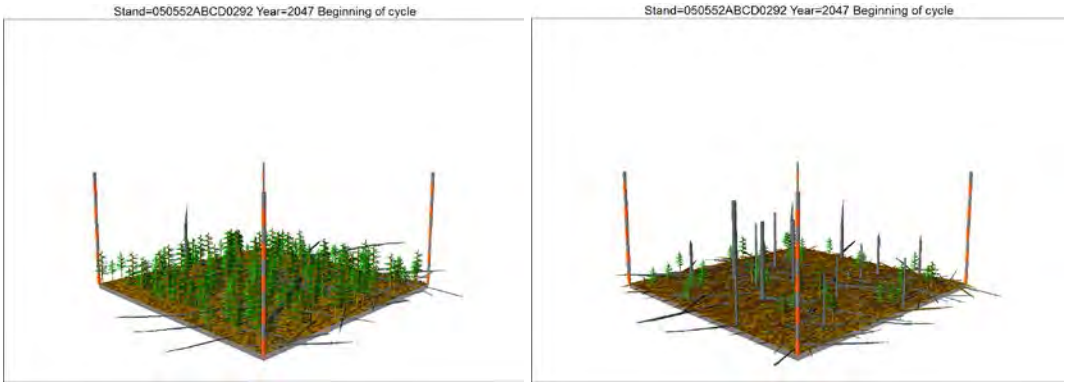
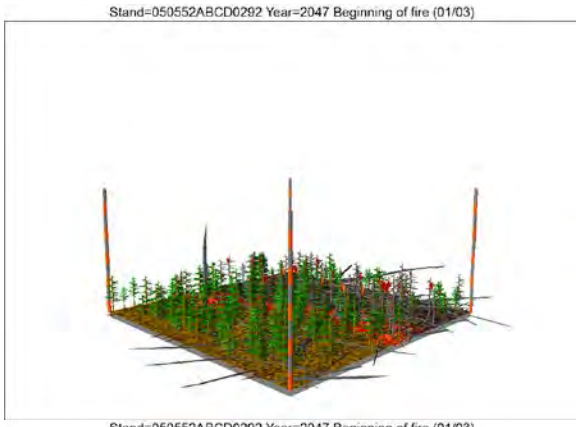


Image 8


Stand=050552ABCD0292 Year=2047 Beginning of fire (01/03)

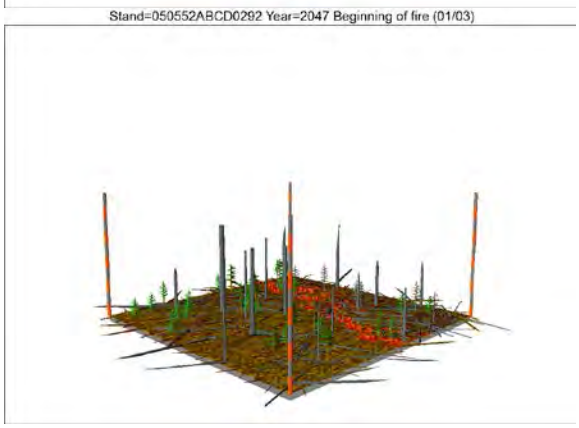
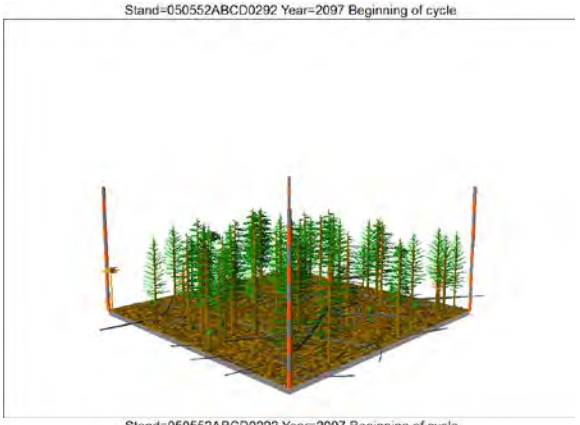

Stand=050552ABCD0292 Year=2047 Beginning of fire (01/03)

Image 9


Stand=050552ABCD0292 Year=2097 Beginning of cycle

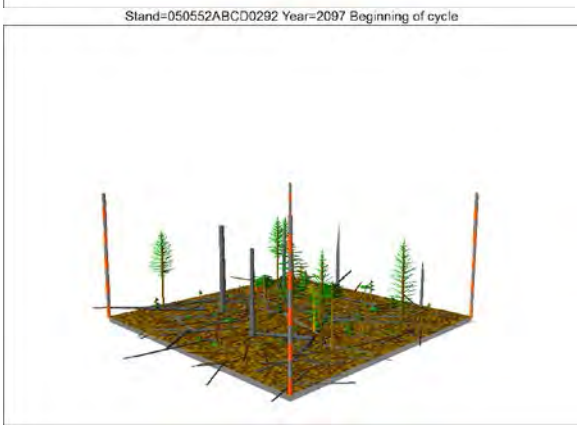
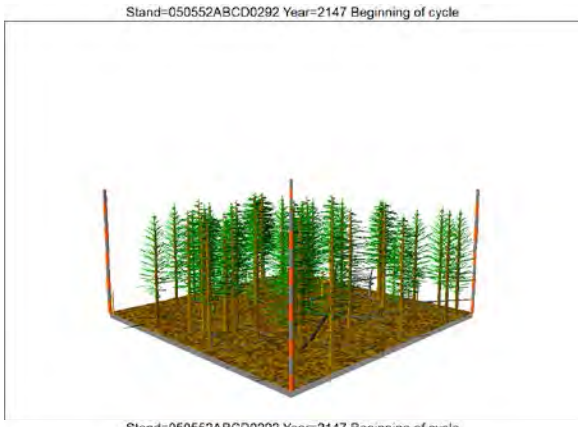

Stand=050552ABCD0292 Year=2097 Beginning of cycle

Image 10



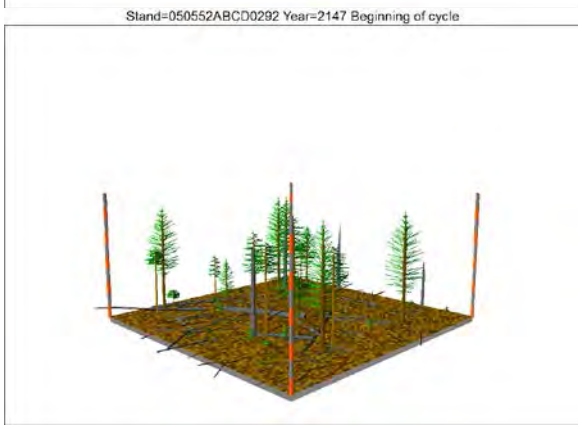
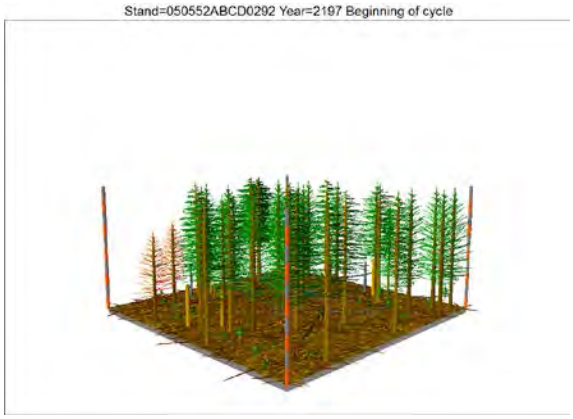


Image 11



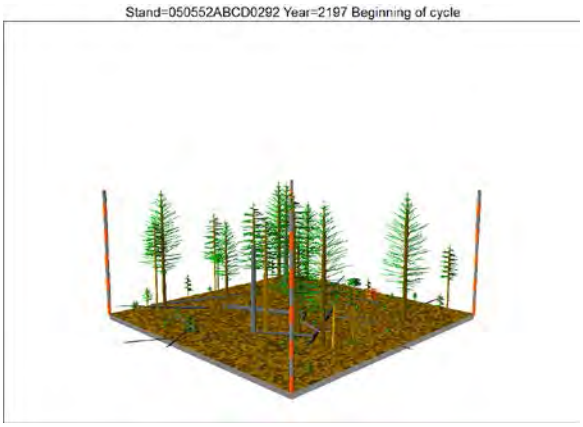
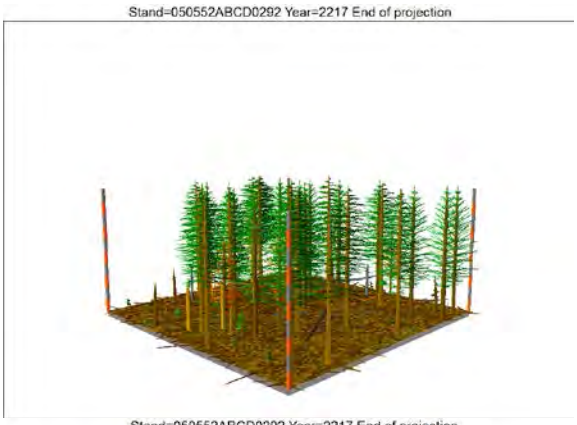
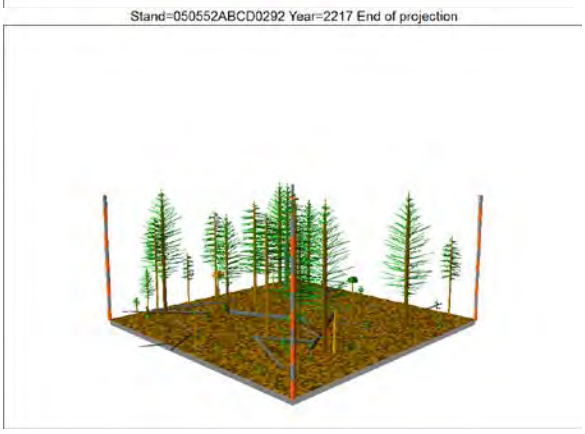


Image 12


Stand=050552ABCD0292 Year=2217 End of projection


Stand=050552ABCD0292 Year=2217 End of projection

Attachment 2: Snag Retention

The Klamath National Forest LRMP requires that within any landscape, management actions ensure that an appropriate number of snags are retained for wildlife habitat. The LRMP direction does not require that these snag metrics be met on every acre; the LRMP requires that within any 100-acre area, the appropriate number of snags be retained. On the Westside Fire Recovery, snag retention within salvage units will occur in hydrologic Riparian Reserves and designated snag retention areas.

Data Sources:

- Plot data was derived from 75 randomly generated plots taken within hydrologic Riparian Reserves. Data was entered and analyzed in FVS to provide an average per acre snag distribution by diameter class.
- E-Veg and RAVG data were used to define forested areas outside unit boundaries (>10 inches) within RAVG classes 3 and 4 (50 to 100% mortality). Snag diameter distribution in these areas was assumed to be the same as those from the Riparian Reserve plots. Mortality in these areas is presumed to be 100% as very few green trees exist in most of these areas. No snags were included from the 0-50% mortality class because of uncertainty and uneven distribution, so this analysis understates the number of snags on the landscape.
- Acres of Riparian Reserve and snag retention areas within units are from the Project GIS database.

Methods:

- 30 randomly generated center points were delineated in salvage units greater than 50 acres. These points were then buffered with a 100 acre circle.
- Acres within the 100 acre buffer in hydrologic Riparian Reserves and Snag Retention Areas within units, and acres >10 inches in diameter with more than 50% mortality outside were tabulated.
- The total acres of snag retention were multiplied times the trees/acre by diameter class to develop a snag distribution by diameter class and total number of snags for each 100 acre circle.
- Areas where snag counts appear to be low were reviewed to determine whether additional snags should be designated. Snag retention areas were added or modified designated in consultation with the Fish and Wildlife Service as necessary.

In addition to snag retention and riparian reserves individual trees have been marked as leave trees. These trees include live trees that will provide future recruitment of snags, trees along unit boundaries and legacy trees. In order to capture the number of trees that were marked as leave trees crews tallied the number of trees being left by fire area. Within salvage units in the Happy Camp fire there are a total of 7,164 leave trees and 1,542 leave trees in the White Fire salvage units.

Random Pt	Unit (Acres)		Outside Unit From E-Veg / RAVG (Acres) >10" and >50% Mortality	Total Acres Snag Retention per 100 Acres	Snag Diameter Distribution from Plot Data				Total >14" / 100 Acres	Total > 20" / 100 acres	Total Acres
	Riparian Reserve	AddSnagRet			14-20"/ 100 acres (37.1/Ac)	20-26" / 100 acres (8.5/Acre)	26-32" / 100 Acres (8.8/Acre)	>32" / 100 Acres (5.1/ Acre)			
1	12	16	18	46	1,716	393	407	245	2,762	1,045	100
2	8	14	25	46	1,698	389	403	243	2,732	1,034	100
3	6	3	11	19	705	161	167	101	1,134	429	100
4	7	5	6	18	654	150	155	93	1,053	399	100
5	9		11	20	745	171	177	106	1,199	454	100
6	0		16	16	607	139	144	87	977	370	100
7	2	6	24	32	1,204	276	286	172	1,937	733	100
8	1		32	32	1,204	276	286	172	1,938	734	100
9	9		35	44	1,617	371	384	231	2,603	985	100
10	35		41	77	2,850	653	676	407	4,587	1,736	100
11	3	3	13	20	731	168	173	104	1,177	445	100
12	0	13	6	19	701	161	166	100	1,127	427	100
13	0	5	10	15	562	129	133	80	905	343	100
14	18	4	18	40	1,496	343	355	214	2,407	911	100
15	14		13	27	987	226	234	141	1,588	601	100
16	9		35	45	1,663	381	395	238	2,677	1,013	100
17	3	1	28	32	1,179	270	280	168	1,898	719	100
18	0	8	31	39	1,444	331	343	206	2,324	880	100
19	0	8	0	8	290	66	69	41	467	177	100
20	0		42	42	1,559	357	370	223	2,508	949	100
21	0		22	22	819	188	194	117	1,318	499	100
22	1	15	19	35	1,303	299	309	186	2,097	794	100
23	14		29	44	1,618	371	384	231	2,604	986	100
24	3	10	2	15	569	130	135	81	916	347	100
25	0	19	3	22	818	187	194	117	1,316	498	100
26	23		23	45	1,688	387	400	241	2,716	1,028	100
27	11		8	20	725	166	172	104	1,166	442	100
28	0	1	41	42	1,566	359	372	224	2,521	954	100
29	6	9	24	39	1,461	335	347	209	2,351	890	100
30	0	5	6	10	388	89	92	55	624	236	100
Total	195	145	591	932	34,568	7,920	8,199	4,938	55,626	21,058	3,000
Average / 100 Acres					1,152	264	273	165	1,854	702	

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