FOREST VEGETATION REPORT: RIM FIRE RECOVERY PROJECT

Analysis by: Roger Brown Forester 7/18/2014

Review and Contributions

by: Dana Walsh R5 Certified Silviculturist 7/18/2014

INTRODUCTION

The 2013 RIM Fire started on August 17, 2013. By the time the fire was contained on October 24th, 2013, the fire had burned over 257,000 acres. The fire burned from the Groveland Ranger District on the Stanislaus National Forest (approximately 133,070 acres) onto the Mi-Wok Ranger District of the Stanislaus National Forest (approximately 41,350 acres) with the rest of acres falling within private and/or other government jurisdictions.

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

The Forest Service completed the Stanislaus National Forest Land and Resource Management Plan (Forest Plan) on October 28, 1991 (USDA 1991). The Stanislaus National Forest "Forest Plan Direction" presents the current Forest Plan management direction, based on the original Forest Plan as amended (USDA 2010a). The Rim Fire Recovery (Rim Recovery) project is designed to fulfill the management direction specified in the Forest Plan Direction. Fuel and vegetation management activities are designed to comply with the standards and guidelines as described in the SNFPA FSEIS and ROD (USDA 2004a, b). The purpose of this analysis is to quantify management effects to determine if the Proposed Action meets current standards and guidelines as listed in the guiding documents above.

Specifically for vegetation management Standards and Guidelines for salvage are:

- Design projects to recover the value of timber killed or severely injured by the disturbance. Examples are activities that would: (1) conduct timber salvage harvest in a timely manner to minimize value loss; (2) minimize harvest costs within site-specific resource constraints; and (3) remove material that local managers determine is not needed for long-term resource recovery needs.
- In post fire restoration projects for large catastrophic fires (contiguous blocks of moderate to high fire lethality of 1,000 acres or more), generally do not conduct salvage harvest in at least 10 percent of the total area affected by fire.
- Use the best available information for identifying dead and dying trees for salvage purposes as developed by the Pacific Southwest Region Forest Health Protection Staff.
- Consider ecological benefits of retaining small patches of mortality in old forest emphasis areas.

NATIONAL FOREST MANAGEMENT ACT

The National Forest Management Act (NFMA) of 1976, including its amendments to the Forest and Rangeland Renewable Resources Planning Act of 1974 state that it is the policy of the Congress that all forested lands in the National Forest System be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans.

ROADSIDE SAFETY AND HAZARD TREE GUIDELINES

Forest Service Handbook (FSH) 7709.59 Chapter 40, Section 41.7 Hazard Identification and Correction, FSH 6709.11, 27.62d specify the need to remove hazardous trees with structural defects likely to cause failure in all or part of the tree, which may fall and hit the road prism, in a timely, efficient and cost-effective manner. The Forest Service routinely removes hazard trees to maintain roads for access and safety. The Hazard Tree Guidelines for

Forest Service Facilities and Roads in the Pacific Southwest Region (Angwin et al. 2012) provides direction on hazard tree identification and abatement. In addition, the Hazard Tree Guidelines for Forest Service Facilities and Roads in the Pacific Southwest Region consider the term “danger tree” as synonymous to hazard tree and uses these two terms interchangeably.

Effects Analysis Methodology

The analysis area is geographically bounded by the perimeter of the Rim Fire with a specific focus on National Forest System (NFS) lands. Conditions prior to the fire are discussed for all lands within the fire perimeter; however, the effects analysis focuses only on the Rim Recovery project area, which is limited to NFS lands. The temporal bounds are discussed in terms of immediate (0-2 years), short-term (about 5 years) and long-term effects (20-30 years).

Stand inventories collected prior to the Rim Fire were used to characterize the existing conditions of stands in terms of trees per acre and basal area. Only stand inventories located within the Rim Fire perimeter were used. Projects included are Two-mile Ecological Restoration: Vegetation Management, Complex, Soldier Creek, Granite, Reynolds Ecological Restoration, Bear Mountain and Peach Growers. Forest stands were inventoried using the Common Stand Exam protocols for the Pacific Southwest Region (U.S. Department of Agriculture [USDA] Forest Service Region 5). Data was collected on live and dead trees. The data is used in the following analysis, data tables, graphs and charts. A geographic Information System (GIS) was used to analyze effects on forest vegetation on the landscape scale.

Stand development over time is analyzed using fire severity data mapping analysis and pre-fire vegetation conditions from the Forest Geospatial Information Systems (GIS) data layers, pre-fire stand inventories, and site visits to the Rim Fire area.

Assumptions

- Pre-fire stand inventory data and GIS data is accurate and representative of the project area.
- California Wildlife Habitat Relationship Classification (CWHR) vegetation type, size class and density is an effective proxy for seral stages and may be used to display the relative distribution of seral stages because it describes vegetation type, average tree size and canopy cover.

Indicators

Measurement indicators are used to measure, compare and contrast the effects of the Proposed Action, No Action and alternatives to the Proposed Action. Measurement indicators are meant to be understandable, and capable of being quantified or classified. Indicators should be responsive to environmental influences and changes in management or treatment activities. The measurement indicators stated below quantify and display effects to forest structure and are relevant to the resource and responses to proposed management activities or lack thereof.

California Wildlife Habitat Relationship Classification

CWHR vegetation typing (Mayer and Laudenslayer 1988) is used to measure cumulative effects of alternatives on forest structure and diversity. In addition, this allows for a congruent analysis of effects on forest vegetation and wildlife habitat. CWHR classifies stands based on the predominate size of trees and stand density. Table 1 summarizes the CWHR classification system. Diameter in inches at 4 ½ feet (dbh) is used to describe diameter classes of trees.

TABLE 1 CWHR SIZE AND DENSITY CLASSES

<table>
<tr><td rowspan="2"></td><th colspan="8">CWHR SIZE CLASSES</th></tr>
<tr><td>1</td><td>2</td><td colspan="2">3</td><td colspan="2">4</td><td>5</td><td>6</td></tr>
<tr><td>Diameter Range</td><td><1 inches dbh</td><td>1-6 inches dbh</td><td colspan="2">6-11 inches dbh</td><td colspan="2">11-24 inches dbh</td><td>>24 inches dbh</td><td>>24 inches dbh</td></tr>
<tr><td>Description</td><td>Seedlings</td><td>Sapling</td><td colspan="2">Pole Tree</td><td colspan="2">Small Tree</td><td>Medium/ Large Tree</td><td>Multilayered canopy with dense Cover</td></tr>
<tr><td rowspan="2"></td><th colspan="8">CWHR DENSITY CLASSES</th></tr>
<tr><th>S</th><th colspan="2">P</th><th colspan="2">M</th><th colspan="2">D</th><th>"Blank"</th></tr>
<tr><th>Canopy Cover</th><td>10-24%</td><td colspan="2">25-39%</td><td colspan="2">40-59%</td><td colspan="2">>60%</td><td><10%</td></tr>
</table>

Tree Diameter Distribution

The tree diameter distribution provides a simple means of illustrating stand structure and can be an effective indicator of stand development and wildlife habitat suitability. The number of trees per acre (TPA) by diameter class is useful to show the effect of treatments on different tree diameter classes, which is an indication of current and future stand structure.

Basal Area

Basal area per acre (BA) is calculated from the sum of cross-sectional areas of all stems in a stand measured at 4.5 feet and expressed in unit of land area (e.g., square feet per acre). It is a measure of stand density, which is a quantitative measure of the area occupied by trees. Stand density is used to estimate stand stocking, which is a relative measure of maximum or desired level of density. A desirable level of stocking is dependent upon management objectives (e.g., maximizing timber production or minimizing risk of insect outbreaks). Basal area combined with TPA provides a basis for evaluating stand structure because it gives you an idea of both the number and size of trees in a stand.

Fire Severity

Fire severity was mapped utilizing Landsat TM satellite imagery and RdNBR classification (Miller and Thode 2007). Fire burn severity affects vegetation type, size class, and density. Based upon field observations and experience, burn severity in areas that had less than 25 percent basal area mortality were classified as having experienced low severity fire. This type of fire behavior would largely categorize surface fires that killed primarily understory, small diameter trees with some mid-story torching. Some areas may not have burned at all. Areas that had 25 to 75 percent basal area mortality would be considered having experienced moderate severity fire. These areas experienced surface fires which killed a substantial component of the understory with increased torching and mortality of the mid-story. Moderately high to high fire severity areas are those with 75 percent or greater basal area mortality. High severity fire behavior and subsequent severity is largely characterized by both passive and active crown fires. In these areas, the understory and mid-story were killed along with the vast majority of the overstory.

Proposed treatments are based on fire severity and post-fire vegetation conditions. Fire severity and relative number of acres in each fire severity class that would be treated are used to quantify size and scale of treatment effects across the post-fire landscape.

AFFECTED ENVIRONMENT

The project area ranges from approximately 3,000 to 7,000 feet in elevation on the west slope of the Sierra Nevada Mountains. The forests affected by the Rim Fire lay pre-dominantly west-side forests of the Sierra Nevada. Vegetation within the project area consisted primarily of pine-dominated Sierra mixed conifer forests, true fir forests, chaparral, and conifer plantations.

PRIOR TO THE RIM FIRE

As with many areas in the Sierra Nevada, the landscape has been heavily influenced over the last 150 years by past management activities that include mining, grazing, railroad logging, fire exclusion, large high-severity fires and drought. At the stand level, the combination of past management activities and fire exclusion had created relatively homogeneous areas typified by small trees existing at high densities (Oliver et al. 1996). In addition, most of these stands were comprised of high amounts of shade-tolerant species such as white fir and incense cedar. Shade intolerant species, such as ponderosa and sugar pine, appeared to be fading from the landscape outside of plantations established after the 1987 Stanislaus Complex fires, the Granite fire. Overstocked stands with high accumulations of ladder and canopy fuels had created conditions vulnerable to stand replacing disturbances such as high intensity wildfire.

CALIFORNIA WILDLIFE HABITAT RELATIONSHIP CLASSIFICATION

CWHR distribution is an effective way of describing vegetation characteristics on a landscape scale. Table 2 summarizes the CWHR distribution on NFS lands within the Rim Fire perimeter prior to the Rim Fire. Figure 1 shows how different CWHR vegetation types were distributed across the landscape prior to the Rim Fire. For conifer forests, the most common CWHR size classes were 4 and 5. This indicates that most conifer stands within the fire perimeter were in the mid- to late-seral stage of stand development prior to the fire. Impacts from the fire to both conifer and hardwood forest are especially important because they provide some of the most beneficial uses to a variety of wildlife and are a major source of resource and economic value to local communities. Conifer forest may take decades to develop from young, seral stands to mature forests characterized by larger diameters and higher canopy cover.

TABLE 2 PRE FIRE CWHR DISTRIBUTION FOR ALL LANDS WITHIN FIRE PERIMETER

Vegetation Type	CWHR Density Class (acres)					Percent of Total
	D	M	P	S, X	Total[2]	
Non-Forest	-	-	-	-	44,201	17
Hardwood Forest	16,735	7,869	4,479	1,706	30,789	12
Conifer Forest[1]	118,613	34,458	13898	16,944	183,913	71
Total	**135,348**	**42,327**	**18,377**	**10,081**	**258,903**	**100**

[1]Mixed conifer/hardwood forest for the purposes of this analysis is included under conifer forest type.

[2]Includes unburned areas within the fire perimeter.

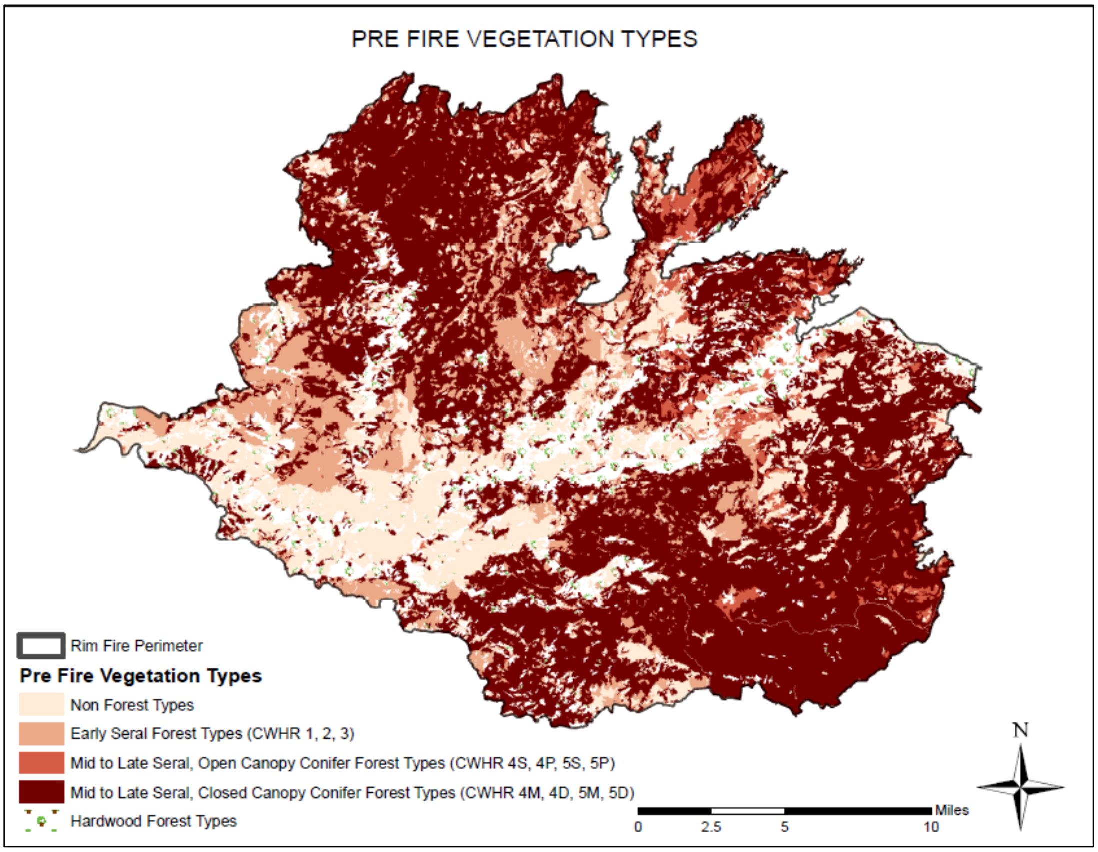

FIGURE 1 CALIFORNIA WILDLIFE HABITAT RELATIONSHIP TYPES WITHIN THE ANALYSIS AREA PRIOR TO THE RIM FIRE

Non-NFS land amounts to almost 104,000 acres within the Rim Fire perimeter. National Park amounts to almost 80,000 acres of this area and is not planned for salvage harvest, although some hazard tree removal is occurring. Management of National Park is not expected to change CWHR beyond the changes that occurred in the fire. Management of private lands is guided by the California Forest Practice rules and harvest on private lands is typically done to meet differing objectives than on National Forest. On private lands salvage logging of lower severity areas of the fire may have affected measures of CWHR in addition to changes resulting from the fire itself.

TABLE 3 PRE FIRE CWHR DISTRIBUTION ON NATIONAL FOREST SYSTEM LAND WITHIN THE FIRE PERIMETER PRIOR TO THE RIM FIRE

Vegetation Type	CWHR Density Class (acres)					Percent of Total
	D	M	P	S, X	Total[2]	
Non-Forest					29,645	19
Hardwood Forest	13,411	5,043	2,604	950	22,008	14
Conifer Forest[1]	70,852	14,584	5,562	12,305	103,303	67
Total	**84,263**	**19,627**	**8,166**	**13,255**	**154,956**	**100**

[1]Mixed conifer/hardwood forest for the purposes of this analysis is included under conifer forest type.
[2]Includes unburned areas in the fire perimeter.

While CWHR types have not yet been remapped within the Rim Fire perimeter, changes to CWHR resulting from the fire are expected to resemble the changes shown in Table 4.

TABLE 4. PROBABLE CHANGES IN CWHR RESULTING FROM THE RIM FIRE

CWHR Veg Type	Percent Basal Area Mortality	Post-Fire Typing Convention
SMC, DFR, WFR, RFR, PPN, JPN, LPN, MHC, SCN	0	No change in CWHR Veg Type, Size or Density Classes
	0-10	No change in CWHR Veg Type, Size or Density Classes
	10-25	No change in CWHR Veg Type, Size or Density Classes in most cases
	25-50	No change in CWHR Veg Type or Size but CWHR Density D/M →P, P→S
	50-75	No change in CWHR Veg Type or Size Class but CWHR Density D/M/P →S
	75-90	Change Veg Type to MCP, CWHR Size → 1 and Density to "null"
	90-100	Change Veg Type to MCP, CWHR Size → 1 and Density to "null"
MCP, WTM, AGS, BAR, URB, CRC, LAR, MCH, PGS, RIV	0-100	No Change in Veg Type or Size Class density (because these types often don't have size class or density associated with them)
MRI, MHW, ASP, BOP, BOW	0-25	No Change in CWHR Veg Type, Size or Density Classes
	25-50	No change in Veg Type or Size but CWHR Density D/M →P, P stays P and S stays S
	50-75	No change in CWHR Veg Type or Size Class but CWHR Density D →P and M/P→S
	75-100	No change in CWHR Veg Type but change Size and Density Classes to 1 and "null" respectively

SMC=SIERRAN MIXED CONIFER; **DFR**=DOUGLAS-FIR**;** **WFR**=WHITE FIR; **RFR**=RED FIR; **PPN**=PONDEROSA PINE; **JPN**=JEFFREY PINE; **LPN**=LODGEPOLE PINE; **MHC**=MONTANE HARDWOOD-CONIFER; **SCN**=SUBALPINE CONIFER; **MCP**=MONTANE CHAPARRAL; **WTM**=WET MEADOW; **AGS**=ANNUAL GRASS; **CRC**=CHAMISE-REDSHANK CHAPARRAL; **MCH**=MONTANE CHAPARRAL; **PGS**=PERENNIAL GRASSLAND; **MRI**=MONTANE RIPARIAN; **MHW**=MONTANE HARDWOOD; **ASP**=ASPEN; **BOP**=BLUE OAK-DIGGER PINE; **BOW**=BLUE OAK WOODLAND

TREE DIAMETER DISTRIBUTION

The discussion regarding tree diameter distribution within the Rim Recovery project area focuses on conifer stands. While some hazard tree removal may occur in non-forest and hardwood forest vegetation types, the vast majority of salvage will occur in vegetation typed as late to mid seral conifer and mixed conifer/hardwood forest.

TABLE 5 AVERAGE TREES AND BASAL AREA PER ACRE BY DIAMETER CLASS IN CONIFER STANDS

DBH Class (inches)	**Average Trees Per Acre**	**Average Basal Area per Acre**
0-15.9	345	69
16-19.9	18	30.8
20-29.9	17	54
30+	5	40.1
Total	385	193.9

Prior to the fire, most of the stands in the Rim Recovery analysis area were dominated by smaller trees with TPA ranging from approximately 145-644 in the 0-15.9"size class and total average TPA ranging from about 171-714 for individual project areas examined. On average, there were fewer trees per acre in the larger size classes than in the smaller size classes. Stands within the project area prior to the Rim Fire, ranged from about 92-331 square feet of basal area per acre.

Post Rim Fire

Fire Severity

The fire severity that resulted from the Rim Fire burned a mosaic across the fire area (Figure 2). Some areas burned at extremely high intensity (Figure 3), resulting in 75-100 percent basal area mortality, while other areas burned at very low fire severity. The varying degrees in burn severity and basal area mortality could be attributed to many reasons. The timing of burning with topography, aspect, weather, vegetation type, stand density and firefighting resources could account for the heterogeneous burn.

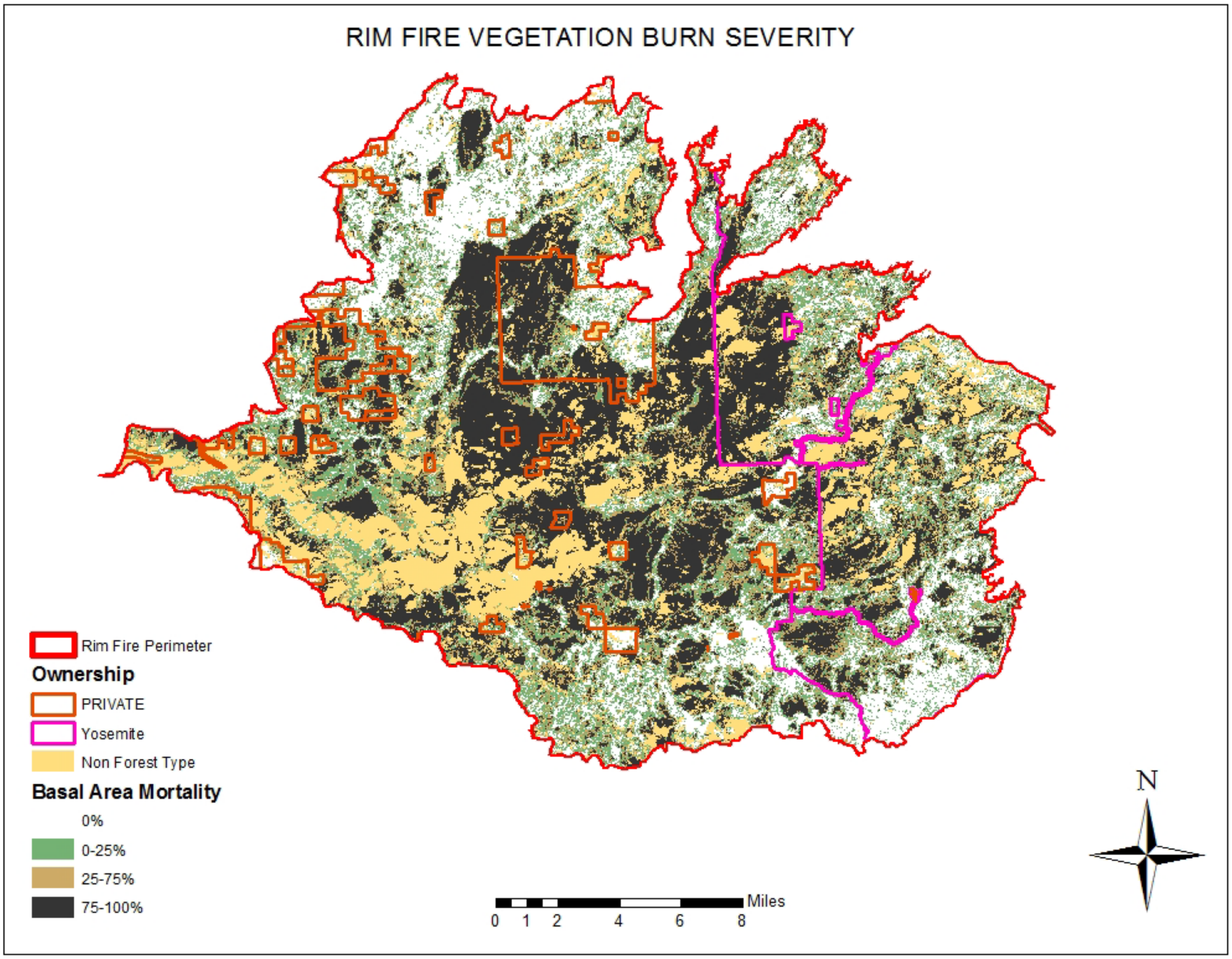

FIGURE 2 FIRE SEVERITY IN THE FIRE PERIMETER FROM THE RIM FIRE

FIGURE 3 PHOTOGRAPH OF HIGH SEVERITY FIRE EFFECTS IN A CONIFER STAND IN THE VICINITY OF CLAVEY RIVER

Table 6 displays the acres of CWHR classes that burned by fire severity in terms of basal area mortality. Fire severities for non-forest vegetation types are not displayed.

TABLE 6 ACRES OF FOREST AND DENSITY CLASSES THAT BURNED IN THE RIM FIRE ON NATIONAL FOREST SYSTEM LANDS

Density and Forest Class	Percent Basal Area Mortality (acres)				
	0	0-25	25-75	75-100	Grand Total
D					
Conifer	18,680	9,277	5,223	14,689	47,870
Hardwood	1,350	2,926	2,225	6,910	13,411
Mixed	4,274	5,422	3,511	9,775	22,982
Total	**24,305**	**17,624**	**10,960**	**31,374**	**84,263**
M					
Conifer	2,296	3,198	2,002	4,039	11,535
Hardwood	319	1,054	977	2,693	5,043
Mixed	257	804	652	1336	3,049
Total	**2,872**	**5,056**	**3,631**	**8,068**	**19,627**
P					
Conifer	851	1,391	873	1,316	4,431
Hardwood	219	690	650	1,044	2,604
Mixed	131	335	245	419	1,131
Total	**1,202**	**2,416**	**1,768**	**2,779**	**8,165**
S					
Conifer	496	1,061	947	1,992	4,497
Hardwood	114	354	256	226	950
Mixed	63	154	125	171	513
Total	**674**	**1,569**	**1,328**	**2,389**	**5,960**
X					
Plantation	780	1,392	1,215	3,910	7,296
Grand Total	**31,676**	**32,554**	**23,573**	**67,153**	**154,956**

The Rim Fire altered CWHR classifications for both size and density. The areas that burned low to moderate versus areas that burned moderately high to high severity show large differences in live trees after the Rim Fire. Areas that burned at lower fire severity have higher residual TPA overall, but especially in the lower diameter classes compared with areas that burned at higher severity. Areas that burned at higher fire severity show a much larger reduction in live TPA overall and moderately high to high severity areas have an almost 100 percent reduction in live trees as a result of the Rim Fire. Areas that burned at moderately high to high severity are considered "under-stocked" as a result of the Rim Fire. In other words, the majority of live trees were killed, live trees are no longer occupying available growing space, and stand productivity is at its lowest potential.

Despite some limitations in the ability to infer landscape fire effects, there are numerous studies documenting the historical occurrence of frequent, low-severity fires in mixed-conifer forests throughout the Sierra Nevada and which suggest that historical forests had a low incidence of high-severity, or stand-replacing fire (Beaty and Taylor 2008; North et al. 2005, 2009b; Scholl and Taylor 2010; Skinner and Chang 1996; Stephens 2001; Stephens and Collins 2004; Taylor and Beaty 2005, as cited in PSW-GTR-237 (North, 2012). Pine dominated forest types historically had a relatively small high severity patch size of less than 25 acres and occupied 10 percent of the fire area (Kane et al. 2013; Safford 2013; Mallek et al. 2013;) while fir dominated forests with functioning fire processes have more high severity patches with most less than 25 acres and 1 one or 2 two patches greater than 120 acres (Collins and Stephens 2010, Kane et al. 2013).

In an examination of fires occurring in the upper elevation, mixed-conifer forests of the Illilouette Basin, Collins and Stephens (2010) concluded that stand-replacing fire is a component of Sierra Nevada mixed-conifer forests (at least in upper elevation mixed conifer similar to the Illilouette area), but at relatively low proportions across the landscape (15 percent or less) with the distribution of stand-replacing patches consisting of many small patches and few large patches. Median stand-replacing patch size examined was 5.4 acres and the largest stand-replacing patches in the Illilouette Basin 200 to 220 ac were an order of magnitude or more below those that occurred in recent northern Sierra Nevada wildfires (Antelope Complex and Moonlight Fire; 2,500 to 6,200 acres).

According to an analysis of final initial fire severity map put out by RAVG using Fragstats analysis, the proportion of the Rim Fire that resulted in high severity fire effects totals about 36% of the landscape, with 1910 patches of areas that burned at high severity and mean patch size of approximately 8,549 acres. The largest patch of high severity fire occupies approximately 20% of the landscape and is 17,378 acres larger than the smallest patch of high severity fire (Estes per comm, 2014). Regeneration of this landscape is therefore expected to be influenced by the uncharacteristically severe nature of this fire.

The ability of forests to regenerate after stand replacing fire is highly dependent on seed sources. Larger patches can create openings larger than available seed from neighboring surviving conifers can reach (Bonnet 2005). Areas that have experienced high severity fire has been shown to have dramatically lower regeneration rates for conifers and especially for pines compared to areas burned at moderate or low severity (Crotteau et al. 2013,). Crotteau et al. (2013) did not sample distance to seed source, but concluded that because seed trees were rare in their observation of high severity fire patches, this was a factor in their finding that fire severity impacted regeneration. Although post-fire seedling establishment is driven by a series of factors (e.g., available moisture, soil insolation, rodent herbivory, damping-off fungi) the foremost requirement for most natural conifer regeneration is a seed source (Bonnet et al. 2005). It is likely that conifer regeneration densities in the low and moderate severity burns would be highest due to nearby remnant mature, seed-bearing trees. In addition to seed production, the remnant overstory in low and moderate severity burns produce high shade, a factor which may limit shrub competition, further permitting high densities of seedlings to establish (Smith et al. 1997). Uncharacteristically large high severity patches, on the other hand, have such poor overstory survival that distance to seed source becomes a limiting factor (Bonnet et al. 2005). High-severity burns may be less likely to naturally reforest if the scale is sufficient to preclude seed-tree adjacency (Turner et al. 1994; Sessions et al. 2004). While some studies have not been able to associate tree regeneration patters in stand replacing patches with patch characteristics (size, perimeter-to-area ratio, or distance to edge) seedling regeneration and especially pine regeneration are reduced in patches of high severity fire (Collins and Roller, 2013). Based on the current scientific information and previous experience it is expected and this analysis assumes that while some regeneration is likely to occur in the 111,732 acres of the Rim Fire that resulted in substantial loss of vegetative cover due to moderate to high soil burn severity, regeneration of conifers and especially of pine in the area classified as high severity will be limited compared to other areas of the fire that burned at lower intensity.

Some areas may induce a reversion from forests back to shrub fields that were present under earlier fire regimes that existed under previous climatic condition (Beaty and Taylor 2008; Nagel and Taylor 2005). Severe fire may also induce type conversions that may not have occurred had the forest been in a more resilient condition (Skinner and Taylor 2006).

The percent of grasses, forbs and brush that establish within in the Rim Fire is expected to increase in the areas that burned at higher fire severity. In areas where shrub development is rapid, shade tolerant trees and brush will likely be the dominant vegetation types into the future. Tall shrubs tend to create a competitive environment that favors shade tolerant conifer species, such as white fir and incense cedar. These species can persist in a shrub understory until eventually overtopping the shrubs. Shade intolerant species, such as ponderosa pine, and partially shade intolerant species, such as sugar pine, are also capable of seeding into sites at the stand initiation phase but competition with shrubs can create an unfavorable environment (Gray et al. 2005; Plamboeck et al. 2008).

Environmental Consequences

The environmental consequences section of this report aims to look at direct, indirect and cumulative effects of the Proposed Action (Alternative 1), the No-Action (Alternative 2), and alternatives to the Proposed Action for the Rim Recovery project. The discussion of effects for forest vegetation is displayed in terms of the measurement indicators described earlier.

Direct effects on forest vegetation are caused by the proposed treatments and occur at the same time and place. Indirect effects are caused by an action and occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may occur as a result of lack of action (e.g., Alternative 2). Direct effects would likely be limited to the project implementation phase. Indirect effects would last beyond the implementation period and occur within the temporal bound of the cumulative effect analysis as described above under “Geographic and Temporal Bounds”.

To understand the contribution of past actions to the cumulative effects of the Proposed Action, No Action Alternative and any alternatives to the Proposed Action, this analysis relies on current environmental conditions as a proxy for the impacts of past actions. Existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. Focusing on individual actions would be less accurate than looking at existing conditions because there is limited information on the environmental impacts of individual past actions and it is not reasonably possible to identify each and every action over the last century that has contributed to current conditions. Using current conditions as a proxy for past actions ensures consideration of all the residual effects of past human actions and natural events, regardless of which particular action or event contributed those effects. The Council on Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions" (CEQ 2005).

Cumulative Effects Common to All Alternatives

Past Projects

The cumulative effects of past management practices combined with fire exclusion and high-mortality fires have largely shaped forest structure. On public and private lands, past harvest activities until fairly recently focused on either removal of dominant and co-dominant trees with retention of biomass and on even-aged management. Fuels reduction activities on National Forest System lands had been implemented in some areas of the Rim Fire perimeter prior to the fire, but many areas remained untreated for the last several decades or longer. Overall, past harvesting which focused on removal of live dominant and co-dominant trees, retention of biomass and no treatment of surface fuels combined with completely untreated reserve areas likely contributed to high severity fire patches of fire in the analysis area.

Commercial thinning from below and removal of biomass, with and without prescribed fire, has been the principal silvicultural treatment implemented on public lands in the analysis area since the mid-1990's. Silvicultural treatments were used to establish several fuel treatment areas within the analysis area (Rim Truck Fuel Break, Peach Growers, and Bear Mountain Thinning). These areas were treated to protect communities, summer home tracts, and to maintain desired conditions in terms of potential fire behavior and tree mortality. The Rim Truck Fuel Break treatment (completed 2012) was designed to protect the communities of Pine Mountain Lake, Groveland, and Big Oak Flat from wildfire coming out of the Tuolumne River drainage to the north of these communities. Peach Growers was a 742 acre project surrounding a summer home tract. Bear Mountain Fuels Treatment included 1,813 acres of mechanical treatments which included lop and scatter and thinning from below with some follow up burning. Today, most of these treated areas typically have many live trees, some newly created snags and surface fuels composed primarily of litter fall from scorched or dead trees. Overall, past fuel treatments contributed to patches of lower fire severity within the analysis area.

Wildfire Suppression and Fire line and Burned Area Emergency Rehabilitation (BAER) Efforts

Suppression tactics taken during the Rim Fire affected forest vegetation and fuels. The tactics included air drops of water and retardant, back burning, construction of control lines by bulldozers and hand crews, live and dead tree falling and construction of staging areas, safety zones, escape routes and drop points. These suppression tactics altered forest vegetation largely through removal of vegetation and/or fuel accumulations or re-arrangement of fuels.

Fire line and BAER rehabilitation efforts were implemented to reduce negative effects of these activities within the fire areas. Fire suppression rehabilitation activities include stabilizing roads, helispots, safety zones and water sources; applying erosion control measures such as water bar construction to dozer and hand lines; pulling vegetative debris back onto control lines; and removing debris deposited in stream channels. These treatments within the analysis area are localized and dispersed across the landscape and have negligible to no measurable effects on forest vegetation. Mulch dropped in blocks during BAER efforts could help facilitate recovery of herbaceous vegetation in some areas of the fire through retention of moisture.

Current and Future Projects

A complete list of current and future projects within the Rim Recovery project area is included in the project record. For this analysis, projects that are likely to affect vegetation within the project area are described and analyzed in detail.

Wood cutting activities may occur within the fire perimeter. Wood cutters will most likely remove dead and down material that are not removed during implementation. Wood cutters are likely to remove dead trees and material along roads, but the effects would be highly dispersed within the project area and limited to approximately 3 years, as the quality of the firewood deteriorates over time.

Projects such as transportation management, aspen release, meadow restoration, weed eradication and green tree thinning are not expected to alter CWHR or forest type to the levels that the Rim Fire itself did or fire salvage will. Therefore, the cumulative effects analysis for vegetation focuses on activities associated with the Rim Fire.

Roadside Safety Projects

The Rim Burned-Area Report (USDA 2013) states that there is a potential for roadside hazard trees threatening the life and safety of road users, obstructing of roadway drainage courses and denying road access. The Rim Fire Hazard Tree project addresses immediate hazards to commonly used routes (Forest System Level 3, 4, and 5 roads) within the project area. The total amount of area proposed in that project is 10,315 acres. Under this project, hazards trees are planned for removal resulting in a reduction of standing snags near major roadways. Effects from the removal of hazard trees with this project are expected to be localized and restricted to roadsides, totaling approximately 7 percent of NFS lands within the fire perimeter with the activities dispersed across analysis area. This calculation represents the maximum extent of measurable effects on forest vegetation that would occur as a result of implementing the project. Due to the limited and dispersed nature of these effects, these activities would not substantially affect forest vegetation on the stand or landscape level.

Post-fire Salvage and Reforestation on Private timberlands

Salvage logging has been implemented on most of privately owned lands resulting in a reduction in densities of fire-killed and fire-injured trees. It is reasonably assumed based on state forest practice regulations and private timber practices that these areas are to be re-planted and managed for maximizing tree growth.

Alternative 1

Direct and Indirect Effects

Harvest treatment effects include the potential for damage to residual trees and incidental removal of live trees. The construction of skid-trails, landings and temporary roads to facilitate logging operations and the creation of activity-generated slash are other associated activities with salvage timber harvest. All harvest operations including the use and construction of skid trails, landings and temporary roads would adhere to the standards and guidelines set forth in the timber sale administration handbook (FSH 2409.15 including Region 5 supplements) and the Best Management Practices (BMPs) as delineated in the Water Quality Management for Forest System Lands in California. The term skid zone is being used in situations where landings for units harvested using ground-based equipment are not located either within or adjacent to the units. The skid zone encompasses an area that skidding equipment would traverse to take logs from the unit to the landing, using specific skid trail patterns that will be determined during harvest operations by a FS timber sale administrator. The intent is to identify areas outside units that need to be surveyed and assessed for potential impacts due to treatment activities. Construction of skid trails, landings and temporary roads would require incidental removal of trees beyond those described for silvicultural purposes. This may include incidental removal of live trees for operability. The removal of trees for operability would be an incidental component of harvesting activities, of minimal size and scale and highly dispersed, and would therefore have negligible effects on forest vegetation. More detailed effects to forest vegetation from hazard tree and salvage logging are discussed further below.

Road construction and reconstruction, and rock quarry work would remove vegetation within and along the quarry and road edges. While site specific effects to vegetation would occur in these areas, the extent of impacts to vegetation is not expected to be measurable outside this zone of influence. Therefore, road work and rock quarry work will not be discussed further.

Mastication of vegetation and piling of vegetation would primarily affect arrangement of surface fuels. Some crushing of resprouting brush, residual tree damage, and damage to advanced regeneration may occur during these activities; however, effects to vegetation are expected to be minimal and short term with these activities. Pile burning may result in some damage and additional mortality of residual trees depending on pile location and heat generated during pile burning. Any damage or additional mortality resulting from pile burning is expected to be minimal.

Subsoiling has the potential to damage roots growing beneath the skid trail where the subsoiling occurs. Effects would be limited to individual trees. Many would be expected to recover from this damage within a few years of subsoiling. Any damage or mortality resulting from subsoiling would be expected to be localized and minimal.

Application of a registered borate compound to freshly cut stumps greater than 14 inches in diameter would provide a barrier to inoculation of stumps with annosum root disease (*Heterobasidion annosum)* (Martin MacKenzie, Forest Health Protection, personal communication). This would reduce the potential for further annosum related mortality in residual live trees within the fire perimeter where trees are not currently affected with the fungus. The risk assessment for human health and safety of this fungicide application is included in this report as Appendix A.

Roadside Hazard Tree Removal

The roadside hazard tree removal as implemented through the marking guidelines would result in reduced snags and green trees with defects within striking distance of roads and facilities. It would also reduce the amount of fire-injured trees that would likely die resulting in reduced snag recruitment within striking distance of roads and facilities.

TABLE 7 ROADSIDE HAZARD ACRES BY FIRE SEVERITY (BASAL AREA MORTALITY) FOR ALTERNATIVE 1

Fire Severity						Total Acres
0% Severity		Low to moderate Severity (1 to 75%)		Moderately high severity (75% and above)		
Acres	Percentage	Acres	Percentage	Acres	Percentage	
5,873	36	6,264	38	4,178	26	16,315

The number of trees per acre actually designated for removal will vary greatly depending on the site, vegetation type, and fire severity. Roadside hazard removal with this project would impact approximately 10 percent of NFS lands within the Rim Fire perimeter.

Based upon timber cruise data from the Rim Fire HT project, an average of about 21 hazard trees per acre will be removed along Level 3, 4, and 5. Similar removal levels are expected on roads with this project in the moderate to high severity burned areas. Lighter removals would be expected in unburned areas and areas with low severity fire effects.

Salvage Timber Harvest

Alternative 1 proposes to economically recover fire-killed trees through salvage on 28,326 acres (Table 8). Salvage timber harvest treatments involve harvesting using ground-based, skyline, and helicopter harvest systems. Additionally biomass removal of trees 4-16 inches dbh is proposed to reduce fuels and improve wildlife habitat in some areas.

Damage to residual trees and vegetation may occur during harvesting operations including damage to stems, bark scraping, wrenched stems, broken branches, broken tops and crushed foliage (McIver et al. 2003). These effects are typical in logging operations, but care would be taken to minimize the potential for damage to residual live trees and snags identified to be left for wildlife purposes. The Forest Service would inspect timber sales during harvesting to ensure that damage to residual trees and vegetation is within reasonable tolerances.

Damage and/or mortality of natural regeneration may occur during harvesting operations, particularly during ground-based harvesting operations (Donato et al. 2006). Areas where the risk of seedling damage and/or mortality is greatest would be within or near skid trails and landings.

In general, dead trees would be removed during salvage harvest; however, retention of snags and down logs would be provided through specified retention areas within the project area. Incidental removal of snags may occur for operability and safety. The snags to be retained would receive preference in locations where operability and safety are not anticipated to be issues. Snags within falling distances of roads, landings and heavily used public areas would receive preference for removal.

Fire Severity

TABLE 8 SALVAGE UNITS ACRES BY FIRE SEVERITY FOR ALTERNATIVE 1

Fire Severity						Total Acres
0% Severity		Low to moderate Severity (1 to 75%)		Moderately high severity (75% and above)		
Acres	Percentage	Acres	Percentage	Acres	Percentage	
1,486	5	8,014	28	18,826	67	28,326

Alternative 1 proposes to salvage approximately 18 percent of NFS lands within the fire perimeter and 47 percent (17,682 acres) of conifer/mixed hardwood conifer forests within NFS lands that burned at moderately high to high (75 to 100 percent basal area mortality) severity.

CWHR

Although many of the stands within the Rim Fire are now non-forested, many structural components of these stands prior to the fire may still remain. Table 9 shows CWHR distribution for all cover types prior to the Rim Fire in low to moderate and moderately high to high severity areas of the fire in relation to how much Alternative 1 proposes to treat. CWHR size class 4 and 5, density M and D represented mid to late seral, closed canopy forest.

TABLE 9 ACRES OF TREATMENT BY CWHR TYPE AND BURN SEVERITY FOR ALTERNATIVE 1

CWHR Size-Density Classes	Low to Moderate Severity (1-75percent basal area mortality)		High Severity (75-100 percent basal area mortality)	
	Salvage Units (acres)	Roadside Hazard Tree Units (acres)	Salvage Units (acres)	Roadside Hazard Tree Units (acres)
0	67	106	98	189
1	117	359	647	451
2	289	925	238	630

CWHR Size-Density Classes	Low to Moderate Severity (1-75percent basal area mortality)		High Severity (75-100 percent basal area mortality)	
	Salvage Units (acres)	Roadside Hazard Tree Units (acres)	Salvage Units (acres)	Roadside Hazard Tree Units (acres)
3D	104	312	560	260
3M	209	378	559	333
3P	66	249	90	128
3S	7	38	6	25
4D	4,343	2,130	11,274	756
4M	768	564	1,249	204
4P	113	83	91	21
4S	15	18	20	17
5D	1,669	406	3,249	113
5M	20	7	6	0
5P	2	0	<1	0
5S	0	0	0	0
Not Classified	226	689	740	1,049

Trees Diameter Distribution

The Rim Fire killed vegetation and changed the relative distribution of live and dead trees in terms of their size classes and densities. Alternative 1 proposes to remove dead trees in the form of a forest product (saw log) and through biomass and mastication. Direct and indirect effects of Alternative 1 include removing most, but not all, trees that have no visible green needles.

The overall effect of salvage is a general reduction in the number and basal area of sound ("hard") snags within the project area. Snag retention areas would have dead tree distributions resembling "existing" conditions with a snag density of approximately 40 per acre greater than 16 inches dbh. Within the first 10 years, the majority of snags are predicted to fall to the ground (Chambers and Mast 2005; Russell 2006; Ritchie et al. 2013).

Cumulative Effects

Current and proposed fire recovery projects on both public and private lands are considered within the analysis area. Areas that would remain untreated would allow for burned forest habitat to be maintained where there is less safety hazard posed to the public. Large down woody debris recruitment would continue within these areas as snags fall to the ground. New vegetation will most likely take the form of either conifer or brush species such as *Arctostaphylosm sp.* or *Ceanothus sp.* Most conifers can effectively disperse viable seeds and naturally regenerate areas within one and a half to two tree heights from the seed source (McDonald 1983).

CWHR and Fire Severity

Table 10 indicates how conifer and hardwood forests and non-forest vegetation types that burned during the fire are affected by the other projects proposed within the fire perimeter.

TABLE 10 ACRES OF AFFECTED VEGETATION TYPES BY BURN SEVERITY BY ALL VEGETATION TREATMENT PROJECTS ONGOING AND PROPOSED IN ALTERNATIVE 1 WITHIN THE FIRE PERIMETER.

Vegetation Type	Project	Fire Severity		Total**
		Low-Mod High (1 – 75%)	Mod High-High (75%+)	
Conifer*	Proposed Action	12,730	20,399	39,502
	Rim Hazard Tree EA	2,568	3,081	8,043
	National Park Service Hazard Tree	230	37	620
	Salvage Non National Forest System Lands	5,100	7,207	16,125
Hardwood	Proposed Action	633	815	1600
	Rim Hazard Tree EA	224	441	725
	National Park Service Hazard Tree	55	8	91
	Salvage Non National Forest System Lands	164	375	586
Non-Forest	Proposed Action	1,817	1,790	2,916
	Rim Hazard Tree EA	372	786	1,549
	National Park Service Hazard Tree	23	9	105
	Salvage Non National Forest System Lands	434	696	1,698

*Mixed conifer/hardwood forest for the purposes of this analysis is included under conifer forest type.

** includes areas within the fire perimeter that did not burn during the Rim Fire.

In all, Alternative 1 would treat almost 28 percent of NFS lands within the Rim Fire perimeter, leaving over 70 percent untreated.

The vegetation type most affected by all of the activities is conifer forests. Within the conifer stands that burned at moderately high to high fire severity, there is a wide range of stand attributes that should be considered. CWHR stands 4M, 4D, 5M, 5D, and 6 usually have stand features such as density and size class that take a long time to develop compared to 1, 2, and 3; higher severity fires can affect these attributes. Within the fire perimeter about 149,451 acres of conifer forest and mixed conifer hardwood forest in CWHR size 4 and 5 burned overall. Of those acres, approximately 43,538 acres with a CWHR density M or D experienced moderately high to high fire severity effects.

Alternative 1 proposes to salvage approximately 30 percent of the CWHR size class 4 and 5, M and D density on National Forest System lands within the Rim Fire. Overall, Alternative 1 affects approximately 38 percent (16,507 acres) of conifer and mixed conifer hardwood stands, CWHR size class 4 and 5, M and D that burned at moderately high to high fire severity within the fire perimeter. Combined with other salvage and hazard tree projects within the fire perimeter 46 percent of the conifer and mixed conifer/hardwood 4 and 5, M and D CWHR types within the fire perimeter would be impacted, and 53 percent of conifer and mixed conifer/hardwood 4 and 5, M and D CWHR type that burned at moderately high to high severity would be impacted.

Untreated areas within the Rim Fire will undergo “natural” processes including post-fire snag recruitment, down wood recruitment and brush and conifer regeneration (Lindenmayer et al. 2004; Letter to Congress 2006). On a landscape level, nearly as much 4 and 5 M and D will not be treated as will be treated under Alternative 1, leading to increased heterogeneity.

Alternative 2

Direct and Indirect

Under Alternative 2, none of the proposed activities in Alternative 1 would take place. However, this does not imply that the current condition will remain static. In fact, no-action simply implies that natural processes will be allowed to occur, whether they are desirable or not.

Existing stand conditions would persist and develop unaltered by active management. Standing snags would persist and the site would be rapidly colonized by grasses, forbs and shrubs within three to five years (Gray et al. 2005; Hogg and Wein 2005; Moghaddas et al. 2008). It is a reasonable expectation that the site would develop comparable to that of similar local fires that burned in the recent past where salvage did not occur including areas of the Fred's and Power Fires (2005) on the Eldorado National Forest and the 2009 Knight fire on the Stanislaus National Forest. On these sites, grasses and shrubs such as Ceanothus (*C. cordulatus, C. intergermis*) and Manzanita (*Arctostaphylos patula*) species have occupied among snags in the high severity burn areas. Under Alternative 2 accessibility would limit future forest management activities (including cultural treatments to enhance survival and growth of natural regeneration) due to the high cost and safety concerns.

Trees Diameter Distribution and Basal Area

There would be no post-fire management activities proposed under Alternative 2. It is expected that tree distribution throughout all of the diameter ranges, as well as basal area, in areas of moderately high to high fire severity would remain low for many decades.

Although there are many existing snags in the project area, many are expected to be down within the first ten years after the fire within higher severity burned areas. Ritchie et al. (2013) found that after the Cone Fire, 80 percent of the basal area of standing dead trees was on the ground after 8 years.

An increase in burned snag fall rate after three to seven years with the predicted falling of standing dead trees in moderately high to high fire severity areas is cause for safety concerns. Existing conditions along Level 2 traveled roadways within the Rim Fire perimeter would persist and are predicted to alter roadways and create an unsafe environment for forest users, contractors and Forest Service employees. Alternative 2 poses a serious threat to all persons using the forest in any capacity. In addition, as dead trees come down, they become down woody debris and potential surface fuels. Most of the recruitment of dead trees in the low to moderate severity areas is expected to come from the lower diameter limits while larger trees are likely to be more common in the areas of higher fire severity.

Cumulative Effects

Under the No Action Alternative, the harvesting of fire-killed and fire-injured trees on NFS lands would be limited to the roadside hazard projects currently planned under the Rim Fire Hazard Tree project. This would provide for safe travel along Level 3, 4, and 5 System Roads within the project area; however, due to the scale and scope of the project, many road segments of untreated burned areas would exist.

Under Alternative 2, no economic recovery would occur through fire salvage. Cumulatively, under other projects proposed in the project area, less than 7 percent of NFS lands within the Rim Fire project area would be subject to timber harvesting under other completed, current or proposed projects. Timber harvesting to recover economic value of fire-killed trees would not occur on 93 percent of NFS lands in the analysis area. Areas proposed for treatment under Alternative 1 would remain untreated and would assume a passive management strategy (no action). Within the fire perimeter other salvage and hazard tree projects would treat approximately 7 percent of the area.

Stand conditions within the Rim Fire perimeter prior to the fire were heavily influenced by mining, historic harvest practices, and fire suppression. This resulted in conditions that along with weather lead to Rim Fire. Over time, the no action alternative would again lead to higher fuel loads from brush and dead and downed trees which are likely to perpetuate future fires in this area such as the Early and Pilot fires followed by the Rim Fire and the 1987 Complex Fire followed by the Rogge Fire. Increased surface fuels would result in increased flame lengths leading to increased mortality of residual live trees and naturally regenerated conifers. Future fires would further limit availability of natural seed sources; thus, resulting in an even lower likelihood of burned areas naturally regenerating into forest cover types. Some fires, both human and lighting caused, would likely continue to escape initial attack in severe fire weather conditions over the next 20-30 years. Standing snags pose serious safety threats to firefighting personnel and heavy large ground fuels overgrown by brush limit firefighting tactics available to suppression forces. For further discussion regarding future potential fire behavior see the Fire and Fuels Report.

Alternative 3

Direct and Indirect Effects

Tree falling and roadside hazard tree removal along Level 2 roads in Alternative 3 will be reduced compared to Alternative 1; however, the area of biomass removal for fuels reduction and wildlife habitat improvement would be increased. Where activities are the same as Alternative 1 activities would result in similar effects to those described in Alternative 1. Where activities do not occur with this alternative, effects are expected to be similar to those described in Alternative 2.

Roadside Hazard Tree Removal

Roadside hazard tree removal proposed in Alternative 3 would be reduced in size from Alternative 1. Removal of hazard trees would result in similar effects as those described for Alternative 1. Roads where hazard trees are not removed would continue to present a risk for members of the public and woods workers in those areas. Likewise, potential for damage to infrastructure from these trees would not be reduced. Hazard tree removal with Alternative 3 would impact less than 10 percent of NFS land in the Rim Fire perimeter.

TABLE 11 ROADSIDE HAZARD BY ACRES OF FIRE SEVERITY (BASAL AREA MORTALITY) FOR ALTERNATIVE 3

Fire Severity						
0% Severity		Low to moderate Severity (1 to 75%)		High severity (75% and above)		Total Acres
Acres	Percentage	Acres	Percentage	Acres	Percentage	
5,768	38	5,943	39	3,542	23	15,253

Salvage Timber Harvest

Alternative 3 would reduce the acres proposed to economically recover fire-killed trees through salvage. Within areas of commercial salvage treatments, additional snags would be left within the fire perimeter through non-treatment of areas and in approximately 1,300 acres with Management Requirements to retain additional snags compared to Alternative 1. Effects of salvage harvest would be the same as described for Alternative 1. While timber would not be removed for economic purposes, deer forage improvement and fuels treatment units are included in the analysis for salvage harvest units.

Fire Severity

TABLE 12 SALVAGE UNITS BY ACRES OF FIRE SEVERITY (BASAL AREA MORTALITY) FOR ALTERNATIVE 3

Fire Severity						
0% Severity		Low to moderate Severity (1 to 75%)		High severity (75% and above)		Total Acres
Acres	Percentage	Acres	Percentage	Acres	Percentage	
1,633	5%	8,500	28%	20,263	67%	30,399

Alternative 3 would impact less than 20 percent of the NFS land within the Rim Fire perimeter with a combination of salvage harvest and biomass removal. Alternative 3 proposes to treat 17,746 acres of conifer and mixed Hardwood Conifer Forests that burned at moderately high to high severity (75 percent or higher basal area mortality) on NFS lands within the Rim Fire perimeter. Alternative 3 would treat 64 less acres of this type compared to Alternative 1. While the total amount of treatment acres of conifer type are reduced additional treatment areas in hardwood and non-forest cover types are identified to improve deer forage and reduce fuel loading.

CWHR

Effects on CWHR with Alternative 3 would be similar to Alternative 1. Alternative 3 proposes additional treatments in all size and density classes except CWHR 4D, 5M, and 5D, which would have treatment reduced from Alternative 1. Alternative 3 proposes salvage on approximately 28 percent of CWHR size class 4 and 5, M and D density on NFS lands within the Rim Fire perimeter, 531 acres less than Alternative 1. Combined with the roadside hazard removal this would impact 32 percent of the 4 and 5, M and D type on NFS lands within the Rim Fire perimeter.

TABLE 13 ACRES OF TREATMENT BY CWHR TYPE AND BURN SEVERITY FOR ALTERNATIVE 3

CWHR	Salvage Units Low to Moderate Severity (1-75% BA Mortality)	Roadside Hazard Tree Units Low to Moderate Severity (1-75% BA Mortality)	Salvage Units High Severity (75-100% BA mortality)	Roadside Hazard Tree Units High Severity (75-100% BA mortality)
0	96	93	157	172
1	148	356	926	360
2	512	881	458	590
3D	152	286	844	192
3M	241	352	679	263
3P	93	229	112	115
3S	17	28	17	23
4D	4,261	2069	10,985	673
4M	778	540	1,274	179
4P	120	74	96	19
4S	15	15	30	12
5D	1621	392	2,996	104
5M	18	6	6	<1
5P	2	0	<1	0
5S	0	<1	0	0
Not Classified	424	621	1,682	837

Tree Diameter Distribution

Changes to TPA and size class distribution within treated units are expected to be similar to Alternative 1.

Cumulative Effects

Cumulative effects are expected to be similar to those described for Alternative 1.

TABLE 14 FIRE SEVERITY BY COVER TYPE FOR ALTERNATIVE 3

Vegetation Type	Fire Severity		Total**
	Low-Mod High (1 – 75%)	Mod High-High (75%+)	
Conifer*	12,803	20,200	39,429
Hardwood	595	1,086	1,829
Non Forested	1,045	2,519	4,394
Total	14,442	23,805	45,652

*Mixed conifer/hardwood forest for the purposes of this analysis is described included under conifer forest type.
** includes areas within the fire perimeter that did not burn during the Rim Fire.

Fire severity by cover type for other projects proposed within the Rim Fire perimeter is displayed in the analysis for Alternative 1.

In all, Alternative 3 would affect 29 percent of the National Forest System lands within the Rim Fire perimeter. Alternative 3 affects approximately 36 percent of conifer and mixed conifer hardwood stands, CWHR 4 and 5, M and D, that burned at moderately high to high fire severity within the fire perimeter, approximately 723 acres fewer than Alternative 1. Combined with other salvage and hazard tree projects within the fire perimeter 40 percent of the conifer and mixed conifer/hardwood 4 and 5, M and D CWHR types within the fire perimeter would be impacted, and 51 percent of conifer and mixed conifer/hardwood 4 and 5, M and D CWHR type that burned at moderately high to high severity would be impacted.

Alternative 4

Direct and Indirect Effects

Alternative 4 would leave more of the fire area untreated compared to Alternative 1. Tree falling and removal of hazard tree falling along Level 2 Forest System Roads in Alternative 4 will be reduced in size to 15,692 acres. Salvage logging of 100 percent dead trees on NFS lands within the perimeter of the Rim Fire would also be reduced in acres. Where activities are the same as Alternative 1 activities would result similar effects to those described in Alternative 1. Where activities do not occur, effects would be similar to those described in Alternative 2

There would be no new road construction and fewer miles of road reconstruction. Road reconstruction activities would result in similar effects to those described for Alternative 1.

Roadside Hazard Tree Removal

Roadside hazard tree removal proposed in Alternative 4 would be reduced in area from the Proposed Action. Removal of hazard trees would result in similar effects as those described for Alternative 1. Roads where hazard trees are not removed would continue to present a risk for members of the public and woods workers in those areas. Likewise, potential for damage to infrastructure from these trees would not be reduced. Roadside hazard tree removal would impact 10 percent of the NFS lands within the Rim Fire perimeter.

TABLE 15 ROADSIDE HAZARD BY ACRES OF FIRE SEVERITY (BASAL AREA MORTALITY) FOR ALTERNATIVE 4

Fire Severity						Total Acres
0% Severity		Low to moderate Severity (1 to 75%)		High severity (75% and above)		
Acres	Percentage	Acres	Percentage	Acres	Percentage	
5,776	37%	6,058	39%	3,859	25%	15,692

SALVAGE TIMBER HARVEST

Alternative 4 would reduce the acres of treatment proposed to economically recover fire-killed trees through salvage harvest. Additional snags would be left within the fire perimeter through non-treatment of areas with Management Requirements to retain additional snags compared to Alternative 1. Effects of salvage harvest would be the same as described for Alternative 1. Effects of areas not treated with Alternative 4 would result in similar effects to those described in Alternative 2.

FIRE SEVERITY

TABLE 16 FIRE SALVAGE BY ACRES OF FIRE SEVERITY (BASAL AREA MORTALITY) FOR ALTERNATIVE 4

Fire Severity						Total Acres
0% Severity		Low to moderate Severity (1 to 75%)		High severity (75% and above)		
Acres	Percentage	Acres	Percentage	Acres	Percentage	
1,516	6	7,830	28	18,481	66	27,826

Alternative 4 would impact less than 18 percent of the NFS lands within the Rim Fire perimeter. Alternative 4 proposes to salvage 16,031 acres of conifer and mixed Hardwood Conifer Forests that burned at moderately high to high (75 percent or higher basal area mortality) severity within the fire perimeter. Alternative 4 would treat 1,651 less acres of this type compared to Alternative 1. While the total amount of treatment acres of conifer type are reduced, additional treatment areas in hardwood and non-forest cover types are identified to improve deer forage and reduce fuel loading.

CWHR

Effects on CWHR with Alternative 4 would be similar to Alternative 1. Alternative 4 proposes reduced treatments in all size and density classes reduced with the most substantial reductions in CWHR 4D, 5M, and 5D compared to Alternative 1. Alternative 4 proposes salvage on approximately 16 percent of CWHR size class 4 and 5, M and D density on NFS lands within the Rim Fire perimeter, approximately 1,774 acres less than Alternative 1. Combined with the roadside hazard removal this would impact 26 percent of the 4 and 5, M and D type NFS lands within the Rim Fire perimeter.

TABLE 17 ACRES OF TREATMENT BY CWHR TYPE AND BURN SEVERITY FOR ALTERNATIVE 4

CWHR	Salvage Units Low to Moderate Severity (1-75% BA Mortality)	Roadside Hazard Tree Units Low to Moderate Severity (1-75% BA Mortality)	Salvage Units High Severity (75-100% BA mortality)	Roadside Hazard Tree Units High Severity (75-100% BA mortality)
0	95	93	141	176
1	144	357	898	366
2	511	881	453	590
3D	151	286	809	197

CWHR	Salvage Units Low to Moderate Severity (1-75% BA Mortality)	Roadside Hazard Tree Units Low to Moderate Severity (1-75% BA Mortality)	Salvage Units High Severity (75-100% BA mortality)	Roadside Hazard Tree Units High Severity (75-100% BA mortality)
3M	215	363	573	296
3P	80	23	87	121
3S	17	28	17	23
4D	3,996	2,094	10,093	799
4M	617	570	1,044	222
4P	84	84	70	23
4S	12	16	27	13
5D	1,496	418	2,632	180
5M	18	7	6	<1
5P	2	0	<1	0
5S	0	<1	0	0
Not Classified	389	626	1,633	851

Tree Diameter Distribution

Changes to TPA and size class distribution within treated units are expected to be similar to Alternative 1.

Cumulative Effects

Cumulative effects are expected to be similar to those described for Alternative 1.

TABLE 18. FIRE SEVERITY BY COVER TYPE FOR ALTERNATIVE 4

Vegetation Type	Fire Severity		Total**
	Low-Mod High (1 – 75%)	Mod High-High (75%+)	
Conifer*	12,280	18,786	37,381
Hardwood	595	1,069	1,812
Non Forested	1,015	2,484	4,322
Total	13,888	22,340	43,515

*Mixed conifer/hardwood forest for the purposes of this analysis is included under conifer forest type.

** includes areas within the fire perimeter that did not burn during the Rim Fire.

Fire severity by cover type for other projects proposed within the Rim Fire Perimeter is displayed in the analysis for Alternative 1. Overall, Alternative 4 would affect 28 percent of the National Forest lands within the Rim Fire perimeter and affects approximately 33 percent of conifer and mixed conifer hardwood stands, CWHR 4 and 5 M and D stands that burned at moderately high to high fire severity within the fire perimeter, approximately 1,965 acres fewer than Alternative 1. Combined with other salvage and hazard tree projects within the fire perimeter 39 percent) of the conifer and mixed conifer/hardwood 4 and 5, M and D CWHR types within the fire perimeter would be impacted, and 48 percent of conifer and mixed conifer/hardwood 4 and 5, M and D CWHR type that burned at moderately high to high severity would be impacted.

COMPLIANCE WITH THE FOREST PLAN AND OTHER DIRECTION

1991 Stanislaus National Forest Land and Resource Management Plan AS AMENDED BY 2004 SIERRA NEVADA FOREST PLAN AMENDMENT

The Rim Recovery project is designed to fulfill the management direction specified in the (SNF LRMP) (USDA 1991), as amended by the Sierra Nevada Forest Plan Amendment (SNFPA) FSEIS and ROD (USDA 2004a, b). Salvage, fuel reduction and vegetation management activities are designed to comply with the standards and guidelines as described in the (USDA 2004a, b).

NATIONAL FOREST MANAGEMENT ACT

The Rim Recovery project would not reduce the proportion of currently forested lands within the Rim Fire perimeter; and therefore, meets the National Forest Management Act (NFMA) of 1976, including its amendments to the Forest and Rangeland Renewable Resources Planning Act of 1974. Evaluation of regeneration needs resulting from the Rim Fire are in process. Based on these evaluations future projects would address the need to maintain forest cover with species of trees, degree of stocking, and rate of growth and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans.

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APPENDIX A- RIM FIRE RECOVERY

SITE SPECIFIC HEALTH AND ECOLOGICAL RISK ASSESSMENT FOR REGISTERED BORATE APPLICATION

INTRODUCTION

The purpose of this analysis is to assess the risks to human health and Forest resources of using the one fungicide proposed for use in the Rim Fire Recover Project. The fungicide active ingredient is sodium tetraborate decahydrate (borax).

DIRECTION FOR PESTICIDE-USE MANAGEMENT AND COORDINATION

Forest Service Manual (FSM) 2150 and Forest Service Handbook (FSH) 2109.14 provide direction to provide for pesticide use safety for public and employees from unsafe work conditions when pesticides are involved. Development of a pesticide risk assessment is part of this planning process. A pesticide risk assessment does not, in itself, ensure safety in pesticide use. The analysis must be tied to an action plan which provides mitigation measures to avoid potential risks identified by the risk assessment.

FSH 2109.14,20 provides direction on the components of a risk analysis, documentation of risk analysis, risk management, risk communication and risk takings.

- Upon completion of a risk analysis, a number of techniques can be used to determine the best course of action for preventing identified problems. These range from taking appropriate mitigation measures to reduce risk, to not taking the proposed action, thus avoiding potential risks.
- Use risk analyses to decide whether, and to what extent, controls on exposure are necessary to protect public health and the environment.
- Managers and decision makers must also recognize the uncertainties associated with risk analyses and incorporate those considerations into their decision making.

COMPLIANCE WITH DIRECTION:

- A risk assessment for the proposed pesticide has been developed for the Forest Service and is incorporated into the pesticide risk assessment for this project.
    - SERA. 2006. Human Health and Ecological Risk Assessment for Borax (Sporax®) – Final Report. February 24, 2006. SERA TR 04-43-21/06-30-02b. Fayetteville, New York. 136 pages
- Forest Service Program Worksheets version 6.00.11 developed for each pesticide proposed for application (Sporax Stump Application at 1 lb a.i. per acre.xlsx) available in the planning record have been used to identify potential areas of higher risk and to document risk analysis.
- Management Requirements have been developed to mitigate risks identified from pesticide application.
- Public participation through the National Environmental Policy Act (NEPA) process has provided a purposeful exchanged of information about health or environmental risks between interested parties.

ANALYSIS OF POTENTIAL EFFECTS TO HUMANS

This risk assessment examines the potential health effects on all groups of people who might be exposed to any of the pesticides that are proposed in this project. Those potentially at risk fall into two groups: workers, and members of the public. Workers include applicators, supervisors, and other personnel directly involved in the application of herbicides. The public includes forest users or nearby residents who could be exposed through the drift of herbicide spray droplets, through contact with sprayed vegetation, or by eating, or placing in the mouth food items or other plant materials, such as berries or shoots growing in or near the forest, by eating game or fish containing to herbicide residues, or by drinking water that contains such residues.

The analysis of the potential human health effects of the use of pesticides was accomplished using the methodology of risk assessment generally accepted by the scientific community (National Research Council 1983, U.S. EPA 1986). In essence, this pesticide risk assessment consists of comparing doses that people may get from applying the pesticide (worker doses) or from being near and application site (public doses) with the U.S. Environmental Protection Agency's (U.S. EPA) established Reference Doses (RfD), a level of exposure that result in no adverse effect over a lifetime or chronic exposures.

Much of the information used in this risk assessment was gathered from the specific risk assessment completed by Syracuse Environmental Research Associates, Inc. (SERA), under contract to the Forest Service. The site specific risk assessment also examines the potential for these treatments to cause synergistic effects, cumulative effects, and effects on sensitive individuals, including women and children. For each type of dose assumed for workers and the public, a hazard quotient (HQ) was computed by dividing the dose by the RfD. In general, if HQ is less than or equal to 1, the risk of effects is considered negligible. Because HQ values are based on RfDs, which are thresholds for cumulative exposure, they consider acute exposures. This aspect is discussed below in the evaluation of possible effects.

One of the primary uses of a risk assessment is risk management. Decision makers can use the risk assessment to identify those pesticides, application methods, or exposure rates that pose the greatest risks to workers and the public. To facilitate this decision-making, acceptable risk levels must be established. EPA has established a significant cancer risk level of 1 chance in a million: the State of California, through Proposition 65, has established a standard of 1 chance in 1 hundred thousand. The RfD is also an EPA-established measure of acceptable risk for non-carcinogen exposures. This assessment uses the standard of 1 chance in 1 million for cancer risk and the RfD for non-carcinogen exposures.

Application rates used in this assessment are shown in Table 1 below. Rates are expressed as active ingredient (ai).

Table 1. Chemical Formulation, Application Rate and Type, and Additives

Pesticide Formulation (trade name)	Expected Application Rate	Application Type
Registered Borate Compound (Sporax or equivalent)	1.0 lbs /acre	Granular Stump Treatment

HAZARD ANALYSIS

A considerable body of information has been compiled in a group of risk assessments completed by SERA (authored by DR. Patrick Durkin, PhD) under contract to the Forest Service. Another source of information for toxicity is the background statements contained in Forest Service Agricultural Handbook No. 633 (USDA 1984). Current peer-reviewed articles from the public scientific literature, as well as recent EPA documents, were also used to update information contained in these reference documents.

The toxicological database for the pesticides was reviewed for acute, sub-chronic, and chronic effects on test animals. Because of the obvious limitations on the testing of chemicals on humans, judgments about the potential hazards of pesticides to humans is necessarily based in large part on the results of toxicity tests on laboratory animals. Where such information is available, information on actual human poisoning incidents and effects on human populations supplement these test results.

Exposure Analysis

Worker Exposure – Pesticide applicators are the individuals most likely to be exposed to a pesticide during the application process. Two types of worker exposure assessments are considered: general and accidental/incidental. The term general exposure assessment is used to designate those exposures that involve estimates of absorbed dose based on the handling of a specific amount of a chemical during specific types of applications. The accidental/incidental exposure scenarios involve specific types of events that could occur during any type of application.

The exposure of workers is based on the number of hours worked per day, acres treated per hour, and the application rates for the various herbicides. Rather than focus on a single value, each of these factors involves a range of values, which when combined created three levels of exposure (typical, lower, and upper). Typical levels are based on recent experience on the Eldorado National Forest. The upper level is a worst-case level, based on the highest application rates, the least dilution and the largest acreage treated per day. The lower level is used as a lower limit, based on lower applications rates, most dilution, and lowest acres per day treated.

Public Exposure – Under normal conditions, members of the general public would not be exposed to substantial levels of this pesticide. Members of the public would generally not be in the areas of maintenance work during pesticide application. In addition, posting signs around treatment areas would provide warning to the public that an area is being or has recently been treated.

A variety of exposure scenarios can be constructed for the general public, depending on various assumptions regarding application rates, dispersion, canopy interception, and human activities. Several conservative scenarios are developed for this risk assessment. The two types of exposure scenarios developed for the general public include acute exposure and longer-term or chronic exposure. All of the acute exposure scenarios are primarily accidental. They assume that an individual is exposed to the compound either during or shortly after its application. Most of these scenarios should be regarded as extreme, some to the point of limited plausibility. The longer-term or chronic exposure scenarios parallel the acute exposure scenarios, but are based on estimated levels of exposure for longer periods after application.

Dose – Response Assessment

In evaluating the doses received under each scenario, the doses are evaluated against the RfDs as previously discussed. If all the exposures are below the RfD (a HQ less than or equal to 1) the assumption is that the herbicide presents little risk of use to either the public or workers. If any exposure exceeds the RfD, a closer examination of various studies and exposure scenarios must be made to determine whether a toxic response is expected from the exposure. The risk assessment describes the RfDs and their bases. For those herbicides scenarios that involve doses exceeding the RfDs, it provides an analysis of various studies and further refines the risk thresholds. Table 2 displays the acute and chronic RfDs used in the risk assessment.

Table 2. Reference doses (RfD) of herbicides and fungicide		
Herbicide	**Reference Dose (mg/kg/day)**	
	Acute	**Chronic**
Borax	0.2	0.2

Risk Characterization

A quantitative summary and narrative description of risks to workers and the public from herbicide exposure is presented in this section. The quantitative risk is expressed as the hazard quotient, which is the ratio of the estimated exposure doses to the RfD.

A caution regarding this and any risk assessment is that absolute safety cannot be proven, and the absence of risk can never be demonstrated. No chemical has been studied for all possible effects, and the use of data from laboratory animals to estimate hazard to humans involves uncertainty.

Workers- Given the low hazard quotients for both general occupational exposures as well as accidental exposures, the results imply that long-term employment applying this fungicide can be accomplished without toxic effects. All worker occupational exposures for the typical, lower and upper application rate result in an HQ of less than 1.

While accidental exposure scenarios are not the most severe one might imagine they are representative of reasonable accidental exposures. For accidental exposure the highest hazard quotient is a factor of over 1300 below the level of concern.

The hazard quotients for general occupational exposure scenarios are somewhat higher than those for the accidental exposure scenarios. Nonetheless, the upper limits of the hazard quotient is below the level of concern (an HQ of greater than 1). As previously discussed, these upper limits of exposure are constructed using the highest anticipated application rate, the highest anticipated number of acres treated per day, and the upper limit of the occupational exposure rate. If any of these conservative assumptions were modified the hazard quotients would drop substantially. The simple verbal interpretation of this quantitative characterization of risk is that even under the most conservative set of exposure assumptions, workers would not be exposed to levels of borax that are regarded as unacceptable.

Table 3: Summary of Worker Exposure Assessments					
Application Rate:					E01-Borax
Scenario	**Receptor**	**mg/kg/day or mg/kg/event**			**Detail Worksheet**
		Central	**Lower**	**Upper**	
Accidental/Incidental Exposures (dose in mg/kg/event)					
Contaminated Gloves, 1 min.	Worker	1.30E-05	5.18E-06	2.88E-05	C02a
Contaminated Gloves, 1 hour	Worker	1.04E-04	4.15E-05	2.30E-04	C02b
Spill on Hands, 1 hour	Worker	Not applicable to granular formulations			
Spill on lower legs, 1 hour	Worker	Not applicable to granular formulations			
General Exposures (mg/kg/day)					
		Standard worker exposure assessments not applicable to stump application method. See Section 3.2.2 of the SERA risk assessment.			

Table 4: Summary of Worker Hazard Quotients (Toxicity)					
Application Rate:					E01-Borax
Scenario	**Receptor**	**Hazard Quotients**			**Toxicity Value**
		Central	**Lower**	**Upper**	
Accidental/Incidental Exposures (dose in mg/kg/event)					
Contaminated Gloves, 1 min.	Worker	6.48E-05	2.59E-05	1.44E-04	**0.2**
Contaminated Gloves, 1 hour	Worker	5.18E-04	2.07E-04	1.15E-03	**0.2**
Spill on Hands, 1 hour	Worker	Not applicable to granular formulations			
Spill on lower legs, 1 hour	Worker	Not applicable to granular formulations			
General Exposures (mg/kg/day)					
		Standard worker exposure assessments not applicable to stump application method. See Section 3.2.2 of SERA risk assessment.			

General Public – Although this fungicide is not applied in residential areas, it is applied in forested areas that may be used by members of the general public, however, because the fungicide would be applied to freshly created stumps during logging of the harvest unit, and because the fungicide would not be applied within in the Riparian Conservation Area (RCA) buffers for tree harvest, or within 10 feet of a water source it is highly unlikely that a member of the public would be exposed to either freshly treated stumps, or water containing the fungicide. All short term and chronic exposure scenarios are well below an HQ of 1.

Table 5: Summary of Exposure Assessments for the General Public					
Application Rate:					E03-Borax
Scenario	**Receptor**	**mg/kg/day or mg/kg/event**			**Detail Worksheet**
		Central	**Lower**	**Upper**	
Acute Exposures (dose in mg/kg/event)					
Direct Consumption from tree stump	Child	8.46E-01	4.23E-01	3.24E+00	D01
Direct Spray of Woman, feet and lower legs	Adult Female	Not applicable to granular formulations.			
Vegetation Contact, shorts and T-shirt	Adult Female	Not applicable to Borax.			
Contaminated Fruit	Adult Female	Not applicable to Borax.			
Contaminated Vegetation	Adult Female	Not applicable to Borax.			
Water consumption, accidental spill	Child	4.77E-02	1.46E-02	1.43E-01	D02
Water consumption, ambient	Child	2.26E-03	2.75E-04	1.13E-02	D03
Fish consumption, accidental spill	Adult Male	Not applicable to Borax.			
Fish consumption, accidental spill	Subsistence Populations	Not applicable to Borax.			

Chronic/Longer Term Exposures (dose in mg/kg/day)					
Contaminate Fruit	Adult Female	Not applicable to Borax.			
Contaminated Vegetation	Adult Female	Not applicable to Borax.			
Water consumption	Adult Male	4.00E-04	4.00E-05	2.40E-03	D04
Fish consumption	Adult Male	Not applicable to Borax.			
Fish consumption	Subsistence Populations	Not applicable to Borax.			

Table 6: Summary of Hazard Quotients (Toxicity) for the General Public					
Application Rate:					E03-Borax
Scenario	**Receptor**	**Hazard Quotients**			**Toxicity Value**
		Central	**Lower**	**Upper**	
Acute Exposures (dose in mg/kg/event)					
Direct Consumption from tree stump	Child	4.23E+00	2.12E+00	1.62E+01	**0.2**
Direct Spray of Woman, feet and lower legs	Adult Female	Not applicable to granular formulations.			
Vegetation Contact, shorts and T-shirt	Adult Female	Not applicable to Borax.			
Contaminated Fruit	Adult Female	Not applicable to Borax.			
Contaminated Vegetation	Adult Female	Not applicable to Borax.			
Water consumption, accidental spill	Child	2.39E-01	7.28E-02	7.16E-01	**0.2**
Water consumption, ambient	Child	1.13E-02	1.38E-03	5.64E-02	**0.2**
Fish consumption, accidental spill	Adult Male	Not applicable to Borax.			
Fish consumption, accidental spill	Subsistence Populations	Not applicable to Borax.			
Chronic/Longer Term Exposures (dose in mg/kg/day)					
Contaminate Fruit	Adult Female	Not applicable to Borax.			
Contaminated Vegetation	Adult Female	Not applicable to Borax.			
Water consumption	Adult Male	2.00E-03	2.00E-04	1.20E-02	**0.2**
Fish consumption	Adult Male	Not applicable to Borax.			
Fish consumption	Subsistence Populations	Not applicable to Borax.			

Sensitive Individuals

The uncertainty factor used in the development of the RfD takes into account much of the variation in human response. The uncertainty factor of 10 for sensitive subgroups is sufficient to ensure that most people will experience no toxic effects. “Sensitive” individuals are those that might respond to lower dose than average, which includes women and children. The National Academy of Sciences report entailed Pesticides in the Diets of Infants and Children (NAS, 1993) found that quantitative differences in toxicity between children and adults are usually less than a factor of approximately 10-fold. An uncertainty factor of 10 may not cover individuals that may be sensitive to herbicides because human susceptibility to toxic substances can vary by two to three orders of magnitude. Factors affecting individual susceptibility include diet, age, heredity, pre-existing disease, and life style. Individual susceptibility to the herbicides proposed in this project cannot be specifically predicted. Unusually sensitive individuals may experience effects even when the HQ is equal or less than 1.

The 1996 Food Quality Protection Act requires that U.S. EPA evaluate an additional 10X safety factor, based on data uncertainty or risks to certain age/sex groupings. The primary targets for boron toxicity are the developing fetus and the testes. Thus, exposure of pregnant women to borate compounds places the developing fetus at risk. Since the oral (chronic) RfD for boron and borates is based on effects (decreased fetal weight) in the developing fetus, risk to this subgroup is assessed. Regarding other sensitive subgroups, males with underlying testicular dysfunction could be at increased risk for boron-induced testicular toxicity. However, no data are available to quantify this risk.

SYNERGISM

The registered borate compound is not applied in combination with other products or additives. In addition, no data are available regarding the effects of boron compounds applied in conjunction with other chemicals. Thus, an assessment of toxicological effects of borax mixed with other chemicals cannot be made. However, no other chemicals are proposed for use in connection with this project.

CUMULATIVE EFFECTS

As noted above, chronic exposure to borax is considered for the exposure scenario of an adult consuming surface water contaminated by runoff. Based on the limited analysis in this risk assessment, as discussed above, there is no indication that repeated exposures will exceed the threshold for toxicity. Sporax is unusual for a pesticide in that the toxicologic agent of concern – i.e., boron – is a naturally occurring compound. Boron is a normal consistent of the earth's crust, all environmental media, as well as all forms of life including humans. Based on estimates of normal background exposures supported by pharmacokinetic analysis, typical exposures to boron are about 0.14 to 0.36 mg/kg/day.

Considering the variability of the estimates of both normal background exposures and estimates of exposure associated with the application of Sporax, Sporax applications lead to exposures that are below those associated with normal background exposures by factors of 13 to 9000. Thus, under proposed application and typical conditions, applications of Sporax in this project will not lead to any substantial increase in exposure.

This is not the case for accidental exposures. For these scenarios, the application of Sporax could approach normal background exposures in the case of an accidental spill. In considering the added exposure to boron associated with the application of Sporax, consideration of the design of the toxicity studies in important. The toxicity studies used to characterize risk quantitatively were all conducted based on the addition of boric acid to the diet (e.g., Heindel et al. 1992, 1994, Price et al. 1996a,b from SERA 2006)). The total exposure of the animals to boron, the agent of concern, involved both the added boric acid as well as background concentrations of boron. Similarly, the reports of human exposures to borax that are used qualitatively modify the risk characterization (i.e., Linden et al. 1986; Wong et al. 1964 from SERA 2006) also involved exposures to boric acid and background concentrations of borax.

The significance of this is evident in a simple comparison of the chronic RfD of 0.2 mg B/kg/day (to normal background levels of exposure – i.e., 0.14 to 0.36 mg/kg/day. Mathematically, these numbers could be used to derive risk quotients of 0.7 to 1.8. Interpreting these risk quotients in a manner to suggest that humans are typically exposed to hazardous or nearly hazardous levels of boron would be a misinterpretation. Many naturally occurring substances such as oxygen and carbon dioxide can be toxic and some of the mechanisms of action – e.g., oxidative damage to tissue and binding of carbon dioxide to hemoglobin – are normal processes in living organisms that cannot be avoided. A more appropriate interpretation of the RfD would be that increase exposure to boron by the amount of the RfD would reach a level of concern. This is the interpretation given in the current risk assessment and is consistent with approach taken by U.S. EPA (1993) in waiving tolerances for boric acid and the salts of boric acid in agricultural commodities.

ANALYSIS OF POTENTIAL ECOLOGICAL EFFECTS

All scenarios for exposure of wildlife resulted in hazard quotients below 1 except the direct consumption of borax from a stump by a large mammal such as a deer at the upper exposure scenario with an HQ of 1.1. As noted in Worksheet G01, this HQ is associated with a dose of about 11.5 mg/kg bw, which is only marginally above the NOAEL of 10.3 mg/kg bw. Borate applied to tree stumps does not appear to have attractant effects for deer and no clinical signs of toxicity have been observed in deer allowed free access to treated stumps (Campbell et al., no date from SERA 2006).

Table 7: Summary of Hazard Quotients (Toxicity) for the Terrestrial Animals						
Application Rate:					G01-Borax	lb a.i./acre
Scenario	**Receptor**	**Hazard Quotients**			**Toxicity Value**	
		Central	**Lower**	**Upper**		
Acute/Accidental Exposures (mg/kg/event)						
Direct Consumption of Borax from Stump						
	Large mammal	3.36E-01	5.55E-02	1.1	**10.3**	NOAEL
	Large Bird	2.52E-02	4.23E-03	8.46E-02	**136**	NOAEL
	Small mammal	1.07E-03	5.44E-04	2.23E-03	**10.3**	NOAEL
	Small Bird	8.09E-05	4.12E-05	1.69E-04	**136**	NOAEL
Contaminated Vegetation						
Fruit	Small Mammal	Not relevant for borax				
Grass	Large Mammal	Not relevant for borax				
Grass	Large Bird	Not relevant for borax				
Contaminated Water						
Accidental spill	Small Mammal	Not relevant for borax				
Expected Peak Conc.	Small Mammal	Not relevant for borax				
Contaminated Insects						
	Small Mammal	Not relevant for borax				
	Small Bird	Not relevant for borax				
Consumption of contaminated Fish						
Accidental spill	Fish-eating bird	Not relevant for borax				
Consumption of contaminated small mammal						
	Carnivorous mammal	Not relevant for borax				
	Carnivorous bird	Not relevant for borax				
Chronic/Longer Term Exposures (dose in mg/kg/day)						

Contaminated Vegetation						
On-site	Small Mammal	Not relevant for borax				
Off-Site		Not relevant for borax				
On-Site	Large Mammal	Not relevant for borax				
Off-Site		Not relevant for borax				
On-Site	Large Bird	Not relevant for borax				
Off-Site		Not relevant for borax				
Contaminated Water						
Water consumption	Small Mammal	1.99E-04	2.84E-05	9.95E-04	**10.3**	NOAEL
Consumption of contaminated Fish						
chronic	Fish-eating bird	Not relevant for borax				

Hazard quotients for acute and chronic exposure of aquatic animals to water contaminated by runoff are all below the level of concern. With the exception of amphibians, all HQs associated with exposure of aquatic animals to water contaminated by an accidental spill are well below the level of concern. For worst-case scenario of the spill of 25 pounds of Sporax into a small pond, the HQ for amphibians of 1.3 only marginally exceeds the level of concern; HQs for spill of 6.25 and 12.5 pounds of Sporax are below the level of concern. Based on the results of this analysis, if large amounts of borax accidentally contaminate surface waters, amphibians may be at risk. However, for all other aquatic animals, there is no indication that adverse effects will occur.

Table 8: Summary of Hazard Quotients for Aquatic Species						
Application Rate:	**1**	**lb a.i./acre**			AqToxSumV6	
Exposures		**Concentrations** (mg/L)				
	Scenario	**Central**	**Lower**	**Upper**	**Worksheet**	
	Accidental Spill	0.63504	0.31752	1.27008	B04b	
	Peak EEC	0.03	0.006	0.1	B04a	
	Chronic	0.014	0.002	0.07	B04a	
Receptor	**Type**	**Hazard Quotients**			**Toxicity Value**	**Toxicity Endpoint**
		Central	**Lower**	**Upper**		
Accidental Acute Exposures						
Fish	Sensitive	3E-03	1E-03	5E-03	**233**	LC50
	Tolerant	6E-04	3E-04	1E-03	**1100**	>LC50
Amphibian	Sensitive	0.6	0.3	**1.3**	**1**	NOEC
	Tolerant	0.6	0.3	**1.3**	**1**	NOEC
Invertebrate	Sensitive	5E-03	2E-03	1E-02	**133**	LC50
	Tolerant	5E-04	2E-04	9E-04	**1376**	LC50
Macrophyte	Sensitive	0.1	6E-02	0.3	**5**	NOEC
	Tolerant	6E-02	3E-02	0.1	**10**	NOEC
Algae	Sensitive	6E-02	3E-02	0.1	**10**	NOEC
	Tolerant	3E-02	2E-02	6E-02	**20.3**	NOEC
Non-Accidental Acute Exposures						
Fish	Sensitive	1E-04	3E-05	4E-04	**233**	LC50
	Tolerant	3E-05	5E-06	9E-05	**1100**	>LC50
Amphibian	Sensitive	3E-02	6E-03	0.1	**1**	NOEC
	Tolerant	3E-02	6E-03	0.1	**1**	NOEC
Invertebrate	Sensitive	2E-04	5E-05	8E-04	**133**	LC50

	Tolerant	2E-05	4E-06	7E-05	**1376**	LC50
Macrophyte	Sensitive	6E-03	1E-03	2E-02	**5**	NOEC
	Tolerant	3E-03	6E-04	1E-02	**10**	NOEC
Algae	Sensitive	3E-03	6E-04	1E-02	**10**	NOEC
	Tolerant	1E-03	3E-04	5E-03	**20.3**	NOEC
Chronic/Longer Term Exposures						
Fish	Sensitive	3E-02	4E-03	0.1	**0.5**	NOEC
	Tolerant	1E-02	2E-03	7E-02	**1**	NOEC
Amphibian	Sensitive	1E-02	2E-03	7E-02	**1**	NOEC
	Tolerant	1E-02	2E-03	7E-02	**1**	NOEC
Invertebrate	Sensitive	2E-03	3E-04	1E-02	**6**	NOEC
	Tolerant	2E-04	3E-05	1E-03	**61.8**	NOEC
Macrophyte	Sensitive	3E-03	4E-04	1E-02	**5**	NOEC
	Tolerant	1E-03	2E-04	7E-03	**10**	NOEC
Algae	Sensitive	1E-03	2E-04	7E-03	**10**	NOEC
	Tolerant	7E-04	1E-04	3E-03	**20.3**	NOEC

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