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Chapter 3 (part a)

Affected Environment and Environmental Consequences

Introduction

The Affected Environment describes aspects of the environment in and near the project area. It focuses on the physical, biological, economic, and social conditions that may be affected by implementation of the alternatives. Conditions discussed during the development of the issues are emphasized. Familiarity with the Affected Environment is essential to understanding the alternatives described and the potential environmental consequences described here. The Affected Environment and the Environmental Consequences are combined in this document for ease of reading and reference.

The Environmental Consequences disclose the environmental and socio-economic impacts of implementing each of the five alternatives. The consequences are directly related to the resource elements described in the Affected Environment, so this FEIS is formatted such that the Environmental Consequences for each resource immediately follow the Affected Environment for that same resource. This way, the reader can read about the present environment and then read how each alternative would change the present environment.

Environmental effects, or consequences, can be direct, indirect, cumulative, and long or short in duration. The terms, effects and consequences, are used synonymously in this FEIS. Effects can be quantitative or qualitative, adverse or beneficial, actual or potential, tangible or intangible, significant or insignificant, unavoidable, irreversible, or irretrievable.

This analysis complies with current management direction found in the Tahoe National Forest LRMP, Regional standards, guidelines, and other policies, NEPA; and other Federal laws and National policies.

Fire and Fuels

Summary of Effects:

- Alternative A would not meet any of the SNFPA Fire Standards and Guides and would leave an average of 170 tons per acre.
- Alternative B would minimally meet SNFPA Fire Standards and Guides. It leaves an average of 75 tons per acre outside the 1,060 acres of mechanical fuels treatment.
- Alternative C would meet several SNFPA Fire Standards and Guides. It leaves an overall average of 85 tons per acre of fuel loading outside the 2,923 acres of SPLATs.
- Alternative D would meet several SNFPA Fire Standards and Guides. This alternative leaves an overall average of 155 tons per acre of fuel loading outside the 2,923 acres of SPLATs.
- Alternative E would meet some SNFPA Fire Standards and Guides, leaves an average of 170 tons per acre within the IRA, and creates 1,683 acres of SPLATs. It leaves an overall average of 102 tons per acre of fuel loadings outside the SPLATs.

Affected Environment

Elements of Fire Behavior

Live Fuel:

Prefire- The vegetation species mix (hardwood, montane chaparral, mixed conifer and red fir) in the project area produce overall high vegetation densities with the exclusion of fire. The growth patterns of the understory of shrubs, hardwoods, and smaller conifers creates a mosaic of variable interconnected canopies that range from near the ground surface, up into the largest, dominant trees. On productive sites, tree densities easily exceed 150 trees per acre. Numerous plots within the Red Star Restoration analysis area contained 300+ trees per acre.

Dead Fuel:

Prefire - Before to the fire, estimated dead fuel loadings within the conifer-dominated sites ranged from 20-100 tons per acre with a mean of approximately 40 tons. Additionally, on these sites there was approximately 10-40 tons of duff. The hardwood and shrub-dominated sites had an estimated 10-30 tons per acre of dead fuel loadings.

Postfire - At this time, there is generally less than 10 tons per acre of surface dead fuel loading within the analysis area. Depending on mortality levels and site productivity, there are up to 523 tons per acres of dead standing biomass within the project area.

Topography - The topography within the analysis area is very steep and rugged. The southwest trending Red Star Ridge comprises the western half of the analysis area, and consists of a very narrow, somewhat flat, ridgeline with steep to extremely steep side-slopes. The eastern portion of the analysis area (east of Mosquito Ridge Road) is for all-practicable purpose completely within the Duncan Canyon watershed (See Map, Appendix A). This area is generally slightly less steep than the western portion, but is incised by numerous drainages. A substantial portion of the area east of the Mosquito Ridge Road is unroaded (See Map, Appendix A).

Climate -The area has a Mediterranean climate with cool, wet winters with considerable amounts of snow, and a long, dry summer season. The dry season normally occurs from May through September; although, during many years the dry season does extend well into October or early November. The area normally experiences a few episodes of very light to moderate precipitation from thunderstorms created by the southwestern monsoon or weak low pressure systems that periodically move through the west coast during the summer the dry season. Periodic strong, dry north to east winds occur during the fall.

Fire History

Number of Fires -Based on the fire records for this portion of the Foresthill Ranger District, the area is significantly outside the average median fire return intervals listed in SNEP (1996); that is, 11 to 26 years. Furthermore, the area is well outside the historical maximum fire return intervals for the mixed conifer forest types (14 to 59 years) and at or just above the extreme maximums for the upper montane forest types (96 years).

Fire history records (1941-1999) at the District listed 43 fires (0.72/year) within the project area and numerous others within a mile of the perimeter. All listed fires within the analysis area were class A and B size (less than 10 acres) and a majority were classified as lightning caused (36 fires). The other main cause was smoking (5 fires). Forty of the fires were less than 0.25 acres in size (Class A). In 1987, a lightning fire (the Big Fire) burned approximately 1,000 acres on the south aspect just west of the confluence of the Middle Fork American River and Duncan Canyon and adjacent to the western perimeter of the Star Fire. Large fire records (fires greater than 10 acres) from 1910-1940 do not show any fires in the French Meadows/Duncan Canyon area. This is in contrast to Leiberg (1902), who indicated that there were numerous indicators of extensive fires prior to his survey of the area.

Fire Size and Severity

The following fire-severity class definitions are used in this document:

1. Low severity: Light surface fire; some small trees may be killed.
2. Moderate severity: Most small trees killed; some subcanopy trees killed or heavily damaged. Charring on bark of live trees. Overstory trees may occasionally be killed.
3. High severity: Small and sub-canopy trees killed; many to most overstory trees killed.

Historical fire regime -Most studies indicate that high severity patches within the Red Star Restoration analysis area forest types were typically confined to small patches (SNEP 1996; Agee 1993; Lieberg 1902; Sudworth 1900). While there has been very few fire history studies on the west side of the northern Sierra Nevada, the observations below are consistent with fire history and fire ecology found in the southern Cascades and the Klamath Mountains that have similar vegetation assemblages (SNEP 1996).

Based on fire history and ecology information primarily from studies in similar vegetation types within the southern Cascades and the Klamath Mountains, fires historically spread over periods of weeks to months. These fires were thought to have spread with various intensities and rates of spread. Pre-settlement fire vegetation conditions allowed fires to "die down" during periods of low winds or moderate weather, but remain capable of renewed spread under patterns of windy or warmer weather. Once started, fires continued to burn until autumn rains came, often covering large areas. The intensity of pre-settlement fires encompassed a wide range of fire severity with many fires, or large portions of them, burning at low to moderate severity. Evidence of low severity burns is seen in the predominance of live older trees with fire scars (many of which are healed over) or basal char in these forests; moderate severity burns are indicated by the coincidence of fire dates and regeneration cohorts, suggesting creation of some growing space by post fire tree mortality. High severity burns are indicated by the absence of conifers on some sites dominated by hardwood trees or shrubs, the dominance of species such as knobcone pine, or even-aged stands of other conifer species (Agee 1993).

For example, Sudworth (1900) reported the fires within the Lake Tahoe (westside of the Sierra Nevada, south of the North Fork American River) and Stanislaus Forest Reserves are peculiarly of a surface nature, and with rare exception there is no reason to believe that any other type of fire has occurred here. He also stated that there was no deep humus to burn to create deep burning to kill the roots. Barring the debris left from timber cutting, the only food for these fires is the light fall of pine and fir needles, irregular patches of low conifer seedlings, and chaparral. He further stated that firebreaks 4-10 feet wide created by scraping away the dead grass were usually effective; additionally, a more effective break was created by burning a strip 15-20 feet wide between two scraped lines. He went on to say that only two cases were found within the region where large timber had been killed outright by surface fires. One burn involved less than an acre, and the other was several hundred acres. He indicated these two burns were exceptional cases, and that the killing of the trees was accounted for by the fact that long protection from fire, and from all management activities but cattle grazing, had resulted in the accumulation of much fallen timber, considerable humus in depressions and on benches, and a dense undergrowth of brush and seedlings. He went on to stress that the most serious and widespread injury to mature timber caused by surface fires is the gradual hollowing out from year to year of the green trunks near the base. He also stated that in the middle or main timber belt, it is scarcely possible to find a tree trunk not blackened by fire, and from 50 to 75% of the trees have fire scars. He estimated that the surface fires killed 1 to 5% of the mature trees within the burned stands.

Based on the forest types in the analysis area, the Fire Return Intervals (FRIs) from the various studies listed in SNEP ranged from 1 to 96 years (composites from multiple trees). Generally, the relative extent of fires within a particular vegetation type appears to increase as the interval between fires lengthens (Swetnam 1993, Husari and Hawk 1994) (SNEP 1996). The mixed conifer zone, located in the western half of the Star Fire, contains the characteristic fire regime of much of the Sierra Nevada (frequent fires of low to moderate severity). The eastern portion extends into the upper montane zone. Here fire regimes are likely to be more variable in frequency and in severity than those from the lower elevations (Agee 1993).

Star Fire Severity - High severity fire affected a minimum of 70% (6,550 acres) of the Red Star Restoration analysis area. This magnitude of high severity appears to be considerably outside what the area experienced the last several thousand years. As stated above, the historical fire regime for this area would be best described as low to moderate severity with patches, usually small, of high severity. Sudworth (1900), Leiberg (1902), and Show and Kotok (1924) all remark that crown fires and extensive areas of mortality (except in previously logged areas) were unusual at the time of their studies (SNEP 1996). Conversely, based on the significant percentage of high burn severity found within the Red Star Restoration analysis area, this area burned like areas described in studies having a fire regime of infrequent, severe, large fires. This is consistent with the SNEP (1996) finding that late 20th century fires were characteristically high severity, with only small portions of low to moderate severity.

Firefighter Safety - The Agency has regulations that specify requirements for safeguarding public health and safety and protection of natural forest resources at all Forest Service public use areas of prime importance (Johnson 1981). This direction is found in portions of the USDA, Forest Service Manual

(FSM) 2303; 2330; 6703; 6730.

The Occupational Safety and Health Act (OSHA) of 1970 assure employees a safe and healthful work environment thereby reducing the number of work-related injuries and deaths. OSHA regulations apply to federal agency employees as well as Federal contractors. This requires employees to take reasonable steps to correct, or to require the correction of hazards of which they could reasonably be expected to be aware.

Hazard trees pose a significant risk to firefighters. Annually, 2-6 firefighters are injured or killed by hazard trees (Thorpe 1999). In the research project, *Injury Analysis during Nighttime Operations in Wildland Firefighting*, the author, Dan Thorpe, made the conclusion that snags are important killers of firefighters at night. While safety measures such as wearing personal protective gear (hard hats), and strategies to recognize hazard trees and post lookouts are employed, the risk is still very high.

The SNFPA decision recognized this and established a management scheme to reduce that threat in areas identified as strategically important to firefighting (ROD A-10-11). These areas are identified as the Urban Wildland Intermix Zone. In this zone standards call for reducing hazard trees to 2 per acre. The Urban Wildland Intermix Zone in the project area is approximately 2,417 acres in size. A majority of this zone suffered greater than 75% mortality. Firefighters would be at extreme risk in this zone unless dead standing trees are felled. OHSA regulations require that the agency manage this risk. The forest plan provides the standards by which the Agency has established it will manage the risk.

Environmental Consequences

All alternatives are evaluated against the objectives, standards and guidelines established by the SNFPA for fuels. The applicable fire and fuels management objectives are to: 1) reduce the amount and intensity of uncharacteristically severe wildland fires, 2) where appropriate reintroduce fire into the ecosystem, and 3) reduce the threat of wildfire damage to human communities and natural resources.

Table 3-1: Summary of fuels objectives by land allocation.

Objective	Measure in Defense Zone	Measure in Threat Zone	Measure in Old Forest
ıce the amount ntensity of ıaracteristically re wildfire.	Within 90% of the area: Under 90th percentile weather conditions manage fuels conditions to maintain 4 ft. or less flame length. Treat live Crown Base Height (based on timber type) average to 15-25 feet. Link to SPLATs	Within 85% of the area: Under 90th percentile weather conditions manage fuel conditions to maintain 6 ft. or less flame length. Treat live Crown Base Height (based on timber type) average to 15-25 feet.	Under 90th percentile weather conditions manage fuel conditions to maintain 6 ft. or less flame length within 75% of the area. Create SPLATs on 30-40% of the landscape.
ıce the threat of ire damage to an communities ıatural urces.	Create a buffer between developed areas and wildlands. Design treatments to increase firefighting efficiency and reduce risks to firefighters, the public, structures, and natural resources Manage snags levels at 2/acre	Fires are controlled through initial attack under all but the most severe weather conditions.	Same as Threat Zone

	Fireline production rates are doubled from pre-treatment levels. Fires are controlled through initial attack under all but the most severe weather conditions.		

Consequences Common to All Alternatives

There are some environmental consequences that are common to all alternatives. The fire itself created the majority of these effects. The consequences will vary among alternatives in proportion to the amount of area available for treatment. The amount of treatment that can be accomplished is limited by a number of things. This includes standards in the SNFPA (2001), issues identified through scoping, balancing trade-offs with other resources in order to meet a variety of laws and resource objectives, economics of the alternative, and balancing priorities for appropriated funds under the National Fire Plan. Following is a summary of common environmental consequences:

- All alternatives leave areas with dead and dying trees untreated.
    - In all alternatives SNFPA guidelines prevent removal of dead-standing fuels greater than 15 inches dbh in Old Forest land allocations unless 75% or more of the stand is dead.
    - SNFPA guidelines require leaving 10% of the area to be left untreated after a catastrophic event.
    - All alternatives leave standing-dead fuel in RCAs to provide for coarse woody debris recruitment. (The untreated RCA widths vary by alternative.)
    - The environmental consequences described in Alternative A are the same in all alternatives where dead standing fuels are less than 75% of the stand, and for 10% of catastrophic event areas required to be left untreated.
- In all alternatives, pre-fire, natural historical fuel conditions would be exceeded due to the amount of fuels left untreated, either as a result of non-treated areas, dead fuels left to meet soil cover requirements, project economics prevent further clean-up, or live fuels (shrubs) that would grow in the future. The cumulative effect result of this is that the overall fire hazard condition of the area does not appreciably change by action alternative.
    - Studies show that fuel treatments reduce the future fire severity and that a direct correlation exists between the amount of fuels reduced and the reduction in fire severity (Jimerson and Jones 2002; Omi and Martinson 2002; Pollet and Omi 2002; Wagle and Eakle 1979).
- In all alternatives, the number of snags remaining in untreated areas would pose an unacceptable safety risk to firefighters if another fire were to occur. For Alternative A, this would be true across the project area; for the action alternatives, it would in areas outside the proposed SPLATs and very low mortality areas. Numerous wildland firefighters have been injured and killed by snags during suppression activities. Due to this concern and OSHA standards, a Fire Use Plan would be developed based on the areas treated for each alternative to give guidance on future suppression activities within the boundaries of the Star Fire.
- In all management alternatives, the predicted excessive fuel accumulations outside the SPLATs,

shrub fields, and low severity areas would preclude the use of any prescribed fire usage in any form over extensive areas for the foreseeable future. The expected heavy fuel loadings would create unacceptable soil heating to approximately 10 centimeters (Ref. Soil Heating Graphs – Appendix G), and the soil cover objective would not be met. Furthermore, prescribed fire is not a viable treatment option during the next 10 years under Alternative A because the soil requirement of 75% soil cover could not be maintained. The only viable resource management fuel treatment outside the SPLATs and low severity areas is the removal of large quantities of the excessive fuel loadings to disposal sites. This treatment is not economically viable at this time and would create very severe soil heating underneath the piles if they were to be burned.

Alternative A – No Action

- No fire restoration and fuels treatment activities would occur.
- The overall fire behavior is low (flame lengths less than four feet, fire line intensity less than 100 BTU per foot per second, with low rates of spread and some short range spotting) in the first 5 years. This increases to extreme (flame lengths exceed 11 feet, fire line intensity exceeds 1,000 BTU per foot per second, high rates of spread, and long distance spotting) starting around year 10.
- The landscape would not move toward the desired fuel conditions described in the SNFPA (2001) for Defense, Threat Zones, and SPLATs (Ref. Map, Appendix A).
- Firefighter safety would be greatly compromised (National Snag Hazard Report 1993) and future suppression options would be limited without the removal of the dead standing trees near the roads and along ridges. On the Apple Fire (2002) suppression options were limited to indirect strategies due to snag concerns in an area that had previously burned during 1987 (Per. Communications with Incident Commander, Norcal Interagency Incident Management Team II, Howard Carlson).
- Vegetative management options, such as planting, would be greatly limited, and the reintroduction of low to moderate severity prescribed burns would be exceptionally problematic.
- Fire suppression actions in the future would be considerably more expensive, and resistance to control would radically increase.
- Environmental conditions could produce another catastrophic event similar to the Star Fire within 20 – 30 years.

Direct and Indirect Consequences

Reduce the amount and intensity of uncharacteristically severe wildfire.

Flame Lengths – Untreated areas would ultimately not meet the SNFPA (2001) Activity-RelatedStandard and Guides of maintaining vegetation and fuel loading conditions to levels that produce 4-foot and 6-foot flame lengths. Over the next five years, the flame length standard would be achieved, unless there is a severe wind event that drops most of the standing dead trees. Overall flame lengths based on the BEHAVE Fire Behavior Prediction System (FBPS) during this period would be less than 2 feet except in areas with jackpots of fuels. In areas of low severity burning and existing shrub fields, an estimated 4 to 14% of the area (384 to 1316 acres), would meet flame length goals within the Old Forest Emphasis Areas over the next 30 years.

Fire Severity/Size –In the first 5 years, the overall fire behavior indices for the analysis area would be low because, although the amount of fuel on the ground is beginning to increase, the fuels bed would not be continuous (Table 3.1). From years 5 through 30, a substantial number of the dead trees would be on the ground (Ref. Appendix G), creating dead fuel loadings ranging from 30-405 tons per acre. Maturing shrubs would become more flammable due to an increasing dead vegetative component;

therefore, the rock and shrub covered areas would become less effective as barriers to fire spread. By the end of this period, the overall fire behavior indices would increase to Extreme. Post fire fuel loadings in untreated areas would greatly exceed the pre-fire fuel loadings; therefore, if one should occur, any future large wildland fire would be expected to produce greater severities and resource damage than the Star Fire.

Years 31 through 100 would see a continuation of the process and conditions described for the period from 5 to 30 years. The fire hazard and the chances of a fire escaping should increase as the shrub growth becomes more decadent, the remaining snags fall to the ground, and fine fuel loadings increase. The shrub fields created by the Star Fire would become decadent with an increasing conifer component.

Any fire occurring in areas containing live residual fuel during the first five years should have low severities. The rock and shrub covered areas should act as barriers to fire spread for the next 20 to 30 years. Hardwood and shrub sprouting along with seedling growth would be vigorous and low in flammability for several years. The high severity burn areas would become young shrub fields with conifer seedlings, as occurred in the 1987 Indian Fire and the 1999 Pendola Fire.

SPLATs - The SNFPA goal of creating SPLATs and treating fuels strategically across 30-40% of the landscape would not be met.

Reintroduce prescribed fire into the ecosystem

This alternative would not meet the SNFPA goal of moving forests towards natural fire regimes and re-introducing fire to fire-dependant ecosystems (SNFPA ROD). Nor would it meet the Beschta Report (1995) recommendation to preserve (and re-establish) the fire and other disturbance regimes that maintain ecological systems and processes, while protecting human life and property.

Fuel loadings would be far beyond the desired condition of 10 to 20 tons/acre. In areas where stand mortality is greater than 75%, the fuel loading at 30 years is predicted to range from 40 to 405 tons per acre. In stands with less than 75% mortality, the fuel loading at 30 years is predicted to be 18-150+ tons per acre. Post fire average fuel loadings, especially coarse woody debris (logs greater than 3 inches in diameter), would greatly exceed those found historically within the local forest types. The estimated overall average 30-year fuel loadings would be 160 tons per acre, with a range of 30 to 405 tons per acre (Ref. Table 3-2 and Affected Environment).

Using prescribed fire to reduce fuel loadings and return fire within the Red Star Restoration analysis area would be very problematic due to the creation of very high heat intensities from the excessive fuel loadings (Ref. Table 3-2). Examples exist from other Tahoe National Forest prescribed burns where considerable mortality of the large trees occurred in high fuel loading areas not previously affected by wildland fire. For instance, a prescribed burn at the Devils Post Pile on the Downieville Ranger District, where fuel loads were 40 to 60 tons per acre, experienced a 1 to 2 acre patch with 100% mortality of the large trees (greater than 16 inches dbh). Despite the fact that this prescribed burn was conducted under moderate evening conditions with a backing ignition pattern, high, long lasting heat intensities produced by the large logs in these high fuel loading patches resulted in the high mortality rates. Other prescribed burns on the Forest have experienced similar results in areas with heavy fuel loadings.

In the Red Star Restoration project area, the First Order Fire Effects Model (FOFEM) indicates that mortality rates in the small diameter trees from any prescribed burn the next 5-30 years would exceed 70%. Based on the previous experiences and FOFEM, if prescribed burning is attempted in the future in untreated areas, significant mortality would occur to both the trees that survived the Star Fire and post fire reproduction and plantations. Mortality would be expected to be highest among smaller trees.

Reduce the threat of wildfire damage to human communities and natural resources

Firefighter Safety - The SNFP desired condition for the Defense Zone of keeping snag levels to two per acre would not be met. Based on Table 3.2, which characterizes representative stands in the analysis area, snag levels range from 44 to 504 per acre at year 3, and decline to 8 to 84 per acre at year 30. These snag levels would result in a high risk to firefighter safety, and as a result, firefighting tactics would need to change to indirect attack (Ref. fire fighter safety - affected environment.)

Initial attack resources would have a harder time preventing fires from escaping. Fire suppression activities on large wildland fires, outside the Urban Intermix Zones, typically occur along ridgetops. Under this alternative, the fuel loadings on the ridgetops and within the Urban Intermix Zone would be tremendous, creating high intensities and extreme resistance to control. The encroaching dense shrubby vegetation cover and snag fall across roads would add to these effects. These conditions would compromise firefighter safety and may limit the options of confining any future escaped wildland fire within the present burned perimeter.

It is unknown at this time if the increased fuel loadings under this alternative would increase the frequency of fire starts (Ref. Affected Environment); however, lightning would be expected to remain as the principal ignition source within the analysis area. The number of fires that exceed 10 acres in size, during the next several decades, would increase due to the great increase in resistance to control from the numerous large diameter down logs (Ref. Table 3-3).

Wildland fire suppression costs would be expected to increase as a result of the increased time required to mop-up the large amounts of coarse woody debris, the large increase in resistance to control, the limited access, and the expected increase in fires that exceed 10 acres in size.

The numerous dead trees near the roads and ridgetops would greatly compromise firefighter safety (Ref. Table 3-2). The safety hazard created by numerous snags would also compromise other management activities and public safety.

Resistance to Control - Heat production, measured as British thermal unit (BTU)/square foot, is a way to relate fire effects to fire intensity. It is also a way to characterize the contribution of large fuels versus small fuels to fire intensity. This impact is measured in terms of resistance to control, fireline production rates and threats to soil productivity from lethal temperatures.

The estimated general heat output for stands within "historical" stands would be 5,854 BTU per square foot. This estimate is based on Sudworth's (1900) characterization of the surface fuels in this portion of the Sierra Nevada as being very light with very little accumulations of woody debris or duff. Based on this characterization and previous prescribed burns, the probable general fuel loading within the "historical" stand were less than 20 tons per acre and most likely 5 to 15 tons per acre.

Table 3-2 below, and similar tables for the other four alternatives(available in the planning records), are based on Forest Inventory Analysis (FIA) data and demonstrate the estimated range of fuel loadings and heat outputs within the analysis area. From this information, the conclusion can be made that by year-three, BTUs begin to exceed the historical BTU estimate. The large fuels (1000 hour +) contribute 40 to 60% of BTU outputs in the first 3 years, and 18 to 57% at year-30. The reduction in large fuels to the overall BTU at 30 years is due to expected decay rates. By year-30 the historical BTU's would be exceeded by as low as one-third in stands where mortality and fuel loading is low, to a high of 6 times the estimated historical BTU. After that, the 30-year heat outputs would drop over the next 70 years due to decay, but this drop would be counterbalanced by the increase in output from the increasingly decadent shrub growth.

Modeling Assumptions -The estimated BTU production does not include the heat produced by standing dead fuels (snags) or shrubs. The bone-dry BTU outputs by the conifer species found within the Star Fire range from 8,400 to 9,100 per bone-dry pound (Howard 1988; Gronoki 1979). For this analysis, to be conservative, 8,500 and 7,000 BTUs per pound were used to calculate the 3 and 30-year estimates, respectively. The 30-year heat output for the large fuels was reduced to incorporate decay. Total estimated loadings of greater than 8 inch in diameter fuels was reduced by 90% to estimate 3 year snag fall, and 30% to approximate 30 year snag fall and decay. A BTU value of 8,000 BTUs per pound (BEHAVE fire behavior prediction system (FBPS) default value) was used to estimate the heat output for the less than 8 inches in diameter fuels.

The heat output estimations were included to compare estimated overall "historical" intensities with potential intensities. These estimates illustrate the increases in severity potential, suppression difficulties, the difficulty of using prescribed fire, and potential resource damage. As a comparison, the estimated general heat output for the "historical" stands is 5,854 BTUs per square foot. This estimate is based on Sudworth's (1900) characterization of the surface fuels in this portion of the Sierra Nevada as being very light with very little accumulations of woody debris or duff. Based on this characterization and previous prescribed burns, the probable general fuel loadings within the "historical" stands were less than 20 tons per acre and most likely 5-15 tons per acre. To be on the high side of the "historical" heat intensities, the estimate above is based on a fuel loading of 15 tons per acre and a heat output of 8,500 BTUs per pound.

Table 3-2 - Alternative A: Estimated Fuel Accumulation of the 0-8 " Size Fuels Over 30 Years (tons/acre) **and Heat Outputs** (BTUs/sq. ft.)

Plot 290.2a (32 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.08	0.23	0.19	3.86	44	1,094	2,695
30	0.26	0.75	0.65	16.45	8	1,467	8,119

Plat 310.1b (32 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.23	0.4	0.4	6.93	249	4,7167,640	7,640
30	0.63	1.17	1.26	31.5	31	10,421	23,115

Plot 305.1b (72 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	.30	0.46	0.50	7.64	292	2,411	6,143
30	0.74	1.36	1.49	33.89	20	2,985	15,085

Plot290.1a (101 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.56	0.99	0.76	13.93	189	3,315	5,965
30	1.43	2.7	2.22	54.86	22	12,846	22,483

Plot 310.2a (153 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.36	0.59	0.67	14.09	290	5,355	11,125
30	1.01	1.79	2.39	65.15	30	18,581	42,511

Plot 305.1a (122 tons/ac.) <75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.29	0.5	0.51	11.11	222	4,271	8,829
30	0.87	1.57	1.79	53.94	27	14,327	35,693

Plot 310.5 (113 tons/ac.) >75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.32	0.56	0.59	12.82	216	3,833	9,082
30	0.96	1.84	1.93	55.43	24	11,775	33,872

Plot 290.7 (315 tons/ac.) >75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.66	1.45	1.54	29.98	345	10,988	23,341
30	0.96	1.84	1.93	55.43	24	37,011	92,357

Plot 305.1-1a.3 (318 tons/ac.) >75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	1.01	2.04	1.57	32.98	404	10,938	24,749
30	3.04	6.4	5.37	136.50	73	37,470	93,048

Plot 290.1a-1b.15 (201 tons/ac.) >75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	-.65	1.07	1.06	19.88	329	6,965	15,288
30	1.79	3.27	3.58	90.62	38	22,291	59,380

Plot 310.1a-1b.9 (523 tons/ac.) >75% Mortality

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.54	1.04	1.54	37.75	504	18,816	33,828
30	1.95	3.99	6.38	213.12	84	66,942	149,748

The table below illustrates the difficulty fire suppression resources would encounter trying to control any wildland fire that may occur in untreated areas. Based on the FBPS fuel model, the area would be in "low" 11 for the first 10 years and the expected rate of spread would be 2 to 3 chains per hour with flame lengths less than 2 feet. After that point, due to the continued build up of the fuel bed, FBPS fuel model 12 would best represent Alternative A. Under 90th percentile weather conditions, the expected rates of spread on a 40% slope would exceed 9 chains per hour and flame lengths would exceed 5 feet (Appendix G).

Table 3-3 - Alternative A: Resistance to Control (Production Rates) within 3 and 30 Years

USDA Forest Service GTR-PNW-95 & PNW-114)

Plot	Year	Code	Production Rate (ch/hr) (40% Slope)	Adjustment (due to loadings of the various fuels)	Adjusted Production Rate (ch/hr/person)
290.2a	3	1MC4PC	6.00	1.00	6.00
30		4MC4PC	0.67	1.00	0.67
310.1b	3	3MC4PC	2.00	1.00	2.00
	30	8MC3PC	0.86	0.15	0.13
305.1b	3	1MC4RC	2.40	0.75	1.80
	30	6MC4PC	0.40	0.25	0.10
290.1a	3	2MC4PC	0.92	1.00	0.92
	30	3MC4RC	0.34	1.00	0.40
310.2a	3	2MC4PC	0.92	0.50	0.46
	30	5TF4PC	0.40	0.50	0.20
305.1a	3	2TF4PC	1.50	1.00	1.50
	30	3MC4RC	0.34	1.00	0.34
310.5	3	2MC4PC	0.92	0.50	0.46
	30	6TF4RC	0.40	0.80	0.32
290.7	3	5MC4PC	0.54	0.40	0.22
	30	3MC4RC	0.34	0.50	0.17
305.1-	3	5MC4PC	0.54	0.40	0.22
1a.3	30	5TF4PC	0.37	0.30	0.11
290.1a-	3	5MC4PC	0.52	1.00	0.52
1b.15	30	3MC4RC	0.34	0.65	0.22
310.1a-	3	5TF4PC	0.37	1.00	0.37
1b.9	30	5TF4PC	0.37	0.20	0.07

The above production rates are for comparison only. They are used here to illustrate the relative difficulty of constructing control lines in areas with heavy fuel loadings. The photos used to execute this model, found in Photos Series for Quantifying Forest Residues in *The Sierra Mixed Conifer Type and Sierra True Fir Type* (Maxwell and Ward 1979), in several cases do not represent well the distribution of the various fuel class sizes found within the above stands. In most cases, the photo that was closest to the estimated overall fuel loadings for the stand was used, since there were no photos with similar fuel loadings in the booklet. In addition, the above production rates do not incorporate shrub growth. Based on a Forest Service research document (source unknown), if 70% of the site is occupied by an understory of manzanita, the fuel loading from the shrubs would be 15 tons per acre and the shrub growth alone would create a resistance to control of High. As an illustration, "High" resistance to control means "slow work for dozers, very difficult for hand crews; hand line holding will be difficult" (Brown, Reinhardt and Kramer 2001). Since considerable shrub growth within the moderate and high severity areas are expected, the above production rates should be considered maximums for the next 30 to 100 years.

Additionally, running the data from the above stands through the 1976 Region 5 Resistance to Control Calculation Matrix gives all stands a numerical rating of 12+; an adjective rating of Extreme.

Soil Effects - Based on a study from the Megram Fire in the Klamath Mountains (Jimerson and Jones 2002), any future fires that escape the initial attack response under this alternative would produce mostly moderate to high severities created by the burning of extremely high fuel loadings. The high burn severities would cause considerable damage to soil structure and microorganisms (Ref. Soils environmental consequences).

The FOFEM model predicted surface fuel soil heating for the data from four stands with a range from the lightest to the heaviest fuel loadings. This data indicates that lethal temperatures would extend several centimeters deep and would last for extended periods of time, except for the areas with the lightest fuel loadings (Ref. Soil Heating Graphs- Appendix G). Stand (290.2a) with the lightest fuel loading would have limited soil-heating impacts. The lethal temperature of 60^0 (C) would penetrate the soil to approximately 1 centimeter for approximately 60 minutes. The other three stands that are more representative of the general fuel loadings within the analysis area show lethal heating to 11 centimeters in depth for extended periods. All three of these stands show a minimum of 900 minutes of lethal heating to the 10-centimeter depth.

Cumulative Effects

Any fire that escapes initial attack under 90^{th} percentile or greater weather conditions in about 20-30 years would be expected to be very hard to control. This is due to high heat intensities, high rates of spread, extreme resistance to control,and suppression options would be limited to indirect strategies due to the numerous snags; therefore, it would be expected to be very large. Based on the information in Table 3-2 above and the Soil Heating Graphs, any future large wildland fire in this area, under this alternative, would have a tendency to convert pre-Star Fire forested areas that burned with moderate to high severities to shrub fields (SNEP 1996; Agee 1993).

There are two approved vegetation and fuels management treatments adjacent to the analysis Area. The End of the World Timber Sale is to the west and upslope of the Star Fire origin. The French Helicopter Timber Sale is located on a south aspect between French Meadows Reservoir and Red Star Ridge.

This alternative would not support the planned "fuels management zone" development over the next five years within the End of the World project area. The "fuels management zones" are 200-500 feet wide along selected roads where mechanical treatments and prescribed burning are being conducted to reduce fire behavior indices. The planned work creates conditions that are identical to the SPLATs proposed under this document, except they are linear and narrower than the ones proposed under Alternatives C, D, and E. They are similar in size to the small, scattered SPLATs proposed under Alternative B. The long-term fuel loading and vegetation conditions created by this alternative would greatly lower the effectiveness of the treatments being conducted within the End of the World project area.

The French Helicopter Timber Sale commercially thins 918 acres within selected units. Slash is being piled within 50 feet of roads. There is no discussion or indication in the project files of any other fuels treatments being conducted. Therefore, we expect open to somewhat open stands with moderate to heavy slash loadings of 0 to 10 inch diameter material. The representative fuel model for these thinned stands would be FBPS fuel model 11 (moderate logging slash). The representative FBPS model for the adjacent Red Star Restoration analysis area is 12. These fuel-loading conditions on both sides of this section of Red Star Ridge would create problems in confining any fire to only one side of the ridge.

The private lands will be or have been salvaged logged. It is unknown if any additional fuels treatment will be conducted on the private lands. If additional fuel treatments were not conducted, the expected fuel loadings would average approximately 30-80 tons per acre. That would be approximately 20-50% of the expected average fuel loadings on Forest Service lands under this alternative.

The proposed fire restoration work on the Eldorado National Forest portion of the Star Fire would be similar and complementary to the planned work in this document.

Alternative B – Proposed Action

- This alternative would move toward desired condition goals in the SNFPA by establishing defense and threat zones.
- Creates 18 SPLATs, 9 to 195 acres in size to over 1060 acres, however, it does not meet SNFPA goal of treating 30 to 40% of the landscape.
- Firefighter safety and resistance to control are improved (Table 3.4)
- Reintroduction of prescribed fire would be possible on 10 to 34% of the acres after treatment.
- Length of soil heating is reduced with the reduction of fuel loading.
- Environmental conditions could produce another catastrophic event similar to the Star Fire within the next 100 years.

Direct and Indirect Consequences

Reduce the amount and intensity of uncharacteristically severe wildfire

Flame Length – Alternative B would meet the SNFPA (2001) Activity-RelatedStandard and Guides (ARSG) of maintaining vegetative conditions and fuel loading to levels that produce 4-foot flame lengths within the Defense Zone (336 acres). It moves the area toward meeting the 6-foot flame lengths in the Threat Zone on 35% of the area; however the SNFPA goal is that 85% of the area should meet that condition. Old Forest areas would move toward the desired condition as well, but would not meet the goal for the extent of area to be treated.

Fire Severity/Size – The effects within the non-harvested areas would be similar to Alternative A. Fuel loadings would not return to pre-fire or natural historical levels. Harvest operations would leave limbs and tops to meet soil cover requirements, creating down fuel loadings that would be high and continuous immediately after the logging. The overall average 30-year fuel loading would be reduced to 76 tons per acre with a range of 44 to 231 tons per acre (Table 3–4). This is an overall average reduction of 84 tons/acre from the No Action Alternative. Even with this treatment the fire behavior indices for areas other than Defense and Threat Zones would be Extreme.

SPLATs – This alternative would not meet the SNFPA goal of creating SPLATs and treating fuels strategically across 30 to 40% of the landscape. Combining the proposed fuels treatment (1,060 acres), areas with predicted low mortality (932 acres), and the shrub fields (384 acres); approximately 15 to 25% (1,444 to 2,376 acres) of the landscape would have fuels treated to acceptable levels. Since the proposed treatment acres (1,060) are allocated to the higher priority Defense and Threat Zones, none of the identified 18 small, scattered SPLATS (9 to195 acres in size for 1,060 total acres), would be developed under this alternative.

Reintroduce prescribed fire into the ecosystem

This alternative would meet the Beschta Report (1995) management goal to preserve (and re-establish) fire and other disturbance regimes that maintain ecological systems and processes, while protecting human life and property on a minimum of 1,060 acres (11%), to an estimated maximum 2.376 acres (25%). Between the number of acres left untreated and treated acres where limbs and tops are left for ground cover, fuel loading would be expected to exceed 5 to 20 tons per acre (the historical natural range) on 90% of the area. However, it was the fire that created potential dead fuel loadings ranging from 30 to 525 tons per acre. Harvested areas outside of SPLATs would have the fuel loading reduced, but it would still be heavy enough to make it extremely challenging in attempting to return prescribed fire to these areas in the future (Ref. Table 3-3).

Because the 1,060 acres of additional fuels treatment would be conducted within the Defense and Threat Zones based on the priorities set by the IDT, the fuel loadings within the SPLATs would be similar to the rest of the harvested areas. The return of prescribed fire (underburning) would be problematic unless the fuel loadings can be reduced to less than 30 tons per acre through some future project(s).

Reduce the threat of wildfire damage to human communities and natural resources

Firefighter Safety – The SNFPA standard of managing snag levels to two per acre in the defense zone would be met. Firefighter safety would be better provided than by Alternative A, because most large dead trees would be removed within the areas having greater than 75% mortality (2,856 acres (31%)) and some or all of the 2,832 acres (30%) predicted to have greater than 75% mortality within 3 years.

However, SNFPA standards in Old Forest Emphasis Areas prevent removal of dead trees larger than 15 inches dbh where stand mortality is less than 75%, in California spotted owl protected activity centers (PACs), goshawk management areas (GMAs), 10% required snag retention areas, and to varying widths in riparian conservation areas (RCAs) (3,631 acres (39%)). Therefore, an estimated 69 to 89% of the analysis area could contain numerous large snags and heavy fuel loadings. Reference Alternative A for the impacts that the numerous snags and heavy fuel loadings would have on fire suppression options, future vegetation management, and conducting prescribed burns.

Resistance to Control – With mechanical fuel treatments on 1,060 acres within the Defense and Threat Zones, fuel loadings and vegetation conditions would be within SNFPA standards for doubling fireline production rates after treatment for approximately 20 to 30 years on that acreage -- especially, if the shrub growth is mechanically treated every 10 to 15 years. Rates of spread would range from 2 to7 chains per hour and flame lengths from 1 to 4 feet. After approximately 30 years, the trees within the mechanically treated areas should be large enough that prescribed fire could again be considered as a tool to maintain the fuel loadings to SNFPA Standards. (Ref. Appendix G).

As with Alternative A, it is unknown at this time if the increased overall fuel loadings under this alternative would increase the frequency of fire starts (Ref. Affected Environment). However, the number of fires that exceed 10 acres in size would be expected to increase. Alternative B would improve resistance to control from 0.07 chains/hour/person at year-30 in a stand with extreme fuel loading (405 tons/acre) to 0.20 chains/hour/person (Tables 3-3, 3-5).). Heavy fuel loadings resulting from logging slash left to meet ground cover requirements, along with other resource objectives, would still impede line construction over approximately 4,628 acres (50% of the Forest Service lands within the Analysis

Area).

This alternative would not improve the ability to conduct initial attack. An FBPS fuel model 12 would be expected in high tree mortality areas after removal of the merchantable size dead trees. Under 90th percentile weather conditions the expected rates of spread on a 40% slope would exceed 9 chains per hour and flame lengths would exceed 5 feet (Appendix G). In contrast, Alternative A would not be in this condition until 10 years later.

As with all alternatives, lightning should remain as the principal ignition source within the analysis area. Wildland fire suppression costs should increase, but not nearly to the extent of Alternative A. The increase in cost is due to the increased time to mop-up the residual heavy fuel loadings outside the mechanically treated areas, the large amounts of coarse woody debris within the non-harvest areas, the resistance to control level achieved, and the expected increase in fires that exceed 10 acres in size.

Shrub growth within the first 5 years would gradually tend to dampen fire indices slightly due to considerably higher fuel moistures, than in similar size dead fuels (Agee 1996). This damping effect would tend to increase as shrub growth increases for approximately 20-40 years, until shrub decadence and the higher fuel moistures in the live portions of the shrubs reach some equilibrium. After that point, the damping effect subsides as the shrubs become more available as part of the overall available fuel bed due to senescence (Agency experience on chaparral covered terrain). Therefore, the rock and shrub areas (384 acres) should act as barriers to fire spread for approximately 20 to 40 years.

The fuel conditions and the resulting effects within the 10% unsalvaged patches (460 acres) and RCA buffers (625 acres) would be the same as conditions described for Alternative A. These unsalvaged patches would create management problems for any future suppression actions or fuels treatment projects that occur within or near them.

Reference Alternative A, Table 3-1, for the assumptions and reasoning for the incorporation of the following table. The information below is from representative areas within the Red Star Restoration analysis area and is included to show the range of predicted fuel loadings under this alternative, and Alternatives C and D. T5, under stand 310.1b, was included to show the expected heat outputs from the mechanically treated areas if fuel loadings were reduced to the desired condition of 10 to 20 tons per acre for the Defense and Threat Zones and SPLATs.

Fire suppression actions in the future would be somewhat to considerably less expensive, and resistance to control would be generally less than under Alternative A. General, fire suppression costs would be less than the costs under Alternative A due to the removal of most of the larger fuels from approximately 61% of the analysis area, and the 1,060 acres of mechanical fuels treatment.

Table 3-4: Alternative B: Estimated Fuel Accumulation of the 0-8 " Size Fuels Over 30 Years (tons/acre) **and Heat Outputs** (BTUs/sq. ft.)

Plot 290.2a (32 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	0.55	1.61	1.45	8	4	3,122	4,481
30	0.26	1.13	1.16	6	0	1,928	2,883

Plot 310.1b (128 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	2.03	4.48	5.410	49	4	19,123	23,494
30	1.02	3.14	4.33	37	1	11,811	14,896
T5	1.62	3.14	2.51	12	4	4,683	7,328

Plot 305.1b (72 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	1.42	2.85	3.24	21	4	8,430	11,192
30	0.71	2.00	1.94	16	1	6,244	7,934

Plot 290.7 (315 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	4.06	10.08	13.86	111	4	43,320	53,065
30	2.03	7.06	11.09	83	2	26,676	34,096

Plot 290.1a-1b.15 (201 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	3.68	6.95	8.53	69	4	26,928	33,980
30	1.84	4.87	6.82	52	1	16,713	21,672

Plot 310.1a-1b.9 (523 tons/ac.)

Year	1hr	10hr	100h	1000hr	Snags/Acre	1000hr+ BTU Output.	Total BTU Output
3	4.74	9.86	16.97	193	4	75,321	86,928
30	2.37	6.90	13.58	145	2	46,602	55,013

As with Alternative A, the 30-year heat outputs would drop over the next 70 years due to decay, but this drop would be counterbalanced by the increase in output from the increasingly decadent shrub growth.

The table below illustrates the difficulty fire suppression resources would encounter trying to control any wildland fire that may occur within the Analysis Area under this Alternative, and again Alternatives C and D (Ref. Alternative A).

Table 3-5: Alternative B: Resistance to Control (Production Rates) within 3 and 30 Years

USDA Forest Service GTR-PNW-95 & PNW-114)

Plot	Year	Code	(40% Slope) (ch/hr/person) Production Rate (ch/hr)	Adjustment (due to loadings of the various fuels)	Adjusted Production Rate
290.2a	3	3MC3PC	2.00	1.00	2.00
	30	1MC4RC	2.50	1.00	2.50
310.1b	3	5TF4RC	1.75	0.60	1.05
	30	4TF4PC	0.40	1.00	0.40
305.1b	3	2MC4RC	0.61	1.00	0.40
	30	4TF4RC	0.90	1.00	.0.90
290.7	3	3MC4RC	0.34	0.75	0.26
	30	5TF4PC	0.37	1	0.37
290.1A	3	6TF4RC	0.41	1.00	0.41
1b15	30	8MC3PC	0.84	1.00	0.84
310.1a	3	3MC4RC	0.33	0.50	0.17
1b9	30	3MC4RC	0.33	0.60	0.20

Additionally, running the data from the above stands through the 1976 Region 5 Resistance to Control Calculation Matrix gives all stands without mechanical fuels treatment a numerical rating of 12+; an adjective rating of Extreme. As an example of what the adjective ratings equate to, "High" resistance to control means "slow work for dozers, very difficult for hand crews; hand line holding will be difficult" (Brown et al 2001).

As stated in Alternative A, the above production rates do not incorporate shrub growth. Based on a Forest Service research document (source unknown), if 75% of the site is occupied by an understory of manzanita, the fuel loading from the shrubs would be 15 tons per acre, and the shrub growth alone would create a resistance to control of High. Since we expect considerable shrub growth within the moderate and high severity areas, the above production rates are considered maximums for the next 30 to 100 years.

Soil Effects – Areas outside of SPLATs and low mortality areas (approximately 80 to 86% of the area) would contain heavy fuel loadings. FOFEM modeling indicates high mortality rates and lethal soil heating to several centimeters in depth for long periods of time (Ref. Soil Heating Graphs and Tree Mortality in Appendix G).

The FOFEM model predicted surface fuel soil heating for the data from four stands with a range from the lightest to the heaviest fuel loadings. This data indicate that lethal temperatures would extend several centimeters deep and would last for extended periods of time, except for the in areas with the lightest fuel loadings (Ref. Soil Heating Graphs- Appendix G). Plot (290.2a) with the lightest fuel loading indicates that areas with fuel loadings under 20 tons/acre would have limited soil-heating impacts. The lethal temperature of 60° (C) would penetrate the soil to approximately 2 centimeters for approximately 50 minutes. The other three stands, which are more representative of the general fuel loadings within the analysis area, show lethal heating to 10 centimeters in depth for extended periods. The modeling shows show lethal heating to 10-centimeters in depth within all three of these stands, but the length of heating is less than under Alternative A.

Cumulative Effects

Based on the information in Table 3-2, any future large wildland fire within the next 50 to 100 years in this area would have a tendency to convert pre-Star Fire forested areas that burned with moderate to high severities to shrub fields (SNEP 1996; Agee 1993). Due to the high heat productions that would be produced, low production rates, and high rates of spread, it would be very difficult to keep any fire that escapes initial attack within the perimeter of the Star Fire. Based on the prevailing winds and the movement of the Star Fire, if a fire escapes initial attack under 90th percentile or greater weather conditions, the likely scenario is that it would continue up into the headwaters of Duncan Canyon. Alternative A reaches a similar condition, however, in a longer time span, 20 to 30 years.

Without additional future fuels treatment within in the burn area the fire hazard and the chances of a fire escaping should increase as the shrub growth becomes more decadent, the remaining snags fall to the ground, and overall fuel loadings increase. The area would not meet SNFPA (2001) direction. Any future fire in this area that escaped initial attack would produce very high severities within the Star Fire created shrub/conifer stands. The areas that previously burned with moderate to high severities would most likely burn with high severities due to the excess large fuel loadings and decadent shrub growth. Consideration for various resource objectives within warm, dry forest types indicates that the optimum quantity of downed coarse woody debris (CWD) (greater than 3 inches diameter) is about 5 to 15 tons per acre (Brown et al 2001). A "reburn" involving optimum quantities of CWD should not lead to unusually severe fire effects (Brown et al 2001). Under this Alternative, the CWD significantly exceeds optimum levels.

There are two approved vegetation and fuels management treatments adjacent to the analysis area. The End of the World Timber Sale is to the west and upslope of the Star Fire origin. The French Helicopter Timber Sale is located on a south aspect between French Meadows Reservoir and Red Star Ridge. This alternative would not support the planned "fuels management zone" development over the next five years within the End of the World project area (Ref. Alternative A Fuels). The planned work creates fuel-loading conditions that are identical to the SPLATs proposed under this alternative. The proposed SPLATs under this alternative are smaller and narrower than the ones being developed in the End of the World project. The scattered 18 small and linear SPLATs would not tie in to the work planned under the End of the World project. The long-term fuel loading and vegetation conditions created by this alternative would lower the effectiveness of the treatments being conducted within the End of the World project area.

The French Helicopter Timber Sale commercially thins 918 acres within selected units. Slash is being piled within 50 feet roads. There is no discussion in the project files of any other fuels treatments being conducted. Therefore, we would expect open stands with moderate to heavy slash loadings of 0-10 inch diameter material. The representative fuel model for these thinned stands would be FBPS fuel model 11 (moderate logging slash). The representative FBPS model for the adjacent Red Star Restoration analysis area under this Alternative is 11. These fuel-loading conditions on both sides of this section of Red Star Ridge would create problems in confining any fire to only one side of the ridge.

The private lands will be or have been logged. It is unknown if any additional fuels treatment will be conducted on the private lands. If additional fuel treatments were not conducted, the expected fuel loadings would average approximately 70 to 80 tons per acre. That would be similar to the expected average fuel loadings on Forest Service lands under this alternative.

The proposed fire restoration work on the Eldorado National Forest portion of the Star Fire would be similar and complementary to the planned work in this document.

Alternative C

Increases area where flame length standards would be met over Alternative B by 16%

Meets goal to have 30-40% of area in SPLAT condition (31%) and increases SPLAT size and improves locations to improve overall effectiveness.

Provides complete fuel treatment on more acres than any alternative.

Improves meeting fireline production goals better than any alternative.

Provides best, out of all the alternatives, for firefighter safety.

Less area subject to lethal soil temperatures in case of another catastrophic fire.

The SPLAT acreage (1240) within the IRA would be converted to a shrub field through prescribed burning (helitorching) the area in about 20-30 years. This SPLAT would be maintained as shrub field through periodic (every 20-40 years) helitorch prescribed burns.

The SPLAT acreage outside the IRA would be treated by various methods to the desired condition of having a vegetation and fuels mosaic that would produce flame lengths less than 4 feet under 90th percentile weather conditions.

Direct and Indirect Consequences

Reduce the amount and intensity of uncharacteristically severe wildfire

Flame Lengths – Effects would be the same as Alternative B for meeting flame lengths, except that the amount of area treated is one percent less due to the increased RCA no-treatment width. Where low severity fire occurred, in SPLATs and in existing shrub fields, an estimated 31 to 41% of the area (2,923 to 3,855 acres) would meet this ARSG over the next 30 years.

Fire Severity/Size – Effects would be similar to those described for Alternative B, except that desired fuel conditions (10 to 20 tons/acre) are achieved over a much more extensive and strategically located areas. Fuel objectives would be achieved on a minimum of 31% of the area versus 15% under Alternative B. Effects of untreated areas would be the same as described in Alternative A.

SPLATs – This alternative increases the acreage within the SPLATs by 175% (1,863 acres) over Alternative B. It would meet the SNFPA goal of creating SPLATs and treating fuels strategically across 30 to 40% of the landscape; this Alternative treats 31% of the landscape to desired levels. Combining the proposed fuels treatment (2,923 acres) acreage with the predicted low mortality acreage, 31 to 41% (2,923 to 3,855 acres) of the landscape would have fuels loadings at vegetation conditions within acceptable levels. This alternative would create approximately 2,043 acres of SPLATs outside the Defense and Threat Zones (Ref. Map, Appendix A).

Reintroduce prescribed fire into the ecosystem

In approximately 10 to 30 years, this alternative would also allow more options of returning prescribed fire to these fire dependent forest types due to the extent of fuel treatments, size and location of the SPLATs,shrub patches, and low mortality areas. After approximately 30 years, the trees within the mechanically treated areas should be large enough that prescribed fire (underburning) could again be considered as a tool to maintain the fuel loadings to SNFPA Standards within these three areas (Ref. Appendix G). Prescribed fire should become an available tool within the low mortality areas (estimated 5-10% of the area) within approximately 10 years.

This alternative would come closer than Alternative B to meeting the Beschta Report (1995) management goal to preserve (and re-establish) fire and other disturbance regimes that maintain ecological systems and processes, while protecting human life and property. It would achieve historical natural fuel conditions on a larger portion of the landscape (a minimum 2,923 acres (31%) to an estimated maximum 3,855 acres (41%) versus 11% to 25% of the landscape in Alternative B).

Outside the SPLATs the reintroduction of prescribed fire effects and opportunities would be the same as Alternative A and B.

Reduce the threat of wildfire damage to human communities and natural resources

Firefighter Safety

This alternative achieves snag objectives similar to Alternative B.

The location and low fuel loadings within the three main SPLATs would provide for firefighter safety and suppression options for a minimum of 20 to 30 years. The increased options would help confine any future fire that escapes initial attack to the areas between any two main SPLATs. The planned treatment would create three large SPLAT zones, plus several small ones. These areas with desirable vegetative conditions and low fuel loadings would provide excellent areas for firefighters to work within during any future escaped fire. Firefighter safety would be better provided than by Alternatives A or B.

Resistance to Control – This alternative meets SNFPA standards for doubling fireline production rates on 2, 923 acres within 5 years. Rates of spread would range from 2 to 7 chains per hour and flame lengths 1 to 4 feet. This would more than double the number of acres (a 1,896 acre increase) meeting this standard over Alternative B. In other treatment areas, the fireline production rates would be the same as Alternative B, and in non-treatment areas the same as Alternative A.

The completion of the fuels treatments within the three areas would reduce the chances of any future fire getting as large as the Star Fire. The probability of another fire getting as large as the Star Fire under this alternative would be considerably less than under Alternatives A and B. There are no tools, papers, or processes to demonstrate any changes in the probability of another large fire, but the proposed fire management strategy of creating strategically located blocks with low fire behavior indices under 90th percentile weather conditions would tier to the strategy of the SNFPA (2001). The location and low fuel loadings of the three main SPLATs provide for firefighter safety and suppression options for a minimum of 20 to 30 years. The increased options should help confine any future fire that escapes initial attack to the areas between any two main SPLATs.

Due to the additional acreage with low fuel loadings, future fire suppression costs would be expected to be lower than those under Alternative B, due to the additional, strategically located 1,863 acres with low fuel loadings.

The fuel conditions and the resulting effects within the unsalvaged patches and RCAs (1,085 acres) would be as those described under Alternative A. These unsalvaged areas would create management problems for any future suppression actions or fuels treatment projects that occur within or near them. They would greatly decrease the effectiveness of the SPLAT on top of Red Star Ridge. Within 10 years, any fire within these unsalvaged areas would be very intense (FBPS Model 12) and they would produce considerable long-range spotting under 90th percentile and greater weather conditions.

Soil Effects - Lethal temperature effects to soils are similar as described in Alternative B, except that it would affect approximately 59 to 69% of the area versus 74 to 85% under Alternative B. More acreage under this alternative would have soil temperatures similar to those that would be experienced under

Alternative A, due to the increased acreage of PACs and RCAs than Alternative B.

Cumulative Effects

Based on the information in Table 3-2, any future large wildland fire in this area outside the low fuel loading areas (SPLATs, shrub patches, and very low mortality areas, under this alternative, would have a tendency to convert pre-Star Fire forested areas that burned with moderate to high severities to shrub fields (SNEP 1996; Agee 1993). However, this effect would be slightly less under this alternative than Alternative B due to the development of the SPLATs and additional mechanically treated acreage (1,863 acres). As under all alternatives, due to the high heat productions that would be produced, low production rates, and high rates of spread over a majority of the analysis area, it would very difficult to keep any fire that escapes initial attack within the perimeter of the Star Fire. However, the development of the SPLATs would give firefighters strategically located safer areas to work from at the beginning of any escaped wildland fire.

SNFPA standards would continue to be met for 20-30 years: Shrub growth would be mechanically treated every 10-15 years. No herbicide treatments are being planned. Prescribed burning (underburning) would become an available option within the low mortality areas in approximately 10 years; approximately, 25-35 years within the SPLATs; and 20-40 years (helitorch burning, or other technology advancements that may be available) within the shrub fields.

There are two approved vegetation and fuels management treatments adjacent to the analysis area. The End of the World Timbre Sale is to the west and upslope of the Star Fire origin. The French Helicopter Timber Sale is located on a south aspect between French Meadows Reservoir and Red Star Ridge. This alternative would support the planned "fuels management zone" (FMZ) development over the next five years within the End of the World project area (Ref. Alternative A – Fire and Fuels). The planned work creates fuel-loading conditions that are comparable to the SPLATs proposed under this alternative. The proposed SPLATS under this alternative are much wider and more extensive than the ones being developed in the End of the World project. The proposed SPLAT along Road 96 would connect to the FMZ being created along the End of the World portion of the 96 Road.

The French Helicopter Timber Sale commercially thins 918 acres within selected units. Slash is being piled within 50 feet roads. There is no discussion in the planning records of any other fuels treatments being conducted. Therefore, would expect open stands with moderate to heavy slash loadings of 0 to 10 inch diameter material. The representative fuel model for these thinned stands would be FBPS fuel model 11 (moderate logging slash). The representative FBPS model for the adjacent area under this alternative, outside the SPLATs would also be an 11. These fuel-loading conditions on both sides of this section of Red Star Ridge could reduce the effectiveness of the SPLAT zone within the IRA by allowing a future fire to burn rapidly around the edge of or spot over the IRA SPLATs.

The private lands will be or have been logged. It is unknown if any additional fuels treatment will be conducted on the private lands. If additional fuel treatments were not conducted, the expected fuel loadings would average approximately 70 to 80 tons per acre. That would be similar to the expected average fuel loadings on Forest Service lands under this alternative. As with the Forest Service system lands located outside the SPLATs, this heavy fuel loading would reduce the effectiveness of the adjacent SPLAT acreage.

The proposed fire restoration work on the Eldorado National Forest portion of the Star Fire would be similar and complementary to the planned work in this document.

Alternative D

The difference between Alternative C and Alternative D is the non-treatment of the dead trees larger than

20 inches dbh within the old forest emphasis area (OFEA). This alternative would not remove any dead trees greater than 20 inches dbh within the OFEA.

Alternative D would leave 70 tons/acre more of dead fuels than Alternative C in OFEA.

The removal of dead trees within the Defense and SPLAT areas is identical for the two alternatives.

Less safe for firefighters to work in OFEA where a high number of trees larger than 20 inches dbh are left.

Direct and Indirect Consequences

Reduce the amount and intensity of uncharacteristically severe wildfire

Flame Lengths- Effects would be the same as Alternative C within SPLATs and the Defense Zone. Effects would the same as Alternative A in the non-treated areas, and slightly less than Alternative A in the Old Forest Emphasis Areas.

Fire Severity/Size- Effects are the same as Alternative C in SPLATs and the Defense Zone. The proposed treatments would reduce to some extent the chances of any future fire from getting large, however, it would be less effective than Alternative C because of leaving an estimated average of 70 tons per acre higher fuel loading in the Old Forest Emphasis Area. Effects would be the same as Alternative A in the non-treated areas. The effects would be closer to Alternatives A than B and C due to having overall fuel loadings slightly less than Alternative A in the OFEA (175 tons per acre compared to 155 tons per acre).

SPLATs – This alternative would implement SPLATs as described under Alternative C. However, an overall additional 70 tons/acre of fuel loading and numerous large snags (average of 19 to 26 large dead trees per acre) within the 6,380 acres of OFEA outside the SPLATs (68% of the Analysis Area) would make these SPLATs considerably less effective than under Alternative C. Due to the large increase in heat intensities (31, 221 BTUs/sq ft.) and long range spotting expected under this alternative, the SPLATs would not expected to be especially effective under 90th percentile and higher weather conditions.

Reintroduce prescribed fire into the ecosystem

As with Alternative C, but to a much lesser degree, this alternative would meet the Beschta Report (1995) management goal to preserve (and re-establish) fire and other disturbance regimes that maintain ecological systems and processes, while protecting human life and property. It would allow more flexibility in future vegetation management and fire suppression options, reduce future fire severities over a minimum of 32% of the analysis area (excluding private lands), and establish three strategically located fuels treatment areas (Ref. Map, Appendix A). Except within the SPLATs and low mortality areas, the rest of the analysis area would have fuel loadings that would prevent the use of prescribed fire for a minimum of 50 to 100 yearswithout some form of very expensive fuels removal. As with all the alternatives, burning these excessive accumulations in place through jackpot or pile and burning projects during the next decade would not meet the soil objective of maintaining 75% soil cover and would severely heat to several centimeters the soil profile (Ref. Soil Heating Graphs – Appendix G).

Reduce the threat of wildfire damage to human communities and natural resources

Firefighter Safety – Firefighter safety in the SPLATs and Defense Zone would be the same as Alternative C. Outside those areas it would be less safe due to the high number of large snags and heavy fuel loadings left.

Resistance to Control – Effects would be the same as Alternative C, except resistance to control and fireline production rates would be greater in OFEA due to the leaving an estimated average of 80 tons per acre higher fuel loadings.

However, the number of fires that exceed 10 acres in size would increase due a large increase in the resistance to control from to the heavy fuel loadings over a minimum of 6,396 acres (68%). Wildland fire suppression costs would be less than Alternative A but higher than Alternatives B, C, and E.

Soil Effects - Lethal temperature effects to soils would be similar to those described in Alternative B, except that the effect would be limited to a smaller area, 59 to 69% of the area versus 74 to 85% of the area in Alternative B. Soil heating effects would be considerably greater under this alternative compared to Alternative C due to the heavier fuel loadings within the harvested areas outside the SPLATs.

Cumulative Effects

Based on the information in Table 3-2 and the Soil Heating Graphs, any future large wildland fire in this area, under this alternative, would have a tendency to convert pre-Star Fire forested areas that burned with moderate to high severities to shrub fields (SNEP 1996; Agee 1993). However, this effect would be slightly less under this alternative than Alternative A due to the development of the SPLATs and the removal of approximately 3 to 4 mbf of dead trees within the OFEA. The development of the SPLATs would give firefighters strategically located safer areas to work from at the beginning of any escaped wildland fire. However, as under all alternatives, due to the of very high heat production from the very heavy fuel loadings over a majority of the area, low production rates, and high rates of spread created from the expected shrub growth over the next 30 years and steep slopes, keeping any fire within the analysis area from escaping would be very difficult. Any fire that does escape initial attack at 90th percentile and higher weather conditions within the next 50 to 100 years would burn at very high severities and would be expected to exceed several thousand acres in size.

There are two approved vegetation and fuels management treatments adjacent to the analysis area. The End of the World Timber Sale is to the west and upslope of the Star Fire origin. The French Helicopter Timber Sale is located on a south aspect between French Meadows Reservoir and Red Star Ridge. This alternative would support the planned "fuels management zone"(FMZ) development over the next five years within the End of the World project area (Ref. Alternative A Fuels). The planned work creates fuel-loading conditions that are similar to the SPLATs proposed under this alternative. The proposed SPLATS under this alternative as with Alternative C are much wider than those developed with End of the World project. The proposed SPLAT along Road 96 would connect to the FMZ along the End of the World portion of the 96 Road. The additional overall average of 80 tons per acre of fuel loading above Alternative C would greatly reduce the effectiveness of the SPLATs and the FMZs.

The French Helicopter Timber Sale commercially thins 918 acres within selected units. Slash is to be piled within 50 feet roads. There is no discussion in the planning files of any other fuels treatments. Therefore, would expect open stands with moderate to heavy slash loadings of 0-10 inch diameter material. The representative fuel model for these thinned stands would be FBPS fuel model 11 (moderate logging slash). The representative FBPS model for the adjacent area under this alternative, outside the SPLATs, would be a 12. These fuel-loading conditions on both sides of this section of Red Star Ridge would reduce the effectiveness of the SPLAT zone within the IRA by allowing a future fire to burn rapidly around the edge of the IRA SPLATs.

The private lands will be or have been logged. It is unknown if any additional fuels treatment will be conducted on the private lands. If additional fuel treatments were not conducted, the expected fuel loadings would average approximately 70 to 80 tons per acre. That would be considerably less than the expected average fuel loadings on Forest Service lands under this alternative. The combination of heavy fuel loadings on private lands and very heavy fuel loadings on public lands would considerably reduce the effectiveness of the adjacent SPLAT acreage.

The proposed fire restoration work on the Eldorado National Forest portion of the Star Fire would be similar and complementary to the planned work in this document.

Alternative E

No SPLATs would be created within the Duncan Caynon IRA.

Would not meet goal to create SPLATs on 30 to 40% of the landscape.

Would not provide any safe place for firefighters to work in the IRA.

Any fire that escapes initial attack within this area, under 90th percentile and higher weather conditions, would be expected to burn with very high severities in the majority of the IRA.

Direct and Indirect Consequences

Reduce the amount and intensity of uncharacteristically severe wildfire

Flame Lengths – This alternative wouldMeet flame length goals in the Defense Zone the same as Alternative C. Outside of the Defense Zone, it meets it on fewer acres than Alternatives B and C due to lack of treatment in the IRA.

Fire Severity/Size - Future fire severities would be reduced over a minimum of 18% of the analysis area (excluding private lands), including two strategically located fuels treatment areas (Ref. Map, Appendix A). The completion of the fuels treatments within the two areas would reduce to some extent the chances of any future fire getting large. It would do it to a much smaller degree than Alternative C due to the non-development of the SPLAT and the heavy fuel loadings within the IRA.

SPLATs – SPLAT and Defense Zone treatments would be the same as described under Alternative C, except that no SPLATs would be created in the Duncan Canyon IRA. This alternative would not meet the SNFPA goal of creating SPLATs and treating fuels strategically across 30 to 40% of the landscape (18%). Fuels treatments would be less effective than those described under Alternative C as the result of leaving an average overall additional 71 tons/acre of fuel loading in CWD (tree boles), leaving numerous snags (8 to 84 per acre standing at year 30 (Ref. Alternative A)), and not creating the SPLAT Zone within the IRA.

Reintroduce prescribed fire into the ecosystem - In approximately 20 to 30 years, this alternative would allow returning fire to these fire dependent forest types only within those areas where fuel loadings are less than 25 to 30 tons per acre. This condition would be expected in the SPLATs and Defense Zone or within the low-severity areas of the Star Fire, an estimated maximum of 2,615 acres. The rest of the analysis area should have fuel loadings that would prevent the extensive use of prescribed fire for a minimum of 50 to 100 years.

This alternative would meet the Beschta Report (1995) management goal to preserve (and re-establish) the fire and other disturbance regimes that maintain ecological systems and processes, while protecting human life and property on a minimum 1,683 acres (18%) to an estimated maximum 2,615 acres (28%). This is within a similar range for Alternative B, but less than Alternatives C and D.

Reduce the threat of wildfire damage to human communities and natural resources

Firefighter Safety - The location and low fuel loadings of the two main SPLATs would provide for firefighter safety and some suppression options for a minimum of 20-30 years within the western section of the analysis area. The effects are the same as discussed for Alternatives C and D.

Firefighter safety would be better provided than under Alternatives A. In one area, it would provide for firefighter safety better than Alternative B (SPLAT development); however, due to the large numbers of large dead trees within the IRA, it would be less safe than Alternative B within the IRA. This alternative proposes to treat fuels to 10 to 20 tons per acre levels, within the next five years where needed, on approximately 1,683 acres, compared to the 1,060, 2,923, and 2,923 acres under Alternatives B, C, and D, respectively. The conditions within the IRA would be identical to those described under Alternative A. Alternative C provides more protection for firefighter safety than this alternative. Alternative D proposes to mechanically treat more acres than this alternative, but leaves 19 to 26 dead trees greater than 20 inches dbh within approximately 6,380 acres of OFEA. The planned mechanical treatment areas would help create two large SPLAT zones, plus several small ones within the western portion of the analysis area. These areas with desirable vegetative conditions and low fuel loadings would produce flame lengths less than four feet under 90th percentile weather conditions, low to moderate resistance to control, and low snag numbers. These elements would create excellent areas for firefighters to work within during any future escaped fire. There would be no safe areas within the IRA for firefighters to work from, and all future escaped wildland fire suppression actions in this area would be limited to indirect strategies.

Resistance to Control – Within the 1,683 mechanically treated acres, this alternative would meet the ARSG for doubling production rates within five years (Ref. Table 3-4). This alternative would double fireline production rates on 18% of the area. This would be greater than Alternatives A and B, but not as high as Alternatives C and D

Based on Forest experience, the risk of another severe wildland fire under this alternative would be less than under Alternatives A, B, and D, however greater than Alternative C. There are no tools, papers, or processes to demonstrate any changes in the probability of another large fire between the five alternatives, but the proposed fire management strategy of creating strategically located blocks with low fire behavior indices under 90th percentile weather conditions would tier to the strategy of the SNFPA (2001). As with Alternative C, the increased options would help confine any future fire that escapes initial attack west of Mosquito Ridge Road to the areas between the two main SPLAT zones. However, due to the large increase in heat intensities (27,709 BTUs/sq ft.), long range spotting, extreme resistance to control, lack access, the numerous large snags, fire, and no SPLATs, suppression strategies would be very limited and tactics ineffective within the IRA. Any fire that escapes initial attack within this area, under 90th percentile and higher weather conditions, would be expected, at a minimum, to burn with very high severities a majority of the IRA.

Outside the IRA, the resistance to control would be identical to Alternative C; however, it would be much greater within the IRA. Outside the IRA, the suppression costs would be similar to Alternative C and less than Alternatives B and D.

The fuel conditions and the resulting effects in untreated areas would be the same as described under Alternative A.

Soil Effects - Lethal temperature effects to soils would be similar to those described in Alternative B, except that the effect would be limited to a nominally smaller area (71 to 82% of the area versus 74 to 85% of the area in Alternative B).

Cumulative Effects

Based on the information in Table 3-2 and the Soil Heating Graphs, any future large wildland fire in this area would have a tendency to convert pre-Star Fire forested areas that burned with moderate to high severities to shrub fields as the result of this alternative (SNEP 1996; Agee 1993). However, this effect would be slightly less under this than Alternative A due to the development of the SPLATs and the removal of the dead commercial sized trees outside the IRA. The development of the two SPLATs would give firefighters strategically located safer areas to work from in the western portion of the analysis area at the beginning of any escaped wildland fire. The risk to firefighter safety would high within the IRA, essentially the same as those described under Alternative A. Preventing a fire from escaping the analysis area would be very difficult under this alternative as the result of a number of factors: very high heat productions resulting from the very heavy fuel loadings in the IRA; low production rates; high rates of spread created from the expected shrub decadence starting in 25-30 years; and steep slopes. Any fire that does escape initial attack at 90th percentile and higher weather conditions within the next 50 to 100 years would burn at very high severities and would be expected to be at a minimum several thousand acres in size. If fire escapes within the IRA, it is estimated by several experience wildland firefighters that the entire IRA and a significant amount of adjacent acreage would be impacted by a high to extreme severity fire.

As with Alternatives C and D, there would be partial to complete accomplishment of fire restoration and fuels treatment objectives and goals under this alternative. This alternative would initiate the SNFPA (2001) desired condition for the identified Defense and Threat Zones, SPLATs (Ref. Map, Appendix A), and the landscape, but it would not accomplish all of these goals.

There are two approved vegetation and fuels management treatments adjacent to the analysis area. The End of the World Timber Sale is to the west and upslope of the Star Fire origin. The French Helicopter Timber Sale is located on a south aspect between French Meadows Reservoir and Red Star Ridge. This alternative would support the planned "fuels management zone"(FMZ) development over the next five years within the End of the World project area (Ref. Alternative A Fuels). The planned work creates fuel-loading conditions that are similar to the SPLATs proposed under this alternative. The proposed SPLATS under this alternative as with Alternative C are much larger than those developed with the End of the World project. The proposed SPLAT along Road 96 would connect to the FMZ along the End of the World portion of the 96 Road

The French Helicopter Timber Sale commercially thins 918 acres within selected units. Slash is to be piled within 50 feet roads. There is no discussion in the planning files of any other fuels treatments. Therefore, would expect open stands with moderate to heavy slash loadings of 0-10 inch diameter material. The representative fuel model for these thinned stands would be FBPS fuel model 11 (moderate logging slash). The representative FBPS model for the adjacent area under this alternative would be a 12. As with Alternative A, these fuel-loading conditions on both sides of this section of Red Star Ridge would create problems in confining any fire to only one side of the ridge.

The private lands will be or have been logged. It is unknown if any additional fuels treatment will be conducted on the private lands. The impact would be the same as those discussed under Alternative C.

The proposed fire restoration work on the Eldorado National Forest portion of the Star Fire would be similar and complementary to the planned work in this document.

Air Quality

Summary of Effects:

- All action alternatives are in compliance with the General Conformity rule.
- Implementation of any action alternative would impact air quality by increasing the amount of PM_{10} and precursors to ozone that are in the air and would reduce visibility for short periods of time. Increases in PM_{10} and precursors to ozone would not be significant.
- Removing trees would reduce the amount of fuel available to burn and thus would reduce the potential amount of PM_{10} and ozone that would be produced and put into the atmosphere, when a wildfire burns. Trees removed would be considered emissions saved.

Affected Environment

The Red Star analysis area lies entirely in Placer County. There are no communities within or adjacent to the project.

Sensitive Areas

The community of Foresthill is approximately 14 miles west, southwest. Desolation Wilderness, a Class I Area, is approximately 13 miles southeast. Very little air quality degradation is allowed for visibility and other air quality related values in Class I Areas.

French Meadows reservoir is adjacent to the analysis area, and due to the high recreation use at certain times of the year, could be considered a sensitive area for visibility and smoke management considerations.

Occasional impacts to air quality within the analysis area occur from wildfires, prescribed burns, fugitive dust from logging, and recreational activities. These activities are conducted on both public and private lands within the area.

Table 3-6 and 3-7 (below) represent estimated wildfire and prescribed fire emissions as listed in the SNFPA.

Table 3-6: PM_{10} Emissions from Wildfires on the Tahoe National Forest

Year	Tons	Year	Tons	Year	Tons

1981	19	1986	42	1991	10
1982	10	1987	4499	1992	21
1983	5	1988	264	1993	6
1984	227	1989	65	1994	20,472
1985	32	1990	213	1995	236

Table 3-7: PM_{10} Emissions from Prescribed Burns on the Tahoe National Forest

Year	Tons
1996	786
1997	1095
1998	877

Table 3-8 (below) represents the volume harvested from the Tahoe National Forest in the 5 years prior to the publication of the Conformity Rule.

Table 3-8: Tahoe National Forest Harvest Volumes

Year	MMBF Harvested	Year	MMBF Harvested
1988	256	1991	95
1989	129	1992	73
1990	130		

Regulatory Framework

The U.S. Congress enacted the Clean Air Act (CAA) of 1963 followed by a number of amendments in 1970, 1977 and 1990 to further improve air quality in the nation. In 1970, the U.S. Environmental Protection Agency (EPA) published a list of six major pollutants ("criteria pollutants") that could endanger public health and welfare. For each criteria pollutant, EPA established National Ambient Air Quality Standards (NAAQS) following studies documenting pollutant exposures leading to harmful effects. Areas that were below the standards were declared in "attainment" and those that exceeded the standards were declared in "non-attainment". For non-attainment areas, the States are required to prepare a State Implementation Plan (SIP) with actions to bring areas back to attainment. The plan must specify measures, rules, and regulations that provide for further progress in achieving annual incremental reductions in the specified pollutants.

The current ozone level in Placer County violates State and Federal standards and the county is classified as severe "non-attainment" for ozone.

Ozone production varies significantly with changing atmospheric conditions and models are not available to predict ozone formulation from project emissions. Instead, emissions of ozone precursors (NO_X and VOCs, compounds that produce ozone when they break down) are usually modeled to help predict the effects of a project.

Although the analysis area is classified as "attainment" by Federal standards for PM_{10} (Particulate matter less than 10 microns), it is classified as "non-attainment" by State standards in both counties. PM_{10} is particulate matter less than 10 microns in diameter and is associated with adverse human health effects.

The closest PM_{10} monitoring stations to the analysis area are located in downtown Truckee, 21 miles to the northeast and Colfax, 22 miles to the west. These monitoring stations show that it is not unusual for the areas to exceed the State's PM_{10} standard. However, it is unusual for the Federal standard to be exceeded. The Federal standards were exceeded in Truckee on August 29th, 2001, during the Star fire. There were no exceedences in 2001 for the Colfax station (personal communication, Ann Hobbs).

Section 176 of the Clean Air Act requires that federal actions conform to the State Implementation Plan (General Conformity Rule 58 FR 63214). The General Conformity Rules were published in November, 1990. It states that in federal non-attainment areas, before actions can be taken on federal lands that have the potential to emit pollutants to the atmosphere, a determination must be made that the emissions will not cause or contribute to any new violation of any standard in any area, increase the frequency or severity of any existing violation of any standard in any area or delay timely attainment of any standard or any required interim emission reductions or other milestones in any area. If the project emissions were below de minimis levels, the project would be considered exempt from Conformity determination. In addition, if the SIP emission inventory includes the project emissions, the project is considered to be in compliance with Conformity determination.

Logging and prescribed fire are activities that were occurring prior to the General Conformity rule. Emissions from these activities are included in the SIP (personal communication between Matt Jones of Sacramento Air Quality Management District and Suraj Ahuja, Air Quality Specialist with the U.S. Forest Service).

Environmental Consequences

Direct, Indirect, and Cumulative Effects of the No Action Alternative

Under this alternative, no increase in ozone precursors or PM_{10} emission levels would be produced from harvest operations or post harvest treatments. The greatest effect of no action in the proposed analysis area would come from wildfire. Potential for substantial degradation of air quality from wildfire in the future would not be reduced. The No Action Alternative would not provide any opportunities to reduce existing forest fuels and the hazard they pose in wildland fires. Dead trees would eventually fall to the ground and contribute to the fuel available in a future wildland fire. This would provide the factors necessary for the production of ozone precursors and PM_{10} during that potential fire.

Direct, Indirect, and Cumulative Effects of the Action Alternatives

Impacts to air quality as a result of the proposed actions would be direct, indirect, and cumulative. Direct impacts to air quality would include short-term particulate matter concentrations resulting from new road construction, timber harvest, construction of temporary roads, maintenance of existing roads, site preparation to plant trees, and fuels treatments which include mechanical methods and prescribed burning of piles. Implementation of any of the action alternatives would impact air quality by increasing the amount of PM_{10} and precursors to ozone that are in the air and would reduce visibility for short periods of time. This would occur through the introduction of vehicle and equipment emissions, dust, smoke, and ash into the air in the project area and areas downwind. Increases in PM_{10} and precursors to ozone would not be significant. Indirect effects would occur as precursors to ozone react with the atmospheric conditions and produce ozone.

Implementation of the proposed actions would contribute to cumulative emissions produced during the same year. The Gap Fire Restoration Project on Nevada City Ranger District and the Star Fire

Restoration project on the Eldorado National Forest may be occurring during the same timeframe. The End of the World Timber Sale and the French Helicopter Timber Sale are currently under contract and could also be occurring. Although there could be cumulative emissions for all the projects, the Conformity rule regulates emissions on a project-by-project basis.

The emissions from these activities would not cause or contribute to any new violation of any standard in any area, increase the frequency or severity of any existing violation of any standard in any area or delay timely attainment of any standard or any required interim emission reductions or other milestones in any area (Gap Fire Restoration Project EA, Star Fire Restoration EIS). The End of the World, French Meadows, Gap and Star Fire Restoration projects are all under de minimus levels and meet conformity (End of the World EA, French Meadows EA, Gap Fire Restoration Project EA, Star Fire Restoration EIS). There would be no irreversible or irretrievable commitment of resources under any of the action alternatives.

Conformity Determination

The Conformity rule applies to the proposed project because the area is in "non-attainment" for ozone. Federal actions conform if the emissions that would be caused by the Federal action are below de minimis levels or if the SIP emission inventory includes the project emissions. The de minimis level for NO_x and VOCs is 25 tons per year each. Timber harvest activities would be expected to take about 3 years to complete. The fuels activities would be expected to take two additional years.

Emission calculations for Table 3.9 and 3.10 are based on information contained in A Desk Reference for Nepa Air Quality Analysis, (USDA Forest Service 1995) and EPA Document 42 (USEPA 1987).

Table 3-9: Emission totals for action alternative for precursors to ozone

Alternative	NO_x	VOC
B	167.36	268.22
C	293.19	352.79
D	286.62	326.58
E	196.70	209.84

Implementation of any of the action alternatives would produce more than 35 tons of NO_X and VOCs per year. The SIP emission inventory includes emissions from logging and prescribed fire. Therefore, the requirement for Conformity Determinations has been met.

Harvesting of Trees

Harvesting trees produces particulates in the form of dust, and the equipment used produces gaseous emissions. The amount of dust produced during timber harvest operations depends on atmospheric conditions present during harvest activities, and the equipment used. Dust and equipment emissions would be produced by bulldozers and other harvest equipment such as helicopters, loaders on skid trails and landings, decking and loading operations at log landings, and falling of trees. Log trucks traveling on dirt roads would also produce dust and vehicle exhaust. The amount of dust produced from timber harvest would be reduced by restricting tractor skidding to days when wind is not in excess of a velocity that would produce dust emissions that exceed the PM_{10} standard. (The timber sale contract requires that operations shut down under high winds because of fire danger). In addition, water or dust palliatives would be applied to landings and roads as needed. Dust emissions are considered short-term impacts to air quality that would reduce visibility in the project area and add to the amount of dust in the atmosphere.

Removing trees would reduce the amount of fuel available to burn, and thus would reduce the potential amount of PM_{10} and ozone that would be produced and put into the atmosphere when a wildfire burns. Trees removed would be considered emissions saved.

Table 3-10: Emissions saved by alternative.

Alternative	NO_x	VOC	PM_{10}
B	782.21	700.08	4008.82
C	1492.41	1335.71	7648.62
D	1122.39	1004.54	5752.27
E	806.10	721.46	4131.27

Fuels Treatment

Air quality in the vicinity of the Red Star Restoration project area may be affected by prescribed fire activities. Any impacts would not be expected to be significant. Impacts to air quality from prescribed burning would include reduced visibility from smoke and contributions of PM_{10} to the atmosphere. Reduced visibility would be short-term (about 24 hours for each burn) and contributions of PM_{10} are not expected to exceed state or federal ambient air quality standards. The emissions from prescribed burning would contribute to the PM_{10} loading locally, regionally, and globally. The local effects include cumulative prescribed burn emissions from within Federal, State, and private lands in the analysis area.

All burning would be in compliance with applicable rules and regulations and would be conducted under permit from the appropriate County Air Pollution Control District. Burning under optimal conditions would not impact visibility in any Class 1 Area or on any State or Interstate Highways. Visitors driving through the area could detect odors and short-term reduced visibility. The degree to which these conditions occur would increase with the number of acres burned, and would be short term. Pile burning allows the Burn Boss to limit the amount of material ignited at any one time based on weather and smoke dispersal conditions.

Future maintenance activities in SPLATs would be expected to meet air quality standards.

If a wildfire event does occur after project implementation, concentrations of all smoke related emissions would be expected to be less than in Alternative A due to the reduced levels of fuel available.

Dust and equipment emissions would be produced from mechanical treatments of fuels. There would be localized short-term impacts that would not be significant.

Road operation, maintenance, temporary roads and road obliteration

Dust would be produced when roads are repaired, maintained, and used. The degree to which air quality is impacted by dust generation is directly related to the number of miles of new and existing earth surface roads, which would serve the project area. Dust abatement would be utilized during road rebuilding and reconstruction. Some dust would be produced during these activities but the amount of dust would not be significant because of the measures taken to reduce it (watering, surfacing, and chemically treating roads). However, impacts to air quality would occur in the project area because of the increased levels of

PM_{10} in the form of dust. The amount of dust generated is difficult to estimate, and is dependent on soil moisture and atmospheric conditions at the time of project implementation.

Road obliteration would be accomplished after timber harvest. Reducing the number of roads in the project area after project completion would reduce the amount of dust produced in the project area in the long-term. Some dust would be produced in the tilling of roads in the short-term. Dust production would not be significant from tilling roads.

Soils, Geology and Watershed Resources

Summary of Effects:

- Alternative A would have the highest risk of accelerated soil erosion and negative cumulative watershed effects.
- Alternative B would have the lowest risk of accelerated soil erosion. It would have a slightly higher risk of negative cumulative watershed effects than Alternative C due to the smaller no harvest buffers.
- Alternative C would have the lowest risks of accelerated soil erosion and negative cumulative watershed effects.
- Alternative D would have slightly higher risks of accelerated soil erosion than Alternatives C and B, but lower than Alternative A. The risk of negative cumulative watershed effects would be higher than Alternatives B and C but lower than Alternatives E and A.
- On areas treated, Alternative E would have a similar risk of accelerated soil erosion to Alternatives B and C. Due to the limited acres treated, the risk of negative cumulative effects would be slightly lower than Alternative A.

Affected Environment

Introduction

This section describes the existing condition of the geologic, hydrologic, and soil resources in the Red Star Restoration Analysis Area. The soil information is based on the TNF Soil Resource Inventory (1986, on file at the Foresthill Ranger District Office), Burned Area Emergency Rehabilitation Report (2001), and some field verification (2001-2002). Tahoe National Forest fish biologists compiled and reviewed available information on fishery resources in the analysis. Information was obtained from USFS stream surveys conducted in 1991 and 1996 and the TNF Land and Resource Management Plan. Stream surveys and watershed condition assessments were conducted by TNF hydrologists and fish biologists in 1996 and 2001. Geologic information is based on geologic maps and reports done by the USGS and the US Forest Service and is on file with the Eldorado National Forest and the Tahoe National Forest. Geomorphologic mapping done by the Adaptive Management Resource office of the US Forest Service was used to determine mass wasting potential and is on file with the Nevada City Ranger District, Tahoe National Forest.

Location

The Red Star Restoration Analysis Area is located within the Upper Middle Fork American River watershed (see Watershed Map in Appendix A). The two subwatersheds, French and Duncan, comprise the Upper Middle Fork American River watershed. The French subwatershed consists of the Middle Fork American River from the headwaters to its confluence with Duncan Canyon. The Duncan subwatershed consists of the Middle Fork American River, Duncan Canyon, and Little Duncan Canyon from its confluence with Duncan Canyon down stream to the confluence with the Rubicon River. The analysis area is comprised of thirteen "planning" subwatersheds situated within Duncan and French subwatersheds.

Physical Environment Description

The subwatersheds in the analysis area vary in aspectranging from north-south to east-west. Elevation ranges from 3,340 feet at the confluence of Duncan Canyon and the Middle Fork American River to 7,182 feet at Duncan Peak Lookout.

Climate and Hydrology

Average annual precipitation ranges from 55 to 70 inches and is predominantly in the form of rain below 4,000 feet and above 4,000 feet is predominantly in the form of snow. Heavy snow accumulations are common in the higher elevations. Rain-on-snow is not common above 6,000 feet. Over half of the runoff is from snow-melt and occurs during the spring.

Geology

There are 3 main rocks types underlying the Star Fire area. These are the Shoo Fly complex of Paleozoic marine deposits, the Valley Springs formation of Miocene volcanic deposits, and the Mehrten formation of Pliocene volcanic deposits. There is a Mesozoic granitic basement rock that crops out in the southeastern area of the Star Fire.

The Shoo Fly Complex is composed of folded and metamorphosed rocks that include sandstone, siltstone, slate, chert, and various metavolcanic rocks. The Shoo Fly Complex is characterized by planar features such as bedding, foliation and joints.

The Valley Springs formation is a rhyolitic ashflow tuff. It also includes some sandstones, siltstones and claystones.

The Mehrten Formation includes volcanic mudflows, tuffs, pyroclastics, andesite flows and related intrusives, conglomerates and sandstones, and debris avalanche deposits. There may also be local outcrops of basalt, dacite or rhyolite.

Geomorphology

A primary land-forming process in the Star Fire area has been debris avalanche. Red Star Ridge and Mosquito Ridge are broad, gently sloping ridges that give way to steep slopes that end in even steeper inner gorge areas along the Middle Fork of the American River and parts of Duncan Canyon. Most of the tributaries along both the Red Star Ridge and Mosquito Ridge have been formed by debris as witnessed by the straight channels that run from top to bottom of the ridge with little to no sinuosity. These channels are the active part of the debris flow basins. The headwall area of the channels is found at the very top of these channels and is identified by an increase in slope from the main part of the channel. Many times these headwall areas are not channelized. Dry ravel and even scarp-like features can be present. The banks within these channels can be prone to bank erosion.

Debris slide and debris flow prone areas have been mapped across the Shoo Fly/granitic contact on the southeast side of Red Star Ridge in areas crossed by Roads 57 and 57-9.

Valley Springs Formation

Slope failures are likely to occur when the Shoo Fly complex unit is adversely oriented (e.g. foliation parallel to a slope). Landslide susceptibilities for Shoo Fly metamorphic rocks were rated extreme on slopes greater than 60% and high on 20-40% slopes.

There is a discontinuous poorly consolidated ash deposit in the Valley Springs that is particularly prone to failure (Lewis, 1987). Slumping in the Valley Springs formation has been noted, especially along the 96-63 road system where springs surface.

The contact between the Valley Springs and overlying Mehrten Formation is also very susceptible to landslides. Debris slide prone slopes have been mapped across or near this contact on the northwest slope of Red Star Ridge in upper Duncan Canyon and on the southeast slope of the North Fork of Long Canyon and southwest nose of Chipmunk Ridge (FS Road 14N21). These areas are considered to have high and/or extreme landslide susceptibilities.

The lower contact of the Mehrten Formation is important with regard to slope stability (Coyle, 1993). Landslide susceptibility was rated extreme at 40-60% slopes and high at 20-40% slopes when a basal gravel was present in the Mehrten.

Slope failures have occurred at the Mehrten's contact with the Shoo Fly Complex and granitic rocks as well as with the Valley Springs Formation mentioned above. Debris slide prone slopes across the Mehrten/Shoo Fly contact have been observed on the sideslopes of Red Star Ridge and on the southeast slope of Mosquito Ridge below Road 57-9-10. Debris slide and debris flow areas have been mapped across the Mehrten/ granitic contact on the northwest side of Duncan Canyon and on the southeast side of the Middle Fork of the American River canyon in the vicinity of FS Road 17N12.

Soil

Soils in the analysis area are formed on volcanic mudflow (60%), meta-sedimentary rock (30%), and glacial deposits (10%). Springs and seeps are associated with the contact between the volcanic mudflow and the underlying meta-sedimentary rock. Soils along the sideslopes and top of Red Star Ridge formed from the weathering of volcanic rocks (McCarthy, Lemount, Crozier Soil Series). The sideslopes of Red Star Ridge have soil of meta-sedimentary origin. Along the upper one-third to one-half of the slope, Hurlbut is the primary soil type interspersed with Deadwood. On the lower slope, Deadwood predominates with pockets of the deeper Hurlbut soil. Soils near French Meadows Dam have formed primarily from glacial deposits. Upper Duncan Canyon has volcanic soils along the ridges and upper sideslopes and meta-sedimentary soils on the mid- to lower- slopes. The glacial soils around French Meadows Dam are highly altered (due to dam construction).

Soil properties summarized in Tables 3-11 and 3-12, include soil rock fragment content, effective rooting depth, erosion hazard rating (EHR), and productivity. These soils properties influence both the inherent productivity of the soil (the soil's ability to provide nutrients to plants) and the susceptibility and resilience to site degradation from management activities. In addition, these properties influence water storage and movement within and downstream from the watershed.

Most of the soils in the Red Star Analysis Area have high rock content. Surface rock fragments can increase the risk of gully erosion by channeling surface water flow. Gully erosion is common in parts of the analysis area (Primarily below impervious surfaces such as rock outcrops and roads).

Rock fragments in the soil do not hinder tree growth but they do reduce the volume of soil in which the roots grow and feed. Rock fragments decrease the effective rooting depth of the soil, but if soil depth is adequate, even rocky soils can produce good tree growth. Soils with high rock fragment content also have a lower nutrient holding capacity and are generally less productive than less rocky soils.

The effective rooting depth is the vertical distance from the soil surface to bedrock or any other layer that stops or hinders the penetration of roots. Shallow soils cannot hold enough water to carry a large tree through long dry periods. For optimal vegetative growth, forest soils generally should be at least 30 inches deep.

Most of the soils in the analysis area have high or very high maximum erosion hazard ratings (Table 3-11). The Erosion Hazard Rating (EHR) system is based on many interrelated factors and is used to determine whether land use activities could cause accelerated erosion. Maximum EHR estimates the risk of accelerated surface erosion on soil with no protective vegetative cover subjected to a 2-year 6-hour storm event (an average storm event). Areas of rock outcrop, very rock soils, and shallow soils can generate runoff and concentrate surface water flow, which can increase the risk of erosion on adjacent soils.

Table 3-11: Some Soil Properties of Soil Types in the Red Star Analysis Area

l Series	Rock Content	Depth (inches)	Max. Erosion Hazard	Comments
ırt	15-20%	20-40	high	
io	20-75%	40-60	high	cemented pan below 40"
ızier	minimal	20-40	mod	
umbrepts	3-80%	Variable	very high	high water table
'o	0-30%	40-60	high	
lied land	N/A	N/A	N/A	-
lmount Variant	15-40%	11-19	high	
Carthy	15-60%	20-40	high	steep slopes, high rock
iss	5-35%	12-20	high	shallow to bedrock
ːr	50-80%	20-40	high	thin surface, rocky
ıto Variant	0-35%	20-40	high	thin surface
t	15-60	20-34	high	overlies silica hardpan
erwash	95%	N/A	N/A	sandy to stony river deposits
:k outcrop, granitic	N/A	N/A	N/A	can concentrate surface runoff, increase erosion
:k outcrop, Volcanic	N/A	N/A	N/A	can concentrate surface runoff, increase erosion
›ble land	95%			little soil between rocks
okey	5-55%	20-40	High	
okey Variant	5-55%	40-60	High	
lac	very gravelly	40-60		high rock content

lac gravelly sandy loam	very gravelly	40-60		thin surface layer, high rock content
ker	high	22-40	High	overlies silica hardpan
ca	high	20-40	Mod to high	impermeable substratum
ıdy	25-55	40-60	Mod to high	
odseye		9-20	High	shallow to bedrock
bright	15-60	40-80	High	coarse texture

Subsurface water flow is common in parts of the analysis area (e.g., soil map units, CUG, WBE, WBF). Cut banks along some existing roads have interrupted this subsurface flow, creating springs and wet areas on the roads, causing gully erosion in some areas. Fire suppression rehabilitation and burned area emergency rehabilitation work corrected some of the drainage problems, but other problem areas still exist. The remaining drainage problems areas are addressed in the cumulative effects analysis (later in this section).

Productivity of the soils in the Red Star Analysis Area ranges from low to high with most of the area having moderately productive soils. Soils rated "not capable" do not produce commercial conifer species. Table 3-12 summarizes the vegetation and productivity associated with the soils.

Table 3- 12: Vegetation and Productivity Associated with Soil Types in the Red Star Analysis Area

ıil Series	Typical Vegetation (in order of predominance)	Productivity (Ft3/Ac/Yr Fiber)
ıart	semi-dense to dense high elevation mixed conifer	85-165
:lio	mixed conifer	50-85
·ozier	densed mixed conifer and hardwoods	120-225
·yumbrepts	alder, willow, carex, juncas	
:fo	dense lodgepole, grass and shrub understory	50-85
ıllied land	n/a	not capable
:dmount Variant	mixed brush and scattered conifer	not capable
cCarthy	mixed conifer and hardwoods	85-120
eiss	grasses, forbs, and scattered conifers	not capable
:er	mixed conifer	85-120
ınto Variant	mixed conifer and brush	85-165
ıtt	mixed conifer and hardwoods	not capable
verwash	n/a	not capable
ɔck outcrop, granitic	n/a	not capable
ɔck outcrop, Volcanic	n/a	not capable
ıbble land	n/a	not capable
nokey	semi-open high elevation mixed conifer and shrubs	50-120
nokey Variant	semi-dense high elevation mixed conifer and shrubs	85-165
ıllac	mixed conifer	85-165
ıllac gravelly sandy	mixed conifer	85-165

am		
nker	semi-dense mixed conifer	50-85
aca	semi-dense to dense high elevation mixed conifer	50-120
indy	mixed conifer	85-120
oodseye	mixed brush	not capable
ibright	mixed conifer and hardwood	120-225

Watershed Information

Hillslope and Stream Channel Attributes

Sheet, rill, and gully erosion are the dominant erosional processes on the hillslopes. As slope gradients exceed 60%, mass wasting and dry ravel are the dominant erosional processes.

Headwater streams in the analysis area are a mixture of high gradient bedrock and boulder-dominated channels, which are steep and highly confined and move large material. The stream banks within the analysis area have high rock content. These channels have high sediment transport capacity due to the steep gradients and entrenchment and are generally stable.

Stream and Aquatic Information

The current stream and aquatic information was obtained from TNF stream surveys conducted in 1996 and 2001. The TNF general stream survey consists of a two-person team made up of a hydrologist and a fish biologist. The hydrology section of the survey concentrates on the physical aspects of the stream, including bank stability, Rosgen channel type, and substrate type. The fish biologist measures fish and amphibian species present, percentage and species of riparian vegetation, and amount of coarse woody debris. During the 2001 surveys, the crew also indicated proximity of the burn to the stream and any loss of riparian vegetation. All survey forms are available for review at the Foresthill Ranger District Office.

The following descriptions provide a general overview of the condition of the stream channels and adjacent riparian zones. Tributaries referred to in this report are the major tributaries delineated on the USGS topographic maps.

Table 3-13: Individual Watershed Statistics

Subwatershed Name	W/S Number	W/S Acres	Road Density mi/mi2	Stream Density mi/mi2	% USFS Ownership
Upper MFAR	G0006	1,976	3.7	5.0	98%
French Mdws	G0008	2,459*	3.4	5.6	100%
French Mdws	G0009	2,669*	4.5	5.6	86%
Lower MFAR	G0010	1,900	5.8	6.3	60%
Lower MFAR	G0011	1,897	4.7	4.7	71%
Lower MFAR	G0012	1,847	2.5	4.7	30%
Duncan Canyon	G0702	2,108	0.4	4.3	94%
Duncan Canyon	G0703	1,467	0.8	5.1	100%
Duncan Canyon	G0704	1,758	3.3	5.1	100%
Duncan Canyon	G0705	1,685	5.8	5.7	99%
Duncan Canyon	G0706	1,553	3.9	5.3	98%

Duncan Canyon	G0707	1,509	2.6	3.8	93%
Little Duncan	G0710	2,046	0.9	4.6	100%

***Acres are net acres; G0008 and G0009 have 800 acres and 298 acres within French Meadows Reservoir respectively. These acres were not included in the road and stream densities.**

French

Upper Middle Fork American River (G0006)

French Meadows (G0008, and G0009)

French Meadows Reservoir is created by the Anderson Dam on the Middle Fork American River (MFAR). The Upper MFAR, along with French Meadows Reservoir itself, comprise the three subwatersheds covering 8,202 acres (see Table 3-13). Approximately 94% of the area is administered by TNF. French Meadows Reservoir waterbody itself comprises 1,098 acres. These acres are deleted from the analysis acres since it is water and skews any land disturbance calculations. Subwatershed G0006 encompasses a section of MFAR up stream from French Meadows Reservoir and has a road density of 3.7 miles per square mile. Subwatersheds G0008 and G0009 have road densities of 3.4 and 4.5 miles per square mile respectively. Average stream density is 4.7 miles of stream per square mile, including all seasonal streams.

The tributaries to French Meadows Reservoir are steep, narrow channels composed primarily of bedrock, boulders, and cobbles. Most have either perennial or intermittent flow. Continuous bank cutting and accelerated point bar formation occurs in most of the streams.

Lower Middle Fork American River (G0010 - G0012)

The MFAR below French Meadows Reservoir (Lower MFAR) contains three subwatershed totaling 5,644 acres. Approximately 54% of the area is administered by USFS. Road density decreases with distance from the dam, ranging from 5.8 miles per square mile in the watershed just below the dam to 2.5 miles per square mile in the G0012. Average stream density is 5.2 miles per square mile. The area directly below French Meadows Dam is highly altered due to the dam construction.

For further information about these watersheds see Appendix H, page A-85, Star Restoration DEIS (USDA Forest Service, Eldorado NF, Feb 2002).

Duncan

Duncan Canyon (G0702 - G0707)

Little Duncan (G0710)

The following information comes from the Duncan/Sunflower Timber Sale FEIS, 1992 and watershed surveys performed in 2001.

The mainstem Duncan Canyon is a perennial, from the north-central part of Section 8 (private land) to the confluence with MFAR. It is predominantly characterized by channel materials dominated by small boulders and very large cobbles, moderate entrenchment and moderate confinement. Gradients are generally greater than 4%. There are many interspersed short sections of bedrock and large cobbles mixed with small boulders and coarse gravel and gradients of 1.5-2.5 percent. Sideslopes to the channel are generally moderate to steep. Although the channel bottom is relatively stable, the system periodically transport large amounts of bedload as evidenced by recent cobble and gravel deposition (1992). The sediment is principally derived from natural channel downcutting in the numerous unstable intermittent and ephemeral tributaries, as well as from some bank undercutting along the main channel, which is exacerbated by periodic peak flow events.

The Duncan Creek Diversion dam is located approximately 1 mile upstream from the 96 Road crossing. The dam is 32 feet high and diverts water into French Meadows Reservoir.

The remaining upper portion of Duncan Canyon, a perennial, is outside the analysis area, but continues from the north-central part of Section 8 upstream to where two branches converge in the NW ¼ of the NE ¼ of Section 8. The west branch is perennial at least one-quarter mile into Section 5, and the east branch is perennial at least one-quarter mile into Section 4. These channels are characterized by large and small boulders, cobbles, and gradients of 4-10 percent. Sideslopes are moderately steep to steep.

Within the analysis area, Little Duncan Canyon, a perennial, is a tributary to Duncan Canyon and is characterized by large and small boulders, cobbles, and gradients of 4-10 percent with steep rocky sideslopes.

There are many miles of tributaries to Duncan Canyon that include both perennial and seasonal flowing streams. They are typically characterized by small boulders, cobbles, coarse gravel, and gradients 4-10 percent, but include cobble beds, and a mixture of gravel and sand, some small boulders, and gradients of 1.5 to 4.0 percent on flatter reaches. A common characteristic is evidence of active channel cutting and sediment transport.

There is no detailed information on sediment delivery in Duncan Canyon. As noted earlier, these channels periodically transport large quantities of bedload material. This occurs during major events such as those that occurred in 1963, 1964, 1986, and 1997. During the 1986 and 1997 events, for example, Placer County Water Agency's diversion dam on Duncan Canyon filled with sediment. About 16,000 cubic yards of material were removed after each event.

Watershed History

Historical land management and use within the Red Star Analysis Area have affected the condition of the soils and watersheds to varying extents. In upper Duncan Canyon, above the Duncan Diversion Dam, land management activities have had minimal impact for the past 30 years. Impacts have been confined to road use associated with recreation and maintenance of the Duncan Diversion Dam and trail use along the Western States, Tevis Cup, and Bald Mountain Trails. In lower Duncan Canyon and along Red Star Ridge, mining, past tractor and cable logging and site preparation have resulted in a network of roads, temporary roads, skid trails, landings and other areas of compacted and/or displaced soils. Recent Forest level soil quality monitoring on the Tahoe National Forest indicates that 10% to 40% of previously tractor-logged areas have existing detrimental compaction. Some of the compacted areas show some evidence of recovery from compaction. Some of the more severely compacted areas (e.g., landings) have not fully recovered from the effects of compaction. These areas are a potential source of increased surface runoff and can increase the risk of gully erosion on adjacent downslope areas. Soil productivity and hydrologic function have been decreased in some of these areas due to residual compaction and soil displacement.

Approximately 56 acres of proposed tractor harvest areas have had previous ground-based harvest disturbance. These activities took place between 1982 and 1989. Based on forest soil quality standard monitoring, these areas have an estimated 10-20 percent residual compaction due to the previous management activities. Surveys between the DEIS and the FEIS will determine compaction levels on the 56 acres in the analysis area that have a previous ground-based logging history.

Gully erosion is present in parts of the analysis area. Gully erosion is usually associated with channelized water runoff from areas of rock outcrop, roads, landings, skid trails, old mining ditches, and clearcut harvest units.

Beneficial Uses of the Water

State designated beneficial uses within the fourth field watershed, North Fork American River, includes municipal and domestic water supplies, hydroelectric power generation, contact and non-contact recreation, canoeing and rafting, cold freshwater fisheries habitat, and wildlife habitat (CRWQCB 1998). The project is located within a fifth field watershed, Upper Middle Fork American River.

The Star Fire has affected and will continue to affect beneficial uses of water. The California Regional Water Quality Control Board (CRWQCB, 1998) for the Central Valley Region sets water quality standards and objectives for these watersheds. The objectives applicable to this project as well as existing conditions are sediment, turbidity, and temperature. The State and Regional Boards entered into an agreement with the U.S. Forest Service which requires the agency to control non-point source discharges by implementing control actions certified by the State Board as Best Management Practices (BMPs). BMPs are designed to protect water quality including sediment, turbidity, and water temperature.

The Placer County Water Agency (PCWA) was organized to control waters of the Middle Fork of the American River for irrigation, domestic and commercial purposes, and for the generation of electrical energy. The hydroelectric project on the Middle Fork features two large storage and five small diversion dams, 24 miles of transmission tunnels, 5 hydropower generation plants, and related facilities. The two large storage reservoirs that include the Rubicon River have a combined capacity of 340,000 acre-feet of water (equal in size to 1/3 the capacity of Folsom Lake). Enough power is generated to meet the needs of more than 200,000 electrical customers.

PCWA provides both raw (irrigation) and treated water to a very large area of Western Placer County through a system comprised of 9 water treatment plants, 11 reservoirs, 5 dams, 22 storage tanks, and a 400 mile network of transmission canals and pipelines and innumerable delivery lines. Water deliveries help assure water to over 130,000 people.

Effects of Star Fire and Past Management Activities

The effects of the Star Fire on the ecological processes and functions related to watershed and soils are highly connected directly, indirectly, and cumulatively. The watershed/soil cumulative effects in turn affect many other resources including vegetation, wildlife, fisheries, and social and economic values (both short- and long-term). Wildfire exerts a tremendous influence over many forest ecosystems in North America depending on its severity, duration, and frequency (Neary et al, 2002). In fact, wildfire is the forest disturbance that has the greatest potential to change watershed condition (DeBano et al., 1998).

Watershed condition, or the ability of a catchment system to receive and process precipitation without ecosystem degradation, is a good predictor of the potential impacts of fire on water and other resources. The surface cover of a watershed consists of the organic forest floor, vegetation, bare soil, and rock. Soils, vegetation, and litter are critical to the functioning of hydrologic processes of forested watersheds (Robichaud et al. 2001). Disruption of the organic surface cover and alteration of the mineral soil by wildfire can produce changes in the hydrology of a watershed well beyond the range of historic variability (DeBano et al, 1998). Low severity fires rarely produce adverse effects on watershed condition. Fires, or portions of fires, with high severity are the ones that greatly affect watershed condition and produce aggravated flood flows (Neary et al, 2002).

The Star Fire burned in a highly mosaic pattern (refer to Table 3-14). The highest potential related impacts would occur in watershed G0011 (53% high severity), G0010 (26% high severity) and G0703 (37% high severity). Burn severity is a measure of resource damage (low, medium, or high). It should not be confused with fire intensity, which is a measure of the rate of thermal energy release per unit area or length of fire line. Where burn severity was high, there was a complete loss of litter and duff; many of the large decaying logs, that were present in the area before the fire, were consumed or heavily charred; and fire-generated hydrophobic soil conditions are moderate, but patchy (Star Fire BAER Report, 2001). Where burn severity was low to moderate, the litter and duff and large decaying logs were only partially affected by the fire.

The primary direct effect of the fire was the removal or alteration of the overstory vegetation, litter and duff layers, coarse woody debris, and soil organic matter. The riparian vegetation along perennial channels was not greatly impacted by the Star Fire (For example, there were seventy acres of high and moderate severity burn within 100 feet Duncan Canyon, Little Duncan Canyon, and the MFAR.). The effects of fire on the physical and chemical properties and processes of soil depended on the amount of organic material consumed during burning, and the magnitude and duration of soil heating (Wells, et. al, 1979). Soil organic matter is the glue that bonds soil particles together providing resistance to detachment, the dominant reservoir for nutrient storage, and a major habitat component/ food source for rhizosphere organisms. It also has substantial influence on the amount of available soil moisture, especially on dry sites.

The effects of fire suppression activities, primarily fire lines, were included in the CWE analysis. Suppression rehabilitation efforts installed erosion control on fire lines, as well, as other disturbed surfaces. The effects of fire retardant are variable. The compound used contains a nitrogen and phosporus fertilizer. The fertilizer component is not strong enough to present a leaching hazard (Bob Powers, personal communication, 2002). This fertilizer is available to recovering vegetation. For fire retardant effects on water quality, see the Aquatic section of this portion of the document. Current effects from fire supression activities are expected to be low (based on observations by FS watershed staff over the last 15+ years on the Tahoe NF).

Table 3-14: Burn severity by watershed

BURN SEVERITY									
		Unburned		Low Burn		Moderate Burn		High Burn	
Subwatershed	Acres	Acres	%	Acres	%	Acres	%	Acres	%
G0006	1,976	1,857	94	76	4	43	2	0	0
G0008	2,459*	2,265	92	108	4	47	2	39	2
G0009	2,669*	2,001	75	222	8	220	8	226	9
G0010	1,900	757	40	204	11	439	23	500	26
G0011	1,897	467	25	93	5	318	17	1,027	53
G0012	1,847	1,589	85	60	3	127	7	87	5
G0702	2,108	691	33	698	33	503	24	216	10
G0703	1,467	25	2	628	43	276	19	538	37
G0704	1,758	418	24	413	23	685	39	242	14
G0705	1,685	950	57	662	39	73	4	0	0
G0706	1,553	879	57	543	35	64	4	67	4
G0707	1,509	1,127	75	301	20	71	5	10	<1
G0710	2,046	1,540	75	347	17	150	7	9	1

***Acres are net acres; G0008 and G0009 have 800 acres and 298 acres within French Meadows Reservoir respectively. These acres were not included for burn severity.**

Geology- Slope failure hazard

Increased overland flow of water due to loss of vegetation will increase erosion and mass wasting potential. The hillslopes in the area are composed of hillslopes that were formed predominantly by debris slides. These areas are the site of naturally occuring mass wasting. Fire can increase the rate at which these feature initiate because of the loss of stabilizing vegetation and increased ground water saturation. Debris slide basins that are already loaded with sediment have a higher risk (than pre-fire) of failure (debris slides or landslides) because of the increased water and sediment load. The slopes most at risk in the Star Fire area for mass wasting (as mapped by the Adaptive Management Resource team) are along Duncan Creek, especially on the north side of Duncan Creek.

Soil - Soil processes that can be affected by fire are nutrient cycling, water transmission and storage, and air transmission. Impacts will be evaluated in terms of the Soil Quality Standards (SQS) found in the Sierra Nevada Forest Plan Amendment EIS, Appendix F and in the Tahoe National Forest LRMP. The standards define threshold levels for soil characteristics that are used as indicators of detrimental soil disturbance that result in reduction in soil productivity, soil hydrologic function, and soil buffering capacity. The soil quality standards that will be used to track effects to soil productivity in this document are soil cover, organic matter (includes soil organic matter and large woody material), and soil porosity. Effects to soil hydrologic function are presented in the hydrology section under cumulative watershed effects analysis.

Fire effects on soil can be highly site-specific or can cause landscape scale impacts. Some impacts can qualify for both site-specific and landscape scale impacts. Examples of site specific impacts include loss of soil porosity or soil cover. Examples of landscape scale impacts include sedimentation and mass wasting. Erosion and sedimentation are examples of impacts that can be both site-specific and landscape scale. Cumulative watershed effects are used to track the impacts to the soil resource of both fire and management projects.

Soil porosity/compaction - The threshold for detrimental soil compaction is more than a ten percent reduction in soil porosity as compared to natural or undisturbed conditions. The continuous pore network that is present in soil is responsible for water movement into and through the soil. Compaction disrupts the continuity and volume of soil pore space by compressing and deforming soil aggregates. This disruption of the pore network can result in impacts to soil organisms, plant growth, and soil hydrologic function. Natural recovery of these compacted soils is expected to take 30-70+ years. The reduction in soil porosity and associated detrimental compaction is most often associated with equipment used in logging operations.

Because soil strength is inversely proportional to soil moisture, dry soils are the most resistant to compaction. Compaction disrupts soil porosity, which is a major structural component of soil organism habitat and, therefore, can have detrimental effects on soil organism populations. Soil organisms are responsible for developing critical properties that underlie basic soil fertility and productivity. These biological communities result from complex interactions and require anywhere from a few years to several hundred years to develop. Compaction or alteration of the surface soil layers can have detrimental effects on soil organism populations. If done properly, subsoiling has been shown to be effective at breaking up the compacted layer and allowing natural recovery to proceed more quickly. But, no quick remedies are available if extensive damage (especially erosion) to the soil system occurs.

Detrimental compaction can decrease tree growth by restricting root growth and decreasing available soil moisture. Studies in a 17-year old ponderosa pine plantation, reported that for each percent increase in soil density there is a reduction in height growth of approximately 0.66%. Stem volume was reduced by 26% on soils with a 12% increase in soil density (Froehlich, 1979).

A loss of soil porosity (compaction) results in reduced permeability and a lowered water infiltration capacity. This lowers the threshold when a given rainfall event will result in overland flow as less water enters the soil. Overland flow can cause increased erosion and downstream water quality effects. The amount of soil erosion that occurs would depend on the amount of disturbance and the amount and distribution of rainfall. Soil erosion would decrease site productivity where the erosion occurs.

The loss of vegetative biomass also reduces the rate at which soils dry out due to greatly reduced evapotransporation. Therefore, soils stay wet/moist longer into the summer. Wet or moist soils are more easily detrimentally compacted.

As compacted areas increase across a watershed, the potential for accelerated erosion and stream sedimentation increases, which can result in negative cumulative watershed effects, such as degradation of aquatic and riparian habitats. Other factors affecting aquatic and riparian habitat quality include road density, removal of stream shading vegetation, and the proximity of management activities to stream channels. The Star Fire could affect the following characteristics of water quality: total dissolved solids, turbidity, suspended sediment, water temperature, and pH.

Soils in the Red Star Analysis Area generally have a moderate susceptibility to erosion. Within the Red Star Analysis Area, there have been 56 acres of ground-based logging within the last 30 years. These acres have residual compaction from these past entries. Based on monitoring on similar soil types and management histories, compaction levels are assumed to be 10-20 percent of these acres (actual levels of residual compaction were field verified).

Hydrologic Conductivity- Fire effects on soil moisture are influenced by the amount of organic matter consumption and soil heating. Loss of soil moisture storage can affect plant regeneration, soil organisms, and surface water movement. Water infiltration and permeability can decrease due to development of water-repellant soil layer, loss of soil structure, and clogging of soil pores caused by displaced soil particles.

Water-repellant soil layers were present in burned and unburned areas of the Star Fire area (BAER field surveys, 2001). Naturally hydrophobic soils occur under certain vegetation and on certain soil types. The post-burn hydrophobicity was rated as moderate and patchy. "In coniferous forests in the USA, fire-induced water repellency has been found to persist for as long as 6 years (Dyrness, 1976), or as little as a few months (DeBano et al., 1976) (Doerr et al, 2000). " In many cases, the water-repellant layers caused by the fire should break down naturally in the first year or so after the fire (Robichard, date unknown). Where hydrophobic soils persist into the second year, water infiltration will be affected and will likely result in increased overland flow and soil erosion compared to areas without hydrophobicity.

Important soil hydrologic processes are water intake, water transmission through the soil to stream systems or ground water aquifer, and water retention. The alteration of soil hydrologic processes can increase erosion and sedimentation rates which affects downstream water quality and aquatic habitats. Further alteration of hydrologic processes would increase the risk of erosion even further.

Abrupt changes in vegetative cover, such as those caused by a wildfire, have been shown to change the volume and timing of stream flows. Spring discharge may occur earlier and may be higher than usual. A small increase in spring discharge across many watersheds can result in a substantial increase in major streams due to the cumulative effect. Flows may be lower later in the year since less water is stored in the soil system.

Potential changes in the hydrologic system resulting from the Star Fire include: increased total stream discharge, increased baseflow, increased peak discharge, and decreased summer flow. Potential adverse downstream water quality effects are increased sediment and turbidity, which result from overland flow and erosion; channel scouring because of increased discharge; and dry ravel and creep accumulations in stream channels. Increased nitrogen, phosphorus, calcium, magnesium, potassium, sodium and manganese levels in stream can occur due to leaching and erosion of nutrients by increased overland flow. Sediment associated nutrient losses can exceed solution nutrient losses. The dual concern is the effect of increased nutrient loading on aquatic habitats and the adverse consequences of nutrient losses to upslope productivity.

Erosion/Soil Cover- The standard and guideline for effective soil cover is based on individual soil characteristics and on the slope steepness of the site (see TNF LRMP, Standard and Guideline #55). The soil cover standard is based on the amount of soil cover required to prevent the rate of erosion from exceeding the rate of soil formation. If the soil cover standard is not met, it is expected that accelerated soil loss would occur as long as the soil cover remains below the standard. The cumulative impact of accelerated erosion over time can represent an irreversible loss of long-term soil productivity.

A major indirect effect of the fire is increased soil erosion. Fire results in a partial loss of the forest floor, which acts as protective soil cover. This can result in increased displacement of soil particles from raindrop impacts and increased soil erosion. The forest floor also helps to transmit surface water flow without displacing soil particles or eroding soil. The surface soil removed by erosion contains large proportions of soil nutrients and soil biota.

In most undisturbed forest ecosystems in the west, soil erosion is an unsteady or discontinuous process. Soil and sediment are transported from a source and through a watershed with intermittent periods of storage. Erosional events are usually triggered by major vegetation disturbances and/or large storm events. Erosion can be the result of water, wind, or gravity. Soil loss is a long-term impact because of the extremely slow rate of soil formation. A soil formation rate of 0.75 to 1.0 tons/acre/year (a soil depth comparable to two sheets of paper) is a reasonable average figure for soils in the Sierra Nevada (Alexander, 1985; USDA Forest Service, 1995, R-5 Supplement 2509.18-95-1).

The magnitude of the effects of erosion depend on the amount of soil erosion that occurs, and how far the eroded soil moves. Not all eroded soil will leave the site, some is usually redeposited lower on the slope, on flat spots or behind organic material or vegetation. This eroded topsoil would be available to support regenerating vegetation. Soil that is removed from one area and moved to another within the same site, would represent an irreversible loss of soil productivity where the soil has been eroded and an increase in soil productivity where the soil has been deposited. In this situation, overall site productivity may be maintained while localized soil productivity may be reduced or enhanced. Soil that leaves the site, as sediment, is lost to the site and represents an irreversible loss in site productivity (10K erosion paper). The cumulative effects of large areas of soil erosion could result in a loss in landscape-scale site productivity.

Postfire erosion rates can increase by sixty to seventy percent in the first year (Amaranthus 1979), and gradually return to normal over a 10-year period (Tiedemann et al 1978). Soil erosion causes loss of ecosystem nutrients when sediment and the attached nutrients move offsite. The only factor effecting soil erodibility that can be managed practically is the cover factor. Rapid surface soil stabilization, revegetation, and organic matter deposition are very important for decreasing the erosion potential. For the purpose of protecting the soil surface from erosion, effective ground cover includes duff, litter, slash, and living vegetation that is on or within six inches of the soil surface, downed logs in all decay classes, and rock fragments.

Cover is generally of poor quality under all burn intensities, with needlecast and rock fragments the primary cover components. The needlecast consists of a thin veneer of fir needles that is ineffective in protecting the soil from overland flow, although the needles provide some protection from raindrop splash. The original duff was entirely consumed under moderate and high burn intensities, and almost entirely consumed where the burn intensity was low.

Large woody material was almost entirely consumed under all burn intensities. Numerous totally consumed Class III and IV logs with adjacent burned soil were observed. Limited field reviews along Red Star Ridge in the spring of 2002 found and average of 2.5 large Class IV and V logs. The remaining large woody material consists almost entirely of Class I and I logs that are scorched or burned.

The high burn severity areas in the Red Star area, approximately 31% of the project area, have lost all or most of the forest floor, and are at risk of soil particle displacement and increased soil erosion. The low to moderate burn severity areas, approximately 69% of the project area, have a lower risk of soil particle displacement and soil loss, because of the lower heat generated during the fire and the fact that needle fall from dead trees will protect the soil surface. In some of the high and moderate burn severity areas, the Star Fire generated enough heat at the soil surface to consume soil organic matter and to alter physical soil structure. Post-fire monitoring (2001) on the Star Fire on the Eldorado National Forest reported and average of 8 percent soil cover on high and moderate burn severity areas (Star DEIS pg. 76, 2002). Preliminary observations in high burn severity areas on along Red Star Ridge found generally less than 25% organic cover. Moderate severity areas had more or less continuous cover of needles (minimum 75 percent organic cover), but had less than 15 percent cover of small woody debris.

Fall rainstorms have already caused some surface and rill erosion within the burn area (observations from several watershed and geology staff, 2001). Spring snow-melt and storms are expected to produce more sheet, rill and gully erosion during the spring of 2002. Limited observations has found up to 2 inches of soil erosion in the first winter (May, 2002). Dry ravel will be a problem in the Red Star area because of the generally steep topography, the high rock content of the soil, and the lack of organic and vegetative soil cover. Debris flows may also be a problem along Duncan Canyon and the Middle Fork of the

American River (field observations 2001 and 2002, project geologist and BAER team geologist).

Accelerated sediment loads are being delivered to streams due to the increased erosion within the Star fire area. Impacts to hydroelectric power generation facilities are caused by sedimentation as well as deposition of other materials such as large woody debris. Sedimentation also leads to a reduction in water storage capacity as dams fill in, impacting not only the hydroelectric facilities at diversion dams, but also reducing storage that might otherwise be available for municipal water supplies. It is a natural phenomenon for dams to fill with sediment, but the rate of sedimentation is accelerated following wildfires

Organic Matter/Soil Biology- The organic matter standard was developed to maintain organic matter in amounts sufficient to prevent significant short- or long-term nutrient cycle deficits, and to avoid detrimental physical and biological soil conditions. Soil organic matter is used as an indicator of soil displacement effects on nutrient and soil moisture supply. Large woody material is a critical component of old forest wildlife habitat and in addition provides for moisture retention, nutrient cycling and microhabitat for soil flora and fauna.

The soil ecosystem is the most biotically diverse part of the forest (Moldenke, 1991, Shaw et al. 1991). The survival of most conifers and many flowering plants depends on associations with mycorrhizal fungi for nutrient and water uptake (Harley & Smith 1983; Trappe & Luoma 1992). Soil organisms, ranging in size from single-celled organisms to large burrowing animals, spend all or part of their life cycles in soils, including both organic and mineral layers. These organisms participate in and affect a wide variety of processes in forest ecosystems, such as nitrogen fixation, nutrient cycling, and regulation of soil/water relationships.

Fire effects on soil organisms are complex and varied. The direct effect of fire on the soil ecosystem is heat, which can kill soil organisms. Generally, the greater the consumption of duff and the higher the soil heating, the greater the immediate negative impact on microorganisms. Populations in the forest floor and near the soil surface are more easily killed. Although there is no way to know the populations of the microorganisms, mycorrhizal fungi often decrease with burning because associations occur more frequently in organic horizons, which can be consumed. Loss of soil structure, accelerated soil erosion, and loss of organic matter are a few of the indirect effects of fire that can alter the habitats for soil fauna by affecting the composition and amount of soil organic matter, the temperatures of the forest floor and mineral soils, and the soil/water relationships. Coarse woody material has many ecological functions, including long-term nutrient storage, habitat and/or food source for soil organisms, a source of soil organic matter, and in some ecosystems it may play critical roles in water retention. Large woody material is critical for maintaining mycorrhizal and saprophytic fungi (Harvey et al. 1979). During the hot, dry season, large woody material may be critical maintenance habitat for the small mammal populations that eat fungal fruiting bodies and disperse the spores. In the Blue Mountains in eastern Oregon and Washington, 175 species utilized coarse woody debris as primary or secondary components of their habitat requirements.

Fire is important in the creation and loss of coarse woody debris. In drier forest types or those with a frequent fire return interval (less than 50 years), fire may be the primary agent for breakdown of coarse woody debris. In ponderosa pine and mixed conifer forests in the Pacific Northwest, 85% of the coarse woody debris can be consumed in understory surface fires in September (fires approximating natural fires during this season) (Kaufmann, et al).

Where burn intensity was high, many of the large decaying logs that were present in the area before the fire were consumed or heavily charred. Restoring the vegetative component of effective soil cover is a primary management concern on all soils in the burn area. Assuring a continuous flow of coarse woody debris, spatially and temporally, is important for maintaining long-term site productivity. Vegetative regrowth and woody debris left on-site would have the highest potential to maintain mycorrhizal fungi and other soil organisms.

Nutrient cycling- In the Red Star Analysis area, approximately 10 to 15 percent of the nutrients are found in the above-ground portion of the vegetation (Bob Powers, Powerpoint Presentation, 2000). Fire effects on soil nutrients are dependent on the degree of consumption and heat generated. Combustion of organic matter is a rapid decomposition process in which oxidation changes the form of carbon, nitrogen, and other mineral elements. Nitrogen, phosphorus, and sulphur can be lost due to volatilization. Some soil nutrients (e.g., nitrogen) can become more available and this can increase the possibility of loss due to leaching. Restoring vegetative cover is the best strategy to decrease losses due to leaching. Many of the primary plant invaders after fire are nitrogen fixing. These plants help to replace the nitrogen lost during the fire and due to subsequent soil erosion.

Studies of low intensity fires in Eastside pine forest show that 50% of the above ground ecosystem nitrogen can be volatilized. Some sulphur and phosphorus is also lost. Moderate and high intensity fires can vaporize up to 90% of the nitrogen, 60% of the sulphur, and 30% of the phosphorus in the above ground ecosystem. Although not measured, it can be assumed that some nutrients were lost due to volatilization during the fire, especially in areas where high intensity burns occurred.

The soils in the burned area tend to have low soil organic matter content and nutrients tend to accumulate in the surface soil horizons. This contributes to the potential for site degradation when surface soil is lost due to displacement or erosion. Given that 85 to 90 percent of the ecosystem nutrients are in the surface soil, it is important to conserve all of the surface soil that we can.

Watershed Assessments

Watershed condition has been assessed at multiple scales utilizing multiple processes if analysis. The 4th field watersheds analyzed at coarse level by the State, found the North Fork American Rive to be a priority watershed for projects to improve watershed health (California Unified Watershed Assessment 1999).

The Region 5 "Watershed Condition Assessment" fifth field watersheds are analyzed at a broad reconnaissance level following Regional Watershed Condition Assessment Protocol (USDA FS 2000). This analysis determines conditions rated as Category I, II or III (I- geomorphic, hydrologic and biotic integrity is of high quality, II indicates moderate integrity and III indicated low integrity). This assessment also provides a description of the relative disturbance levels within each of these watersheds and the expression of the conditions in terms of qualitative ratings that look at channel stability, riparian condition, floodplain connectivity, water quality, water quantity and aquatic habitat. The R5 Assessment (ENF 2000) identified the Upper Middle Fork American Rive watershed to be in a condition Category II. This watershed is exhibiting moderate and low geomorphic, hydrologic and biotic integrity related to their natural potential conditions. The R5 assessment was completed by the ENF prior to the Star Fire. The Star Fire has adversely affected the Middle Fork American River to the point where it should be reconsidered for Category III status.

Cumulative Watershed Effects (CWE) Analysis

Watershed Size

Watershed boundaries form the basic area for CWE Analysis regardless of land ownership patterns or administrative boundaries. The Star Fire burned within the Upper Middle Fork American River, a priority watershed for the Tahoe National Forest. The Upper Middle Fork American River is a 5th field watershed (5th field watersheds range from 40,000 to 250,000 acres). Nested within the Upper Middle Fork American River watershed are two 6th field subwatersheds, French and Duncan (6th field subwatersheds range from 10,000 to 40,000 acres). Nested within the 6th field subwatersheds are 7th field "planning" subwatersheds (7th field "planning" subwatersheds generally range from 1,000 to 2,000 acres). Watershed condition has been assessed at the 7th field planning subwatershed level for this project. Larger watershed sizes would be used to form something on the order of Watershed Analysis, or for Forest level planning. While CWE can occur and may be detected at any size scale of watershed, the effects are most discernible in the watershed where they occurred. The effects at the subwatershed level are likely to be greater within the subwatershed where the activities are taking place because downstream reaches are diluted by inflow from other tributaries.

Table 3-15: Watershed Hierarchy

5th Field Watershed	6th Field Subwatershed	7th Field "planning" Subwatershed	7th Field Number	Acres
Upper Middle Fork American River				70,890
	French			37,467
		Upper MFAR	G0006	1,976
		French Meadows	G0008	2,757
		French Meadows	G0009	3,469
		Lower MFAR	G0010	1,900
		Lower MFAR	G0011	1,897
		Lower MFAR	G0012	1,847
	Duncan			33,423
		Duncan Canyon	G0702	2,108
		Duncan Canyon	G0703	1,467
		Duncan Canyon	G0704	1,758
		Duncan Canyon	G0705	1,685
		Duncan Canyon	G0706	1,553
		Duncan Canyon	G0707	1,509
		Little Duncan	G0710	2,046

Causes of Cumulative Watershed Effects

Approximately one-quarter of the 21,705 acre watershed analysis area is under private ownership. Portions of the area have been managed for timber production. The dominant watershed impacts being addressed by CWE analysis in the Red Star area are erosion and sediment delivery. Roads are the primary producer of fine sediment, especially where they run parallel to streams within RCAs and at stream crossings. At these locations there islittle distance available between the road and the stream to act as a buffering filter strip and roadside ditches sometimes discharge runoff directly into the stream.

The road density ranges from 0.4 miles of road per square mile in the upper part of Duncan Canyon watershed to 5.8 miles of road per square mile in the middle part of Duncan Canyon and Lower French Meadows Reservoir subwatersheds. Many of the roads in the analysis area had some level of maintenance as a part of the Star Fire suppression rehabilitation. Some of the native surfaced roads may still need drainage corrections and maintenance. The native surfaced roads in the analysis area are on soils that are highly compressible and have low bearing strength when wet, which makes the subgrade highly susceptible to rutting. Ruts disrupt the engineered drainage structures designed into the road and channel water. The ruts can eventually turn into gullies if not corrected. Cut banks have interrupted subsurface waterflow, which has resulted in springs and wet areas on roads, and, in some cases, has caused gully erosion.

Mass wasting is closely associated with large disturbance events (e.g., fire) and/or major climatic events and so can be considered episodic in nature. The debris slide areas in Duncan Canyon and along the Middle Fork of the American River may be affected by the loss of vegetation and soil cover. Effects on streams can be varied and may include loss of residual pool volume, and reduced permeability of stream-bed gravel. The channel morphology is made up of channels that transport debris and have low sensitivity to the type of disturbance brought on by prudent forest management. The channels serve as deposition sites for fine sediment transported down-stream or off-site.

Natural Watershed Sensitivity/Watershed Tolerance to Land Use

The Tahoe National Forest has developed a standard method for determining watershed thresholds of concern (TOC) values based on several factors. Each watershed is assessed for its ability to withstand erosion processes and handle sediment delivery to stream channels. The assessment is based on erosion hazard rating, climate regime (i.e. rain on snow), stream density, as well as extensive on-the-ground surveys of the stream channels and upland areas.

Cumulative Watershed Effects Analysis

The Pacific Southwest Region (R-5) of the Forest Service has developed a standardized cumulative watershed effects (CWE) analysis (FSH 2509.22) that serves as a surrogate method for determining the risk of delivering excess sediment to streams. There are two parts to CWE analysis: 1) determination of the TOC, and 2) assignment of Equivalent Roaded Acre (ERA) coefficients to activities.

The TNF has developed a standard method for determining watershed TOC values based on several factors. Each watershed is assessed for its ability to withstand erosional processes and handle sediment delivery to stream channels. The assessment is based on climatological, geologic, and soils information, as well as extensive on-the-ground surveys of the stream channels and upland areas. A range of TOC values from a high of 18% to a low of 9% was determined using the compaction guidelines in the TNF LRMP and literature review of research on impacts of timber harvesting activities on sediment production.

Two major factors associated with accelerated erosion are the amount of impermeable surfaces (either rock outcrops or compacted soils such as occur on roads, skids trails, and landings) and the amount of effective soil cover within a watershed. The TNF LRMP addresses minimization of accelerated erosion in Standard and Guide 55. Compaction is allowable on no more than fifteen percent of an area. The required amount of effective soil cover (material that minimizes rain drop splash) depends on soil type and slope but generally more than fifty percent of an area must have effective soil cover. Research at various experimental forests throughout the United States has also shown that intensive timber harvest, such as clearcutting, should be limited to less than fifty percent of a watershed. Many authors suggest the maximum area impacted should not exceed thirty-three percent.

The TOC for a given watershed is determined using a flow chart that first assesses the percentage of the watershed in each Erosion Hazard class. The R-5 Interagency Erosion Hazard Rating (EHR) system (7/90) is used to evaluate the response of a specific soil to disturbance when there is no effective ground cover. The EHR system integrates climatic, topographic, hydrologic and soil properties and assigns a numerical value to each soil by slope class. The numbers are grouped into four ratings: Low (0-3.9), Moderate (4-12), High (13-29) and Very High (>29), which are defined below.

A low EHR means that accelerated erosion is not likely to occur except during periods of above average storm occurrence. If accelerated erosion does occur, adverse effects on soil productivity and to nearby water quality is not expected.

A moderate EHR means that accelerated erosion is likely to occur in most years. Adverse effects on nearby water quality may occur for the upper part of the moderate EHR range or during periods of above average storm occurrence.

A high EHR means accelerated erosion will occur in most years. Adverse effects on soil productivity (especially to shallow and moderately deep soils) and to nearby water quality is likely to occur, especially during periods of above average storm occurrence.

A very high EHR means accelerated erosion will occur in most years. Adverse effects on soil productivity and to nearby water quality is very likely to occur, even during periods of below average storm occurrence.

The TOC analysis focuses on the percentage of the watershed in High and Very High categories since adverse impacts to water quality are more probable when accelerated erosion occurs. The analysis also considers the percentage of rock outcrops in the watershed, since concentrated surface runoff from rock outcrop areas can increase erosion on adjacent soils. Watersheds composed predominantly of Very High EHR soils would have a lower TOC than watersheds with Moderate EHR soils.

Table 3-16: EHRs by watershed.

Subwatershed	Subwatershed Name	Acres	EHR % Mod	EHR % High	EHR % V. High	EHR % Rock
G0006	Upper MFAR	1,976	13	65	10	12

G0008	French Mdws	2,459	21	65	9	5
G0009	French Mdws	2,669	19	65	8	8
G0010	Lower MFAR	1,900	15	55	5	25
G0011	Lower MFAR	1,897	2	89	1	8
G0012	Lower MFAR	1,847	9	75	1	15
G0702	Duncan Canyon	2,108	8	71	11	10
G0703	Duncan Canyon	1,467	4	80	4	12
G0704	Duncan Canyon	1,758	17	70	6	7
G0705	Duncan Canyon	1,685	13	63	17	7
G0706	Duncan Canyon	1,553	20	65	8	7
G0707	Duncan Canyon	1,509	14	70	4	12
G0710	Little Duncan	2,046	11	73	8	8

***Acres are net acres; G0008 and G0009 have 800 acres and 298 acres within French Meadows Reservoir respectively. These acres were not included for EHR calculations.**

The next factor considered is the elevational range of the watershed and the type of precipitation regime found. Rain-on-snow events have been shown to have the highest probability of causing accelerated erosion. In the north central Sierras, rain-on-snow events are common between the elevational ranges of 3500 to 6000 feet. Watersheds within this elevational band would thus have a lower TOC than watersheds at higher or lower elevations. Above this elevation, winter rains are uncommon and snow is the predominant form of precipitation. The risk of erosion in snow-dominated areas is generally considered to be low. At elevations below 3500 feet, rain predominates and the risk of accelerated erosion is less than in the rain-on-snow areas but higher than in snow areas.

The last geomorphic feature examined is the density of stream channels within a watershed. The density of stream channels can be used to infer the inherent resistance of the parent rock material. Softer more erosive rocks have a higher density of streams than harder more resistant rock. Watersheds with a high stream density would have a lower TOC than watersheds with a low density.

After determining the above-mentioned physical properties of the watershed, a preliminary TOC is set. This TOC reflects the "inherent" ability of the watershed to resist erosion. However, this rating has not considered the ability of the streams within the watershed to handle flow.

The supply of water to a stream is determined by precipitation and regulated through interactions between geology, soils, and vegetation. For example, when precipitation falls on areas of rock outcrop or shallow soil, water moves overland and quickly enters the stream system. When rain falls on deeper, permeable, well-vegetated soils, it enters the ground water system and may not reach a stream channel for many seasons. The minimum annual flow of a stream depends on the distribution of annual precipitation, the amount of water used by forest vegetation, and the contribution of groundwater to streamflow. The relative amounts of channel interception, overland flow, and groundwater flow can have a great influence on the time distribution of water arriving at the stream channel and the watershed outlet.

Stream channels in hydrologic balance have reached an equilibrium between the amount of water delivered to the channel by surface flow and the amount delivered through the soil/groundwater system. The "steadying" force of stream flow is the amount of water delivered through the soil system. The continuous network of large and small pores in the soil acts like a giant sponge, slowly releasing water to the stream and maintaining perennial flow. Surface flow input to channels tends to be "flashy" or short-term but high in energy. Generally, the higher the proportion of overland flow input to streamflow, the more rapid streamflow increases post-precipitation. "Flashy", high-energy flows are largely responsible for damage to stream channels, bridges, and culverts.

Upland watershed condition can often be inferred from channel condition. The formation of point bars, the filling of pools with small sized particles such as sand and silt, or a channel substrate primarily composed of sand to silt sized material indicate the stream is carrying an increased sediment load. This indicates accelerated erosion is occurring somewhere in the watershed. Downcutting of stream banks or incising of a channel are also indicators that the hydrologic balance in a watershed has been altered. Often the sediment source can be traced to stream adjacent processes, such as debris slides, gully erosion, or bank cutting. It also may indicate accelerated soil erosion in the uplands.

If the balance between surface flow and groundwater release moves toward surface flow, the existing channel often cannot handle the added high-energy flow. The result is either widening or deepening of the channel. Another change is that late summer flows decrease since less water is stored in the soil system; thus, less water is available.

Many researchers believe that the source of the majority of sediment in streams comes from erosional processes that occur within the floodplain. Erosion will accelerate if streamflow increases or the integrity of the banks is weakened through trampling or removal of vegetation. Thus, the last step in assigning the TOC is an extensive survey of the channels within the watershed. The TOC is adjusted either up or down based on the results of two widely accepted stream assessment techniques: the Pfankuch Rating (USDA-FS R2, 1978) and the Rosgen Channel Assessment (Rosgen, 1993). If streams have excellent ratings the TOC rating would be adjusted up. If the streams have poor ratings, the TOC is adjusted down. If the streams have average ratings, the TOC stays the same.

Approximately75 percent of the slopes in the analysis area exceed 25%. Most of the subwatersheds in the analysis area have soils with high or very high maximum erosion hazard ratings. Table 3-x shows the percent EHR and rock outcrop by subwatershed.

The lower slopes, mainly following the Middle Fork American River, are located within the rain on snow elevation belt where erosion from precipitation events is most severe. The upper slopes above 6,000 feet are above the rain-on-snow elevation belt. The extent of erosion and disturbance is most likely a result of management activities, primarily roads, logging, and site preparation activities. The majority of subwatersheds have mid-range to low TOCs.

Environmental Consequences

The major environmental consequences of implementing an alternative are strongly interrelated in terms of watershed, soils and fisheries values. Impacts on fisheries are evaluated by analyzing changes in riparian and aquatic habitats. The two main issues associated with the cumulative impact of accelerated erosion are deterioration of water quality and loss of soil productivity. Water quality and soil productivity are affected similarly by management activities.

The effects found in this section are based on the personal experience of the watershed staff with other recent fire recovery projects on the TNF and ENF (e.g., Cottonwood, Cleveland, Pendola).

Alternative A - No Action Alternative

Direct and Indirect Effects

Under Alternative A, existing conditions on the landscape would continue to proceed through the natural post-fire processes discussed, in part, above. Natural processes include: hill slope erosion and stream channel sedimentation, hill slope and riparian vegetation growth, recruitment of coarse large woody debris (CWD), and balancing stream flow, stream gradient and stream substrate composition. Alternative A would have both positive and negative impacts to watershed condition and aquatic- and riparian-dependent resources.

The No Action Alternative precludes opportunities that may benefit riparian and aquatic resources such as reducing fuels accumulation, increasing the amount of soil cover through activity generated slash, and improving portions of the road system that are currently delivering sediment to the stream system. At the beginning of last winter, all of the high severity and portions of the moderate severity burns had little to no ground cover other than rock fragments. Field observations made in May 2002, showed that the high severity burn areas generally have less than 25 percent organic cover. The moderate and low severity burned areas generally had soil cover (75 percent) consisting of brown needles and some small branches. The cover is highly mobile due to its small size and could be transported off-site by overland flow. The addition of small branches would help to anchor the needles. The recovery of the effective soil cover would take place at a slower rate and would be in a random pattern depending on the natural decay of the trees. Field observations by TNF watershed staff on other fires on the Forest show that cover generated by standing dead trees usually takes at least 5 to 10 years. For example, in May of 2002, the Crystal Fire (Truckee Ranger District) had snags that have tops that have snapped off at approximately 30 feet, eight years after the fire. In April 2002, trees left on the Pendola Fire have dropped a low percentage of their branches two years after the fire. The sediment delivery to streams would be expected to remain relatively high with the slow recruitment of new effective soil cover on the areas upslope of the RCAs and within the RCAs. The Duncan Diversion Dam located on Duncan Canyon would experience increased sediment delivery to the facility. The diversion dam generally experiences enough sediment capture to require dredging every ten to fifteen years. Effects of the Star Fire would accelerate sediment delivery for the short-term but sediment delivery would diminish as vegetation grows and standing dead material begins to fall to the ground.

There could be a negative impact on soil and water quality by selecting the No-Action Alternative. The amount of soil erosion that occurs would depend on the amount and distribution of rainfall. Soil erosion potentials would be elevated for approximately 10 years. More than half of the post-fire erosion usually occurs in the first year (Amaranthus, 1988; WEPP modeling, Kennedy, 2002; see Appendix D). As grasses, forbs, brush, and seedlings re-vegetate the site, erosion rates would decrease to pre-fire levels. Many of the first plants to invade disturbed sites are nitrogen-fixing species. Brush species would also help to maintain mycorrhizal populations necessary for forest reestablishment.

The effects on long-term soil productivity would vary depending on the amount of soil lost to erosion and how far the eroded soil moved. The effect of erosion on site productivity is less if the eroded soil is deposited further down slope, than if the eroded soil is moved off-site into a stream. Soil that is moved off-site represents an irreversible loss of soil productivity.

A positive outcome of the No Action Alternative is that no new ground disturbance would occur, thus reducing the potential for loss of soil porosity, increased sediment transport to streams, or degradation of riparian or aquatic habitats associated with land management activities. The potential recruitment of coarse woody debris to both the stream channel and to adjacent riparian and aquatic habitats would be the highest under the No Action Alternative since snag levels within the riparian conservation areas (RCAs) would be maintained.

Natural fuels accumulation would be slow in the short-term (up to 10 years based on observations on other fires on the TNF and ENF), but since no fuels reduction activities would take place, the long-term fuels accumulation would increase beyond the fuels desired condition (see Fire/Fuels input). Existing dead and dying tree boles would fall to the ground over the next 20 to 50 years resulting in 30 to 525 tons per acre of woody material in a variety of size classes. Coarse woody material (>3" diameter) would decompose gradually over the next 40-200+ years. "Natural processes of decay are unlikely to remove the current dead tree material before the next fire event, thus managed reductions in fuel loading is recommended (Everett, 1995)." The amount of dead wood in some areas of the Red Star area would be in excess of soil ecosystem needs as defined by both the TNF LRMP and the SNFPA.

Many of the roads within the burn area would continue to deliver sediment to both the stream channel and to adjacent riparian and aquatic habitats where roads are within the RCAs.

Cumulative Effects

Cumulative effects of the No Action Alternative would include the continued short-term impact to downstream water quality from hillslope erosion and associated sediment delivery to the stream system due to reduction in effective ground cover caused by the Star Fire. This effect is highest where a high burn severity has reduced the existing ground cover and consumed the needles and leaves on the residual trees. Sedimentation risk also depends on the proximity to streams or other aquatic features. Erosion and sedimentation rates would decline gradually over time when vegetation and woody debris begins to establish a protective soil cover (approximately ten years). This alternative would have the highest potential impacts to Duncan Diversion and Ralston Reservoir due to potential sediment and coarse woody debris movement.

The greatest risk to watershed, soil, and fisheries values associated with selection of the No Action Alternative is the potential of a future high intensity fire. Even though the current fire hazard is low, the hazard would increase as standing dead trees fall. The amount of woody material combined with vegetation re-growth could result in a ground-fire that would generate extreme heat at the soil surface with a long enough residence time to severely affect soil process and function (at least 6,167 acres). The First Order Fire Effects Model (FOFEM, see Appendix G) was used to predict soil temperatures generated by future fires and to identify potential effects to the soil resource (see Appendix N). The FOFEM model was run for the Star Fire and the Gap Fire. The results of the modeling on both fires show that surface soil temperatures increase with time and that the depth of heat penetration into the soil also increases with time. Around year five, soil organisms would be impacted to a depth of 3 to 7 cm. and soil organic matter would be destroyed to a depth of 0 to 2 cm. By year 25, soil organisms would be killed to a depth of 9 to 11 cm. and soil organic matter would be destroyed to a depth of 1 to 4 cm. This type of fire could have severe adverse soil, water, and fisheries impacts. This type of fire could also require the use of fire retardant and fire lines in excess of the amount used on the Star Fire.

The cumulative effect of past management activities and the soil compaction effect of roads, landings, and skid trails would continue to recover over time. This analysis includes effects of Red Hot Roadside Hazard Tree Reduction, French Helicopter Sale, and the post-fire logging on private land. The cumulative watershed effects (CWE) analysis for the existing condition, Alternative A, is shown in Table 3-16 below.

The existing road system would not be upgraded where roads and culverts need maintenance and are negatively impacting the aquatic ecosystem. The TNF applied for and will receive funding under the National Fire Plan to fix some of these road related impacts (These projects have already been through NEPA analysis.). The projects will be implemented as soon as the funding becomes available.

Consequences Common to Action Alternatives

Management requirements incorporated into the proposals should reduce the risk of accelerated erosion and sedimentation of aquatic habitats due to timber harvest and fuel reduction activities. The most important factor considered in mitigating effects of the proposed project was the selection of the appropriate logging system based on soils, slopes, geomorphology, proximity to streams and other aquatic features, and effects of previous management activities. The effects of the proposed activities would also be mitigated by the timing of burning and harvest activities, designating primary skid trails, limiting secondary skidding, tillage, backblading, water barring and/or spreading slash or mulch on skid trails and temporary roads, and designating riparian conservation areas (RCAs) along all perennial and seasonal streams, and requiring an aerial logging system within all RCAs. This would reduce the risk of accelerated erosion, loss of long-term soil productivity, and sediment related impacts on water quality and aquatic resources.

This analysis covers both the existing greater than 75 percent mortality and the predicted greater than 75 percent proposals. A concern of the watershed staff was the effects of re-entering "priority" areas that have already been harvested to treat areas that prove to be dead. The areas of predicted mortality often form a halo around the current mortality areas. Areas proposed for ground-based harvest were reviewed by the watershed and timber staff to ensure that log removal from the "predicted area" would not cumulatively effect areas of "priority" that have already been harvested. Detrimental cumulative soil and watershed effects from the removal of trees from the areas of "predicted" dead are not expected to occur.

There are no effects to soil buffering capacity predicted from these proposals.

All action alternatives would have similar impacts on slope stability. The geologist on the Red Star IDT delineated areas with potential risk of slope failure. These areas were considered and avoided or mitigated for in all project proposals. Project proposals would not increase the risk of slope failure.

Fuels Reduction Activities

Direct and Indirect Effects

Salvage harvest activities can result in direct, indirect, and cumulative soil and watershed effects. Together, direct, indirect and cumulative effects may result in the reduction of overall long-term productivity of the soil or water quality/ beneficial uses. Sedimentation effects are highly dependent upon the proximity to a stream or other aquatic feature. Loss of soil cover and associated erosion and sedimentation is a concern within the Red Star Restoration analysis area.

Several researchers, including Bestcha and McIver and Starr, have reported that logging, particularly ground-based may have effects on soil erosion and sediment production. Other studies show that logging does not necessarily increase erosion and sediment rates: "Despite measuring averages of 35% and 18% of the area disturbed for tractor- and cable-logged units, respectively, Chou and others (1994) detected no difference in sediment output between logged and unlogged units, largely because of considerable among-unit variation, and because sediment contributed by logging was overwhelmed by sediment produced as a consequence of the fire." "McKay and Cornish found increased overland flow after post-fire logging. They attribute at least some of the increase to logging. However, they attribute most of the increases in peak flows and overland flows to decreases in transpiration rates in the post-fire environment, a conclusion illustrating the difficulty in distinguishing between erosion due to logging and that from the fire itself (McIver and Starr, 2000)." Although logging (particularly ground-based) can have significant effects on sediment yields in post-fire watersheds, logging residue can mitigate some of these effects. Post-fire eucalyptus logging slash reduced soil loss by up to 95% by impeding overland flow (Shakesby and others 1996). Walter Megahan in response to Bestcha's report wrote, "Fire salvage done correctly, can maintain or reduce erosion rates, not increase them. Numerous studies show that woody debris on slopes provides for sediment storage thereby reducing downslope sediment movement." Many of the studies being quoted were conducted between 1960 and 1990, and forest management has changed since then. In fact, between 1988 and 1996, the number of miles of rivers and streams reported as having "major impairment" due to silviculture dropped from 8,454 to 1,436 (NCASI, 1999). The Environmental Protection Agency recognizes in its guidance documents for non-point pollution control that, careful logging can result in only slightly increased sedimentation.

Soil Quality Standards are used to measure impacts to the soil resource. The primary direct effects of salvage harvest are compaction, displacement, and removal of woody material. Indirect effects to soils can include accelerated erosion due to reduction or removal of soil cover and accelerated erosion due to greater overland flow caused by reduction in infiltration and soil water storage, a result of increased compaction.

BMPs and the Forest Plan's Standards and Guidelines are the primary measures for preventing and mitigating to water resources.

The proposed aerial harvesting systems for the San Juan project are cable and helicopter. Aerial harvesting systems generally have a low impact on soil and water resources. Drag channels left after cable logging would be cross-drained (hand-installed waterbars) to prevent channelizing water. Small material left after harvest would act as mulch and would lower the erosion potential.

The effects of salvage harvest are highly dependent on the harvest system, with helicopter and skyline logging systems having lower impacts than ground-based logging systems (Klock, 1975). The proposed salvage logging would use a combination of ground-based, skyline, and helicopter logging systems. Ground based logging systems would be used on slopes generally less than 25% (765 to 830 acres). Because of residual compaction from previous management activities and the loss of surface organic matter due to the fire, the impacts of ground-based skidding are higher in areas that have been ground-based logged in the last 30 years (56 acres in the 1980's). High severity burn areas have exposed mineral soil and are highly susceptible to compaction. Helicopter and skyline yarding would take place on slopes generally over 25% (4,503 to 5,337 acres) and within all RCAs. RCAs would be established on all streams and around French Meadows Reservoir to protect the aquatic and riparian ecosystems. The following RCA widths would be established for the Red Star Fire Restoration area: French Meadow Reservoir - 300 feet, perennial streams – 300 feet, seasonal streams, including intermittent and ephemeral streams – 150 feet, and springs – 300 feet. Within the RCA, no ground-based equipment would be allowed except at designated crossings.

Ground-based logging equipment can cause a loss of soil porosity (compaction), which results in reduced permeability and a lowered water infiltration capacity. This lowers the threshold when a given rainfall event will result in overland flow as less water enters the soil. Ground-based logging equipment operating in a burned area would be expected to have a higher risk of detrimental soil compaction due to the loss of surface organic matter which absorbs and buffers some of the ground pressure exerted by vehicle traffic.

The soils in the proposed tractor units are susceptible to damage when wet due to low subsoil strength. Research has shown that compaction is much more likely to occur when soil moisture is high. In general when soils are dry down to 8 to 12 inches, one or two loaded passes over the soil by heavy equipment does not result in detrimental compaction. In this project skidding off of designated main and secondary skid trails would be prohibited until the soil is dry to 10 inches, therefore the extent of compaction from skids would be reduced. Low ground pressure equipment would also need to be restricted to skid trails until soils are dry to approximately 6 inches unless monitoring shows that compaction is not occurring with less dry soil. This may be hard to achieve because the decreased transpiration water use would result in higher amounts of soil moisture than pre-fire conditions.

The impact of skid trail density is reflected in the high ERA values associated with mechanical harvest; however, this impact would be partially mitigated by subsoiling of compacted skids. To minimize compaction effects, ground-based harvesting would use pre-existing skid trails where possible, all main skid trail locations would be designated, secondary skidding off of designated skids will be limited, and the number of designated skids minimized. All detrimentally compacted skid trails with gradients <15 percent (124 to 135 acres), landings, and temporary roads would be subsoiled using standard subsoiling guidelines that have generally proven effective on other fire salvage areas on the Tahoe NF (e.g., Cottonwood, Pendola, and Indian Fires). These standard guidelines include tilling at the appropriate soil moisture (usually late-season in post-fire areas) and using the appropriate equipment to avoid excessive soil disturbance. Subsoiling compacted skidtrails would partially ameliorate the effects of compaction by restoring 60-90% of the hydrologic conductivity of compacted soils. Recovery of stable surface soil structure with a macropore network requires time (a 10 year recovery is used for cumulative watershed effects analysis). All skid trails would be mulched. Subsoiling and mulching skidtrails would decrease the concentrated surface runoff, decrease the risk of rill and gully erosion, and lower the risk of adverse effects on long-term soil productivity and water quality. Areas proposed for ground-based logging are along the top of Red Star Ridge and many areas are separated from the steep, lower side slopes by existing Forest Service system roads.

The helicopter harvest system would result in the least amount of ground disturbance. Usually less than 5% of the harvest unit is disturbed, including the landing. The greatest ground disturbing impact from helicopter yarding is the landings that could be up to 1 acres in size and highly compacted.

A direct effect of salvage harvesting activities is the removal of woody material. Some of the indirect effects of removal of woody material are: loss of structural component of terrestrial and aquatic habitats; effects on short- and long-term nutrient cycling; effects on effective soil cover and erosion; and the effects on future fire risk and fire-related impacts. The Star Fire itself affected nutrient levels in the high burn severity areas by volatilizing nutrients contained in the needles and small branches of standing trees. The boles of the fire-killed trees contain low concentrations of nutrients and removing them would not have a large effect on nutrient status of the site. Areas of moderate and low severity have already started to drop their needles, which is adding to protective soil cover. When the trees are felled, most of the remaining fine material would remain on-site, except where in direct conflict with fuel management objectives. The tops and limbs of most fire-killed trees would be left on-site to provide short-term soil cover until litter and duff and vegetation have re-established soil stability. Activity slash is not the same as undisturbed litter and duff, but can increase infiltration of rainwater and decrease the amount of erosion and sedimentation (Swank et. al., 1989). Slash would cover fifty to seventy-five percent of the ground (based on TNF and ENF fuels modeling and field observations in May 2002). The additional ground cover added by lopping and scattering slash would benefit watershed resources by reducing potential soil erosion. All erosion models (e.g., WEPP, USLE) recognize the importance of the soil cover factor. The proposed retention of snags and downed logs per acre should meet large woody material needs for long-term soil productivity requirements without adding excessively to the fuel loadings (an estimated 10 logs per acre would be left between snags, down logs, cull material and pre-existing down logs). Any future deficit of large woody material caused by the Star Fire would not be averted by leaving more wood now. The mosaic nature of the Star Fire has left many areas that would not have any fire-killed trees removed. Therefore, where some sites might have short-term deficits in large woody material until new trees are grown, others will have a surplus of large woody material.

Site Preparation and Post-Harvest Fuels Reduction Activities

Fuels reduction activities would occur along specified roads and trails, within tractor units, within portions of skyline and helicopter units, Defense and Threat zones, and SPLATs. Fuels reduction activities would include the use of hand cutting, grapple piling, and/or cutting with a low ground pressure mechanical masticator (on slopes less than 25 percent (approximately 25 to 35 tons per acre of less and 3" material)) and burning of piles. Fuel reduction activities would not occur unless ground cover exceeds 75 percent unless otherwise agreed by watershed and fuels staff.

Grapple piling of slash and mechanical brush control (approximately 510 to 1,200 acres, depending on the alternative) have the potential to impact a high percentage of the ground by displacing surface soil, disrupting soil pore-continuity, increasing compaction, and leaving the soil highly susceptible to wind, water, and gravity caused erosion. Grapple piling of slash and mechanical control of vegetation would leave up to 50% of the soil exposed to erosive forces (e.g. wind, water, and gravity). There can also be a slight increase in soil density on 60-80% and soil displacement on 20-80% of the area. Using low-ground pressure, low-ground disturbance equipment; using grapples to pull brush; or mastication can limit impacts. On this project, use of ground-based equipment for fuel management activities and site preparation would occur when the soil is dry to 6 inches and would use low-ground pressure equipment with tracks, so that the risk of detrimental compaction would be reduced.

Fuel reduction activities would decrease downed woody material in areas treated. Although woody material is removed, leaving a minimum of 75 percent soil cover (organic material usually less than 3") and 4 snags and 4 downed logs per acre would meet the long-term soil needs without adding excessively to the fuel-loading of the site. Leaving 75 percent soil cover would reduce the current erosion hazard from high and very high to low and the low end of high depending on slope (Region 5 Erosion Hazard Rating System). Leaving 50 percent soil cover would reduce the current erosion hazard from high and very high to moderate and high depending on slope (Region 5 Erosion Hazard Rating System).

Fuel reduction activities would have little direct or indirect effects on riparian, soil and aquatic resources if management requirements and BMPs are implemented, such as using low ground pressure equipment and human labor to implement the treatments.

Burning of slash piles can result in highly hydrophobic soils. Burning of piles would be coordinated with biologists and soil specialists to minimize effects to aquatic and terrestrial wildlife and soils.

Overall fuels and vegetation management proposals would not reduce the soil cover below the 75 percent minimum requirements in the TNF LRMP Standard and Guideline 55. To achieve this standard, material would be left on site and would not be piled or removed unless in excess to the 75% ESC. Some isolated areas may not achieve the 75% ESC through management activities, such as scalped planting areas and beneath burn piles.

Maintenance of SPLATS would require periodic mechanical treatment and/or burning. The next treatment would need to be implemented in approximately 15 to 20 years and is not included in the current CWE analysis as a foreseeable future action. The goal would be low intensity mosaic burns that would meet soil quality standards and would therefore have little negative effects on soil and water. These types of treatments were analyzed in the SNFPA and were not found to decrease long-term soil productivity.

Planting Trees

Planting would cause minor, localized site disturbance. Reforesting the burn area as rapidly as possible with desired conifer species would establish vegetative cover that would increase the rate of litter and duff formation. This would also limit the need to re-disturb the soil at a later time to re-establish conifers and would help to restore the soil, watershed, riparian, and aquatic ecosystems.

Remove Competing Vegetation

Grubbing would cause a short-term decrease in nitrogen fixation by N-fixing brush species, disruption of soil by hand-crew, increase in small woody debris, and increase the potential for minor soil movement in a 5-foot radius. Clipping would cause a minor disruption of soil by hand crew and increase forest floor organic matter. Pre-commercial thinning would have same effects as clipping, and this effect is also minimal

Transportation Management Proposal

The improvement to the current road system would reduce sources of erosion and sediment delivered to the stream system. Maintenance and repair of the current road system includes clearing debris, surface grading, culvert installation, rocking identified sections of roads within RCAs, and installation of driveable dips. These improvements would have both direct and indirect benefits to the stream system by reducing erosion and sediment coming from the road system and its effects on downstream beneficial uses. Roads identified in the road management objectives for the Red Star Fire Restoration project for decommissioning would reduce erosion and sediment sources and promote vegetative growth on previously compacted surfaces.

The closure, obliteration, and rocking of roads in the analysis area would result in decreased soil erosion, and potentially decreased sediment loading to aquatic habitats. There would be no adverse impacts to the soil, watershed, riparian, and aquatic resources resulting from transportation management as proposed.

Maintenance of the road surfaces and repair of roads could cause a short-term increase in sediment, but would provide a long-term benefit to water quality since drainage and stream crossings would be improved. Improving drainage would change the overland flow pattern, which would result in minimizing both accelerated erosion and increased sediment loading to streams.

Road decommissioning (8.4 miles) and road closures (3.0 miles) would affect 11.4 miles of road that would indirectly benefit riparian and aquatic habitats within the Red Star Restoration analysis area. Since roads are the primary source of sediment to streams on Forest Service lands, obliteration and limiting use on roads would help to reduce soil movement from roads to streams. Also road obliteration and closures would help to achieve a desired condition of connectivity within a watershed. Roads can form barriers to waterflow both overland, subsurface, and instream. Recovery of roads to the watershed landscape can result in long-term benefits to riparian and aquatic habitats through improved natural hydrologic regimes and improved water quality.

Cumulative Effects

This project is designed to promote watershed recovery from the Star Fire by reducing potential direct and indirect effects associated project activities, such as erosion and sedimentation and protecting sensitive lands while meeting other resource objectives including fuels reduction, re-establish forest vegetation, restore Old Forest characteristics, provide for Old Forest wildlife habitat, and management of the road system. By reducing the direct and indirect effects, cumulative effects would also be reduced under all action alternatives.

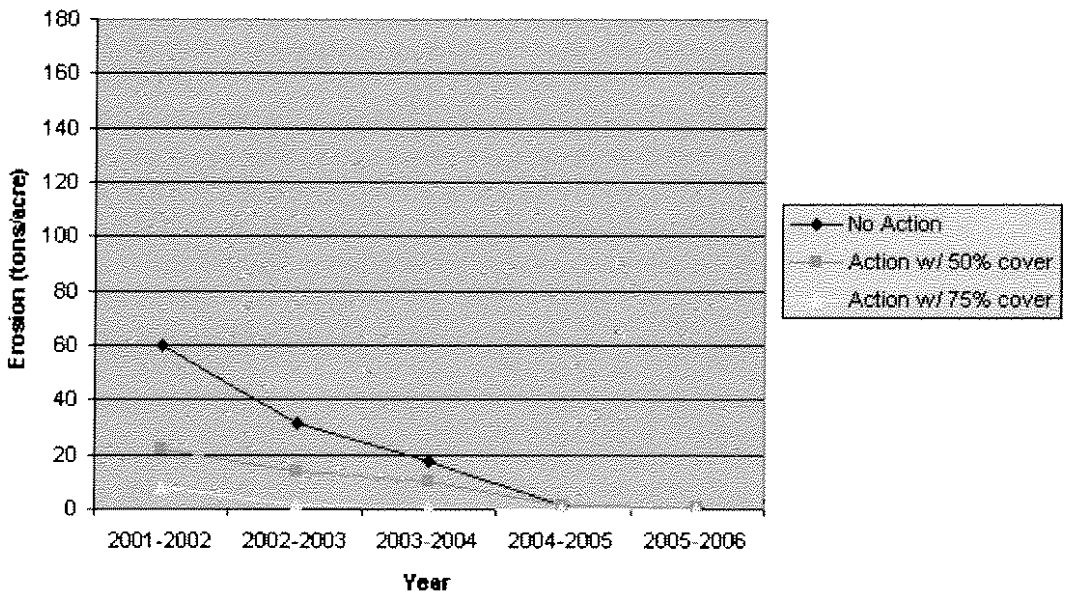
The RCAs in all subwatersheds and activities within RCAs are consistent with the Sierra Nevada Forest Plan Amendment (Framework) and were set to protect and restore aquatic, riparian, and meadow ecosystems (See RCO analysis, Appendix H).

Table 3-17 is a summary of the criteria used to analyze effects of the proposed project.

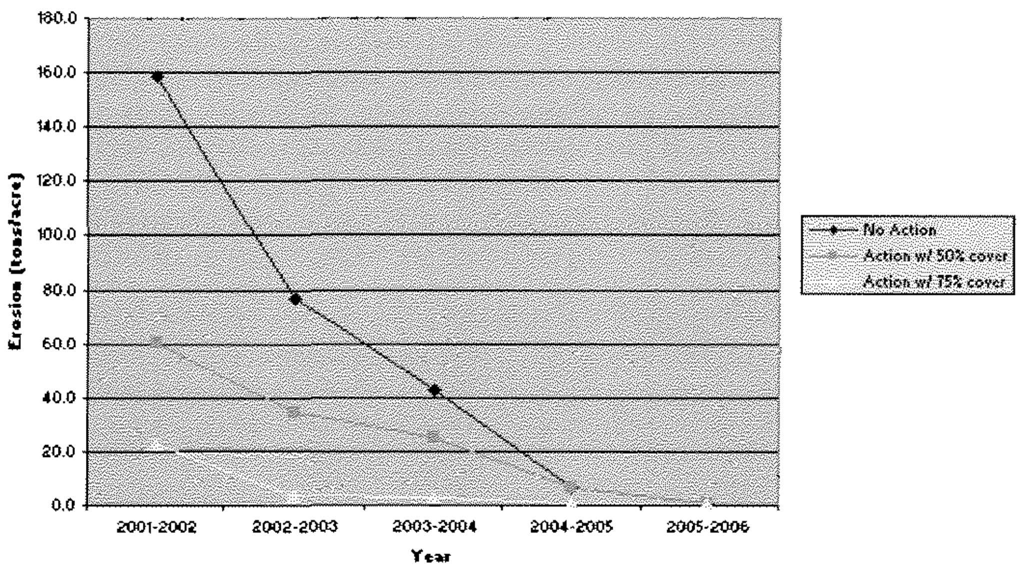
The erosion and sediment predictions presented in Table 3-17 and Graphs 1 and 2 (below) are the result of water erosion prediction project (WEPP) modeling using "average" erosion and sediment losses (see Appendix D). Modeling a variety of site conditions (using soil and slope information based on the Star Fire area) resulted in "average" erosion and sediment predictions. All other factors were held constant except for ground cover, which was modeled using the amount of ground cover expected to be generated by all of the action alternatives. Based on observations of available material to be used for ground cover in the fire area, the modeling used 50 and 75 percent cover. The compaction analysis for the project shows an estimated 10 percent of the area would have some type of compaction from the ground-based skidding operation. These areas would generally be at the ends of the skid trails away from landings and would therefore have lower levels of compaction. The proposed 75 percent cover also helps to mitigate the erosion impacts from concentrated water movement on skid trails.

The value of this type of modeling is as a comparative tool to assess the effect of adding different amounts ground cover on erosion and sedimentation rates. All action alternatives increase ground cover faster than the No Action Alternative and therefore reduce erosion and sedimentation faster. Graph 1 shows the benefit of adding cover on slopes less than 30 percent. Graph 2 shows the effects of adding cover on slopes greater than 30 percent. Both graphs show that cover reduces the predicted erosion (the sedimentation curve is very similar). While erosion and sedimentation are not stopped by the action alternatives, they are reduced by at least 50 percent. The amount of reduction is highly dependent upon timing, percent cover, and location on the landscape.

Graph 1. Predicted Erosion (<30% slopes) (WEPP)



Graph 2. Predicted Erosion (>30% slopes) (WEPP)



Limited field review of high burn severity areas in the Red Star Ridge area in May, 2002, shows that the WEPP modeling is consistent with on-site erosion. Soil pedestals ranging from 1/8 (~20 tons per acre) to 2 (320 tons per acre) inches high were found in many areas. Rill erosion has occurred and has formed a branching network in many areas.

Table 3-17: Comparison of cumulative effects of alternatives

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
sion/ imentation k	Increased erosion risk for ~10 yrs. Increased Sediment risk for 10-30 yrs.	On sites where soil cover is added (~70-75%), erosion risk is reduced from high- very high to moderate- low end of high - the year project implemented due to increased soil cover.	Erosion risk is reduced from high- very high to moderate- low end of high - the year project implemented due to increased soil cover.	Erosion risk is reduced to varying degree depending on the amount of soil cover generated. Would be less than Alts B, D, and E, but more than Alt. A.	Same as D
:PP 2001-2 erosion	~60 ton/ac on < 25% slopes; 160 t/ac on >25% slopes	Same as A	Same as A	Same as A	Same as A
:PP 2002-3 erosion	~30 ton/ac on < 25% slopes; 75 t/ac on >25% slopes	Same as A	Same as A	Same as A	Same as A
:PP 2003-4 erosion	~18 ton/ac on < 25% slopes; 43 t/ac on >25% slopes	~0.8-10 ton/ac on < 25% slopes; 3-25 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B

;PP 2004- '5 erosion	~2 ton/ac on < 25% slopes; 7 t/ac on >25% slopes	~0.2-0.5 ton/ac on < 25% slopes; 0.6-1 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B
;PP 2005- '6 erosion	~0.5 ton/ac on < 25% slopes; 2 t/ac on >25% slopes	~0.2-0.5 ton/ac on < 25% slopes; 0.6-1 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B
;PP 2001- '2 imentation	~65 ton/ac on < 25% slopes; 175 t/ac on >25% slopes	Same as A	Same as A	Same as A	Same as A
;PP 2002- '3 imentation	~30 ton/ac on < 25% slopes; 75 t/ac on >25% slopes	Same as A	Same as A	Same as A	Same as A
;PP 2003- '4 sediment	~18 ton/ac on < 25% slopes; 43 t/ac on >25% slopes	~0.8-10 ton/ac on < 25% slopes; 3-25 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B
;PP 2004- '5 sediment	~2 ton/ac on < 25% slopes; 7 t/ac on >25% slopes	~0.2-0.5 ton/ac on < 25% slopes; 0.6-1 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B
;PP 2005- '6 imentation	~0.5 ton/ac on < 25% slopes; 2 t/ac on >25% slopes	~0.2-0.5 ton/ac on < 25% slopes; 0.6-1 t/ac on >25% slopes	Same as B	Less than A, but more than B, C, & E.	Same as B
l porosity	Past ground-based logging = 56 acres with approximately 10-20% legacy compaction.	382 acres of proposed ground-based logging. Mgt. requirements for skid trails could result in less compaction than pre-project levels (by removing pre-existing skids and landings); all TS units would meet the SQS for porosity.	400 acres of proposed ground-based logging. Mgt. requirements for skid trails could result in less compaction than pre-project levels (by removing pre-existing skids and landings); all TS units would meet the SQS for porosity.	400 acres of proposed ground-based logging. Mgt. requirements for skid trails could result in less compaction than pre-project levels (by removing pre-existing skids and landings); all TS units would meet the SQS for porosity.	400 acres of proposed ground-based logging. Mgt. requirements for skid trails could result in less compaction than pre-project levels (by removing pre-existing skids and landings); all TS units would meet the SQS for porosity.
ody Material	All fire-killed material would be retained on-site.	Snags, downed logs, and cull logs would result in ~10 large logs (>16" dbh/dib) per acre. This would meet the SQS for LWM.	Same as B	Snags, downed logs, and cull logs would result in ~10 large logs (>16" dbh/dib) per acre. This would meet the SQS for LWM.	Same as B
: Risk	Intensity of future fires would cause further soil damage due to	Would have reduced fire intensity in areas treated, this would result in lower soil	Same as B	Slightly lower than Alt A but higher than Alts B, C and E.	Same as B

	the fuel loading. FOFEM modeling shows highest potential soil temperatures to a depth of 10 to 12 cm (Appendix N).	damage than Alt A. FOFEM modeling shows damaging soil temperatures to around 2 to 4 cm.			

The priority areas for salvage logging would be within areas that burned at a high severity (>75% mortality). These areas would receive the greatest benefit from increased ground cover through lopping and scattering of limbs and tops of harvested trees. Areas of moderate and low burn severity would also benefit from the increase of woody material although much of these areas have some ground cover in the form of leaves and needle cast. This increased ground cover would have cumulative benefits from the subwatershed scale up to the Middle Fork of the American River watershed as a whole.

Ground-based logging systems would be used on five percent or less of the project area. Restricting ground-based equipment to slopes generally under 25 percent and utilizing aerial systems in the remaining area, including all RCAs, would reduce potential effects of compaction and disturbance of soils in the project area. Implementing the proposed action alternatives, with the specified management requirements, would result in a low risk of negative cumulative watershed effects even in the watersheds that are over TOC.

The Duncan Diversion Dam and Ralston Reservoir would still experience increased sediment delivery to the facility but to a lesser amount than Alternative A. Effects of the Star Fire would still have accelerated sediment delivery for the short-term but sediment delivery would diminish in a shorter time due to accelerated deposit of woody material through lopping and scattering of limbs and tops of harvested trees, along with vegetation growth.

A risk to watershed, soil, and fisheries values associated with selection of the any of the Acton Alternatives is the potential of a future high intensity fire. Even though the current fire hazard is low, the hazard would increase as standing dead trees fall, vegetation grows, and overall fuel loading increases. The amount of woody material left after harvest would vary by alternative. The amount of woody material combined with vegetation regrowth could result in a ground-fire that would generate extreme heat at the soil surface with a long enough residence time to severely affect soil process and function. The First Order Fire Effects Model (FOFEM, see Appendix G) was used to predict soil temperatures generated by future fires and to identify potential effects to the soil resource (see Appendix N). The FOFEM model was run for the Star Fire and the Gap Fire. The results of the modeling on both fires show that surface soil temperatures increase with time and that the depth of heat penetration into the soil also increases with time. Alternatives B, C and E would have similar post-project fuel loadings and therefore, would have similar soil impacts from a future fire. For all years modeled (5 through 25), soil organisms would be impacted to a depth of 2 to 4 cm. and soil organic matter would not be impacted except on the soil surface. Alternative D would have soil temperatures similar to the No Action alternative. By year 5, soil organisms would be impacted to a depth of 3 to 7 cm and soil organic matter would be destroyed to a depth of 2 cm. By year 25, soil organisms would be killed to a depth of 8 to 11 cm. and soil organic matter would be destroyed to a depth of 1 to 4 cm. This type of fire could have severe adverse soil, water, and fisheries impacts. This type of fire could also require the use of fire retardant and fire lines in excess of the amount used on the Star Fire. This type of fire could also require the use of fire retardant and fire lines in excess of the amount used on the Star Fire.

Watershed Information for all Alternatives

Water Quality

As compacted areas increase across a watershed, the potential for accelerated erosion and stream sedimentation would increase resulting in decreased water quality. Other factors affecting risks to water quality include underlying geologic structure and soil types found in the watershed, the amount and type of precipitation, and the proximity of management activities to stream channels. Increased stream sedimentation would negatively affect cold-water fisheries rearing and spawning habitat and would result in higher turbidity levels negatively affecting domestic drinking water supplies.

Cumulative Watershed Effects on Water Quality

Ground disturbing activities can cause both direct and indirect effects that persist through time. The cumulative result of all these effects is the potential to adversely affect downstream beneficial uses of the water. Cumulative watershed effects (CWE) analysis may reveal that even though the proposed activities themselves may not be sufficient to substantially impact the watershed, when analyzed in connection with past and foreseeable future activities, the proposed activities may become a cause of concern. The CWE analysis serves as a method for determining the risk of delivering excess sediment to streams. The CWE methodology is just one of the Best Management Practices that would be used to ensure that water quality is maintained and beneficial uses not impaired within the watersheds.

As discussed in the Affected Environment section for Soils, Geology, and Watershed Resources, each watershed is assessed for its ability to withstand erosional processes and handle sediment delivery to stream channels and assigned a threshold of concern (TOC) value. The TOC is used as a "yellow light" or caution indicator. As watersheds approach TOC, proposed management activities must be carefully planned to ensure that water quality is not impacted.

Past, present and reasonably foreseeable future impacts on the watershed are quantified using an "Equivalent Roaded Acres" (ERA) methodology. The ERA methodology assigns weighted coefficients to each management activity to normalize the acres of ground disturbance. The weights are based on each activity's potential to deliver the same amount of sediment to a channel as a native surfaced road. Each acre of road is assigned a coefficient of 1.0. Since accelerated erosion can also result when soils do not have sufficient effective ground cover, ERA coefficients were assigned by burn severity to the acres in each watershed that were burned due to the Star Fire.

High severity burn areas had all litter and duff removed and are most susceptible to erosion; these areas were assigned an ERA coefficient of 0.15. Moderate severity burn areas have some of the pre-fire litter and duff left, although, it may be charred. There also are needles remaining on the trees that will contribute to the litter and duff layer after the fire. Moderate burn severity sites were given an ERA coefficient of 0.05. Low severity burn areas had the majority of the litter and duff intact after the fire and were assigned an ERA coefficient of 0.02.

Fire suppression activities associated with the Star Fire, including constructed firelines, was analyzed as part of the ERA methodology. ERA coefficients assigned to the fire suppression activities were 0.10 even though the suppression activities were rehabilitated after the fire. Soil disturbance, more than compaction, was the major contributor to CWE.

Each acre treated by a given method is multiplied by the ERA coefficient for that method. These weighted acres are summed to determine the ERA for each watershed. The ERA value is usually reported as a percent by dividing the calculated ERA value by the total acres within the watershed. The ERA value is compared to the TOC value to determine how close the watershed is to the threshold.

The risk of adversely impacting water quality is related to how close the % ERAs in given watersheds approach and exceed estimated thresholds. Assignment of ERA values assumes that standard Best Management Practices (BMPs) designed to minimize sedimentation and maintain natural water temperatures, would be implemented. Any deviation from these practices is documented in the analysis.

Lands impacted by management activities are considered to "recover" linearly and deliver less sediment over time. The recovery period for each watershed is determined by estimating the time required to render the watershed hydrologically similar to its condition prior to harvest. For the watersheds analyzed in this analysis, that time was estimated to be 30 years. Roads, landings, and other impervious surfaces do not recover unless obliterated.

The CWE analysis for the proposed project covers all known activities in the watersheds including, but not limited to, the burn effects of the Star Fire, the post-fire logging on private land, the French helicopter sale, the Red Hot road side hazard tree reduction, the proposed Star Restoration project on the Eldorado NF, and the proposed Red Star Restoration project on the TNF. The CWE analysis for the proposed project did not forecast impacts from future management activities in the affected watersheds on National Forest Lands or private lands because not enough detail is known about those actions at this time to perform a meaningful CWE analysis. Trying to guess on where, when, and how future activities would occur was not attempted. Future CWE analyses would assess any future management activities should they occur. Forest Service and private timber sales from the past thirty years were included in the CWE analysis. The detailed CWE analysis is available in the project file.

The Thresholds of Concern (TOC) for each watershed are summarized in Table 3-18.

Table 3-18: Cumulative Watershed Effects Analysis Results by Alternative

Subwatershed	Subwatershed Name	Acres	TOC	ALT. A Existing % ERA	ALT. B %ERA	ALT. C % ERA	ALT. D % ERA	ALT. E % ERA
G0006	Upper MFAR	1976	14%	6.5%	6.6%	6.6%	6.6%	6.4%
G0008	French Mdws	2459*	14%	5.7%	5.7%	5.8%	5.8%	5.6%
G0009	French Mdws	2669*	14%	9.6%	10.3%	10.5%	10.5%	10.1%
G0010	Lower MFAR	1900	10%	**20.6%**	**24.0%**	**23.8%**	**23.8%**	**23.7%**
G0011	Lower MFAR	1905	10%	**18.0%**	**21.8%**	**20.4%**	**20.4%**	**20.4%**
G0012	Lower MFAR	1863	10%	**11.9%**	**12.4%**	**12.4%**	**12.4%**	**12.4%**
G0702	Duncan Canyon	2108	12%	4.0%	4.2%	5.5%	5.5%	3.1%
G0703	Duncan Canyon	1467	12%	7.4%	6.9%	9.3%	9.3%	7.1%
G0704	Duncan Canyon	1758	12%	5.7%	7.0%	7.6%	7.6%	6.7%
G0705	Duncan Canyon	1685	12%	5.7%	7.9%	8.3%	8.3%	8.3%
G0706	Duncan Canyon	1553	12%	5.4%	6.6%	6.2%	6.2%	6.2%
G0707	Duncan Canyon	1509	12%	4.5%	5.8%	5.6%	5.6%	5.6%
G0710	Little Duncan	2046	12%	0.9%	1.4%	1.8%	1.8%	1.0%

***Acres are net acres; G0008 and G0009 have 800 acres and 298 acres within French Meadows Reservoir respectively. These acres were not included for CWE analysis.**

Note: Bold numbers represents subwatersheds over threshold of concern.

Risk to cumulative watershed effects

Low risk subwatersheds include: G0006, G0008, G0702, G0707, and G0710

Moderate risk subwatersheds include: G0009, G0703, G0704, G0705, and G0706

High risk subwatersheds include: none

Very High risk subwatersheds include: G0010, G0011, and G0012

Low risk = (%ERA/TOC less than 0.50)

Moderate risk = (%ERA/TOC = 0.50 - 0.79)

High risk = (%ERA/TOC = 0.80 - 0.99)

Very High risk = (%ERA/TOC = 1.00 or greater)

Subwatersheds with lower ERAs in the action alternatives than from the existing condition (Alt. A) is due to the reduction of the high burn severity effects by helicopter harvest and lopping and scattering slash to increase ground cover. Helicopter harvest in combination with lopping and scattering slash has a lower ERA coefficient (0.05) than high burn severity (0.15).

In terms of minimizing negative impacts to water quality and soil productivity, Alternative C and D provides the best protection followed by Alternative B, Alternative E and then Alternative A. However, none of the alternatives eliminates the risk. As stated previously, over 85% of the analysis area is located on highly to very highly erosive soils. This means that accelerated erosion occurs in most years. Adverse effects to soil productivity and water quality are likely to occur during periods of normal precipitation on highly erosive soils and even during periods of below average precipitation on very highly erosive soils.

Aquatic Resources

Summary of Effects:

- Alternatives C and D provide the greatest amount of potential CWD to meet long term fish habitat needs.
- Alternative B would provide for long-term CWD needs, but at a lesser degree than Alternatives C and D.
- Alternatives A and E would provide for long-term CWD needs, but would also result in fuel levels that would increase the risk of another severe wildfire damaging aquatic resources.
- All action alternatives provide for some additions of ground cover that would reduce sedimentation, thereby reducing the loss of stream habitat.

Affected Environment

Introduction

This section describes the existing condition of fisheries resources in the Red Star Restoration analysis area. Tahoe National Forest fish biologists compiled and reviewed available information on fishery resources in the analysis. Information was obtained from USFS stream surveys conducted in 1991, 1996, and 2001, and the Tahoe National Forest LRMP

Tahoe National Forest hydrologists and fish biologists conducted stream surveys and watershed condition assessments in 1996 and 2001. The hydrology section of the survey concentrates on the physical aspects of the stream, including bank stability, Rosgen channel type, and substrate type. The fish biologist recorded fish and amphibian species present, percentage and species of riparian vegetation, and amount of coarse woody debris. During the 2001 surveys, the crew also indicated proximity of the burn to the stream, and any loss of riparian vegetation. All survey forms are available for review at the Foresthill Ranger District Office.

This section discusses fisheries and herptile species and their specific habitat needs. A broader discussion of aquatic resources can be found in the soils and hydrology portion of this chapter. A more detailed discussion of the impacts to threatened, endangered and sensitive species can be found in Appendix B. Information from all of those discussions is included in this analysis in summarized forms.

Location

The Red Star Restoration Analysis Area is located within the Upper Middle Fork American River watershed. The two subwatersheds, French and Duncan, comprise the Upper Middle Fork American

River watershed. The French subwatershed consists of the Middle Fork American River from the headwaters to its confluence with Duncan Canyon. The Duncan subwatershed consists of Duncan Canyon and the Middle Fork American River from its confluence with Duncan Canyon down stream to the confluence with the Rubicon River. The analysis area is comprised of thirteen "planning" subwatersheds situated within Duncan and French subwatersheds.

Stream and Aquatic Information

The following descriptions provide a general overview of the condition of the stream channels and adjacent riparian zones. Tributaries referred to in this report are the major tributaries delineated on the USGS topographic maps.

The subwatersheds in the analysis area vary in aspectranging from north-south to east-west. Elevation ranges from 3,340 feet at the confluence of Duncan Canyon and the Middle Fork American River to 7,182 feet at Duncan Peak Lookout.

Aquatic species of interest that have been observed within the analysis area include native rainbow trout (*Oncorhynchus mykiss*) (an MIS), brown trout, (*Salmo trutta*) (an MIS), hardhead (*Mylopharadon conocephalus*), western toad (*Bufo boreas*), western aquatic garter snake (*Thamnophis couchii*) (part of an MIS), California newt (*Taricha torosa*) and Pacific tree frogs (*Hyla regilla*) (part of an MIS group). The analysis area also provides suitable and possibly occupied habitat for foothill yellow-legged frog (*Rana boylii*) and Northwestern pond turtle (*Clemmys marmorata*), both Region 5 US Forest Service sensitive species.

Rainbow trout and brown tout are MIS found within the project area. Rainbow trout is a native game species and brown trout is an introduced game species. Neither species have any special status. Suitable habitat for these trout includes lakes, ponds and streams with cool water temperatures, high oxygen concentrations and clean, well oxygenated gravel substrate for spawning. Rainbow trout deposit eggs in gravel nests (redds) in the late winter to early summer and the eggs hatch within 80 days, depending upon water temperatures and spawning date. Brown trout deposit eggs in redds in the late fall to early winter, and eggs hatch .120-150 days, depending on water temperatures and spawning date. For both species, newly hatched alevin remain in the red and depend on the yolk for 7-15 days after which the fry emerge from the graven and begin exogenous feeding. Mortality rates are very high during this live stage and fry survival is considered critical to maintaining population densities. Adult rainbow and brown trout are highly aggressive in establishing and defending feeding territories. They are sit-and-wait predators that generally feed on drifting invertebrates, but will feed on small fish when available. Optimal feeding habitat is slow, deep pools located downstream from riffle habitats. This feeding habitat allows trout to conserve energy by swimming in low velocity pools while positioning themselves next to swift velocity areas where higher prey densities exist. These pools can be further enhanced as feeding habitats when structural complexity in the form of woody debris and boulders exist to provide velocity shelters. It is this velocity shelter effect as well as the pool forming effect of coarse woody debris (CWD) that makes it such a crucial habitat need for salmonids.

Currently, (CWD) along the Middle Fork American and Duncan Canyon is lower than desired conditions, averaging 39 pieces of wood per stream mile. The desired condition for large woody debris, based on previous Tahoe NF woody debris surveys, is within the range of 160 to 400 pieces per stream mile (Berg et al. 1998). Portions of the Middle Fork American, Duncan Canyon and Little Duncan Canyon were not impacted by the fire and may be able to provide CWD to downstream areas. However, the Middle Fork American and Duncan Canyon possess dams that would restrict the movement of CWD from upper portions of the watershed. As a result, the stream areas below the dams that are impacted by the fire would depend solely on the forest adjacent to the stream for recruitment until the forest recovers.

The following descriptions provide a general overview of the condition of the stream channels and adjacent riparian zones. For ease of discussion, the area is divided into three major areas, French, Duncan and Little Duncan. Tributaries referred to in this report are the major tributaries delineated on the USGS topographic maps.

French -

The French Meadows Reservoir is created by the Anderson Dam, located on the Middle Fork American River (MFAR). The MFAR, along with French Meadows Reservoir itself, comprise the three subwatersheds covering 8,202 acres. Approximately 94% of the watershed is Tahoe National Forest land. The French Meadows Reservoir waterbody itself comprises 1,098 acres.

The tributaries to French Meadows Reservoir are steep, narrow channels composed primarily of bedrock, boulders, and cobbles. Most have either perennial or intermittent flow. While riparian vegetation tends to be abundant, the overstory conifers contribute a high percentage of the total streamside vegetation and are critical for providing canopy closure and bank stability. Continuous bank cutting and accelerated point bar formation occurs in most of the streams.

Surveys of the watershed above the reservoir were conducted during the French analysis. Pacific tree frogs and a diversity of invertebrates were found in these streams, but no fish were found. Amphibian surveys have located Pacific tree frogs, western aquatic garter snake, western toad and California newt in the immediate area of the reservoir and tributaries upstream. Surveys conducted during spillway repair resulted in sightings of rainbow trout, brown trout and hardhead in the Middle Fork American, downstream of the dam. Northwestern Pond turtles have been sighted near the North Fork of the Middle Fork American River, approximately 10 miles west of the analysis area. Habitat for pond turtles exists in this drainage within the analysis area.

Duncan -

The mainstem Duncan Canyon is a perennial from the north-central part of Section 8 (private land) to the confluence with MFAR. It is predominantly characterized by channel materials dominated by small boulders and very large cobbles, moderate entrenchment and moderate confinement. Gradients are generally greater than 4%. There are many interspersed short sections of bedrock and large cobbles mixed with small boulders and coarse gravel and gradients of 1.5 to 2.5%. Sideslopes to the channel are generally moderate to steep.

The remaining upper portion of Duncan Canyon, a perennial, is outside the analysis area, but continues from the north-central part of Section 8 upstream to where two branches converge in the NW ¼ of the NE ¼ of Section 8. The west branch is perennial at least one-quarter mile into Section 5, and the east branch is perennial at least one-quarter mile into Section 4. These channels are characterized by large and small boulders, cobbles, and gradients of 4 to 10%. Sideslopes are moderately steep to steep.

Duncan Canyon contains a rainbow trout fishery. Historic surveys have recorded brook trout in the upper reaches, but no recent surveys of that area have been conducted to confirm the status of the fishery. Fish habitat is fair with pools being common, with coarse woody debris averaging 39 pieces per stream mile. The short lower gradient areas contain gravels that provide spawning habitat, but the rarity of these areas may be limiting.

Surveys for amphibians have resulted in sightings of western aquatic garter snake. No other species have been sighted. Two ponds providing potential habitat for California red-legged frogs exist at the Red Star Mine, but surveys have failed to locate any amphibians at these sites and the habitat was assessed to be of poor quality. Habitat for foothill yellow-legged frogs exists within the mainstem of Duncan Canyon, but surveys for this species have failed to locate any individuals at this site.

There are many miles of tributaries to Duncan Canyon that includes both perennial and seasonal flowing streams. They are typically characterized by small boulders, cobbles, coarse gravel, and gradients 4 to 10%, but include cobble beds, and a mixture of gravel and sand, some small boulders, and gradients of 1.5 to 4.0% occur on flatter reaches. A common characteristic is evidence of active channel cutting and sediment transport.

Little Duncan Canyon –

Within the analysis area, Little Duncan Canyon, a perennial, is a tributary to Duncan Canyon and is characterized by large and small boulders, cobbles, and gradients of 4 to 10% with steep rocky sideslopes. Surveys from the mid-1970s indicated that rainbow trout were present in this stream at a low abundance. No recent surveys have been conducted in that area to confirm the status of the fishery.

No surveys for amphibians have been conducted in Little Duncan Canyon. Habitat for foothill yellow-legged frogs exists within the mainstem of Little Duncan Canyon, but no surveys specific for this survey have been conducted. This drainage is within the elevational range for mountain yellow-legged frog, but the steepness of the channel makes the habitat unsuitable.

Effects of the Fire upon Fisheries and Aquatic Species -

Wildfire can impact aquatic systems by killing or injuring organisms. It can destroy instream and riparian habitat components, resulting in short-term and long-term impacts to coarse woody debris, channel stability, water quality and sedimentation.

Studies of the impacts of wildfire upon aquatic ecosystems have shown that fish mortality can occur during severe wildfires (Minshall et. al. 1997, Novak and White 1989). The cause for fish mortality is unknown, but it is believed that changes in water chemistry, not lethal water temperatures are the cause (Gresswell 1999). The risk of death or injury during a wildfire is greater to species that migrate away from the streams and use riparian habitats, such as amphibians and reptiles. During the fire and immediately after, resource specialist walked along portions of the Middle Fork American River and Duncan Canyon. No dead fish, amphibians or turtles were reported.

Fish kills have been reported during wildfire suppressions as the result of retardant application to streams (Norris and Webb 1989, McDonald et al. 1997). The retardants used during the Star Fire, Phos-Chek and Fire-Trol, are ammonia-based retardants. These types of retardants, were applied to streams environments, have resulted in high levels of un-ionized ammonia, which can be toxic to aquatic species (Norris and Webb 1989). Salmonids appear to be particularly sensitive to the ammonia (McDonald et al. 1997). The effect of the ammonia appears to be short lived, with concentrations decreasing quickly over time and with distance downstream from application. Little or no effect is known to occur if applications occur outside of riparian zones (Norris and Webb 1989). Because of these factors, the USFS has developed guidelines for retardant applications during wildfire suppression that minimize its application within streams and riparian zones. During the Star Fire, no applications of retardant are known to have occurred within 300 feet of waterbodies. Post-fire stream surveys have failed to locate any stream reaches that appear to have retardant applications and no fish or amphibian kills were seen.

A number of post-wildfire studies have examined the effects upon stream macroinvertebrates (Minshall et. al. 1997, Minshall et. al. 2001, Roby 1995). The results of these studies are variable in terms of taxa richness and abundance. All reports showed a shift in the community, typically towards taxa more tolerant of disturbance. Within 10 years, the macroinvertebrate communities had recovered to levels similar to pre-fire conditions.

The impacts to fisheries and aquatic species habitat is much more significant than direct effects to animals. If a fire burns into the riparian area, riparian and overstory vegetation adjacent to the stream can be consumed, resulting in a loss of shade and overhanging cover. The loss of shade may result in increases in water temperature, which can have detrimental, even lethal, impacts to fish. Monitoring of water temperatures after severe wildfire has shown increases up to 10° C (Gresswell 1999).

As discussed previously, impacts of the wildfire upon soil resources often results in increased soil movement and sedimentation to streams. This increased sedimentation results in stream habitat alterations, including reduction of pool volume, reduction of bank stability, and increased substrate embeddedness (Gresswell 1997). These changes can result in losses of critical habitat components for fish such as loss of pools providing rearing and resting habitats and loss of gravels providing spawning habitat (Minshall et. a. 1989). The increased embeddedness can impact macroinvertebrates, shifting the community towards disturbance tolerant species (Minshall et. al. 1997).

One of the greatest impacts of wildfires to fisheries habitat is the loss of instream coarse woody debris (CWD) and increases in its potential recruitment. Coarse woody debris is critical to streams and fisheries as it stabilizes stream channels, retains organic material and sediments and provides habitat for fish and macroinvertebrates (Bilby and Bisson 1998, Bisson et al. 1987). A study of the role of CWD in Sierra Nevada streams has shown that streams typically have 160 to 400 pieces of medium and large CWD per stream mile, depending on channel size and type (Berg et al. 1998). Another study of streams in the Sierra Nevada showed that streams of similar size and channel type as those found in the Red Star Restoration project area had CWD densities ranging from 275 to 395 pieces per stream mile (Ruediger and Ward 1996). During severe wildfires, fire may cross streams, resulting in consumption of CWD in drainages (Greswell 1999). Additional loss of CWD can occur post-wildfire as resulting high flows flush debris from the system (Minshall et. al. 1989). Post-wildfire increases in CWD can occur as fire-killed trees fall into the stream (Minshall et. al. 1997). Debris recruitment levels would be expected to be high during the first 5 to 30 years after a wildfire, but then decrease until the adjacent forest recovers (Greswell 1999). Surveys of the Star Fire area revealed that little if any CWD in the major drainages was lost as the result of the fire; the fire did not approach these streams closely, and burned with a mosaic of intensities where it did approach. However, surveys also indicated that these drainages average 39 pieces of CWD per mile, far below the desired condition of 160 to 400 pieces per mile.

Environmental Consequences

This area discusses the effects of the different alternatives upon aquatic species and their habitat, including fish, amphibians, reptiles and macroinvertebrates. The impacts to fisheries and aquatic species are highly interrelated to the impacts to soils and hydrology; therefore, this discussion will refer to those discussions of impacts. For a more thorough discussions of Federally listed species, USFS listed species, refer to the Biological Evaluation in Appendix B. Summaries of those evaluations are included in the discussions below.

Effects Common to All Alternatives

Direct Effects

No activities are proposed under any alternative that would kill or injure fish.

The trout populations in the Middle Fork American River, Duncan Canyon and Little Duncan Canyon would continue to exist. Hardhead populations would continue to exist in the Middle Fork American River.

Two ponds exist at the Red Star Mine site within the project area. These ponds are within the elevation range and maintain water levels through the July, making them suitable breeding habitat for California red-legged frogs. Surveys for California red-legged frogs were conducted in May 2002 and failed to locate any amphibians of any kind. The closest sighting of red-legged frogs is 10 miles west of the project area on the Eldorado National Forest. Based on the poor quality of the habitat at Red Star Mine, the lack of suitable habitat or known populations within 2 miles of the project area, and the lack of presence of frogs after surveys at the Red Star Mine ponds, it is determined that no effects to California red-legged frogs or their habitat would occur as the result of any proposed activities.

Surveys of the project area have not resulted in the location of any foothill yellow-legged frogs, although habitat for these species is known to exist. Species-specific surveys will be conducted prior to management activities to determine the need to mitigate for these species. In Alternative A, no activities would occur, eliminating the risk of killing or injuring frogs. In Alternatives B, C, D and E the following mitigations would be implemented where foothill yellow-legged populations exist: 1) The operation of ground-based equipment would be prohibited within 300 feet of perennial streams during the wet season (the first 0.25 inch of rain after October 1 through April 15). 2) Road improvement projects could occur within 300 feet of perennial streams; however, they would be scheduled to occur outside of the wet season to minimize the risk of killing or injuring these animals. Foothill yellow-legged frogs do not typically move more than 300 feet from perennial water sources and that movement occurs primarily during wet conditions (Zeiner et al. 1988). Therefore, eliminating ground-based operations within 300-feet of perennial streams would greatly reduce the risk of injuring or killing frogs. Frogs that migrate out from the stream often utilize rodent borrows or downed logs for cover (Zeiner et al. 1988). Fuels reduction projects, such as the creation and burning of debris piles within 300-feet of streams, would be done outside of the wet season and in a manner (directional ignition and no direct application of chemicals) to allow frogs to escape. These mitigations would reduce the risk of killing or injuring any frogs that may have moved away from the stream during the wet season. As a result, no direct impacts to foothill yellow-legged frogs would occur under any of the alternatives.

A change in the macroinvertebrate community would be expected over the first 3-5 years post-fire, as increased sediment and water temperatures would shift the community towards more tolerant species; however, as the stream recovers towards an equilibrium state, the macroinvertebrate community would be expected to shift back towards its pre-fire composition.

Indirect Effects

For all alternatives, aquatic habitat would be protected from disturbance by ground-based equipment within RCAs. With Alternative A, no activities would occur, eliminating the risk of ground based equipment causing bank instability or increased sedimentation. With Alternatives B, C, D and E, no ground-based equipment would be used within RCAs, and all removal of fire-killed trees would occur using aerial based systems.

Cumulative Effects

When discussing cumulative effects to the aquatic environment, it is best to discuss those impacts in the context of a watershed. All cumulative impacts for this project are discussed relative to the Upper Middle Fork American River watershed (HUC-5), which contains all of the Red Star Restoration project area and most of the Star Fire area. Within this watershed, a variety of land management practices have occurred on adjacent lands and through time, resulting in cumulative impacts to aquatic species and their habitat.

Road construction over time has resulted in an average road density of 3.3 miles per square mile over the burn area, that intersect streams and riparian areas, reducing stream and watershed connectivity. Historic timber sales have removed trees from streamside areas, resulting in a loss of shade and CWD to some streams. Mining activity in portions of the watershed has resulted in bank instability and sedimentation.

The Star Fire had many impacts upon aquatic resources in the area. In some areas, the fire burned intensely, consuming most or all of the ground cover and increased sedimentation is expected as the result. Fire line construction can also increase sedimentation and result in the removal of vegetation that provides shade and CWD to streams. Rehabilitation teams reviewed the area during and after the fire and implemented measures to repair damage done during suppression and mitigate impacts of the fire upon aquatic resources. No fish, amphibians or turtles were identified as having been killed by the fire. No effects to fish, amphibians or turtles are expected to have occurred due to fie suppression activities.

Fire retardant was applied during fire suppression, but no applications were known to occur within 300 feet of waterbodies. No mortality of fish or amphibians from fire retardant occurred during the fire and no impacts have been identified since. The application of retardants during suppression has not added to any cumulative impacts to aquatic animals in this watershed.

Three projects are currently being implemented adjacent to the proposed Red Star Restoration project area: Red Hot Roadside Hazard Salvage, French Helicopter Timber Sale, Deep Timber Sale and End of the World Timber Sale. These projects include timber harvest, fuels reduction and transportation system management. These projects have mitigations to reduce impacts to fisheries and aquatic resources, and would not add to cumulative effects.

The Star Fire Restoration is proposed on the Eldorado National Forest, and fuels reduction and road improvement projects are proposed to occur within the Upper Middle Fork American River HUC-5. That project proposes management measures and mitigations to protect aquatic species and their habitat. Resources specialists working on that project and specialists associated with the Red Star Restoration project have coordinated analysis and recommendations to minimize any risks or impacts to aquatic resources. As a result of these efforts, no cumulative impacts are anticipated to occur as a consequence of the two fire restoration proposals.

Road rehabilitation projects are proposed to occur during the next 1 to 2 years using National Fire Plan funding. The projects would include the resurfacing of roads and the rocking of stream crossings. These projects would have positive effects to aquatic ecosystems by reducing the potential for roads systems to deliver sediment to streams. These projects are being designed in coordination with the roads management objectives analyzed for this project, and would have a cumulative benefit to the watershed.

The development of SPLATs would require follow-up treatments to maintain desired fuels conditions. Potential treatments can include hand treatment, mechanical mastication, prescribed burning, and herbicide application. Mitigations typically prescribed for thinning, mastication and burning projects protect aquatic resources. The maintenance plans for the SPLATs proposed in this document would include only hand thinning and prescribed burning; no herbicide applications would occur. With the implementation of mitigations, RCAs and BMPs, no cumulative impacts would occur as the result of SPLAT maintenance.

Hydroelectric and water storage facilities exist within and adjacent to the project area, including the Duncan Diversion and L. L. Anderson Dams. These structures could alleviate some of the impacts of sedimentation resulting from the fire; however, the dams would trap CWD and spawning gravels moving from upstream reaches and resulting in reductions of in fisheries habitat quality downstream.

No irreversible or irretrievable impacts to aquatic resources would occur under any alternative. No alternative would result in a trend towards federal listing or in a loss of viability for any of the aquatic species found in the project area.

Alternative A – No Action

Direct Effects

Because no activities would occur under this alternative, no risk would exist of killing or injuring northwestern pond turtles.

Fuel loading would be higher with this alternative, resulting in an increased risk of a severe wildfire occurring in the area. A severe wildfire could have direct impacts to the species discussed above by injuring or killing them.

Indirect Effects

Existing conditions would continue to proceed through natural post-fire processes, including: riparian and upslope vegetative growth, recruitment of large woody debris, and trending of physical characteristics (e.g., streamflow, water temperature and substrate composition) towards a post-fire equilibrium.

Riparian vegetation (including alders and willows) is expected to regenerate quickly after the fire, and can be expected to return to pre-fire conditions within 3 to5 years. This riparian vegetation would provide some thermal regulation of stream temperature as well as over-hanging cover for fish and organic inputs to the aquatic food web. While the riparian vegetation would meet some of the shade needs of the streams, the adjacent hillslope and conifers provide much of the shade for streams in the fire area. Regeneration of conifers and hardwoods adjacent to the stream would occur more slowly under this alternative, depending primarily on the native seed bank and surviving trees for propagation. This delay may result in a time period during the first 30 to 50 years after the fire where little shade would be available to the stream, other than that provided by riparian vegetation. This delay in regeneration would be even greater in areas of red fir, as little or no black oak exist that can provide canopy cover more quickly (refer to the vegetation portion of this chapter for a full discussion of forest regeneration). The dead and dying trees, while devoid of their canopy cover, could potentially provide some shading to the stream and adjacent riparian areas. The amount of shade provided by these dead trees is minimal in comparison to that provided by live trees, and most likely does not significantly contribute to thermal regulation.

No change in the amount of CWD available to the stream would occur. All of the fire-killed trees, as well as existing live trees and snags, that could fall and provide down woody material to the stream and riparian areas would still have that potential. Based on a study of CWD function in streams on the Tahoe National Forest, the desired level of CWD is approximately 160 to 400 pieces of wood per stream mile (Berg et al. 1998). Under this alternative, CWD amounts are expected to be in excess of the desired condition by a magnitude of four. The majority of the trees available for CWD recruitment within streamside areas are less than 9 inches in diameter and less than 50 feet in height. These trees would be expected to recruit small pieces of CWD that typically move through and leave the system more quickly. Based on the size of trees available for recruitment, it is anticipated that much the CWD would be of small sizes and leave the system in the short term and not provide long-term habitat structure or stability. However, because of the large amount of CWD anticipated to enter the system, the desired condition would still be achieved and maintained with this alternative. Coarse woody debris would create pool habitat and fish cover. Woody material in streams would provide both organic inputs as well as habitat structure for aquatic macroinvertebrates.

High fuel loading would make the re-introduction of fire in the future difficult. No SPLATs would be created, making the suppression of future wildfires more difficult. These factors would increase the risk of a severe wildfire occurring in the area that could impair aquatic resources.

Sediment inputs to streams in the fire area are expected to increase during the first 10 to 20 years after the fire as the result of a loss of ground cover and increased flows caused by the fire. This may result in some pool filling and reduction of spawning and macroinvertebrate habitats (Gresswell 1999). Increase sedimentation may also increase suspended fines and nutrients, reducing the water quality for fish. As material from dead and dying trees falls on the ground and vegetation re-establishes itself, the amount of sediment should decrease over time, but at a slower rate than would be expected with other alternatives. The large quantities of CWD expected with this alternative should create many new pools that would capture some of the sediment and release it slowly during high flows (Bragg and Kershner 1999). None of the road improvement projects proposed under Alternative B, C, C, or E would be implemented with this alternative, and the risk of sediment delivery from roads would continue.

Fuel loads would be higher with this alternative, resulting in a higher risk of a severe wildfire in the area. A severe wildfire could have indirect impacts to aquatic resources by consuming CWD and reducing pool habitat, reducing canopy cover and thermal regulation, and increasing sedimentation that would reduce pool and spawning habitat.

Cumulative Effects

Cumulative impacts would occur with the No-Action Alternative. The increased sedimentation resulting from loss of ground cover from the fire, paired with sediment inputs from road-stream interactions would continue under this alternative without opportunity for mitigation. These effects would add to the sedimentation and habitat loss that has and is currently occurring because of historic mining and transportation management.

The high level of fuel loading that would occur with this alternative would increase the risk of another severe wildfire occurring in the area that could impact fish and herptile populations or destroy their habitat. No SPLATs would be created, making suppression more difficult if another wildfire were to occur. High fuel loading would eliminate any opportunity to meet the SNFPA objective to re-introduce fire as a natural process on the landscape.

Alternative B – Proposed Action

Direct Effects

Northwestern pond turtles have not been sighted within the project area. The closest sighting of a turtle was on a road adjacent to the North Fork of the Middle Fork American River, approximately 10 miles away from the project area. Large pools and slower stretches of Middle Fork American River within the project area provide habitat for this species. This species is most often associated with permanent water bodies, but may move considerable distances for foraging or nest building (Holland 1994). The activities proposed with this alternative may have direct impacts to this species, if turtles occur in the project area. Because they move considerable distances away from stream courses and burrow under soil and duff, ground-based machinery may crush individuals or nests. Mitigations to protect foothill yellow-legged frogs would provide some protection to this species.

A change in the macroinvertebrate community would be expected over the first 3 to 5 years post-fire, as increased sediment and water temperatures would shift the community towards more tolerant species; however, as the stream recovers towards an equilibrium state, the macroinvertebrate community would be expected to shift back towards its pre-fire composition. The requirement under Alternative B that material be lopped and scattered to achieve 50 to 75% soil cover would reduce sedimentation and alleviate some of this effect upon the macroinvertebrate community.

Indirect Effects

Riparian vegetation has been found to extend from 3 to 30 feet from the edge of streams within the fire area and therefore would be protected from any disturbance by the 50-foot CWD management buffer. Riparian vegetation (including alders and willows) is expected to regenerate quickly after the fire and can be expected to return to pre-fire conditions within 3 to 5 years (Minshall et al. 1997). This riparian vegetation would provide some thermal regulation of stream temperature as well as over-hanging cover for fish and organic inputs to the aquatic food web. While the riparian vegetation would meet some of the shade needs of the streams, the adjacent hillslope and conifers provide much of the shade for streams in the fire area. Regeneration of conifers and hardwoods adjacent to the stream would occur more quickly under this alternative, as replanting of some harvested areas is proposed. Regeneration would be expected to occur somewhat slower in red fir dominated areas, as they lack a black oak component that would provide shade more quickly (refer to the vegetation portion of this chapter for a full discussion of forest regeneration). The dead and dying trees left in the 50-foot CWD management buffer, while devoid of their canopy cover, could potentially provide some shading to the stream and adjacent riparian areas. Some trees that could potentially provide some shade to the stream would be removed under this alternative. However, the amount of shade provided by any dead trees is minimal in comparison to that provided by live trees, and most likely does not significantly contribute to thermal regulation; therefore, no significant effects to water temperature would be expected as the result of the removal of some trees within shading distance to the stream (approximately one tree height, or 100 feet). An increase in water temperature may have detrimental effects on rainbow trout if it approached the lethal level of 20° C. Increases in water temperature are a common result of wildfire and its killing of shading vegetation. Water temperatures are not anticipated to exceed lethal levels in any of the fish bearing streams as a result of the fire or the removal of fire-killed trees.

The amount of CWD available for recruitment to the streams would be reduced with this alternative. A 50-foot no-harvest buffer would be placed on either side of perennial streams; fire killed trees outside of that buffer, but within the RCA, would be removed by helicopter yarding systems. Any fire-killed trees tall enough to reach the stream but outside the CWD management buffer would be removed and unavailable for recruitment to the stream. It is predicted that the amount of large woody debris available to perennial streams 30 years after the fire would be approximately 300 pieces per stream mile. The majority of the trees available for CWD recruitment within streamside areas are less than 15 inches in diameter and less than 50 feet in height. These trees would be expected to recruit small pieces of CWD that typically move through and leave the system move quickly than CWD that has a length greater than twice the stream's bankfull width. As a result, it is anticipated that much of the material available for CWD recruitment with this alternative would leave the system in the short term, resulting in less than the 300 pieces of CWD per stream mile that is predicted. As a result, CWD levels would most likely be in the lower end of the desired range of 160 to 400 pieces per stream mile. Levels of CWD in Duncan Canyon below the diversion dam may be lower, as the dam would block any wood that could recruit from upstream reaches. The larger pieces of CWD would remain in the system and create pool habitat and fish cover. Woody material in streams would provide both organic inputs as well as habitat structure for aquatic macroinvertebrates.

The fuel loads would be reduced with this alternative, increasing the opportunity of re-introducing fire to the landscape. Disturbances such as fire are important for the creation of snags in riparian areas that can recruit to the stream and form fisheries habitat. A number of SPLATs would be created that could be used during suppression and decrease the risk of future wildfires becoming large in size. The reduction of fuel loading would also reduce the severity of a future fire resulting in reduced impacts to aquatic resources.

Sediment inputs to streams in the fire area are expected to increase during the first 5-10 years after the fire as the result of a loss of ground cover caused by the fire and increased flows. This may result in some pool filling and reduction of spawning and macroinvertebrate habitats. Increase sedimentation could also result in increases in suspended fines and nutrients that would reduce water quality for fish. Alternative B proposes to lop and scatter limbs and tops from harvested trees to achieve 50-75% soil cover. This alternative also proposes to place rock upon segments of road that cross streams or enter RCAs. These actions would decrease the amount of sediment entering streams and reduce the risk of the loss of aquatic habitats.

Cumulative Effects

Cumulative impacts would be minor with Alternative B. The creation of ground cover and the rocking of roads would decrease the risk of sedimentation and prevent the loss of any additional habitat that has occurred from historic land uses. There is an increased risk of loss of shade and warming of water temperatures, as some of the trees within RCAs would be removed. However, this impact would be minor and would not compound any issues with shade or water temperature that may exist from past timber harvest activities or the hydroelectric facilities.

An increased risk of killing or injuring northwestern pond turtles during project activities exists with this alternative. The loss of any turtles as the result from the activities proposed under this alternative would add to historic impacts to this species resulting from habitat loss (from past land management) and the introduction of exotic predators.

Alternative C

Direct Effects

Direct effects would be the same as those described for Alternative B.

Indirect Effects

With the exception of shade and CWD, all indirect effects would be the same as those described for Alternative B.

Impacts to riparian vegetation would be the same as described for Alternative B. The 100-foot CWD management buffer would result in any tree that could provide shade remaining. No decreases in shading to the stream or increase in stream temperature would occur as the result of fuels reduction.

The desired condition for CWD in streams in the long term would be met under this alternative. A 100-foot CWD management buffer would be placed on either side of perennial streams; fire killed trees outside of that buffer, but within RCAs, would be removed by helicopter yarding systems. Any fire-killed trees tall enough to reach the stream would remain and be available for recruitment to the stream. It is predicted that the amount of large woody debris available to perennial streams 30 years after the fire would be approximately 800 pieces per stream mile, or double the desired condition; however, the majority of the trees available for CWD recruitment within streamside areas are less than 15 inches in diameter and less than 50 feet in height. These trees would be expected to recruit small pieces of CWD that typically move through and leave the system more quickly than CWD that has a length greater than twice the stream's bankfull width. As a result, it is anticipated that much of the material available for CWD recruitment under this alternative would leave the system in the short term, resulting in 400-500 pieces of CWD per stream mile. This would achieve the desired condition at the high end of the desired condition range of 160 to 400 pieces per stream mile. The larger pieces of CWD would remain in the system and create pool habitat and fish cover. Woody material in streams would provide both organic inputs as well as habitat structure for aquatic macroinvertebrates.

Cumulative Effects

Cumulative impacts would be minor with Alternative C. The creation of ground cover and the rocking of roads would decrease the risk of sedimentation and prevent the loss of any additional habitat that has occurred from historic land uses. The would be an increased risk of loss of shade and warming of water temperatures that would occur with Alternative B would not occur with this alternative, as any trees could provide shade would be retained in the no-harvest buffer.

An increased risk of killing or injuring northwestern pond turtles during project activities exists under this alternative. The loss of any turtles as the result from the activities proposed under this alternative would add to historic impacts to this species resulting from habitat loss (from past land management) and the introduction of exotic predators.

Alternative D

Direct Effects

Direct effects would be the same as described for Alternative B.

Indirect Effects

With the exception of the increased risk of future fire impacts, all indirect effects would be the same as those described for Alternative C.

The fuel loads would be reduced under this alternative, but the retention of all trees greater than 20inches dbh would result in a higher fuel load than would be found with Alternative C. This would reduce the opportunity of re-introducing fire to the landscape. The higher fuel load that would result with this alternative (when compared to Alternative C) would also result in greater impacts to aquatic resources if another wildfire were to occur. A number of SPLATs would be created that could be used during suppression and decrease the risk of future wildfires becoming large in size.

Cumulative Effects

Cumulative impacts would be minor with Alternative D. The effects of decreased sedimentation and increased risk of injury or death of northwestern pond turtles would be the same as those described with Alternative C. The higher level of fuel loading that would occur with this alternative would increase the risk of another severe wildfire occurring in the area that could impact fish and herptile populations or destroy their habitat.

Alternative E

Direct Effects

The direct effects to pond turtles outside of the IRA would be the same as those described for Alternative C. Because no activities would occur within the IRA under this alternative, no risk would exist of killing or injuring northwestern pond turtles in this portion of the project area.

The requirement that material be lopped and scattered in areas of fuels treatment outside the IRA would reduce sedimentation and alleviate effects upon the macroinvertebrate community, as described with Alternative C. However, within the IRA, ground cover would recover slower, and the macroinvertebrate community would be expected to have a longer recover period as well.

Fuel loading would be higher within the IRA under this alternative, resulting in an increased risk of a wildfire re-occurring in the area. A second wildfire could have direct impacts to fish and herptiles by injuring or killing them.

Indirect Effects

Within the IRA, existing conditions would continue to proceed through natural post-fire processes, including: riparian and upslope vegetative growth, recruitment of large woody debris, and trending of physical characteristics (e.g., streamflow, water temperature and substrate composition) towards a post-fire equilibrium.

Within the IRA, regeneration of conifers and hardwoods adjacent to the stream would occur more slowly under this alternative, depending primarily on the native seed bank and surviving trees for propagation. The effects of this delay would be identical to those impacts described with Alternative A. Outside of the IRA, regeneration of conifers and hardwoods adjacent to the stream would occur more quickly, as replanting of some harvested areas is proposed, and effects would be the same as those described for Alternative C.

Within the IRA, no change in the amount of CWD available to the stream would occur, and the effects of that CWD to stream habitat would be the same as those described under Alternative A. However, these increased amounts of CWD would not contribute to stream habitat downstream of the IRA as the Duncan Diversion Dam would capture any CWD that would normally move through this system. As a result, the lower reaches of Duncan Canyon as well as all other stream outside of the IRA would have the same CWD amounts and CWD effects as described for Alternative C, and not benefit from any additional CWD that may enter the system in the IRA.

Within the IRA, the addition of ground cover would occur as material from dead and dying trees falls on the ground and vegetation re-establishes itself. This would result in a greater amount of sedimentation over a longer time compared to areas outside of the IRA, where material would be lopped and scattered during the removal of fire-killed trees.

Fuel loads would be higher within the IRA, resulting in a higher risk of a severe wildfire in the area. A second wildfire could have indirect impacts to aquatic resources by consuming CWD and reducing pool habitat, reducing canopy cover and thermal regulation and increasing sedimentation that would reduce pool and spawning habitat. The increased fuel loads within the IRA would also increase the difficulty of re-introducing wildfire to the landscape.

Cumulative Effects

Cumulative impacts would occur under this alternative. The increased sedimentation resulting from loss of ground cover from the fire would continue within the IRA without opportunity for mitigation. These effects would add to the sedimentation and habitat loss (from past land management) that has occurred, and is currently occurring, because of historic mining and transportation management. Outside of the IRA, the creation of ground cover and the rocking of roads would decrease the risk of sedimentation and prevent the loss of any additional habitat that has occurred from historic land uses.

In areas outside of the IRA, an increased risk of killing or injuring northwestern pond turtles during project activities exists with this alternative. The loss of any turtles as the result from the activities proposed under this alternative would add to historic impacts to this species resulting from habitat loss and the introduction of exotic predators.

The high level of fuel loading anticipated within the IRA would increase the severity of wildfire if it were to occur that could impact fish and herptile populations or destroy their habitat.

MIS

Aquatic MIS found within the project area are rainbow trout, brown trout, Pacific tree frog (part of the Meadow group), and aquatic garter snake (part of the Meadow Group). The Tahoe National Forest LRMP identifies mountain yellow-legged frogs (part of the Meadow and Riparian Groups) as occurring within the project vicinity, but no habitat or species occurrences are known to exist (refer to Appendix B for a discussion of mountain yellow-legged frog habitat needs and project habitat assessments).

As discussed above, no direct impacts would occur to trout as the result of any proposed alternative. The effects to trout habitat would different depending upon the alternative implemented. In Alternative A, the CWD and shade would occur at or above desired levels, but the lack of increased ground cover would result in increased sedimentation and loss of pool and spawning habitat. Alternative A would provide no fuels reduction activities that could reduce the impacts of another wildfire to impacting aquatic resources. Alterative B would provide approximately 80 % of the CWD needs over the long term and would provide increased ground cover, reducing sedimentation. Alternatives C, D and E would provide all of the needed CWD over the long term and provide increased ground cover, reducing sedimentation. All action alternatives have re-forestation strategies that would accelerate the growth of shade and CWD-providing trees. All action alternatives provide fuels reduction strategies that would decrease the impacts of a wildfire upon aquatic resources by reducing the size and severity of future fires. No significant detrimental impacts to trout would be expected to occur as the result of any alternative proposed, and Alternatives C and D have the potential to improve trout habitat. Alternatives B and E would improve trout habitat over existing conditions, but to a lesser extent than Alternatives C and D.

Pacific tree frogs and western aquatic garter snakes are to MIS associated with the Meadow Group. No meadow habitats are known to exist within the project area. Pacific tree frogs and western garter snakes have been located in general herptile surveys and are considered to be common throughout the project area. Population trends for these species are unknown. Both species take advantage of a variety of aquatic habitats, ranging from ephemeral pools, ditches, streams, ponds and lakes. Both also have the ability to move considerable distances overland as needed to find breeding and feeding habitats. All of the effects discussed for trout habitat would be the same for the stream habitat used by these species. Any pond, lake, or spring would be buffered from activities under each alternative, so no impacts to those habitats would occur. Any action alternative would have the potential to have direct impacts to these species as equipment could injure or kill individual frogs or snakes; however, because these species are considered to be common and because little ground-based activity is proposed in any alternative, impacts to these populations would be minimal. There are no expected significant detrimental impacts to Pacific tree frogs or western aquatic garter snakes as the result of any alternative proposed.

Socioeconomic

Summary of Effects:

- In Alternative A, there would be a negative value of approximately one million dollars in Forest Service costs, no local jobs would be created, nor would the local economy receive any revenues.
- In Alternative B, there would be a positive value of approximately 699 thousand dollars, approximately 121 local jobs would be created, and the local economy would receive approximately 23.0 million dollars in direct, indirect, and induced revenues.
- In Alternative C, there would be a negative value of approximately 804 thousand dollars, approximately 113 local jobs would be created, and the local economy would receive approximately 21.5 million dollars in direct, indirect, and induced revenues.
- In Alternative D, there would be a negative value of approximately 2.02 million dollars, approximately 88 local jobs would be created, and the local economy would receive approximately 16.6 million dollars in direct, indirect, and induced revenues.
- In Alternative E, there would be a negative value of approximately 2.70 million dollars, approximately 60 local jobs would be created, and the local economy would receive approximately 10.9 million dollars in direct, indirect, and induced revenues.

Affected Environment

Socioeconomic Analysis

This component will examine the socioeconomic effects of each alternative. All estimates and all calculations based on these estimates are approximations of likely real world outcomes and should therefore be viewed in this light.

The use of the modifier "socioeconomic" in reference to natural resource valuation and management is sometimes mistakenly substituted when performing a purely financial valuation. It is important to note this distinction, since the modern economic view of the value of the natural resource base has evolved to include all market and non-market goods and services produced by the resource. Conceptually, the total economic value of a resource may be envisioned as the sum of all such goods and services it produces, whether these are openly traded commodities or not.

Specifically, market and non-market goods and services relating to the Red Star Fire event generally fall into four categories:

use values (also referred to as direct use or on-site values) are those from which people benefit directly or indirectly from their interaction with the resource; examples include timber products, forage for livestock, hunting, fishing, recreation (hiking, biking, camping, nature photography, wildlife viewing, horseback riding, etc.); local businesses (timber mills, guided nature tours, etc.); terrestrial and aquatic habitat for flora and fauna; carbon sequestration in wood products, soils, and aboveground biomass; water purification; oxygen production; and soil maintenance and enhancement;

option values – essentially an insurance premium to provide for potential uses in the future;

bequest values – designating uses and amenities now for the benefit of future generations (such as wildlife populations, old growth forests, or harvestable timber);

nonuse values (also called existence or passive use values) – peace of mind that different uses of the resource are available even though a person might not have ever participated in a use of the area or ever will in their lifetime; an example is knowing that a mature forest stand or sufficient habitat for an endangered species is protected, even though a person never intends to visit the particular area.

Hence, the total socioeconomic value of a forest can be thought of as the sum of all its use, option, bequest, and nonuse values. In practice, a common unit of measurement needs to be specified for each type of value to give meaning to the resultant summation; this unit is most often the dollar, for lack of a better measure. It is important to note that ignoring a value derived from a natural resource can lead to the neglect of this specific component during decision-making, as well as the undervaluing of the entire forest.

With the exception of market commodities, monetary evaluation of the socioeconomic value of non-market goods and services is very difficult, if not impossible, to quantify. Social scientists have developed techniques that attempt to approximate the worth of such values to society (such as the contingent valuation method (CVM)), but findings from CVM are hypothetical by their very nature because no means for validating the findings exists in the marketplace. Adding to the problem, surveys attempting to measure willingness-to-pay (or WTP – the hypothetical dollar amount a person or household states they will exchange for management of a resource for certain amenities) usually focus on a single or small set of goods and services. This narrow focus is known to produce estimates of a household's WTP that are larger than otherwise would be found if multiple goods and services were instead addressed simultaneously. Some researchers argue that society's socioeconomic evaluation of all non-market goods and services can never be truly known, but this is an ongoing area of study and debate.

The CVM was not directly applied to measure non-market values associated specifically with the Red Star Fire burned area due to cost and time considerations. Cost was the overriding factor in the decision not to proceed with a site-specific exhaustive evaluation.

Affected Environment

The Red Star Fire burned approximately 9,319 acres on the Tahoe National Forest over a 20-day period, and the total cost of fire containment was approximately $30 million. Approximately 1,137 acres under management for California spotted owl habitat and 570 acres of Northern goshawk habitat were destroyed. A total of 7,600 acres under management for old forest emphasis – potential habitat for the spotted owl and goshawk, as well as other mature forest-dependent species – was destroyed and existence values lost. Of the approximately 4,300 acres burned in the Duncan Canyon Inventoried Roadless Area (IRA), a small fraction was back-burned by fire managers during the event with the intent of protecting neighboring mature forested areas from catastrophic loss.

Public health has been put at significant risk due to thousands of fire-killed standing and downed trees.

Access has therefore been restricted, and short-term recreational use has been irretrievably lost. These conditions have made work in the forest significantly more dangerous and greatly constrain future firefighting strategies since no crews would be placed on the ground at night when mitigation is often most effective.

In addition to public access roads, portions of the Western States and Tevis Cup trails are currently impassible due to downed logs and hazardous standing dead trees created by the fire. These trails are host to local events of national prominence, and annual participation in these events generates approximately $3 million per year for the local economy of Placer County, California.

Environmental Consequences

The objective of all alternative actions is to re-establish a forest managed primarily for old forest conditions in accordance with the SNFPA. The alternative actions differ in their means of achieving this single objective.

The IMPLAN (Minnesota IMPLAN Group, Inc. 1999) software v2.0 was used to estimate effects of the different management scenarios on the local economy. Data for the use with the software in the region in 1999 was used since this is the most recent regional economic data available from the IMPLAN group. IMPLAN is an input-output model commonly used to measure direct impacts and indirect and induced effects on an entire economy. A *direct impact* is defined as an initial inflow of money into a region in exchange for goods and services. The revenue that would be generated from timber sales is an example of a direct impact. An *indirect effect* results from the direct impact due to cycling of inflowing money throughout the region economy in the producing sectors. The largest indirect effects of a timber sale would be on sawmills and planning mills, wholesale trade, logging contractors, motor freight, transport, and warehousing. An *induced effect* is defined as those effects on the regional economy from changes in household spending caused by the direct impact and indirect effects. Induced effects generally arise from increases or decreases in wages and employment, and such effects are assumed here to be directionally invariant across other sectors. In other words, a directional percent change in total regional employment or average household income is thought to affect other producing sectors (e.g., restaurants, dentists, entertainment, etc.) in the same direction of the change. Only the short-term impacts from salvage activities were considered since these can be estimated in advance with more certainty. Effects on tourism and recreational experiences for each alternative were not estimated since these estimates have much more related uncertainty in both the short-term and long-term. However, it is reasonable to assume that salvage activities may affect tourism and recreation on this portion of the forest in the short-term.

To estimate the size of direct impacts for use in IMPLAN, the Forest Service's Transactional Evidence Appraisal method was used to estimate the minimum average value of timber from dead trees in the burned area. This appraisal method compares harvest and haul costs (and other miscellaneous costs) to the lumber prices published in the Western Wood Products Association's quarterly journal in order to determine advertised bid rates. Assuming that one third of the dead timber is at least 25" diameter at breast height (dbh) and averaging across species, the average weighted stumpage value was found to be $115 per thousand board feet (mbf). Due to a sufficient increase in supply, a large volume of timber harvested during a short period of time may decrease stumpage values locally, but a constant rate is assumed here to reflect future price uncertainties.

Fire-killed trees are worth considerably less in the marketplace than live trees, and the value of fire-killed trees decreases rapidly with time. Limited data exists in the region, but preliminary estimates of financial loss in the value of fire-killed trees range from a 57.4% decline in value for Jeffrey pine to a 66.8% decline in value for White fir, both after just one year (based on a representative sample of 35 fire-killed trees from the Gap Fire, which occurred on the Tahoe National Forest in the summer of 2001). Other commercially viable tree species were killed by the Red Star fire that were not sampled in the above study; these include Incense cedar, Douglas fir, Ponderosa pine and Sugar pine. Since incomplete data is currently available at the time of writing, annual decay rates for all species will be conservatively assumed to occur at one half the average rate for Jeffrey pine and White fir, or 31.1% per year. The value for all fire-killed trees by the Red Star fire is therefore assumed to decrease by 31.1% after one year, decrease by a total of 52.5% in value after two years, decrease by a total of 67.2% in value after three years, decrease by 77.4% after four years, and decrease by 84.4% after five years. *Time is of the essence to capture the total possible value of fire-killed trees to help offset the costs of forest restoration on the landscape.*

Financial comparisons of the different management scenarios follow. All comparisons are performed with a 4% discount rate (Row et al. 1981) in order to compare costs and revenues that occur in different periods of time. Comparisons therefore depend on the discount rate; a rate of 4% is consistent with valuing investments that occur over long time horizons, such as those in forestry.

The following values per acre for silvicultural activities are used in all subsequent analyses: tree planting = $300, PCT = $300, conifer release = $425, and mechanical fuel reduction = $600. The following values per mbf for salvage activities are used in all subsequent analyses: loading = $20, hauling = $53 (assuming a 140 mile roundtrip @ 5 mbf per load and 2 hours of standby to load and unload), BD deposits = $10, road reconstruction = $7, surface replacement and road maintenance deposits = $40, fall, limb, buck, and lop = $34. All related road maintenance costs were included in the timber appraisal.

Approximately 3,200 acres (containing approximately 56,800 mbf) currently meets the harvest criteria of 75% stand mortality. Only dead trees with no green needles will be available for salvage harvest. Between 2003 and 2005, an additional 3,700 acres (containing approximately 68,000 mbf) is expected to reach 75 percent stand mortality and thereby become available for harvest (however, only trees with no green needles within these areas would be salvaged, just as before). For all economic impacts, it was assumed when running IMPLAN that existing harvestable acres were available for harvest immediately in 2002. Since additional acres are expected to meet harvest criteria in the future, it was assumed for analysis purposes that one third of this total would become available in each of the years 2003, 2004, and 2005, respectfully.

Direct, Indirect, and Cumulative Effects

To ease comparisons among the five alternative actions studied, the number of acres proposed for salvage (existing acres and those predicted to become available over the next few years) both outside and inside Duncan Canyon Inventoried Roadless Area (IRA) are presented in Table 3-19. Table 3-19also lists the estimated amount of timber that would be salvaged for each action. Table 3-20 presents the revenues and costs of commercial and restoration activities. Lastly, direct, indirect, and induced revenues and employment estimates of each action on the regional economy obtained from IMPLAN are presented in Table 3-21.

Alternative A – no action

Because no action is to be taken, there are no revenues. The only cost is that of EIS preparation, resulting in a negative net present value of the no action alternative. However, an EIS likely would not have been prepared if the proposed action was that of "no action". The Red Star Fire event does pose an opportunity for generating revenue and employment, performing restoration activities, and reducing long-term fire risk, so the opportunity costs of the no action alternative are the foregone benefits from the alternative with the highest net benefits.

No action also results in a short-term fire risk that is less than that of the proposed action, but in the long-term the catastrophic fire risk of no action is expected to far exceed that of the proposed action. Since the affected area is to be managed for old-growth emphasis and a return to the natural fire cycle (more frequent but smaller and less intense fires that are not expected to reach the forest crown), increasing the risk of another catastrophic event (i) decreases the chance that a mature forest will be available for use by future generations, and (ii) decreases the likelihood of achieving the management objective for this area as mandated by the SNFPA.

Alternative B – proposed action

The purpose of the proposed action is to perform ecological restoration activities in the burned area to enable and speed recovery, as well as to provide revenue to the Forest Service to reduce the financial burden from these activities and mitigate suppression costs. By designating the burned area as OFEA, the SNFPA has decided upon the particular use of the land for the benefit of future generations. The objective of restoring an OFEA follows existing policy guidelines, and, since the land use has been designated, the longer the affected area does not contain Old Forest conditions, the less the bequest value is to current and future generations. Thus, speeding recovery of the area thus speeds the increase in bequest value accrued. The actual monetary value of the bequest is intangible but any such foregone value should be considered during decision-making.

To this end the proposed action was developed. The return of catastrophic wildfire in the affected area is an unavoidable risk to the forest as it recovers and re-attains mature conditions. Although the long-term risk cannot be eliminated, it can be decreased, and this is one of the main considerations of the proposed action. The proposed action is expected to increase short-term fire risk over that of no action since the lopping and scattering of needles, branches, and small diameter trunks to enhance soil protection increases the amount of fine fuels on the ground. However, this risk decreases rapidly as these fine materials naturally decay.

Average values for the timber are used, but in reality the Forest Service may receive less in revenue since the majority of the estimated 124,800 mbf is on ground proposed for helicopter logging only. Costs of helicopter logging are much higher than more traditional systems (the regional average for helicopter logging is $140/mbf over that of a tractor system), so a contractor would be willing to offer much less for timber that must be extracted by helicopter. Another reason why less revenue might be received is because of transportation costs. The nearest mills are located approximately 70 miles away from the burned area. Although this is not an unusually large distance for timber transport, it may render extraction on helicopter ground financially infeasible for private firms. For these reasons, estimated revenues from timber sales may be optimistic.

Assuming all sales are made for an average price of $115 per mbf, the proposed action has a positive net present value of $700,000 (Table 3-19). This includes the cost of EIS preparation. Approximately $11.5 million would be received in revenue, and this exceeds the amount to be spent on restoration. The action is estimated to have beneficial cumulative effects of $23.1 million on the regional economy over the life of the project and support 121 new jobs (Table 3-20). Effects on the regional economy are expected to be short-term in nature and last for one to three years after the termination of harvest activities. Since the impacts of harvest activities on other short-term aspects such as local quality of life (e.g., increased traffic and/or noise) are intangible, these were not included; however, the decision must be made as to whether the cumulative regional economic impacts and the benefits from decreased long-term catastrophic fire risk outweigh changes to such intangibles.

Lastly, due to decreases in the timber value of fire-killed trees, it is possible to estimate the cumulative reduction in value from direct, indirect, and induced effects in the regional economy if harvests were delayed. From IMPLAN results, if harvests did not occur until 2003, the total direct, indirect, and induced impacts are estimated to decline by 55.1%; if harvests did not occur until 2004, the percent decline is estimated to be 95.6%; and if harvests did not occur until 2005, the percent decline is 99.6% of the 2002 estimated value.

Alternative C – modified proposed action

Alternative C differs from the proposed action in that fewer trees near riparian areas would be salvaged and 2,923 acres would be devoted to Strategically Placed Area Treatments (SPLATs) for catastrophic fire risk reduction would be created (Alternative B devotes 1,060 acres to SPLATs). This change in SPLAT placement changes costs considerable, and salvaging fewer trees does have a net financial impact.

Although Alternative C reduces the number of acres salvaged under the proposed action by just 6.3% (Table 3-19), the net change in revenue is a negative $765,000 (Table 3-20), resulting in a negative net present value of -$804,425. The negative net present value means that the Forest Service would have to pay $804,425 for this set of management activities. However, when the cost of EIS preparation is not considered, Alternative C has a positive net present value of $195,575 (in fact, only Alternatives B and C have positive net present values when EIS preparation is ignored). Net cumulative effects on the regional economy are estimated to result in an increase of $21.5 million (a 6.8% reduction from the proposed action) and support 113 new jobs (Table 3-21).

Alternative D – no removal of trees greater than 20 inches dbh

This alternative was developed from public comments that no large trees be removed from the ecosystem. The belief is that such trees are difficult to replace and important to the ecosystem. Therefore, such fire-killed trees are thought by some to have a net social benefit that is higher if they are left on the land over that if instead the trees are removed and turned into forest products consumed and demanded by society.

Alternative D results in a negative financial value to the Forest Service of -$2.0 million (Table 3-20), meaning that the value of leaving large fire-killed trees in the ecosystem needs to be worth at least this amount to the concerned citizens who helped develop this set of actions and to society as a whole. The Forest Service essentially would need to pay $2 million to enact Alternative D in addition to the $30 million already spent on fire suppression. However, Alternative D is estimated to bring net cumulative benefits of $16.6 million on the regional economy (Table 3-21 – a 28.0% reduction from the proposed action) and support 88 new jobs.

Alternative E – no commercial activities in Duncan Canyon IRA

This alternative was also developed from public comments. Under Alternative E, no salvage operations would be performed in Duncan Canyon IRA. The belief is that such operations would harm the natural character of the area, thus decreasing its net social value.

Alternative E has a negative financial value to the Forest Service of $2.7 million (Table 3-20), meaning that the Forest Service would need to pay $2.7 million for restoration activities that would be applied only to the burned area not in Duncan Canyon IRA. The cumulative net effects on the regional economy are estimated to be a positive $10.9 million dollars (Table 3-21 –a 52.7% reduction from the proposed action), and 60 new jobs would be supported.

It should be emphasized that Duncan Canyon is among the list of areas to be designated as Wilderness under California U.S. Senator Barbara Boxer's bill, entitled "California Wild Heritage Wilderness Act of 2002". With regard to this alternative, a decision must be made if the net loss from this set of actions is at least as large as the net decrease in social benefits that would occur if commercial activities were performed in the IRA.

Table 3-19. Acres and mbf proposed for salvage under each alternative action. These are categorized by Inventoried Roadless Area (IRA) status and further partitioned by harvest availability.

		Alternative A	Alternative B	Alternative C	Alternative D	Alternative E

Acres salvaged	Outside IRA- existing predicted	0 0	2,055 1,170	1,683 1,104	1,683 1,104	1,683 1,104
	Inside IRA- Existing predicted	0 0	1,019 1,658	1,036 1,707	1,036 1,707	0 0
Total acres proposed for salvage		0	5,902	5,530	5,530	2,787
Total acres *not* proposed for salvage		9,319	3,417	3,789	3,789	6,532
Mbf to be salvaged	Outside IRA- existing predicted	0 0	36,990 19,890	30,294 18,768	30,294 18,768	30.294 18,768
	Inside IRA- existing predicted	0 0	18,342 28,186	18,648 29,019	10,360 15,363	0 0
Total		**0**	**103,408**	**96,729**	**74785**	**49,062**

Table 3-20: Comparisons of costs and revenues of the different management scenarios. Note: NPV = present net value.

and Revenues, ars	**Alternative A** (no action)	**Alternative B** (proposed action)	**Alternative C** (modified proposed action)	**Alternative D** (no removal of trees ≥ 20" dbh)	**Alternative E** (no commercial activities in IRA)
lanting	0	-1,010,700	-1,010,700	-1,010,700	-1,010,700
mmercial ng	0	-1,010,700	-1,010,700	-1,010,700	-1,010,700
r release	0	-1,431,825	-1,431,825	-1,431,825	-1,431,825
nical fuel on	0	-636,000	-1,753,800	-1,753,800	-1.009.800
posits (NPV)	0	-998,040	-931,470	-722,270	-76,550
naintenance commissioning	0	-698,040	-652,030	-505,590	-333,580
e replacement id maintenance ts (NPV)	0	-3,992,100	-3,725,900	-2,889,100	-1,906,200

r (NPV)	0	11,477,000	10,712000	8,306,100	5,480,300
eparation	-1,000,000	-1,000,000	-1,000,000	-1,000,000	-1,000,000
NPV	**-1,000,000**	**699,005**	**-804,425**	**-2,017,885**	**-2,699,055**

Table 3-21. Comparisons of direct, indirect, and induced revenue and employment on the regional economy for the different management scenarios.

Effects on regional economy	**Alternative A** **(no action)**	**Alternative B** **(proposed action)**	**Alternative C** **(modified proposed action**	**Alternative D** **(no removal of trees ≥ 20" dbh)**	**Alternative E** **(no commercial activities in IRA)**
Direct effects, in $	0	17,020,102	15,854,582	12,262,704	8,055,183
Indirect effects, in $	0	3,748,316	3,491,637	2,700,600	1.773,983
Induced effects, in $	0	2,283,915	2,127,514	1,645,523	1,080,919
Total, in $	**0**	**23,052,333**	**21,473,733**	**16,608,827**	**10,910,085**
Effects on regional employment					
Direct number of jobs	0	57.6	53.7	41.5	27.3
Indirect number of jobs	0	34.4	32.1	24.8	16.3
Induced, number of jobs	0	29.3	27.4	21.2	16.1
Total number of jobs	**0**	**121.3**	**113.2**	**87.5**	**59.7**

Heritage Resources

Summary of Effects:

- In Alternative A, no mechanism would be provided to remove hazards that could negatively affect heritage resources.
- In Alternative B, all heritage resources would be protected through management requirements as outlined in Chapter 2. This alternative would provide for lessening the risk of negative affects to heritage resources through the elimination of hazards and fuels reduction work that would lessen the chance of severe wildfires, which could. Cause negative effects to heritage resources.
- Alternative C would have essentially the same affects to heritage resources as Alternative B, but the creation of larger, more strategically place SPLATs would further reduce the risk of negative effects occurring to heritage resources.
- In Alternative D, all heritage resources would still be protected, but there would be an increased risk of negative effects than Alternative C, because there would be more, larger snags left, which could fall and damage some of the heritage resources.
- Alternative E would have essentially the same affects to heritage resources as Alternative C, with the exception of one heritage resource site located within the Duncan Canyon IRA, which would not receive the benefits of hazard reduction.

Affected Environment

The Forest Service Multiple Use Policy (FSM2361), Executive Order 11593, Sections 106 and 110 of the National Historic Preservation Act, 36 CFR 800, the American Indian Religious Freedom Act (1978), and other regulations require the Forest Service to take into account the effects any undertakings may have on heritage resources that may be eligible for the National Register of Historic Places (NRHP), and the effects of such undertakings on the interests of Native American groups. The Tahoe National Forest Land Management and Resource Plan standards and guidelines (page V-18) mandate inventory, evaluation, protection, and enhancement of heritage resources.

The area encompassed by the Red Star Restoration project has a long history of Native American occupation and utilization for over 5,000 years and through the last half of the nineteenth century. Two different Native American ethnographic groups (Nisenan or Southern Maidu and Washoe) likely utilized the resources within the Red Star Restoration area. Archaeological evidence documents seasonal use as exemplified by bedrock milling features and lithic scatters.

During the Gold Rush beginning in 1848 and in subsequent years, Native Americans in the area were displaced by miners and other groups of immigrants. The discovery of gold in California caused a virtual population explosion of Euroamericans in the Foresthill area. The growth of the gold mining industry eventually led to the establishment and development of other businesses and industries in the area. Historic mining sites, cabins, adits, artifact scatters, ditches, tunnels, tailings, and trails associated with this era have been identified within the project vicinity.

Over thirty previous surveys have provided archaeological coverage for large portions of the project area. Additional fieldwork in the fall of 2001, surveyed the remaining archaeologically sensitive topography. As a result of this, archaeological survey and fieldwork relating to this project is extensive and intensive. All archaeologically sensitive landscape has been surveyed. Some areas were not surveyed due to steep slope, however, based on historic use of the area and past survey experience,these areas are doubtful to contain significant cultural resources.

A total of 18 archaeological sites have been identified during previous surveys and through the current inventory. These archaeological site types may be characterized as two multi-component, six historic, and ten prehistoric sites. Additionally, twenty-one isolated finds or features were noted previously or during survey of the Red Star Restoration project area. None of these sites have been evaluated for inclusion on the National Register of Historic Places, nor are there any listed National Register sites within the project area.

The Star Fire considerably degraded the integrity of these sites. The effects from this conflagration extend from melting, spalling, charring, and incinerating artifacts to complete obliteration of wood cabins and flumes.

The loss of vegetation, increased visibility, and damage to the soil structure, may increase negative effects to certain sites. Sites that are located within heavily forested areas, may sustain additional damage when dead trees fall on them.

The effects listed above have already occurred, or may occur naturally over time. No further effects to heritage resources from proposed project activities are identified nor are any anticipated. The results of this Heritage Resource Inventory for the Red Star Restoration project may be found in Heritage Resource Report (HRR) 05-17-1633 (Brooke 2002).

Environmental Consequences

Alternative A – No Action

With Alternative A the Tahoe National Forest would not implement any of the proposed management activities. If this alternative were selected there would be no direct effects from project activities to heritage resources as a result of this alternative. However if selected, this alternative would provide no mechanism to remove dead or dying trees that would naturally fall within cultural resources, thus potentially causing damage to these resources.

Cumulative effects are the result of past events both human and natural caused. These events have had varying levels of effects on heritage resources, the effects ranging from minimal to extensive. Causes of these effects are the results of logging, mining and mining support activities, road and trail construction, erosion, wildfires, and exposure to the weather. Protection requirements for all federal actions would preserve heritage resources.

Without managing for the potential increased fuel loading and anticipated shrub fields that typically replace stand replacement fires, heritage resources would again be at risk to wildfires.

Alternative B – Proposed Action

Ground disrupting activities associated with this alternative have the potential to displace or destroy heritage resources. However, the archaeological survey and fieldwork relating to this project is extensive and intensive. This work is adequate to identify heritage resources in the analysis area as well as effects to those resources that would likely be the result of project related activities. Based on the results of this work and previous works, implementation of this alternative is not expected to have any direct or indirect effects on heritage resources from planned project activities. Activities proposed with this alternative would move the fire-damaged ecosystem towards Old Forest characteristics, thus reducing the long-term threat of large wildfires; this potential reduction of large wildfires would be beneficial to heritage resources.

There are approximately eighteen heritage resource sites and various features located within or adjacent to the areas of potential effects. All of the heritage resources would be protected by avoidance or would be evaluated and if determined ineligible for listing on the National Register of Historic Places would be released from management concerns. Those heritage resources determined eligible would be protected through avoidance. All heritage resources would be managed in accordance with the provisions outlined in the Programmatic Agreements among the U.S.D.A. Forest Service, Pacific Southwest Region, California State Historic Preservation Officer, and Advisory Council on Historic Preservation Regarding the Identification, Evaluation and Treatment of Historic Properties Managed by the National Forests of the Sierra Nevada, California and or the First Amended Regional Programmatic Agreement.

The five Management Requirements described in Chapter 2 for heritage resources would be in effect during implementation of any and all activities. There would be no direct, indirect, or cumulative effects to these resources since all resources would be tested, evaluated, released and/or flagged for avoidance. Tribal communities would continue to be consulted for any concerns regarding this project.

Alternative C

This proposed alternative is similar to Alternative B, however the treatment of SPLATS would help reduce the fuel loading which would be beneficial to heritage resources in that it would reduce the potential for future high severity wildfires. Management of heritage resources would be the same as described in Alternative B.

Alternative D

This proposed alternative is similar to Alternative C, however, no trees larger that 20 inches in diameter would be harvested. This alternative would leave larger standing dead trees that may increase the future potential for high severity wildfires. Although treatment of the SPLATs would be beneficial to heritage resources, this alternative would not afford the protection to heritage resources as Alternative C. Management of heritage resources would be the same as described in Alternative B.

Alternative E

This proposed alternative is similar to Alternative C, with the exception that there would be no commercial logging in the Duncan Canyon IRA. This alternative reduces the number of heritage sites to be managed by one, and affords greater protection to the Western States and Tevis Cup trails. Management of heritage resources would be the same as described in Alternative B.

Irreversible and Irretrievable Effects

The selection of Alternatives B, C, D, or E, would not have anyirreversible or irretrievable effects upon heritage resources. The selection of Alternative A would not allow for removal of dead or dying trees that could damage existing sites. Additionally, Alternative A would not manage for the potential increased fuel loading and anticipated shrub fields that typically replace stand replacement fires, resulting in an increased risk of damage to heritage resources from wildfires. Therefore, the selection of Alternative A could have irretrievable effects on heritage resources.

Botany

Summary of Effects:

- In Alternative A, there is potential for an indirect effect to sensitive plants, by potentially shortening the fire return intervals, perpetuating an ecosystem with a lower seral state, which could degrade habitat for sensitive plants that are dependent on Old Forest ecosystems.
- In all the action alternatives, no direct, indirect, or cumulative effects are anticipated.

Affected Environment

The Red Star Restoration project area has experienced numerous past management activities including timber harvest, recreation activities, reservoir development, mining, grazing, and road development. The project area is generally within a mixed conifer plant community with oak communities on the southern slopes and lower elevations and true fir communities on the northern slopes and higher elevations. The project elevation is about 3,350-7,182 feet in elevation.

The project area has potential habitat for *Botrychium ascendens, Botrychium crenulatum, Botrychium lineare, Botrychium montanum, Calochortus clavatus var. avius, Clarkia stellata, Cypripedium fasciculatum, Cypripedium montanum, Epilobium howellii, Eriogonum umbellatum var. torreyanum, Fritillaria eastwoodiae, Lewisia cantelovii, Lewisia serrata, Meesia triquetra, Meesia uliginosa, Phacelia stebbinsii*, and *Scheuchzeria palustris var. americana.* The entire fire area on the TNF was surveyed for sensitive plants, watchlist plants, and noxious weeds in 2002.

Two occurrences of *Phacelia stebbinsii* known before the fire and four more located during field surveys are now known within the fire area (six total known occurrences). Field surveys in 2002 also located one occurrence of the sensitive species *Botrychium ascendens.* Two known occurrences of the watchlist plant *Viola tomentosa* and fifteen new occurrences (seventeen total known occurrences) are now known within the fire area. Other newly located watchlist species and habitats include two fens, one occurrence of *Sphagnum* sp. moss, and one occurrence of *Drosera rotundifolia.* No threatened or endangered species are expected or known within the project area. No new occurrences of noxious weeds were located during the 2002 field surveys. The invasive-exotic weeds bull thistle, wooly mullein, and cheatgrass are known from the French Meadows basin along roadsides. Roads leading from Foresthill have occurrences of yellow star thistle, skeleton weed, Italian thistle, and Scotch broom along them and pose a possible distant threat of introduction to the Star Fire area from vectors independent of the Red Star Restoration Project.

Environmental Consequences

Sensitive and Watchlist Plants

Alternative A – No Action

No direct effects to sensitive plant occurrences are expected with Alternative A. By not implementing the Red Star Restoration project, indirect effects to sensitive and watchlist plant habitat and occurrences (if they are present) may occur. The no action alternative in the project has the risk of shortened fire return intervals, and perpetuating ecosystems in a lowered seral state that could degrade sensitive plant habitat for the sensitive plant species dependant on older forest ecosystems.

Alternatives B through E

For all activities stated with any of the proposed actions (Alternatives B-E), direct, indirect and cumulative effects are not expected. An analysis of effects types are discussed below:

Direct Effects -

No direct effects to sensitive plants would occur during implementation of the Red Star Restoration project. Six occurrences of the sensitive plant *Phacelia stebbinsii*, and one occurrence of *Botrychium ascendens* are known from the project area. All or part of those occurrences are near perennial creeks and are within the RCA and will be protected. Where activities proposed in the Red Star Restoration Project are located near these plants, they will be flagged and avoided during project implementation. Surveys for sensitive plants were completed prior to project implementation. If any additional sensitive plant occurrences were located within the project area, they would be flagged and avoided during project implementation.

Indirect Effects -

Indirect effects to sensitive plants for the Red Star Restoration project are not expected. The known occurrences of sensitive plants, watchlist plants, and watchlist habitatswill be buffered from impacts. Where activities proposed in the Red Star Restoration Project are located near theseplants, they will be flagged and avoided during project implementation. Appropriate buffers would be maintained to prevent indirect effects from the Red Star Restoration Project such as off-site sediment movement and change in overstory vegetation composition (created by the Red Star Restoration project).

Cumulative Effects -

It is recognized that a critical step in cumulative effects analysis is to compare the current condition of the resource and the projected changes (due to management activities) with the natural variability in the resources and processes of concern. This is difficult for sensitive plants since long-term data is often lacking, and many sensitive plant habitats have a long history of disturbance, i.e. an undisturbed reference is often lacking. Minimizing on-site changes to sensitive plants may be the most effective way of reducing cumulative impacts. If the largest effect of a given action is local and immediate, then these are the spatial and temporal scales at which the effect would be easiest to detect. If one can minimize the adverse effects at this local scale, it follows that there would be a greatly reduced potential for larger-scale effects. If adverse effects have not been minimized at the local level, cumulative effects would occur. Management activities that have cumulatively impacted sensitive plant occurrences on the forests include: historic grazing, timber harvest, fire suppression, prescribed fire, mining, recreational use, road construction, urban development, and noxious weed infestation. These cumulative impacts have altered the present landscape to various degrees. Cumulative impacts vary from species to species. These species-specific impacts are discussed in the B.E. under the "Description of Affected Species" section.

It is recognized that past and current activities on National Forest System lands have altered potential habitats for *Botrychium ascendens, Botrychium crenulatum, Botrychium lineare, Botrychium montanum, Calochortus clavatus* var. *avius*, *Clarkia stellata, Cypripedium fasciculatum, Cypripedium montanum*, *Epilobium howellii*, *Eriogonum umbellatum* var. *torreyanum*, *Fritillaria eastwoodiae*, *Lewisia cantelovii*, *Lewisia serrata*, *Meesia triquetra*, *Meesia uliginosa*, *Phacelia stebbinsii*, and *Scheuchzeria palustris* var. *americana* across the forest from grazing, road development, timber harvest, mining, recreation activities, invasive/exotic/noxious weed invasions, and changes to hydrology. Flagging and avoiding sensitive plants is the most frequently recommended management strategy for reducing cumulative impacts to known occurrences. Flag and avoid management is effective in reducing cumulative impacts and is the recommended method for the occurrences of sensitive plants, watchlist plants, and watchlist habitats.

Implementation of the Red Star Restoration project would not contribute to negative cumulative effects to sensitive plant species. Complete inventory of the potential habitat for sensitive and watchlist species was surveyed in 2002. All of the previously known and newly located occurrences of sensitive plants, watchlist plants, and watchlist habitats will be protected from cumulative impacts that could result from project implementation.

Environmental Consequences

Noxious Weeds

Alternative A – No Action

In the no action alternative, no fuels treatments would occur. This reduces the short-term risks of introduction of noxious weeds from project-related vectors such as heavy earth-moving equipment. The long term risk of weed introduction is higher due to the possibility of repeated high intensity fire in the dead material left on site leaving exposed mineral soil that is prime habitat for noxious weeds to become established.

Alternatives B through E

Risk of weed introduction associated with project implementation increases with the increase of the amount of projects proposed under each alternative. The risk of weed introduction is generally the same for all alternatives. The fire area is weed-free and mitigations to prevent the introduction of weeds have been incorporated into the Noxious Weed Risk Assessments for the areas in and out of the Duncan IRA. These mitigations include the use of certified weed free straw and mulch in areas that need erosion control, the use of road gravel from inspected weed-free sites, and contractual clauses that require clean equipment for operations that involve equipment in the Red Star Restoration Project. With inventory complete, the project area in a weed-free state, and mitigation measures in place, all alternatives in the Red Star Restoration Project have a low risk of noxious weed introduction.

See the noxious weed risk assessment table below that displays noxious weed risk. For a more complete discussion of noxious weed risk and impacts, see the Noxious Weed Risk Assessments for the Red Star Restoration Project in Appendix "C".

NOXIOUS WEED RISK ASSESSMENT TABLE

Factors	Components	Variations	Risk
1. Inventory	Site specific area, identify, map, estimate	Inventory complete.	Low

	numbers/acres		
2. Known noxious weeds	Number of A, B, or C-rated weeds, number of infestations, size	Cheatgrass, bull thistle, and wooly mullein are present in the area. None are known within the project area at this time.	Prevention high priority; control high priority. Risk high due to presence in the area.
3. Habitat vulnerability	Previous disturbance, plant cover, soil cover, shade, soil type, aspect/moisture.	The analysis area has experienced and continues to experience many disturbances. Historic grazing has occurred in the analysis area, the area has experienced historic timber harvest, and many open areas with little to no soil cover exist adjacent to the project area before and after the fire.	High risk.
4. Non-project dependent vectors.	The project area is accessed by a well maintained forest collector system. Unimproved roads include those used for fire and other infrastructre maintenance use.	There is a network of Forest Service Roads, non-system/unimproved roads, fireline, and private roads are in the vicinity. Recreation use is high in the area for boating, hiking, camping, fishing, and hunting. Equestrian use in also high in the area.	High risk.
5. Habitat alteration expected as a result of project	Some of the project area could lose ground cover for several seasons.	Reduction of potential soil cover, but fuel reduction and reforeatation will improve the area in the long-term..	Low-moderate risk, dependant on short or long-term perspective.
6. Increased vectors as a result of project implementation	Traffic increases.	No new system roads would be constructed. Temporary spur roads/skid trails for equipment access would be created and obliterated after use. Traffic related to project implementation would increase.	Low risk overall. Moderate to high risk of weed infestation on temp. roads.
7. Mitigation measures	Prevention (equipment washing, weed-free materials, monitoring), control (prompt action on small infestations), cultural practices (maintain shade, minimize disturbance, design project to reduce weed flow).	If project areas are located in known weed occurrences, require that those units be entered last in an area and wash equipment prior to moving to another location or off-forest ("C"-clause). Utilize weed free straw for erosion control. Utilize gravel from gravel pits (if gravel is needed) that have been inspected and do not have noxious weeds.	Low risk if completely implemented.
8. Anticipated weed response to proposed action	Tally "high risk" responses in previous factors; consider mitigation if it is adopted as part of the proposed action.	If fully implemented, the mitigations should prevent the introduction/spread of noxious weeds.	Moderate risk for weed spread. Reduced soil cover would be created under this project in limited areas (landings etc.) in the short

term.

Vegetation

Hazard Trees

Summary of Effects:

Alternative A

- Trails – Trails remain closed
- Roads – Level 1 and 2 roads would not be treated
- Firefighter Safety – Snag levels in Urban Wildland Intermix would not be reduced to 2/ac. Would require more dependence on indirect firefighting methods.

Alternative B

- Trails – Open trails. Fell and remove hazard trees.
- Roads – Hazard trees would be removed along level 1 and 2 roads associated with future forest stand tending and administrative uses.
- Firefighter Safety – Snags would be reduced to 2/acre in the Urban Wildland Interface Zone.

Alternative C

- Trails – Open trails. Fell and remove hazard trees.
- Roads – Hazard trees would be removed along level 1 and 2 roads associated with future forest stand tending and administrative uses.
- Firefighter Safety – Snags would be reduced to 2/acre in the Urban Wildland Interface Zone.

Alternative D

- Trails – Open trails. Fell and remove hazard trees.
- Roads – Hazard trees would be removed along level 1 and 2 roads associated with future forest stand tending and administrative uses.
- Firefighter Safety – Snags would be reduced to 2/acre in the Urban Wildland Interface Zone. Snags greater than 20 inches dbh would be left throughout the old forest and in the IRA (except within SPLATs where 4 snags/ac would remain). Would require more dependence on indirect firefighting methods.

Alternative E

- Trails – Open trails. Fell and leave hazard trees.
- Roads – Hazard trees would be removed along level 1 and 2 roads associated with future forest stand tending and administrative uses.
- Firefighter Safety – Snags would be reduced to 2/acre in the Urban Wildland Interface Zone.

Affected Environment – Hazard Tree Management

Trees that were killed in the fire eventually pose a hazard in certain locations an certain situations as the deteriorate and fall. Live trees can also be a hazard when they have burned and become structurally damaged and unstable. In the Red Star Restoration project area there are roads, trails, buildings, camping areas, and dams. The hazard trees pose a threat to these facilities and the people that use them. Hazard trees pose at threat to fire fighters. Key allocations of National Forest lands have been designated for protection from forest fires by managing the fuels and vegetation in those zones. Deploying fire fighters in those zones is an essential element in fire suppression.

Trail and Facilities

The Western States, Tevis Cup and Little Bald Mountain trails pass through the burned area. Hazard trees can be found along portions of the 10.1 miles of these trails in the burn. Hazard trees also exist around Duncan Diversion Dam, L.L. Anderson Dam, the dam tenders house and the dispersed campground in Duncan Canyon.

Roads

Five levels classify Forest Service roads. Levels 5, 4, and 3 are the highest use roads by the public, permittees, cooperators, and employees. Policy described in the SNFPA calls for hazards along these roads to be fell and removed (ROD, Appendix A-29). Hazard tree removal, authorized by a separate decision, began in October 2001 on these roads within the Red Star project area. Road levels 1 and 2 would also have priority for treatment based on use of those roads for timber removal and the level of use associated with future use such as access for reforestation, stand tending duties, maintenance of SPLATs, administrative use, and private property access. Of the 43 miles of road in the burned area, about 11 are level 3, 4 and 5. The remaining 32 miles are levels 1 and 2.

Firefighter Safety

Hazard trees pose a significant risk to fire fighters. Annually 2 to 6 firefighters are injured or killed by hazard trees (Thorpe 1999). In the research project, ***Injury Analysis during Nighttime Operations in Wildland Firefighting***, the author, Dan Thorpe, made the conclusion that snags are important killers of firefighters at night. While safety measures such as wearing personal protective gear (hard hats) and strategies to recognize hazard trees and post lookouts are employed, the risk is still very high.

The SNFPA decision recognized this and established a management scheme to reduce that threat in areas identified as strategically important to firefighting (ROD A-10-11). These areas are identified as the Urban Wildland Intermix Zones. In these zones, standards call for reducing hazard trees to 2 per acre. The fire burned through approximately 1,985 acres of Urban Wildland Intermix zones, leaving high concentrations of dead trees.

Forest Workers

Hazard trees pose a threat to forest workers who are responsible to prepare, administer, and log timber sale contracts and forest workers who would subsequently be responsible for tree planting and stand tending duties.

Environmental Consequences – Hazard Tree Management

Direct/Indirect/Cumulative Effects

In most cases the risk associated with hazards would be reduced to an acceptable level through different management actions. The different management actions, however, have different effects on recreation users, the amount of land base where forest management can be safety managed by forest workers, or may require different strategies to be employed, such as avoiding nighttime fire fighting in areas with high densities of snags, or may require contractors to stop work on windy days. These things would affect efficiency and operation costs.

No action (Alternative A) in the Urban Wildland Intermix Zones would leave these strategic firefighting zones in a condition of high risk that does not meet OSHA requirements to provide a safe working environment for employees, nor does it meet forest plan standards and guidelines to reduce the hazard to firefighters in strategically important areas. The following tables summarize these findings.

Table 3-22: Hazard Tree Risk Management: High/Moderate/Low Risk by Resource and Action

Management Action	Resource – WST, LBMT & Tevis Cup Trails	Relative Level of Risk
Alternative A	No Action: Trail Remains Closed	**Low**
Alternative B, C, & D	Fell & Remove Hazard Trees. Open Trail	**Low**
Alternative E	Fell Hazard Trees/Do Not Remove. Open Trail	**Low**

Management Action	Resource - Roads	Relative Level of Risk
Alternative A	No Action: Level 1 & 2 roads would not be treated, however roads would not be needed for future standing tending (Some admin. and Recreational use).	**High**
Alternatives B, C, D &E	Hazard trees would be removed along level 1 & 2 roads based as associated with future forest stand tending and administrative uses.	**Low**

	Resource – Firefighter safety	Relative Level of Risk

Management Action		
Alternative A	No Action: Snag levels in Urban Wildland Intermix would not be reduced to 2/acre. To mitigate the hazard, firefighting crews may not be put into area of high-density snags at night. Would require more dependence on indirect firefighting methods.	High
Alternatives B, C, E	Snags would be reduced to 2 /acre in the Urban Wildland Interface Zone.	Low
Alternative D	Snags would be reduced to 2 /acre in the Urban Wildland Interface Zone. Snags greater than 20 inches dbh would be left throughout the old forest and in the IRA (except within SPLATs where 4 snags/ac would remain). To mitigate the hazard, firefighting crews may not be put into area of high-density snags at night. Would require more dependence on indirect firefighting methods.	Moderate

Management Action	Resource - Timber harvest & stand tending	Relative Level of Risk
Alternative A	No Action: Forest workers would not need to be in the woods (Some admin. and recreational use).	**Moderate**
Alternatives B, C, E	Where timber harvest & tree planting takes place snags would be reduced to 2-4/acre depending on land allocation.	**Low**
Alternative D	Snags greater than 20 inches dbh would remain in areas where future stand tending activities would occur. However, through implementation of safety measure, such as avoiding work in areas with high density snags on windy days the hazard can be mitigated	**Moderate**

Vegetation

Summary of Effects:

- **Alternative A** - Longest amount of time required for the reestablishment of Old Forest attributes.
- **Alternative B** - Shortest amount of time required for the reestablishment of Old Forest attributes (similar to Alternative C).
- **Alternative C** - Shortest amount of time required for the reestablishment of Old Forest attributes (similar to Alternative B). Portion of one SPLAT would not be artificially reforested to allow for the reintroduction of fire
- **Alternative D** - Shorter period of time required than Alternative A but longer than Alternative B, C, and E (except within the IRA for Alternative E) for the reestablishment Old Forest attributes.
- **Alternative E** - Shortest period of time (similar to Alternative B and C) required for the reestablishment of Old Forest attributes outside of the IRA. Longest period of time to reestablish Old Forest attributes within the IRA (similar to Alternative A).

Vegetation Affected Environment

Historic Conditions

The earliest report on conditions within the project area comes from Leiberg's (1902) report on Forest Conditions in the Sierra Nevada. Leiberg observed that in the Duncan Canyon drainage the forest had been so extensively burned that the stands were extremely uneven. He says that the stands occurred in blocks, mostly of small extent, separated by narrow lanes of brush or thinly scattered through dense masses of undergrowth. He goes on to say that at the head of Duncan Canyon and around Duncan Peak the forest was extremely thin and uneven with most of the timber of the Shasta-fir (red fir) type, badly burned, with brush following in great quantities. The report states that the remainder of the forest was set in thick chaparral or in straggling lines along watercourses and hillsides. In canyons and on northern slopes the trees were tall, of medium diametrical dimensions, but of poor quality, owing to the fire marks. On the ridges, where the ground is rocky and soil thin, the trees were stocky and limby.

Leiberg's report describes the middle portion of the main canyon of Middle Fork of the American River as resembling Duncan Canyon in the character of its forest. Leiberg observed close-set stands alternating with thin lines of trees or scattered individuals rising out of heavy undergrowth. Yellow pine (ponderosa pine) prevailed to the extent of 40%, with sugar pine, incense-cedar, red fir (Douglas fir was referred to as "red fir"), and white fir. The report goes on to say that from the lower end of French Meadows to the head of the canyon, the forest varied with elevation and the extent to which it had been burned. On the slopes west of the canyon, the stands were open and consisted of yellow pine (60 or 70%) and small quantities of white fir and Shasta fir. The flats bordering the river were covered with stands of lodgepole pine, mixed here and there with yellow pine, white fir, and Shasta fir.

Vegetation Zones

According to Fites-Kaufman (2001), general vegetation zones within the project area range from lower montane at the lower elevations to upper montane and even some isolated patches of subapine zones at higher elevations. Historic fire regimes described for these zones range from frequent, low severity to mixed severity fires. Fire regimes for the mid montane zone are poorly studied, but it is likely transitional between the lower montane and upper montane zones.

Fites-Kaufman (2001) describes the conditions typically found in the lower montane, mid-montane, and upper montane zones. She describes the lower montane zone as characterized by ponderosa pine, black oak, and live oak forests with interspersed chaparral. At higher elevations (above 3,000 feet), Fites-Kaufman says that Douglas fir often dominates north or east aspects (generally ranging from 4,500 to 5,000 feet in elevation) and occurs in smaller amounts elsewhere. Above 4,000 feet, white fir occurred historically intermixed with Douglas fir. Large areas with black oak as a dominant or co-dominant occur in this zone as well, particularly on ridges or upper slopes or south or west aspects.

According to Fites-Kaufman (2001), white fir and Jeffrey pine typically dominate the mid-montane zone that occurs generally above 5,000 feet as a narrow band between the lower montane and upper montane zones. The vegetation varies considerably in this zone from mixed conifer to pure white fir with the common element that white fir is either dominant or co-dominant. Sugar pine and incense-cedar are also commonly present. Douglas fir is often absent or present in low amounts. Red fir may also be present in low amounts. Extensive areas, particularly with rocky or shallow soils may be dominated by or intermixed with evergreen shrubs. Huckleberry oak (*Quercus vaccinifolia*) and greenleaf manzanita (*Arctostaphylos patula*) are the primary dominants.

The upper-montane zone generally occurs above 6,000 feet but can finger down to lower elevations where cold air drainage and pooling happens (Fites-Kaufman 2001). Red fir is the dominant species across most productive sites. The forests vary from pure red fir to varied mixtures of red fir and white fir. Rocky areas are more prevalent than in other zones and are typically dominated by Jeffrey pine and various amounts of evergreen shrubs. Greenleaf manzanita, huckleberry oak and pinemat manzanita (*Arctostaphylos nevadensis*) are the prevalent shrub species.

Major Forest Type Subcategories

Within the vegetation zones, forest types vary depending on elevation, aspect, topographic position, soil depth, subsurface water, and bedrock fracturing. Generally below 5,000 feet in elevation, the mixed conifer forest type of the lower montane can be further categorized, by aspect and slope position, into subgroups called mixed conifer-dry (upper 2/3 of south and southwest facing slopes and ridge tops), mixed conifer-moist (lower 1/3 of south and southwest slopes and north and north east facing slopes), and mixed conifer rocky. Generally, mixed conifer-dry slopes have more pine, while mixed conifer-moist sites have higher amounts of Douglas fir. Mixed conifer stands of the mid montane zone (elevations greater than 5,000 feet) can be similarly categorized into dry productive, dry rocky, moist productive, and moist rocky using the same topographic features as previously mentioned. These higher elevation mixed conifer stands typically have more white fir and/or pine on the dry sites. The upper montane can be grouped into red fir productive, red fir rocky, and Jeffrey pine (rocky). However within the project area, there are broad transitions with red fir mixed conifer, pure white fir, and white fir-red fir stands, as well as unique combinations of red fir, white fir and Douglas fir. Consequently, stands do not always fit neatly into these categories.

For simplicity, in the following discussion the various forest types are grouped into broad categories of mixed conifer-dry, mixed conifer-moist, red fir, and hardwood. High elevation mixed conifer (mid montane zone) is only broken out for the description of the Iventoried Roadless Area (below).

Inventoried Roadless Area

The Duncan Canyon IRA contains a diverse mixture of tree species, but generally the area can be divided into two forest types, red fir and high elevation (mid montane zone) mixed conifer-dry. The red fir forest type occurs mostly on the northwest-facing slope of Duncan Canyon and in scattered stands on the southeast-facing slope. The high elevation mixed conifer-dry (ranging from white fir to white fir-pine dominated) occurs mostly on the southeast-facing slope of upper Red Star Ridge and on the southeast-facing slope of Duncan Canyon as well as at the north end of the westerly facing slope. Jeffrey pine, a third forest type, occurs in isolated areas. Additionally, within the project area there are broad transitions with red fir-mixed conifer, pure white fir, and white fir-red fir stands, as well as unique combinations of red fir, white fir, and Douglas fir. The IRA also includes riparian areas, shrub fields, and rocky areas. Before the fire, structural diversity was high in forested stands including areas of very large trees (greater than 30 inches dbh) with overlapping branches (vertical diversity) and openings with small trees and/or shrubs (horizontal diversity).

The Star Fire burned in Duncan Canyon at varying intensities ranging from a moderate underburn where many of the large trees will probably survive to areas where all of the trees were killed. Estimates are that 25% of the area within the IRA suffered 100% tree mortality, and another 40% of the burn area is predicted to be stand-replacing in the future.

Outside The IRA

Outside of the IRA, stands fall primarily into the mixed conifer and hardwood forest types (lower and mid montane), but they grade into the red fir type (upper montane) at higher elevations. These areas include lower Red Star Ridge, a portion of Chipmunk Ridge, and a small portion of Mosquito Ridge. The southeast-facing slope of lower Red Star Ridge (mixed conifer-dry) has greater than 75% tree mortality across most of the area. The northwest-facing slope of lower Red Star Ridge (mixed conifer-moist and mixed conifer-dry) burned in a patchy pattern with scattered large areas of greater than 75% mortality. Most of the portion of Chipmunk Ridge lying within the project area has greater than 75% mortality. Here, the (mixed conifer-moist) stands are heavy to white fir, which is typical of the mid montane zone. The portion of Mosquito Ridge outside of the IRA but within the project area, burned in a patchy pattern, with over 50% of the area having greater than 75% mortality. This area contained a mixture of forest types including hardwood, red fir, and mixed conifer-dry.

Hardwoods

The hardwood stands in the project area suffered severe damage to the above ground portions of tree boles, which are extremely susceptible to fire-induced mortality. However, nearly all hardwoods are expected to re-sprout from below ground burls or root crowns. Many of the sprouts will survive to grow and eventually replace the trees that were top-killed.

Shrubs

Shrubs such as manzanita and ceanothus survive fires by re-sprouting and by producing seed that remain viable in the soil for 200 or more years. Unlike greenleaf manzanita, whiteleaf manzanita does not re-sprout but germinates readily after fire or other disturbances from seed stored in the soil. Generally, the hotter and more complete the burn, the greater the germination from stored seed (Noste and Bushey, 1987).

Data Analysis

Stand examination plots (both variable radius and fixed plots) were established on a grid pattern throughout the project area and data was collected on both live and dead trees (according to Entomologist Sheri Smith's Guidelines). Other data collected on each plot included canopy cover, shrubs, downed logs, fuels, and pre-existing snags. The data was then processed through Forest Inventory Analysis Program (FIA). FIA data was then transferred to the Forest Vegetation Simulator (FVS), a growth and yield model, to simulate the effects of no management and management (for example natural regeneration versus artificial regeneration). The results were compiled and presented below and in the Red Star Landscape Analysis.

A stand-replacing event is defined in the SNFPA as a fire that burns with sufficient intensity to kill the majority of living vegetation over a given area. A stand-replacing event occurs when 75% of a stand (a group of trees that occupies a specific area and is of similar species, age, and condition) within a fire is killed (measured as percent of dead basal area in stems larger than 6 inch dbh). The September 30, 2001 orthophoto was used to identify the stand-replacing event. Areas predicted to become stand-replacing were determined from the plot data previously mentioned. Mortality guidelines recommended by Entomologist Sheri Smith (which are based on Wagener's Guidelines, 1961) for use on the Pendola Fire Restoration Project (2000) were used to determine future predicted mortality. Tree data for stands with greater than 75% mortality are summarized below in the Table 3-23. (Refer to map in Appendix A).

Table 3-23. Tree Data in the Stand-Replacing Event

Patch #	% of Stand-Replacing Area	Veg. Type	Site Type	Species	Percent Cover	QMD	TPA	BA/AC
1	3	MC	Dry	wf,pp	8	1	267	20
2	9	UM	RF	------	0	0	0	0
3	5	UM	RF	Wf	8	5	65	20
4	20	UM	RF	wf,rf,ic,df	5	3	56	9
5	16	MC	Dry	wf,ic,bo	11	7	59	30
6	4	MC	Moist	wf,ic	31	6	235	44
7	11	MC	Dry/Moist	wf,ic,bo, df	27	4	165	34
8	32	MC	Dry	wf,ic,bo, pp,sp,df	25	5	102	28

***MC = Mixed Conifer, UM = Upper Montane, RF = Red Fir**
QMD = quadratic mean diameter, TPA = trees per acre, BA/AC = basal area per acre
wf=white fir, ic=incense-cedar, bo=black oak, pp=ponderosa pine, sp=sugar pine, df=Douglas fir

Table 3-24. Displays some Old Forest attributes of areas within (1) and outside (2) of the stand-replacing event.

Table 3-24. Old Forest Attributes

Forest Type	AVG % Cover 1	AVG % Cover 2	AVG # Large Trees/Acre 1	AVG # Large Trees/Acre 2	Downed Logs 1	Downed Logs 2
MC-Dry	21	35	1	2	4 tons	3 tons
MC-Moist	26	41	0	3	4 tons	1 ton
HW	-----	20	-----	3	-----	2 tons
RF	0-10	15	0	1	4 tons	2 tons

*** 1 = areas with >75% mortality, 2 = areas with < 75% mortality**
Large trees = > 30" dbh for conifers and > 15" dbh for oaks
Hardwood stand attributes are an average of all stands and burn intensities.

Diversity of plant communities can be measured by looking at the distribution of seral stages or age/size classes represented in an area. Pre and post-fire seral stages for the project area are shown below in Table 3-25.

Table 3-25. Pre and Post Fire Seral Stages

Seral Stage	Description	Tahoe NF Pre-fire Acres	Tahoe NF Post-fire Acres
1	Grass/forbs stage with or without scattered shrubs and seedlings.	1,268	4,950
2	Shrub/seedling/sapling stage.	146	68
3A	Pole/medium tree stage. Tree canopy cover is less than 40%. Commonly supports a substantial shrub layer.	1,252	722
3B&C	Pole/medium tree stage. Tree canopy cover is greater than 40%. Shrub layer is variable.	2,984	1,624
4A	Large tree stage, mature and over mature. Tree canopy cover is less than 40%. Commonly supports a substantial shrub layer.	896	563
4B&C	Large tree stage, mature and over mature. Tree canopy cover is greater than 40%. Shrub layer is variable.	2,823	1,392
	TOTAL	9,319	9,319

Plantations

There are 25 pre-existing plantations (211 acres) that were damaged or destroyed by the fire. In the plantations that were damaged but not totally destroyed, fire created a mosaic effect depending on the fire behavior and the pre-existing stand conditions. One of the reasons for the patchy pattern within some of the plantations was the presence of large downed logs. Plantation trees adjacent to these large downed logs were killed. In other areas within the same plantations, a cooler fire burned the bottom portions of crowns, but the top portions remained untouched and alive. In some areas, trees were not affected by fire or heat. Most plantations north of French Meadows Reservoir on Red Star Ridge were completely lost. These stands burned very hot because of crown fire in adjacent stands.

Environmental Consequences - Vegetation

Direct and Indirect Effects to Vegetation Common to All Alternatives

Direct Effects

Wood Quality - The two primary defects affecting product yield are weather checks and sap rot. One year after death, Douglas fir, sugar pine, and ponderosa pine can loose 1%, and true fir can lose 5% of their cubic volume (Lowell and Cahill 1996). Blue stain is also present in significant amounts in pine sapwood, probably causing the largest economic loss associated with the use of one-year-dead pine sawtimber. By the second year, blue stain, deterioration from weather checking, and the occurrence of sap rot have increased. Pockets of rot large enough to warrant scaling deductions have developed. When averaged over all logs within a species group, percent volume loss would probably be less than 10% for every species. After 3 years, the percentage of logs containing sap rot would nearly double from the previous year. The cubic volume loss in logs containing sap rot would also more than double for all species, except Douglas fir. Overall, in the third year, sap rot would represent a much larger proportion of defect than weather checking (Lowell and Cahill 1996).

Variables in the effect of deterioration on salvability involve tree size, the proportion of sapwood to heartwood, and the relative decay resistance of each. As mentioned previously, deterioration of conifers includes blue-stain and decay. Blue-stain primarily affects the pines and causes degrade but no loss of wood strength. Depending on the species of fungi involved, decay may include sapwood or heartwood or both (Dale, 1987). The following table summarizes the main points in deterioration of conifer wood.

Table 3-26 – Deterioration of conifers, by species

SPECIES	BLUE STAIN	SAPWOOD	HEARTWOOD	AVG SALVAGE PERIOD	SALVAGE FOR LARGE TREES
white fir	-	Very thick, rapid decay	Rapid decay	1-2 yrs	4 yrs
Ponderosa pine	+	Thick, slow decay	Thin, slow decay	2-3 yrs	5 yrs
sugar pine	+	Thin, slow decay	Thick, slow decay	> 5 yrs	10 yrs
Douglas Fir	-	Thin, slow decay	Thick, slow decay	> 10 yrs	20 yrs

(Dale, 1987) *Red fir is similar to white fir and Jeffrey pine is similar ponderosa pine

Indirect Effects

Tree Survival - The fire left many ponderosa and Jeffrey pine with a high percentage of brown-colored foliage. Some of these trees may still be alive, but this uncertainty will not be resolved until spring, when those trees that are alive sprout new needles (Wagener 1961). The weakest of these fire-injured trees would be very susceptible to bark beetle attack. Except during a period of moisture stress, trees not injured by the fire either within the area of the burn or in the surrounding forest are rarely attacked because of the concentration of bark beetle attacks in fire-injured trees (Pendola Fire Restoration Entomologists Report FEIS 2000). Concentration of beetles and related losses typically occur within the first two to three years after a fire. Fire damaged trees that survive are the most likely candidates to be attacked during periods of moisture stress in subsequent years.

Stand examinations were conducted over the project area shortly after the Star Fire. Mortality guidelines developed by Entomologist Sheri Smith (Pendola FEIS 2000) were used to estimate tree mortality on the inventory plots (Sheri's November 8, 2001 guidelines were not available at this time). During the initial stand inventory, some conifers were sampled for cambium damage by chopping into the bole of the tree just above ground level. This method of checking the cambium is standard practice and has been used for years to determine the extent of cambium damage in conifers. Open wounds left on surviving trees could serve as entry points for decay fungi and insects.

In addition to the area identified as having greater than 75% mortality, additional areas are expected to have greater than 75% mortality within the next 3 years because of fire related injuries. Most of these areas would be adjacent to stands that currently have greater than 75% mortality.

Cumulative Effects of All Alternatives

There are four timber sales under contract within and adjacent to the project area. The Red Hot Roadside Salvage Timber Sale (currently in progress) removes fire-damaged and fire-killed hazard trees along level 3 roads. About half of the volume has been removed to date. Reforestation within the stand-replacing event is addressed in all action alternatives. French Helicopter Timber Sale (currently in progress) is a CASPO thinning sale that is located on the southeasterly facing slope of Red Star Ridge above the 96 Road. Although the fire occurred within the sale area boundary, the fire did not affect the original harvest units. The fire burned approximately 170 acres outside of the harvest units. Removal of fire-killed trees and reforestation are analyzed in this document. Deep Timber Sale is another CASPO green sale that is currently under contract, but no work has been completed to date. A letter to the file identifies approximately 500,000 board feet of timber burned and approximately 45 acres needing reforestation. End of the World Timber Sale is a CASPO thinning sale just to the west of the project area. The timber sale is under contract and logging is currently underway. Cumulative effects to all alternatives from the removal of hazard trees would be that less dead standing material would pose a risk to public and forest worker safety. The removal of green trees in CASPO thinning sales adjacent to the project area could reduce the chance of fire spreading into the project area if ladder fuels are removed. However, thinning may increase the risk of fire in the short-term.

Outside of the Tahoe National Forest on private property much of the area affected by the Star Fire has already been salvage logged. On the Georgetown Ranger District of the Eldorado National Forest, planning for the Star Fire Restoration is currently underway. This project proposes to treat fire killed and damaged trees, contribute to snag and log needs of wildlife, improve aquatic habitats and stream channel function, and provide for public safety and forest worker safety on approximately 1,714 acres of the area burned in the Star Fire. If these projects proceed as planned, the chances of a fire spreading from these areas into the Red Star Restoration Project Area would be reduced.

Direct Effects of Alternative A - No Action Alternative

In this alternative, there would be no fuels reduction treatments, tree planting and follow-up treatments, or any other projects. Imminent hazard trees would be addressed in a separate document. No funds would be generated through the sale of fire-killed trees to implement future restoration projects.

Kimmey (1955) describes the break-up of a fire-killed stand as follows: During the first two years after the fire there is little noticeable change in the general appearance of fire-killed timber stands. Over the three to five years following the wildfire, many of the ponderosa pine and white fir of smaller sizes will break off at ground level or up to 50 or more feet above the ground. Even some of the larger trees of these species as well as smaller sugar pine and Douglas fir will break off by the fifth year. After the fifth year the general breakup continues until only scattered barkless snags and stubs remain standing. The last remnants of the stand are short stubs of the larger Douglas fir and incense-cedar.

Indirect Effects of Alternative A

Forest Re-establishment

Shrubs - The indirect effect of not removing dead trees and reforesting the area would be that shrubs would regenerate by sprouting and by seed stored in the soil, and they would dominate the site for decades before natural conifer regeneration would become noticeable. Greenleaf manzanita

(*Arctostaphylos patula*), deer brush (*Ceanothus integerrimus*), whitethorn (*Ceanothus cordulatus*), pinemat manzanita (*Arctostaphylos nevadensis*), cherry (*Prunus virginiana* and *Prunus emarginata*), chinquapin (*Castanopsis sempervirens*), tanoak (*Lithocarpus densiflora*), and huckleberry oak (*Quercus vaccinifolia*) burned in the fire would quickly resprout, forming dense thickets in many areas. Whiteleaf manzanita (*Arctostaphylos viscida*) and ceanothus seed will germinate during the first growing season, becoming dense in some areas within 3 to 4 years after the fire. These shrubs, especially those with root systems already established, would rapidly deplete the soil moisture, leaving little for conifer seedlings.

Thirty years following the fire, predicted shrub cover and height would vary depending on elevation and site conditions. According to predictions of shrub growth by Fites et al, in the mixed conifer zone generally at 5,000 feet or less, dry slopes and ridgetops would consist of over 60% cover of predominantly deer brush and whiteleaf manzanita averaging over 5 feet in height. On moist slopes and dry rocky slopes at elevations of 5,000 feet or less, white leaf manzanita over 3 feet tall would make up over 60 percent cover. At elevations of greater than 5,000 feet, on productive fir sites, whitethorn less than 3 feet tall would make-up over 60% cover. In areas having a mixture of pine and fir at elevations of greater than 5,000 feet, shrub cover would consist of greenleaf manzanita and whitethorn (greater than 30% cover and less than 3 feet tall). On sites with predominantly pine over 5,000 feet in elevation, greenleaf manzanita, huckleberry oak, and pinemat manzanita would occupy 30 to 60% cover at less than 3 feet in height. Finally, hardwood stands would contain manzanita, canyon live oak, and black oak at about 30% cover and 5 to 15 feet in height.

Tree Species Diversity - The only source of conifer seedlings would be seeds from cone bearing trees that survived the fire, trees that died but released viable seed last fall, and live trees from adjacent stands. White fir produced a heavy cone crop and large numbers of seeds were released into the burned area last fall. Thus, it is highly likely that much of the natural regeneration would be white fir. Additionally, in some areas, high numbers of white fir and incense-cedar saplings survived where most of the overstory trees were killed. Consequently, these species would make up a high percentage of the naturally regenerating stands. True firs range in fire sensitivity from moderate to very sensitive. The thin bark and shallow root systems of true firs are major factors in this susceptibility (Franklin 1981). While these tree species naturally occurred on these sites prior to the fire, other more fire and drought resistant species such as pine and Douglas fir (also present before the fire) should be represented in the mixed conifer forest type where site conditions allow.

Many large sugar pines were killed or severely damaged by the fire. Whether some of the damaged trees survive long enough to produce a viable cone crop remains to be seen. Sugar pine cones take two years to mature. Individual trees do not produce cone every year and relatively few have cones every other year. Good cone crops are borne at intervals of 2 to 7 years, averaging about every 4 years. Sugar pines do not become good seed producers until about 30 inches in diameter or about 150 years old. Additionally, sugar pine seed are large and have a small wing, so they are not carried great distances by air currents. Furthermore, shrub growth severely hinders the establishment and growth of sugar pine seedlings. However, where sugar pine has an even start with brush, it can compete successfully (USDA 1965). Unfortunately, many of the naturally regenerating sugar pine seedlings and saplings will be killed by white pine blister rust.

Because conifer seeds generally are not dispersed long distances, recovery of conifers throughout the burned area would be a slow process, especially in areas with few live trees. However, tree height, wind speed, and shape of openings in the forest can greatly influence the distance that seed is dispersed. Cones take 1 to 2 years to mature (depending on species), and good seed crops occur at 2 to 5 year intervals depending on species. In areas with heavy shrub competition, shade tolerant (able to survive in lower light levels) and slower growing conifer species such as white fir, red fir, and incense-cedar have the advantage over the more shade intolerant (like more sun) species such as pine and Douglas fir. Once established, shade-tolerant white fir saplings can endure decades of suppression in dense shrubfields.

Under these conditions leader growth is very slow. Fifty-year-old suppressed trees may be only 3 feet tall. When the crowns grow above competing vegetation in shrubfields, white fir dramatically increases in diameter and height (USDA Forest Service 2002). Unlike shade intolerant pine and even Douglas fir, true firs eventually overtop and kill brush (Gordon 1970).

Currently, conifer seed sources are limited within large openings such as those on the east-facing slope of lower Red Star Ridge. This area would likely have some natural white fir regeneration along with scattered residual patches of white fir and incense-cedar saplings. Douglas fir, ponderosa pine, and sugar pine regeneration would be minimal because of the size of the opening, proximity to seed sources, and the heavy amount of shrub cover that is expected. Over time, as trees mature and begin to shade out the shrubs, more seed would disperse into openings and clumps of trees would begin to develop, which would then shade out more shrubs. As these conifers mature, seed would disperse further into the shrub-dominated openings. The recovery to a mixed conifer forest would be a very slow process and white fir (a less fire and drought tolerant species) would be the dominant species.

Within the red fir forest, large openings having greater than 75% mortality would probably have little natural tree regeneration, especially if future mortality predictions are correct (see predicted mortality map). If or when this additional mortality occurs (predicted 1 to 3 years), very large openings with little to no conifer seed sources would be created. Within these openings, the small number of red fir seedlings present would likely be one foot tall after 5 to 10 years (USDA 1965). With the exception of some pockets of concentrated seedlings that would eventually form clumps, heavy shrub cover such as greenleaf manzanita and whitethorn would be the dominant vegetation in these openings for decades. The slow growing fir would eventually overtop and shade out some of the shrubs, but canopy cover would most likely remain very low (less than 40%) over the next 100 years (Forest Vegetation Simulations – FVS).[1]

Based on inventory data, relying on natural regeneration would result in species composition in red fir stands of red fir, white fir, sugar pine, and incense-cedar at both 30 and 100 years (FVS). In contrast the desired condition for species mix would be red fir, Jeffrey pine, and sugar pine (Red Star Landscape Analysis 2002).

In the mixed conifer forest, with no treatment, white fir, black oak, incense-cedar, and a small amount of ponderosa pine would be the primary tree species at both 30 and 100 years (FVS). Drought and fire resistant species such as sugar pine and ponderosa pine would be missing in desired quantities from the future forest.

Canopy Cover - In the short term if mortality predictions are correct, very large openings containing mostly shrubs and little tree cover would result in the Red Star Restoration project area over the next 3 years. In 30 years, canopy cover would range from about 1 to 18% in red fir stands and about 4 to 58%, depending on the amount of black oak present, in mixed conifer stands. In the mixed conifer forest type, especially on lower Red Star Ridge, canopy cover would not be as limiting as in the higher elevation fir stands over the next 100 years because of the black oak that are expected to resprout. In 100 years canopy cover would range from about 9 to 42% in red fir stands and about 25 to 64% (depending on percentage of black oak present) in the mixed conifer forest.

Tree Size - The Forest Vegetation Simulator (FVS) was used to simulate tree growth in naturally regenerating stands. In 30 years following the fire, average tree size would range from 2 to 13 inches diameter at breast height (dbh). In 100 years following the fire, average tree size would range from 14 to 23 inches dbh.

In hardwood stands in 30 years, trees would average 25 per acre greater than 15 inches dbh, but none would be larger than 24 inches. In 100 years, hardwood stands would average 37 trees per acre greater than 15 inches dbh, with about 7 greater than 24 inches dbh.

The fire destroyed over half of the existing plantations within the project area. If planting were not to occur in these plantations, tree densities in some areas would be slightly higher than surrounding stands, depending on the extent of damage to plantation trees. These existing plantation trees would have a head start on regenerating shrubs, giving them a better chance of out-competing the shrubs than the surrounding naturally regenerating trees. These existing plantation trees would add horizontal diversity to the regenerating forest that may be apparent in some areas over the next 100 years.

Cumulative Effects of Alternative A

The cumulative effects of Alternative A are that old forest attributes such as large trees, high canopy cover, and a diverse tree species mix would take longer to develop over areas of high tree mortality than if action were taken to reduce woody fuels, plant trees, and implement follow-up (release and thinning) treatments within the stand replacing event. Also, without the implementation of fuels reduction treatments in the project area, the chances of escape are increased if another fire were to occur before trees become reestablished, especially if future stand mortality predictions are correct.

In the event of another fire within the next 50 years, most of the remaining live trees and any naturally regenerating trees in the vicinity of the fire would likely succumb to radiant heat or direct flame due to the high fuel build up over time from the dead trees. Areas that burned hot during the Star Fire would likely burn hotter this time around, consuming snags and leaving only brush skeletons behind. The result would be fewer live trees left to reforest the site. Sprouting shrubs such as green leaf manzanita would sprout from live root crowns underneath shrub skeletons and quickly reoccupy the site. In the event that another fire occurred within 30 to 60 years of the last, it is highly likely that the combination of lack of conifer seed sources and degraded soils would result in the creation of large brushfields that would remain for an indefinite period of time. However, fuels reduction treatments on private land and those planned on the Eldorado National Forest portion of the Star Fire would reduce the chance of a fire starting in those areas and moving into the project area.

There are no known irreversible effects to vegetation from Alternative A. Alternative A would have an irretrievable loss of tree growth and volume because dead trees and shrubs, rather than live trees, would occupy many areas for decades. The effect would be that a longer period of time would be required to return to an Old Forest condition. Likewise, the chance of irretrievable effects to tree densities is increased with Alternative A because of the increased chance of a wildfire escape without fuels reduction treatments.

Direct Effects of Alternative B – Proposed Action

Forest Re-establishment

Logging Damage – Alternative B proposes to remove approximately 124,000 MBF(thousand board feet) from 5,902 acres. There is a slight risk of adverse effects to living trees from logging. Damage to trees from machinery and dragging logs can occur, primarily by removing sections of bark from the tree bole. This type of damage could occur in tractor and skyline logged areas. Additionally, trees that are felled can break limbs off of nearby trees and crush small live trees. However, since there is a relatively low proportion of live trees in stands proposed for harvest and because provisions in the timber sale contract provide for protection of residual trees, this type of damage would be expected to be minimal.

Tree Planting - Tree planting would initially occur on approximately 3,580 acres (including existing plantations). The removal of dead standing trees would help ensure the survival of regenerating conifer seedlings. Falling dead trees and the buildup of downed woody material after they fall can damage and kill small regenerating trees. Also, follow-up treatments such as shrub removal are much more difficult if not impossible with heavy fuels accumulations (This type of situation may occur in a small percentage of the planted areas such as within the no-harvest buffers in RCAs, snag retention corridors, and within PACs. The risk of falling snags to forest workers may preclude planting and follow-up treatments all together in some areas with excessive numbers of dead trees.) Additionally, the removal of hazard trees along roads and trails would provide a safer place for working and recreating. Please refer to hazard tree marking guidelines (Appendix F).

Planting Priorities - As funding becomes available for planting, it would be applied in order by priority. Priority areas for tree planting were developed with consideration to:

- site quality,
- size of opening and proximity to potential seed sources,
- access,
- visual concerns specifically from major roads, French Meadows Reservoir, and the Western States Trail, and
- wide dozer lines from fire suppression activities.

Based on the criteria above, five major planting priority areas were identified along with two subcategories (see map Appendix, A).

1) the southeasterly facing slope of lower Red Star Ridge below the 96 road,
2) the southeasterly facing slope of upper Red Star Ridge on the north side of French Meadows Reservoir and areas adjacent to the dam,
3) areas on the northwestern part of the project area along the 96 road and the road to the Duncan Diversion Dam,
4) the northwesterly facing slope of lower Red Star Ridge,
5) planting with poor access primarily within the IRA. The fifth priority also includes small openings on lower Red Star Ridge and areas with poor accessibility surrounding the Duncan Diversion Dam.

The two sub-category priorities are the Strategically Placed Area Treatments (SPLATs) located within the IRA and areas of visual concern that fall outside of the first three planting priorities. SPLATs 4, 4L, and 8 (Shown as 'High Priority SPLATs' on the Alternative B – Planting Priorities Map – Appendix A) would be planted with the second priority. The remaining SPLATS within the IRA would be planted at the same time as the fifth priority. The areas of visual concern that are visible from the 96 road and the reservoir would be combined with priority two planting and areas of visual concern from the Western States Trail would be planted first among the fifth priority. Areas within the IRA were identified as fifth priority primarily because of poor accessibility and the increased cost and difficulty of transporting trees and crews into this isolated area. Given sufficient time, most of the openings would seed in naturally, but growth would be very slow initially and canopy cover in the long-term (100 to 150 years) would probably be low (less than 40%). All of the priority areas fall within the stand-replacing event.

Areas outside the stand-replacing event would be monitored to detect mortality and future planting needs (see monitoring plan). An additional approximately 4,000 acres is expected to have greater than 75%

mortality over the next 3 years. These areas would be planted in the future as needed (depending on funding) when they meet the stand-replacing definition. Additionally, pre-existing plantations either partially or totally destroyed by the fire would be replanted. Some of these plantations would be planted under a separate document (83 acres). The remaining plantations (211 acres) would be planted along with the first priority for planting because of minimal residual fuels and thus minimal need for site preparation relative to other areas within the burn.

Tree Planting Spacing - Planting densities and tree spacing (see Table 3-29) would vary depending on numbers of residual live trees and site-specific objectives (i.e. SPLATs, Urban Wildland Intermix Zone, and major forest type). Areas with live residual (pre-existing) trees would require fewer planted trees. Hardwood stands would be encouraged to remain as such and would not be planted with conifers. After about 10 years, shrubs may be cut from around black oaks and sprouts may be thinned back to 3 to 4 main stems, to encourage growth. Additionally, individual hardwoods would have 20 foot spacing between their crown and planted conifer seedlings to ensure sufficient room for future growth. Some areas would be left unplanted (0 to 5% of the planting unit) to add horizontal diversity. These areas may include rocky areas and areas of heavy slash accumulation. Vertical diversity would be more difficult to achieve at an early stage because all planted and natural seedlings would be similar in height, however residual live trees would add some vertical diversity.

Conifers would not be planted within riparian vegetation along streams. Defense Zones, Threat Zones, and SPLATs would be planted at a wide spacing to allow room for follow-up fuels treatments. Outside of these areas, tree spacing may vary in some areas to form a clumpy pattern that would more closely mimic naturally regenerating stands. Other areas would have a closer spacing to encourage the shading out and killing of shrubs. Although planting densities may vary because of site-specific objectives, areas to be planted would have an average of about 300 trees per acre including undamaged residual trees.

Silvicultural Implications of Artificial Regeneration - Beschta et al. (1995) states that from an ecological perspective, there is frequently no need for artificial regeneration. The authors state that artificial reintroduction of species will circumvent natural successional changes, are often unsuccessful and will have unanticipated side effects even if successful. In response to this statement, artificial reforestation would shorten the natural successional process by more quickly moving from a shrub dominated community to a forested environment. Additionally, survival rates and thus the success of planted seedlings have been greatly improved over the years through the utilization of high quality seedlings and containerized stock.

Beschta et al. (1995) states that if warranted, artificial regeneration should use only species and seed sources native to the site, and should be done in such a way that recovery of native plants or animals is unhampered. Additionally, the authors say that in general, active planting and seeding has not been shown to advance regeneration and most often creates an entirely new exotic flora. Conrad's (1995) response is that certainly there is evidence that seeding (e.g. with grasses) can suppress natural regeneration processes, and there is little evidence of its beneficial effects on reducing erosion. However, except where off-site conifers may have been planted (as was done years ago on some sites), seeded herbaceous species usually drop out of the picture within 3-5 years after a fire—leaving their effect on the structure and composition of the natural vegetation. Finally, the authors recommend that such practices (active reseeding and replanting) should be employed only where there are several years of evidence that natural regeneration is not occurring. Weatherspoon's (1995) response to this comment is that seed sources for natural regeneration of trees in most forest types often are eliminated over broad areas of stand-destroying fires. Given the likely occurrence of another wildfire occurring in the area, if suppression is abandoned as the authors suggest, many centuries could pass before the native forests are re-established naturally. In many areas, waiting several years before resorting to artificial regeneration would simply doom a plantation to failure in the absence of the kinds of vegetation management measures that the authors would prohibit.

Nursery seedlings are grown from seed collected in the same seed zone (same area and elevational range) as the planting site. There are several advantages to planting nursery stock. One advantage is the size of the seedlings. Seedlings coming from the nursery are 1 to 2 years old when planted, giving them a head start over shrub competition. Another advantage is that the desired tree species for the site can be encouraged through planting. In areas with greater than 75% mortality, most of the residual live trees (and the expected natural regeneration) are white fir and incense-cedar, which are not fire resistant species. Additionally, rust resistant sugar pine can be planted, increasing the likelihood that this species would be well represented within the project area as it has been in the past. The disadvantage of planting nursery seedlings is the added cost of planting the trees and follow-up costs (release and thinning) of tending the trees.

Based on Forest Vegetation Simulator (FVS) runs, tree planting on mixed conifer sites resulted in a more desirable tree species mix. With no treatment, white fir, black oak, incense-cedar, and a small amount of ponderosa pine would be the primary tree species in 100 years. With treatment though, Douglas fir, white fir, incense-cedar, ponderosa pine, black oak, and sugar pine would occupy the stands in 100 years (see Appendix F). This mixture of species would include more fire and drought resistant trees, and it would more closely meet the desired condition for the mixed conifer forest type.

Shrubs - Along with tree planting, reforestation includes site preparation and follow-up (release and thinning) treatments necessary for the survival and growth of planted trees. The survivability and subsequent growth of the planted trees is largely determined by promptness of reforestation. Delays in planting give shrubs more time to dominate a site, thus reducing the survival rates of planted conifers. Site preparation after a fire can sometimes be skipped if planting occurs before shrub cover is too high (within the first 1 to 2 years after the fire). Except where timing of fuels treatments would conflict with planting, those areas that could be planted without treatment should be planted as soon as possible, thus reducing reforestation costs and increasing survival and growth rates of seedlings.

Site preparation on slopes greater than 25% could include treatments such as hand-cutting of shrubs and small (less than 10 inches dbh) dead trees (if not already removed in fuels reduction treatments), grubbing (uprooting) and/or scalping of grasses, forbs, and shrubs, hand-piling, and burning. On slopes less than 25% these methods along with mechanical treatments such as mastication (including the creation of planting spots) may occur. The type of equipment used would be an excavator or other low ground-pressure tracked vehicle with the appropriate attachments to implement these treatments. Although within the IRA, only non-mechanical treatments (except for chainsaws) would be considered.

After planting, shrubs and forbs would need to be removed from around the conifer seedlings to help ensure survival and growth. According to McDonald and Fiddler (1995), the best conifer release treatment is one that effectively controls vegetation and does so in a timely manner. The first three years are important; the first year is critical (McDonald and Fiddler, 1995). Fiske (1981) recommends keeping shrub competition under 30%. However, he cautions that even light densities of manzanita will cause substantial growth losses in seedlings. The SNFPA (FEIS Vol. 1, Chap 2 page 57) recommends that shrub cover be maintained between 10 and 20% in plantations within the Urban Wildland Intermix Zones in Westside mixed conifer types. Planted areas (including the approximately 83 acres planted in the spring of 2002 but analyzed under a decision memo)would be monitored and released as funding allows. Release methods analyzed in this document would include grubbing and hand-cutting of grasses, forbs, and shrubs. Herbicide use is not analyzed in this document, nor is it anticipated that there will be any future use of heerbicides within the project area. Without treatment in the first couple of years after planting, pine and Douglas fir seedlings would have very low survival rates. True fir on the other hand, while benefiting from release by increased growth, continue to grow slowly under shrub cover and eventually overtop and kill the shrubs. In fact, one study shows that shrub cover may provide beneficial seedling protection and higher survival in red fir seedlings (Barbour 1997).

Thinning - Thinning (pre-commercial) usually occurs between 10 and 30 years after planting or when tree crowns begin to overlap (crown closure). The advantage to thinning at crown closure is that many of shrubs have been shaded out and killed. This works especially well in areas having predominantly Douglas fir and not as well in stands consisting of predominantly pine (because of the crown characteristics of the pine). If seedlings are planted at a wide spacing, shrubs remain in the stand and release treatments become more important to tree growth. The advantage to planting trees at a wide spacing is the reduced cost in planting and follow-up treatments on a per tree basis (although more treatments may be necessary), more space between trees for fuels treatments, and less dead material left on the ground after thinning.

Variable Density Thinning - Thinning of young stands is an important tool that can be used to create richness in individual structures and heterogeneity in the spatial arrangement of these structures (Franklin 2001). While one objective of thinning may be to stimulate development of some large trees, there are many other goals (Franklin 2001). Thinning to remove smaller trees can reduce the risk of fire spreading into the canopy, while improving the growth of remaining trees. Variable density thinning can help mimic the clumped distribution and associated processes found in pre-settlement stands (Brown 2002). Variable density thinning would be used to incorporate "skips" (areas with no thinning) and "gaps" (areas that are heavily thinned) along with a dominant stand matrix that receives intermediate treatments. Gaps would not be viewed as clearcuts and would retain at least some trees. Franklin (2001) recommends that a variable scale of 0.25 to 1.25 acres is probably appropriate. Franklin states that spatial heterogeneity is the general rule in natural stands and one of the greatest contrasts with our artificially regenerated stands. Therefore, uniformly spaced thinnings from below (smallest trees only) would not be appropriate over more than a few acres.

Thinning would reduce the risk of stand replacing wildfire in the long-term by improving the height to live crown, and reducing stand density (Omi and Martinson 2002). If desired, the thinned material could be removed to reduce the surface fuel loading. However, without treatment, small material would break down after several years. Thinning would be completed after mid July in pine-dominated stands and the slash properly treated at that time to reduce the likelihood of insect infestation. Thinning would be accomplished using chainsaws or mastication. After thinning, numbers of trees less than 10 inches dbh would average 150 to 200 trees per acre.

Within Defense and Threat Zones as well as within SPLATs, pruning of the trees would be desirable. In the past, pruning was utilized to increase the economic value of the timber, but in this case pruning would be used to raise the crown base height, thus helping to prevent future crown fires. In areas where pruning is desired, trees would be pruned to a height of about 10 feet, although 50% live crown would be maintained to ensure vigor (SNFPA Chapter 2). For efficiency, pruning could be implemented at the same time as thinning. Some species such as true fir may be poor candidates for pruning. Pruning of true fir can be very time consuming and can lead to the introduction of decay fungi. If properly pruned, both ponderosa pine and Douglas fir are resistant to invasion by decay fungi.

Other considerations when pruning are sun-scald and epicormic branching. Sun scald results when bark temperature from direct sunlight reaches lethal levels killing the cambium beneath the newly exposed bark. Epicormic branching occurs with some tree species (i.e. Douglas fir) when sunlight stimulates dormant buds within the bark to produce new shoots. Sun scald and epicormic branching can be avoided by leaving enough crown on a tree to shade the lower bole and by thinning lightly to avoid opening the stand too much on exposed hot south-facing slopes. The best time to prune is during late summer, fall, and early winter when the cambium is not actively growing (USDA 1996).

Indirect Effects of Alternative B

Old Forest Characteristics

The indirect effects of removing most of the dead trees and planting conifer seedlings together with follow-up treatments such as release and variable thinning is that the area burned by the fire would begin to develop important Old Forest characteristics (i.e. variety of tree sizes, species, canopy cover, horizontal diversity). Funds generated through the sale of fire-killed trees could be used to help finance restoration projects such as tree planting and follow-up treatments. Additionally, with most of the dead trees removed, the probability that the area would experience another catastrophic wildfire in the next several decades is reduced.

Planting trees along with prescribed follow-up treatments would meet several objectives. It would help to ensure a rich variety of tree species and a high degree of horizontal heterogeneity or spatial patterning within the stands visible as structural patches, including canopy gaps (openings) and areas with high stem densities. Additionally, reforestation treatments would provide future canopy cover for wildlife and help to improve the view from the main roads, the reservoir, and the trails more quickly than if no treatments were to occur.

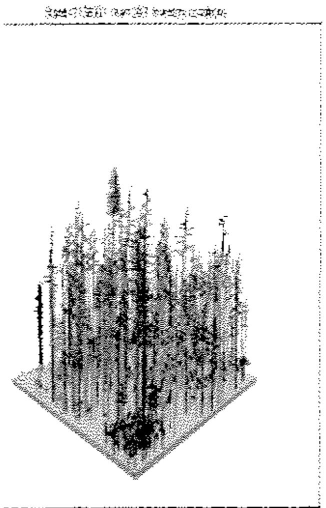
Within RCAs, where scalping of vegetation during site preparation and grubbing of competing vegetation during release would be restricted to a 2 foot radius, tree survivability may be acceptable (up to 84%), but tree growth and vigor may be low (McDonald and Fiddler 1997). Subsurface water could help to improve growth and vigor in some areas though (Carol Kennedy, pers. comm.).

Tree Species Diversity - In the red fir zone the species mix at 30 and 100 years would include red fir with white fir, sugar pine, Jeffrey Pine, and incense-cedar. Jeffrey pine probably would not occur in the species mix in many areas without artificial regeneration. In the mixed conifer forest types, FVS runs demonstrate that at 30 and 100 years tree planting resulted in a more desirable tree species mix. With no treatment, white fir, black oak, incense-cedar, and a small amount of ponderosa pine would be the primary tree species. With treatment though, Douglas fir, white fir, incense-cedar, ponderosa pine, black oak, and sugar pine would occupy the stands. This mixture of species would include more fire and drought resistant trees, and it would more closely meet the desired condition for the mixed conifer forest type.

Canopy Cover - In the red fir forest, FVS was used to model stand growth with and without reforestation treatments (see figures 1-5 and 1a-5a). After 30 years, the model showed that canopy cover was higher in the treated stands (1 to 18% in untreated versus 21 to 32% in treated stands). At 100 years, canopy cover was consistently higher with reforestation treatment (9 to 42% in untreated versus 52 to 57% in treated stands).

FVS runs completed for the mixed conifer forest type showed some important differences from those in the red fir. Here, canopy cover was predicted to be high for both untreated and treated stands at 30 and 100 years (4 to 58% for untreated versus 25 to 55% for treated at 30 years and 25 to 64% untreated versus 44 to 64% for treated at 100 years), most likely because of the high amount of black oak present in some areas.

Table 3-26. FVS Simulation in Red Fir Forest Type – Stand A.



e 1. Current Condition (red

:es per acre, average dbh = 6
s, canopy cover = 5 percent.

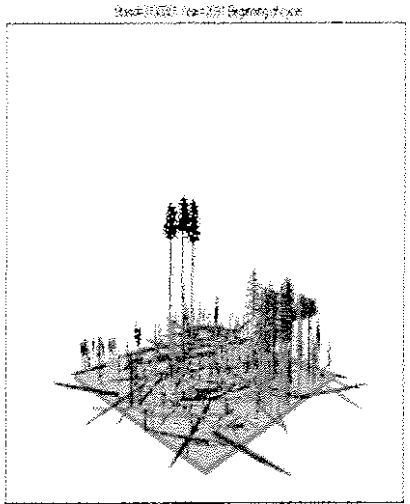


Figure 2. Condition in 30 years without reforestation (red fir)
122 trees per acre, average dbh = 9 inches, canopy cover ≈ 18 percent.

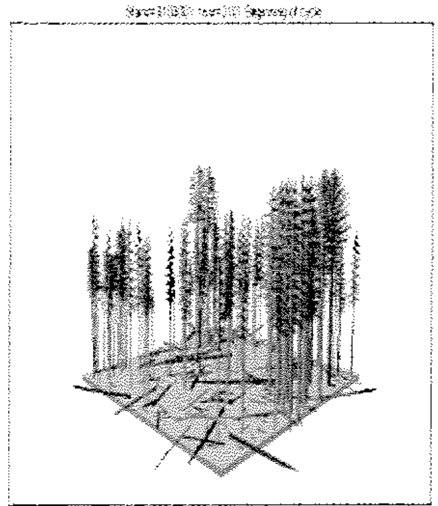
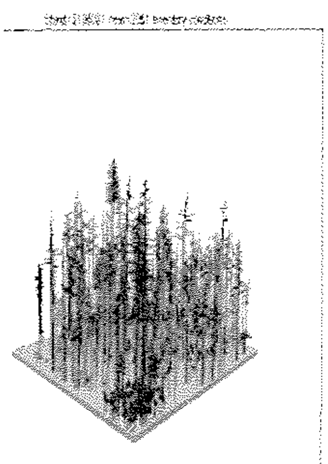


Figure 3. Condition in 100 years without reforestation (red fir)
102 trees per acre, average dbh = 20 inches

Canopy cover ≈ 42 percent.



as Figure 1.

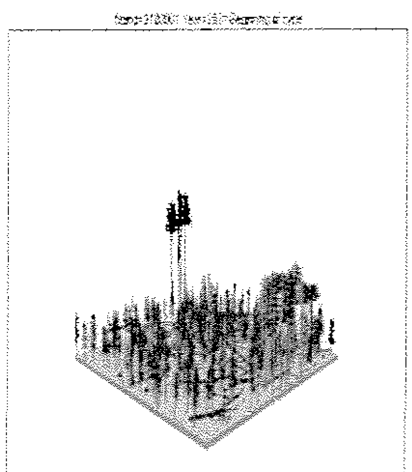


Figure 4. Conditions in 30 years with reforestation (red fir)
222 trees per acre, average dbh = 9 inches, canopy cover ≈ 32 percent.

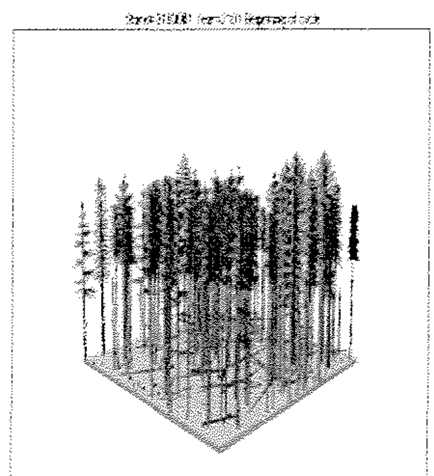
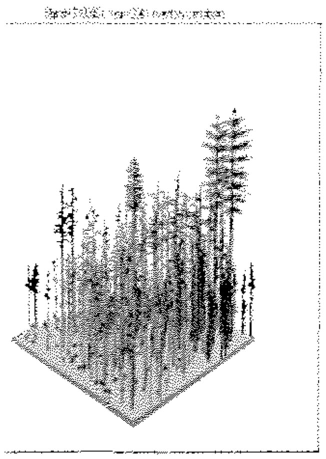


Figure 5. Conditions in 100 years with reforestation (red fir)
119 trees per acre, average dbh = 22 inches, canopy cover = 52 percent.

Table 3-28. FVS Simulation in Red Fir Forest Type – Stand B.



e 1a. Current Condition (red
s per acre, average dbh = 35
s, canopy cover = 5 percent.

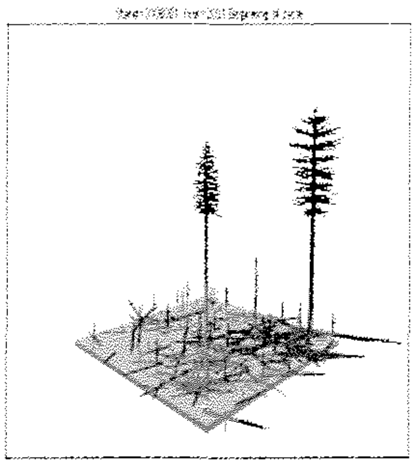


Figure 2a. Condition in 30 years without reforestation (red fir)
32 trees per acre, average dbh = 13 inches, canopy cover = 8 percent.

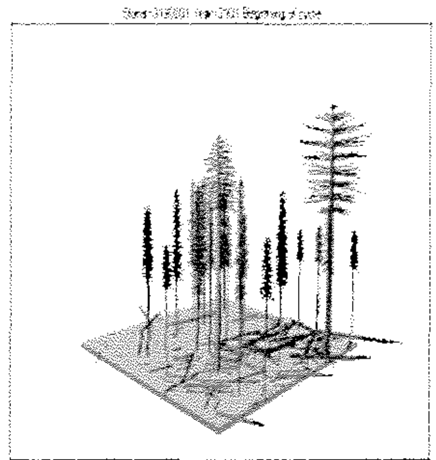
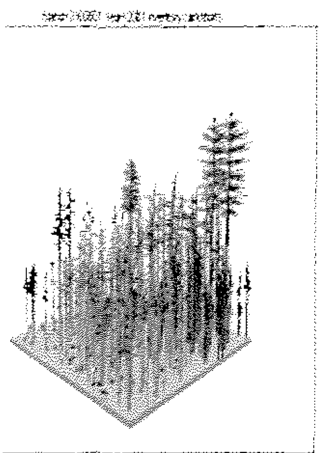


Figure 3a. Condition in 100 years without reforestation (red fir)
31 trees per acre, average dbh = 23 inches
Canopy cover = 20 percent.



as Figure 1a.

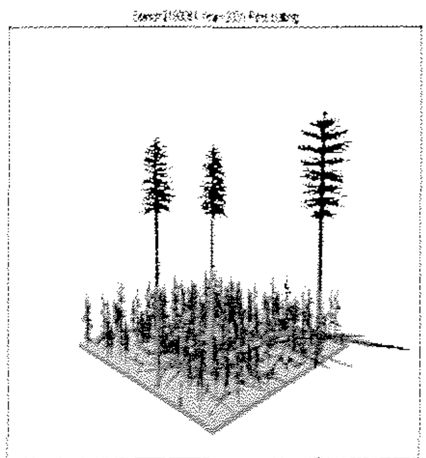


Figure 4a. Conditions in 30 years with reforestation (red fir)
162 trees per acre, average dbh = 9 inches, canopy cover = 27 percent.

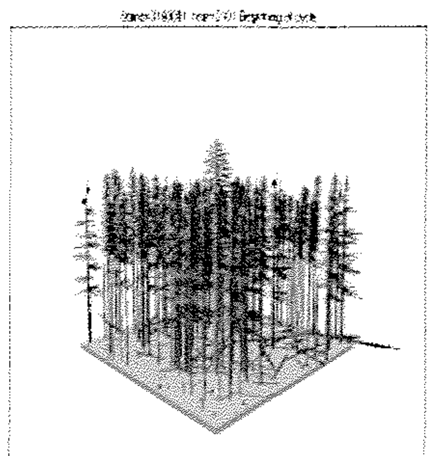


Figure 5a. Conditions in 100 years with reforestation (red fir)
95 trees per acre, average dbh = 23 inches,
canopy cover = 56 percent.

Tree Size - In the red fir forest at 30 years, tree sizes ranged from 2 to 13 inches dbh in untreated stands and 8 to 9 inches dbh in treated stands. At 100 years, average tree size was 20 to 23 inches dbh in untreated stands and 22 to 23 inches dbh in treated stands. Numbers of naturally regenerating trees for this scenario were taken from the SNFPA (Vol. 4, Appendix B-57).

In the mixed conifer forest at 30 years, tree size in untreated stands averaged less than those of treated stands (2 to 12 inches dbh in untreated versus 6 to 13 inches dbh for treated). At 100 years, the difference in tree size was about the same (14 to 22 inches without treatment versus 18 to 24 inches with treatment).

Hardwoods - The indirect effects to hardwood stands would be the same initially as Alternative A since planting in hardwood stands is not proposed. After 10 years, if hardwood sprouts are thinned and shrubs are removed from around hardwoods, growth would be expected to increase on the released hardwoods.

Plantations - The fire destroyed over half of the existing plantations within the project area. If planting occurs in existing plantations, higher tree densities would assure adequate stocking levels leading to future canopy cover and a diverse tree species mix. The surviving plantation trees would have a head start on regenerating shrubs, giving them a better chance of out-competing the shrubs than planted trees in the surrounding areas. These existing plantation trees would add horizontal diversity to the regenerating forest that may be apparent in some areas over the next 30 to 50 years. Plantations would be managed to eventually blend in with the surrounding forest.

Cumulative Effects of Alternative B

The cumulative effects of harvesting and removing fire-killed trees, hazard trees along roads and trails (Refer to hazard tree marking guidelines in Appendix F), developing and maintaining SPLATs, maintaining future live fuel loadings (shrubs), and tree planting along with follow-up treatments would allow Old Forest conditions to return more quickly then if no treatment occurred. More specifically these treatments would help ensure a safe environment for working and recreating; provide a possible funding source for restoration projects; provide future adequate canopy cover for wildlife; provide a variety of individual structures such as large trees, diversity of tree species, snags, and downed logs; horizontal heterogeneity visible as structural patches, including canopy gaps and areas of high stem densities; and most importantly the time necessary to reach these objectives before another major wildfire occurrence.

In the event of another fire in the project area, the reduction in long-term fuel loading would aid in the survival of the remaining live trees in treated areas. In the 10% retention areas, RCA inner buffers, snag retention corridors, and PACs, fuel loading would eventually become extreme, making the survival of trees in these areas unlikely in the event of a fire. Fuels reduction treatments on private lands and those planned on the Eldorado NF portion of the Star Fire, along with those planned within the project area would reduce the risk of a catastrophic fire in the future.

There are no known irreversible effects to vegetation if Alternative B is implemented. The risk of irretrievable effects to tree densities is reduced in this alternative because of the reduced risk of a future catastrophic fire.

Table 3-29. Reforestation Prescriptions

llocation	Spacing	Trees Per Acre	Release	Precommercial Thinning	Pruning
efense Zone	20'x 20', 2 trees per spot, or	250	2 times, with radial cut/grub*	150 tpa*, at 10-15 years (use variable density thinning)	Yes - 10' high, maintaining 50% LC*
	22' x 22', 3 trees per spot	300	Same as above	Same as above	Same as above
hreat Zone	20'x 20', 2 trees per spot, or	250	2 times, with radial cut/grub	150 tpa, at 10-15 years (use variable density thinning)	Yes - 10' high, maintaining 50% LC
	22' x 22' 3 trees per spot	300	Same as above	Same as above	Same as above
PLATs	20' x 20', 2 trees per spot	250	2 times, with radial cut/grub	150 tpa, at 10-15 yrs (use variable density	Yes - 10'high, maintaining

				thinning)	50% LC
ld Forest ed Fir Type	Variable spacing	300	1-2 times, with radial cut/grub for pine	200 tpa, at 20-30 years (use variable density thinning)	No
ld Forest lC Dry	20' x 20', 2 trees per spot, or 13' x 13', 1 tree per spot	250 300	2 times, with radial cut/grub	150 tpa, at 10-20 years (use variable density thinning)	No
ld Forest lC Moist	13' x 13', 1 tree per spot	300	2 times, with radial cut/grub	150 tpa, at 10-20 years (use variable density thinning)	No
xisting lantations		100 – 300	2 times, with radial cut/grub	150 tpa 10-20 years (use variable density thinning)	Only if in Defense, Threat, or SPLATS

* TPA = **Trees per acre.** LC = **Live Crown.** Radial Cut = **All Veg. removed (cut) in 5' radius around tree.** Grub = **All Veg. removed (cut at surface, along with underground removal of roots or portions of) in 5' radius around tree.**

*** Although fewer trees would be planted per acre in Urban Intermix Zone than recommended in SNFPA, trees per acre at precommercial thinning would generally meet those prescribed in SNFPA.**

Effects of Alternative C

The effects of Alternative C would be similar to Alternative B except as follows:

Direct Effects

Timber Harvest - A direct effect of not removing fire-killed trees from within 100 feet of the Middle Fork American River, Little Duncan Canyon, and Duncan Canyon would be that less merchantable material would be removed from within the RCAs, but the difference in the total volume removed from the project area as compared to Alternative B would be minimal. Alternative C would remove approximately 17-18,000 board feet per acre from approximately 5,530 acres (including both stand-replacing and predicted mortality).

Tree Planting - Reforestation priorities would be similar to Alternative B, except for the portion of the northerly most SPLAT that drops into Duncan Canyon. Within this portion of the SPLAT, except for areas of visual concern from trails, no trees would be planted to allow for the reintroduction of fire in 30 to 50 years. Tree planting would occur on approximately 3,288 acres in this alternative. Prior to burning, protection measures would be devised to reduce tree mortality in areas of visual concern from trails. Shrubs, forbs, and naturally regenerating conifers would re-establish and occupy this portion of the SPLAT, however most of the vegetation would not survive the reintroduction of fire. Under most weather conditions, this SPLAT would act as a barrier to flames, or at least it would slow the advancement of flames, protecting the valuable Old Forest adjacent to and beyond its boundaries. After about 30 years, dead material would accumulate within the shrubfield portion of the SPLAT, causing it to be less effective in the event of a fire. To maintain the effectiveness of the SPLAT, fire would be reintroduced to the shrubfield, setting the seral stage back to a more advantageous condition. Because planted red fir would not have reached sufficient size to survive even low flame lengths, no trees would be planted in this predominately red fir forest portion of the SPLAT. Even with flame lengths as low as 2 feet, there is a good chance that red fir would suffer high rates of mortality at 30 and even 50 years (64 to

77% FOFEM) because they are less fire resistant and slower growing than other species.

Structural Diversity - Because of the change in the number, size, and location of SPLATs, the structural pattern or arrangement of planted trees across the landscape would change from that in Alternative B. In Alternative C, trees within SPLATs would be planted 18 to 20 feet apart (125 – 150 trees per acre) to allow room for future fuels reduction treatments. As a result of the increase in SPLAT size, Alternative C would produce larger continuous areas with a similar initial tree spacing in the mid to lower portions of the project area. The exception would be in the northerly-most SPLAT where no trees would be planted in Duncan Canyon, increasing the vertical diversity somewhat over Alternative B in this area. The initial effect across the landscape would be a reduction in the horizontal diversity but an increase in the vertical diversity from that in Alternative B. If thinning becomes necessary in 10 to 15 years because of the ingrowth of natural seedlings (thinning in red fir would occur later than in mixed conifer stands because of slower growth), this pattern would be broken up to some extent by implementing variable density thinning (see Alternative B). However, variation in tree spacing would be limited within the SPLATs because of the wider tree spacing at the time of planting and the emphasis on reducing ladder fuels and crown fires. Generally, the wider tree spacing in SPLATs would be appropriate for these areas because SPLATs would incorporate ridge tops where trees were historically more widely spaced.

SPLAT Treatments - Within SPLATs, on slopes generally less than 25%, felling of dead trees less than 10 inches dbh would most likely be implemented through a service contract immediately following the logging operation. Hand piling and burning of dead fuels would occur approximately 2 to 5 years later, however timing of both treatments would be funding dependent. Likewise, on slopes generally greater than 25%, helicopter yarding of the less than 10-inch material would be accomplished when funding becomes available. Additionally, in areas outside of the stand-replacing event but within SPLATs and Defense Zones, treatment of dead trees less than 15 inches dbh would be considered. The wider tree spacing within SPLATs would allow for piling and burning between planted trees, however a small percentage of planted trees may be killed in some areas. Monitoring for survival of conifer seedlings through stocking surveys would identify any areas that may need to be replanted.

Site Preparation - As mentioned in Alternative B, site preparation after a fire can sometimes be skipped if planting occurs before shrubs dominate the site. In order to reduce reforestation costs and to increase survival and growth rates of planted seedlings, areas that could be planted without treatment should be planted as soon as possible. Timing of fuels treatments should not interfere with reforestation treatments in most areas. Coordination between the Culturist and Fuels Officer may be necessary for safety (such as when helicopter yarding small fuels) and for efficiency. On slopes generally less than 25%, mastication along with the creation of planting spots may be needed if too much time has passed and excessive shrub growth has occurred. However, if mastication of vegetation becomes necessary, treatment would not exceed 50 to 75% of the area. The creation of planting spots would cover less than 25% of the area, if needed (see Table 2-1).

RCA Inner Buffers, Snag Retention Corridors, 10% Retention Areas, and PACs - Unless determined to be unsafe, tree planting would occur within the no harvest buffers in the RCAs up to the edge of the riparian vegetation. Reforestation follow-up treatments would be more difficult in some areas and the effects less beneficial to the planted trees because of the difficulty of working around large amounts of slash and downed logs. However, the percentage of area that would be affected would be small in comparison to the area where removal of dead trees would occur.

Within no-harvest buffers in RCA inner buffers, snag retention corridors, 10% retention areas, and in PACs, planted trees may have lower survival rates when compared to trees outside of these areas from crushing or damage caused by falling snags.

Indirect Effects

Tree Growth - Within RCAs, where scalping of vegetation during site preparation and grubbing of competing vegetation during release would be restricted to a 2 foot radius, tree survivability may be acceptable (up to 84%), but tree growth and vigor may be low (McDonald and Fiddler 1997). Subsurface water could help to improve growth and vigor in some areas though (Carol Kennedy pers. comm.).

Vegetation Control - An indirect effect of the larger SPLATs is that a larger area would need to be managed more intensively for vegetation control in order to meet fuels objectives (except within the upper SPLAT that would be planted). Release from shrub competition helps to ensure tree survival and encourage growth, thus returning tree cover to SPLATs more quickly. Vegetation control would also reduce the risk of tree mortality in the event of another fire. Ideally, vegetation within SPLATs would be treated while relatively small so that the remaining residue would not create an additional fuels problem. Mastication could be used as an alternative to hand cutting of shrubs outside of the IRA on slopes generally less than 25%. Timing and number of shrub reduction treatments would be funding dependent. After about 30 years within the portions of SPLATs planted more heavily to pine (south and southwest facing slopes and ridge tops), fire would be reintroduced as part of SPLAT maintenance treatments. Some tree mortality would occur, but ponderosa pine should be of sufficient size to withstand low (2 foot) flame lengths without excessive amounts of mortality (FOFEM predicts 25 to 43% mortality in ponderosa pine at 30 years. Mortality of 30-year-old sugar pine could be as high as 51 to 63%). Similar treatments would be applied to the Defense and Threat Zones.

Thinning and Pruning - While thinning and pruning would reduce the risk of stand replacing wildfire in the long term by improving the height to live crown and reducing stand density (Omi and Martinson 2002), thinning may increase the risk in the short term by adding dead material to the ground. If desired, residual fuel accumulations can be lessened by thinning at an earlier age (for example when trees are just starting to show dominance). Depending on location and site-specific conditions, thinning residue would be treated by methods such as lopping of branches and bucking of boles, mastication, chipping, removal, and/or hand piling and burning. Thinning residue should be sufficiently dry before piling to prevent insect infestation, especially in pine-dominated stands. Within SPLATs, thinning may not be necessary because of the lower planting densities, thus reducing the need for fuels treatments (thinning residue) and the associated costs. Pruning within SPLATs would occur over a larger area than in Alternative B. Priority areas for pruning would be adjacent to roads. Branches removed during pruning would be treated by scattering or by one of the methods previously mentioned, depending on site conditions and fuels objectives. Although treatment within SPLATs such as vegetation control, thinning (if needed), and pruning would cover a greater amount of area, thus increasing total costs over that in Alternative B, per acre costs may be reduced because treatment areas would be fewer and less scattered.

Cumulative Effects

Fire history records show that 43 fires occurred within the Red Star Ridge and Duncan Canyon areas between 1941 and 1999. Thirty-five of these fires were determined to be lightning caused.

The cumulative effects of Alternative C would be similar to those of Alternative B except that the SPLAT configuration in Alternative C would theoretically provide more protection to live trees within and outside of the project area, especially in the upper reaches of Duncan Canyon. However, within RCAs where the no-harvest buffer would be increased to 100 feet, increased amounts dead material would lessen the chance that any trees would survive in these areas in the event of another wildfire.

There are no known irreversible effects to vegetation if Alternative C is implemented. The risk of irretrievable effects to tree densities is reduced in this alternative because of decreased resistance to control and the decreased heat intensities expected in the event of a wildfire.

Effects of Alternative D

The effects to vegetation of Alternative D would be similar to Alternative C except as follows:

Direct Effects

Timber Harvest - In addition to all of the changes and associated effects in Alternative C, Alternative D would retain all fire-killed trees greater than 20 inches dbh within the OFEA, excluding the Defense and Threat Zones and SPLATs. Within these fuels emphasis areas, treatments would be the same as in Alternative C. The direct effects to vegetation of leaving all fire-killed trees greater than 20 inches dbh (except as mentioned above) would be that fewer dead trees would be removed to make room for regenerating trees and less funding would be available to support tree planting and follow-up reforestation treatments.

Inventory data collected within the stand-replacing event shows that on the average approximately 19 trees per acre greater than 20 inches would not be removed within the stand-replacing event. In areas predicted to be stand-replacing in the future, approximately 26 fire-killed trees per acre greater than 20 inches dbh would be left. Retaining these fire-killed trees and removing trees less than 20 inches dbh, would result in approximately 9-10,000 board feet per acre of timber removed from within the OFEA.

Hazardous Conditions - With this alternative, reforestation treatments would be more difficult because of the risk of injury to forest workers and Forest Service employees from falling snags. These dead trees would pose a risk to any other members of the public as well. The risk of falling snags to forest workers may preclude planting and follow-up treatments all together in some areas with excessive numbers of dead trees. Additionally, falling snags would severely injure, deform, and/or kill live residual saplings and pole sized trees as well as natural and planted seedlings and saplings.

Indirect Effects

Release - Follow-up release treatments outside of the fuels emphasis areas would be more difficult and time consuming because of the accumulation of dead material on the ground. Also, the increased hazard of falling snags may result in areas not being treated and increased contract time from days not worked because of windy conditions. Depending on snag distribution, in several years some areas could become too dangerous for forest workers to enter. Assuming that most areas could be safely entered, site conditions would result in higher unit costs for reforestation treatments.

Survival and Growth - Because of damage caused by falling snags and the difficulty of conducting follow-up treatments, areas having high numbers of dead trees greater than 20 inches dbh would probably have lower survival rates. Tree growth would also be compromised because of the difficulty involved or the inability to implement reforestation treatments. Lower survival rates, or stocking levels, of planted and natural trees within these areas may result in a more clumpy regeneration pattern across the landscape. As a result, thinning may be unnecessary in these low stocked areas. However, in the long term, lower stocking levels and reduced rates of tree growth would result in less canopy cover and fewer large trees within the OFEA.

Cumulative Effects

Alternative D would provide more opportunities for snag retention in regards to diversity of species, size, and condition of existing and future snags and the recruitment of large downed woody material. However, if another fire were to occur in the project area within the next 30 to 50 years, chances for an escape are greater because of increased resistance to control. If an escape occurred, it is highly likely that most of the living trees would not survive within the Old Forest emphasis area because of high fuel loadings and intense radiant heat. Within fuels emphasis areas, tree survival would be higher, and SPLATs would still be effective in slowing the advancement of flames and isolating and protecting some stands within the Old Forest. If fire does not occur, the length of time to return to an Old Forest condition would be increased with this alternative because of slower tree growth (difficulty in release) and lower tree densities resulting in lower canopy cover. Old Forest conditions would be expected sooner with Alternative D than Alternative A, however.

There are no known irreversible effects to vegetation if Alternative D is implemented.

Alternative D would have an irretrievable loss of tree growth and volume because dead trees and shrubs, rather than live trees, would occupy more area. The effect would be that a longer period of time would be required to return to an Old Forest condition.

Additionally, the risk of irretrievable effects to tree densities is increased in this alternative because of the increased resistance to control and the increased heat intensities expected with another wildfire occurrence.

Effects of Alternative E

The effects of Alternative E would be similar to Alternative C except as follows:

Direct Effects

Timber Harvest - A direct effect of not removing merchantable dead trees within the IRA would be a reduction in the total timber sale volume available to help fund projects such as reforestation and follow-up treatments. Hazard trees would be felled and left along the Western States and Tevis Cup trails. Harvest volume retained within the IRA is estimated to be approximately 17,000 to 18,000 board feet per acre. The IRA occupies about 4,309 acres of which approximately 30% is in areas currently having greater than 75% mortality and 52% is predicted to suffer greater than 75% mortality in the future (Exception Analysis 2002). Harvest volumes removed from outside of the IRA are estimated to be 17-18,000 board feet per acre from about 2,787 acres.

Tree Planting - The direct effects to vegetation within the IRA would be the same as Alternative A, the no action alternative. Outside of the IRA, the direct effects would be the same as Alternative C. Tree planting would occur on approximately 2,276 acres in this alternative.

Indirect Effects

Diversity - The indirect effects to vegetation within the IRA would be similar to Alternative A. Likewise, the indirect effects to vegetation outside of the IRA would be the same as Alternative C. The only difference would be that at the landscape level, the spatial arrangement of the regenerating trees would be more diverse because the IRA would regenerate more slowly. Naturally regenerating stands require a longer period of time to fully occupy sites and growth rates are more varied. However species diversity may be reduced within the IRA without tree planting (see Alternatives A and B).

Cumulative Effects

Cumulative effects for the area outside of the IRA would be similar to Alternative C. The cumulative effects for the IRA would be similar to Alternative A. In summary, outside of the IRA, fuels reduction treatments would provide more protection for live trees in the event of another fire, thus returning the area to an Old Forest condition more quickly than if a fire were to escape within the project area. Within the IRA, where no fuels reduction treatments would be implemented, survival of trees in the event of another wildfire would be minimal because of high fuel loadings, intense radiant heat, and resistance to control.

There are no known irreversible effects to vegetation if Alternative E is implemented.

Alternative E would have an irretrievable loss of tree growth and volume, because dead trees and shrubs, rather than live trees, would occupy more area. The effect would be that a longer period of time would be required to return to an Old Forest condition.

Additionally, the risk of irretrievable effects to tree densities is increased over Alternative C in the IRA because of increased resistance to control and the greater heat intensities expected with another wildfire occurrence.

[1] The Forest Vegetation Simulator (or FVS) is a growth and yield model that simulates stand growth under different silvicultural treatment scenarios over time. Using stand inventory data and user-defined parameters, the model predicts various conditions such as species composition, number of trees per acre, height, dbh, canopy cover, etc.