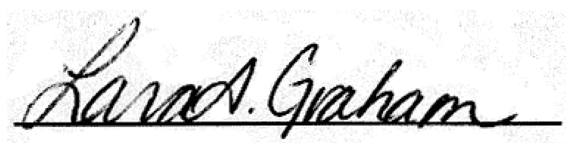
Appendix F: Fire and Fuels Assessment

Specialist Report
Browns Project

Shasta-Trinity National Forest
Trinity River Management Unit

4/27/06

Prepared by: 

I. Introduction

A. Purpose and Need

The purpose and need, regarding Fire and Fuels, is to remove surface and ladder fuels; and treat activity fuels in excess of desired conditions to reduce wildfire behavior and fire severity effects to the ecosystem.

Shasta-Trinity Land and Resource Management Plan (LRMP)

The proposed project area is within the Weaverville/Lewiston Management Area (Area 7) as identified in the LRMP. Management direction identifies the proposal as being within Adaptive Management Area lands as identified in the Northwest Forest Plan, within a Management Prescription III area that emphasizes Roaded Recreation.

Shasta-Trinity Forest-wide Standards and Guidelines:
Remove only biomass material that is in excess of that required to meet the standards for soil quality, wildlife diversity, and natural fire regimes (pg. 4-15 #3).

Matrix Lands-Roaded Recreation:
In Roaded Recreation areas, maintain an average of 10 tons per acre of unburned dead/down material on slopes less than 40 percent. Preference is to have a portion of this tonnage in large material (*i.e.*, 4 to 6 logs over 10 feet long at the largest diameter available). Where feasible, maintain the same amount on slopes over 40 percent (pg 4-65).

B. Issues

There were no identified significant issues regarding Fire and Fuels during the scoping process.

II. Alternatives

See Alternative descriptions in the Browns Project Environmental Impact Statement.

III. Affected Environment

Project Area Description

The Browns analysis area (includes private land) is located in the Klamath Mountains[1] of northern California on the Trinity River Management Unit of the Shasta-Trinity National Forest. It is approximately two air miles north of Weaverville, California, which is listed in the Federal Register

[1] The Klamath Mountains are a complex of mountain ranges that include the Siskiyous, Marble, Trinity, Salmon, Scott and Yolla Bolly Mountains (Frost and Sweeney 2000).

for Communities at Risk from Wildfire (2001). Elevations range from 2,400 to 4,000 feet, and slopes range between 0-60 percent.

Wildland Urban Interface (WUI)

The wildland urban interface is an area where structures and other human developments intermingle with undeveloped wildland (NWCG 1996). Approximately 60 percent (8,144 acres) of the Browns analysis area is within the Weaverville WUI (WUI Map, Appendix A-Fire and Fuels Specialist Report, Browns Project File). Reducing fire hazard within the WUI is a national priority (Cohesive Strategy 2000).

Fire Hazard

Fire hazard reflects fire behavior potential and its magnitude of effects as a function of fuel conditions (USDA 2004). A map (Appendix A-Fire and Fuels Specialist Report, Browns Project File) was created to display this across the analysis area in which 88 percent is considered high fire hazard. This is a concern because current surface fuel loadings are in excess of desired conditions[2], which can result in extreme fire behavior and high fire-severity effects.

Fire Regime

Historical fire regimes in the Browns analysis area, as described by the Cohesive Strategy (2000), are within Groups I and II (Table A). Both groups describe many of the lower elevational zones across the United States, which have been affected by the presence of human intervention; and are the furthest away from historical levels (Cohesive Strategy 2000). These areas are at greatest risk to loss of highly valued resources, commodity interests, and human health and safety (Cohesive Strategy 2000). Conifer stands within the analysis area are classified as I, and brush stands are classified as II.

Table A. The Five Historic Natural Fire Regime Groups (Cohesive Strategy 2000).

Fire Regime Group	Frequency (Fire Return Interval)	Severity
I	0-35 years	Low severity
II	0-35 years	Stand replacement severity
III	35-100+ years	Mixed severity
IV	35-100+ years	Stand replacement severity
V	>200 years	Stand replacement severity

Fire History

In pre-settlement (1626-1849) forests of the Klamath Mountains, biomass ultimately burned by frequent, low to moderate-severity fire. High-severity fires more than a few acres in size were unusual. Dead fuels on the forest floor were kept at low levels, and small understory trees were killed

[2] Desired conditions are discussed under the Fuel Models heading in the Affected Environment section of the Fire and Fuels Specialist report.

and later consumed by fire (Weatherspoon and Skinner 1996). Most of the native species (*e.g.*, ponderosa pine and Douglas-fir) and communities evolved with fire; and therefore, are adapted to its frequent occurrence (Frost and Sweeney 2000).

Native Americans of the Klamath Mountains were dependent on local resources for commodities and shelter; therefore, periodic, planned understory burning was a desired strategy. These forests were frequently burned along ridgetops to maintain travel corridors and openings for food and commodity production (Agee 1993). Lightning was another main cause of fire within this area, and it continues to be today.

Euro-American settlement emerged in 1848, in which fires may have been set; however, there is no written record of this (Taylor and Skinner 2003). A fire suppression policy was introduced in 1905 on the Trinity Reserve, which was established as part of the National Forest Reserve System (Taylor and Skinner 2003). Logging (mostly high-grading) occurred along ridgetops in the 1960's; and clear-cut logging occurred between 1980 and 1990 (Taylor and Skinner 2003). From 1990 to present day, logging has decreased considerably in this area to protect the Spotted Owl and other species. This decrease in logging, in addition to fire exclusion, has allowed natural fuels and biomass to build up to conditions that promote extreme fire behavior (crowning and spotting).

Mining was another disturbance that occurred in the Browns analysis, which is evident by rock tailings and holding ponds. This activity stripped small areas of forest to bare mineral soil, which may have allowed uncharacteristic vegetation (*e.g*., grass and brush) to grow back.

A map was created (Appendix A-Fire and Fuels Specialist Report, Browns Project File) to show fire history (1931-2003) for the Browns analysis area. A mean fire return interval (FRI) was then calculated and compared to the historical mean FRI. This is the arithmetic average of all fire intervals in a given area over a given time, which uses data from multiple fires in the same stand (Agee 1993). This estimate is used to describe how often fires entered a given area. Too much emphasis, however, was not be placed on the statistical difference between past and present fire frequencies since it is probable not all fires were recorded; and there were occasional errors in fire dates and locations. This information in conjunction with stand density, forest health, climate, the Land and Resource Management Plan (LRMP), and the Cohesive Strategy, was used to determine the desired fire regime (low severity).

The historical fire frequency and fire regime is the desired condition for this particular area because it once played a key role in stand development, thus promoting forest health and vigor (LRMP 1994). From a fire suppression and severity effects standpoint, it is also the desired condition because it results in fire behavior conducive to safe suppression and low to moderate[3] tree mortality. The current estimated mean FRI ranges from 17-40 years compared to the historical level determined by Agee (1993) of approximately 11-17 years; and Taylor and Skinner estimated approximately 10 years (Frost and Sweeney 2000).

[3] Fire severity (percent mortality) in this report is described as Low (0-33%); Moderate (34-66%) and High (67-100%).

Weather

Historical weather data is important for assessing current fire behavior. This was used to obtain 90th percentile weather data (Appendix B- Fire and Fuels Specialist Report, Browns Project File), which is associated with large fire events. For the Browns analysis area, a high west wind, low humidity, and high temperature occur approximately ten percent of the time each year (May 1-October 31). This creates extreme fire behavior such as crowning and spotting, which results in high tree mortality rates (67-100%). Large fires burning under these conditions are difficult and sometimes impossible to suppress. One example is the Oregon fire (2001), which resulted in both surface and crown fire, destroyed approximately 25 homes, and resulted in high fire severity effects to vegetation.

Weather was recorded from the Weaverville Remote Automated Weather Station (RAWS). Historical data (ten years) was then extracted from the National Interagency Fire Management Integrated Database (NIFMID) through Kansas City Fire Access Software (KCFAST). This information was used to help determine fire behavior in the Browns analysis area.

Fuels History

In California's Mediterranean climate, decomposition rates are generally low and limited by temperature. Neither historically, nor presently has decomposition been the primary remover of dead fuels in a mixed-conifer forest (Weatherspoon and Skinner 1996). Frequent, low-severity fire plays an important role in regulating fuel accumulations in forested stands of the Klamath Mountains. This type of fire influences vertical and horizontal fuel continuities; as well as, create and maintain canopy gaps that mitigate crown fire spread (Skinner and Chang 1996).

Information of past fuel loadings is limited in the Browns analysis area. Old photographs from the late 1800's and early 1900's of Trinity County were assessed to determine fuel loadings. Either no photographs were found, or fuel loadings were indistinguishable. However, fuel assessments were conducted in the later part of the 20th century and are found in four Forest Service Environmental Assessments (Table B).

Table B. Average fuel loadings within the Browns analysis area from four Forest Service Environmental Assessments.

Environmental Assessment	Date	Tons/Acre
East Weaver	1985	35
Browns	1985	35
Lewiston	1988	21
West Weaver	1992	15

Existing Vegetation

The Browns analysis area is located in a montane forest, with vegetation characterized as mixed conifer-Douglas-fir with a hardwood component (Agee 1993). Dominant conifer species are *Pseudotsuga menziesii var. menziesii* (Douglas-fir), *Pinus ponderosa var. ponderosa* (ponderosa pine), *Pinus lambertiana* (sugar pine), *Calocedrus decurrens* (incense-cedar) and *Pinus sabiniana* (gray pine).

Dominant hardwood species consist of *Quercus garryana* (Oregon white oak), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), and *Quercus chrysolepis* (canyon live oak). Dominant brush species consist of *Arctostaphylus patula* (greenleaf manzanita), *Arctostaphylus viscida* (whiteleaf manzanita), and *Ceanothus* sp. (buck brush).

Stand composition in the Browns analysis area was determined from collected data using a variable plot sampling method (Bell and Dilworth 1988). Plots in China Gulch were sampled in 1999; and plots at Musser Hill and Little Browns creek were sampled in 2003. The total sample area consists of 561 acres, 12 units, and 136 plots. Units were determined for preliminary sampling purposes only, and may not coincide with proposed treatment units discussed in alternatives. Basal area (BA) per acre, trees per acre, and canopy closure were determined by unit (Table C). This information was used for determining percent mortality in conifers; as well as, estimating crown fire potential[4]

Table C. Basal area per acre, trees per acre, and canopy closure for the Browns analysis area.

Unit	Basal Area Per Acre (ft^2)	Trees Per Acre	Canopy Closure (%)
1A	**Brush**		
1B	51	158	44
1C	94	431	80
1D	105	280	50
2A	151	307	73
3A	**Brush**		
3B	221	519	74
3C	240	678	82
3D	192	533	84
3E	**Brush**		
China Gulch 1	245	322	NA
China Gulch 4	248	386	NA

In addition, a weighted average was calculated for basal area per acre (BA), trees per acre, trees per acre between 2-12 inches dbh, and canopy closure (Table D). This was calculated so it could be applied to the entire area, rather than a specific unit. By calculating trees per acre, we determined whether stands were overstocked with ladder fuels and/or crown fuels. The desired amount of trees for this growing site would be approximately 40-70 trees per acre at 16 (minimum) inches dbh and greater. Currently, there are excess trees per acre[5], especially in the 2-12 inch diameter class (ladder

[4] Crown fire potential was not determined using a fire behavior model; however, it was estimated based on trees per acre, size class, weather, fuel models, and past local fire behavior. This is further discussed under the Fire Behavior heading in the Browns Fire and Fuels Specialist Report.
[5] This is based on factors such as site quality and was determined by the unit's silviculturist.

fuels). This is a concern because ladder fuels allow fire to move up into the tree canopy, which causes extreme fire behavior (crowning and spotting) and high tree mortality rates.

Table D. Weighted average BA per acre, trees per acre, trees per acre (2-12 inches dbh), canopy closure for the Browns analysis area.

BA/Acre (ft^2)	Trees/Acre	Trees/Acre (2-12 dbh)	Canopy Closure (%)
185	369	233	73

Existing Fuels

Fuel Loading: The Browns analysis area is comprised of timber stands with varied surface fuel loadings. Surface fuels (*e.g.*, twigs, branches and trees that fall onto the forest floor) create a cris-cross mosaic that stack up over time. Vertical fuels in this area include small diameter trees (2-12 inches dbh) and a small portion of brush.

A random sampling method was conducted utilizing the Photo Series (Maxwell and Ward 1980) to assess fuel loadings in the Browns analysis area. The total sample area consists of 458 acres, 10 units, and 126 plots (ten plots from China Gulch were excluded due to a conflicting sampling method). Data was then entered into the Fuels Management Analyst Plus version 1.2.38 (FMA +) computer software program to calculate average fuel loadings for each unit (Appendix C- Fire and Fuels Specialist Report, Browns Project File). Fuel loadings range from approximately 1-33 tons per acre (Table E). This information was then used to determine fuel models.

Table E. Minimum and maximum fuel distributions by size class and fuel class for the Browns analysis area.

Size Class (inches)	Fuel Class	Minimum (tons/acre)	Maximum (tons/acre)
		Timber	**Timber**
0-.24	1 hr	0.3	1.0
.25-.9	10 hr	1.0	3.2
1-2.9	100 hr	0.4	7.9
3+	1000 hr	0.0	27.1
	Total	**1.70**	**33.20**

Fuel Models: Andersen (1982) classifies forest fuels as grass, brush, timber, and slash. Differences in fire behavior among these groups relate to fuel load and how they are distributed among fuel size. These four classifications are further separated into the 13 fire behavior fuel models (Andersen 1982). They are tools to help estimate fire behavior in the modeling program Behave Plus (version 2.0.2.).

Fuel models within the Browns analysis area were chosen based on sampled fuel loads, a fuel model map (Appendix A- Fire and Fuels Specialist Report, Browns Project File), and knowledge of past fire behavior for this area (Oregon 2001). Since sample plots show a range of fuel loadings, the map was used to help identify the location of various fuel models.

Fuel model 9 (Table F) best represents current expected fire behavior and is found in approximately half of the Browns analysis area, and in more than half of the proposed treatment units. Fuel model 10 (Table F) represents small scattered pockets of heavier surface fuels, which would result in worse case fire behavior. Fuel model 8 (Table F) exists on a substantial portion of the area and represents the desired condition due to its low flame length, rate of spread, and fireline intensity. Fuel model 6 (Table F) represents a small component of brush and plantations scattered throughout the analysis area, and is found adjacent to several proposed treatment units.

Table F. Estimated acres and percentages of fuel models found within the Browns analysis area[6], and proposed treatment units (alternatives 3 and 4 combined).

Fuel Model	Description	Browns Analysis Area[7]		Proposed Treatment Units	
		(acres)	(%)	(acres)	(%)
8	Closed Timber Litter	4707	33	264	33
9	Closed Timber Litter	6167	44	469	59
10	Closed Timber Litter	486	3	39	5
6	Brush	2274	16	0	0

Fire Behavior

A surface fire is one that burns in surface fuels, which include dead and down logs, branches, twigs, cones, needles and leaves. Surface fire outputs, from the fire behavior model-Behave Plus 2.0.2, discussed in the effects analysis are rate of spread, flame length, and fireline intensity. Rate of spread and flame length show how resistant the fire might be to suppression control and containment. Generally, flame lengths greater than four feet high prevent firefighters from accomplishing direct attack, and pose other safety and tactical problems. Fireline intensity is the energy released per unit length of fireline per unit of time (BTU/foot/second), and is related to flame length.

A crown fire burns in the elevated canopy fuels, which include live and dead foliage, branches, twigs, cones, bark, and lichens. Crown fires create special problems for fire managers because they are more difficult to control than surface fires and their rate of spread is several times faster (Scott and Reinhardt 2001). This type of fire creates long-range spotting, high flame lengths, and increased fireline intensity (Scott and Reinhardt 2001).

The effects of crown fire to suppression result in larger firefighter safety zones, a difficulty in defending structures, and greater risk to human life. The effects of crown fire to vegetation are usually total tree mortality, greater smoke emissions, and foliar nutrient loss from the site (Scott and Reinhardt 2001).

Fire behavior within the Browns analysis area was determined using Behave Plus, version 2.0.2. Outputs are based on fuel models and 90^{th} percentile weather data. One limitation of the program is it represents static conditions; assuming weather, topography, and fuels are constant. In addition, it does not predict crown fire behavior; however, this phenomenon is likely to occur under certain weather

[6] Calculations include approximately 3,084 acres of private land within the proposed Browns analysis area.
[7] Alternative 3 (794 acres) was used in determining percentages.

and vegetative conditions. For example, the Oregon fire (2001) is a real time model of what fire in this fuel type can produce under 90th percentile weather. This fire burned through similar fuels and during strong west winds, which resulted in surface and crown fire. The chance for crown fire does exist, which might occur irregularly across the landscape as changes occur in fuels, weather, and topography.

Fire Severity

Fire severity[8] is the degree to which a site has been altered or disrupted by fire; a product of fire intensity and residence time (NWCG 1996). Fire severity is also described as an ecological parameter that loosely shows the effects of fire (Carey and Schumann 2003). Larger fuels (>3-inches) result in a higher energy release over a longer period. This increases fire severity and reduces fireline construction rates (Agee et al. 2000). Fuel treatments such as thinning trees and removing surface fuels can lessen fire severity. Changes to fuels are related to potential fire behavior at any given site and have resulted in reduced severity effects (Finney 2003).

Probability of mortality is the likelihood that a tree will be killed by fire. This is based on bark thickness and percent crown volume scorched. First Order Fire Effects Model (FOFEM, version 5.0) was used to determine percent mortality in Douglas-fir trees. Other tree species exist within the analysis area, such as pine, cedar, and oak; however, the dominant species (Douglas-fir) was used in modeling tree mortality. Inputs to the model were flame length, species, dbh, tree height, trees per acre, and crown ratio. There are several limitations to the model, one of which, FOFEM assumes a continuous fire. Since post-treatment fuels continuity would be discontinuous in proposed units, a wildfire would burn only portions where fuels were concentrated. Predicted mortality rates were then adjusted by multiplying them to the estimated proportion of area burned (Reinhardt 2004), which is approximately 50 percent. This adjustment gives a more accurate mortality rate for conifers after thinning and treating surface fuels.

Another limitation to FOFEM is that it does not consider ladder fuels, which allow fire to move up into the tree canopy, thus burning the crowns of larger trees. Generally, a large tree (e.g., greater than 16 inches in diameter) is more susceptible to fire due to its thick bark and high crown base[9]. However, a fire burning in the canopy usually results in a total loss of foliage, which causes high mortality. Due to this limitation, FOFEM was not used to predict mortality rates for current conditions (Alternative 1- Direct Effects). Instead, mortality expected to occur from Alternative 1 (Browns analysis area) was compared to mortality that resulted from the Oregon fire (2001). This fire burned through similar vegetation, topography, fuels, and weather, in which standing vegetation suffered high mortality (Wideman 2002).

Baseline Conditions

A baseline was established for the comparison of environmental effects in order to assess a possible change in conditions. Its purpose is to act as an anchor point for adding the increment of past, present,

[8] The terms Fire severity and tree mortality are used synonymously in this report.
[9] This further varies by species.

and reasonably foreseeable effects. Several factors were considered before choosing the baseline: the natural, or reference fire regime; fire history; fuels history; climate; and existing conditions. All these factors were previously discussed in this document under their specific headings.

The baseline for assessing cumulative effects is the current condition (2006) because it considers how conditions have changed over time; and how they are likely to change in the future without the proposed action. For example, fire exclusion over the past 70 years has resulted in overstocked stands with high fuel loadings, which can create extreme fire behavior and high severity effects to vegetation. Furthermore, if this condition continues fire behavior is predicted to increase as well as tree mortality rates.

IV. Environmental Consequences

A. Fire Behavior: Direct Effects

Table G. A comparison of alternatives for estimated fire behavior, by fuel model, within the Browns analysis area[10] (14,069 acres) using 90th percentile weather.

Browns Analysis Area Current Condition	Fuel Model	Fuel Structure	Area Affected (acres)	Area Affected (%)	Flame Length (ft)	Rate of Spread (ch/hr)	Fireline Intensity (btu/ft/sec)
	6	Brush	2,274	16	8.3	53.5	563
	8*	Timber	4,707	33	1.6	3.6	16
	9	Timber	6,167	44	4.4	15.7	140
	10	Timber	486	3	8.0	17	528
Alternative 1	No change from existing conditions	No change from existing conditions	13,634	96	No change from existing conditions	No change from existing conditions	No change from existing conditions
Alternative 3	8*	Timber	794	6	1.6	3.6	16
Alternative 4	8*	Timber	568	4	1.6	3.6	16

*Desired condition is described by fuel model 8, which consists of approximately 8-10 tons of dead and down fuels per acre.

Alternative 1 would be no action within the analysis area. The direct effects of fire behavior (flame length, rate of spread, and fireline intensity) would be variable within fuel models 6, 8, 9, and 10 (Table G). Fuel model 8 had the lowest flame length, rate of spread, and fireline intensity. Direct attack by firefighters would be feasible without mechanical and aerial support, such as dozers and air tankers. Fuel model 8 is considered the desired condition because it produces fire behavior conducive to successful suppression and fire fighter safety (exception during drought conditions). Currently, fuel model 8 comprises approximately 33 percent of the analysis area.

[10] The remaining 435 (4%) acres are comprised of grass, water, or are barren, and were not considered in the discussion of direct and indirect effects.

Fuel models 9 and 10 have higher fire behavior outputs (Table G); therefore, mechanical equipment would be needed. Generally, flame lengths greater than four feet produce radiant heat too hot for fire fighters to work near. Indirect fireline must then be constructed a distance from the fire, which increases the amount of acres burned, and reduces rates of fireline construction. Approximately 47 percent of the analysis area would result with this type of fire behavior.

There is potential for passive and active crown fire due to high fuel loadings, ladder fuels, and overstocked tree stands. This fuel structure, in addition to surface fireline intensity provides a way for fire to get into the canopy (RMRS-RN-22-2-WWW 2004). Fuel models 9 and 10 pose the biggest threat of crown fire; however, this can occur in fuel model 8 under drought conditions (Hann and Strohm 2003). The Oregon fire (2001), which threatened the town of Weaverville, is a real time model of what can occur in this fuel model and forest structure. This fire burned through similar fuels and during strong west winds, which resulted in surface and active crown fire.

Fuel Model 6 would produce extreme fire behavior (Table G) in isolated brush patches, and plantations within the analysis area. Control problems from crowning and spotting are frequent in this fuel model. Suppression efforts would be ineffective at the head of the fire due to a high rate of spread; and fireline intensity would be too great for firefighters to work near (NWCG 1998). Indirect attack would need to be used, which increases the amount of acres burned and reduces fireline construction rates.

Alternative 3 would treat more acres than alternative 4, thus changing fire behavior within a greater area (Table G). In addition, more acres of fuel model 10 (approximately 39 acres) would be treated, compared to alternative 4 (approximately 17 acres); therefore having the greatest benefit. This is because fuel model 10 results in extreme fire behavior (spotting and crowning), which creates unsafe conditions for firefighters and the public.

Alternatives 3 and 4 would modify canopy, ladder, and surface fuels by thinning suppressed and intermediate trees, reducing trees per acre, raising crown base heights, and removing surface fuels. The chance for crown fire initiation and spread would be reduced by implementing proposed treatments. Thinnings, combined with surface fuel treatments, have been shown to be effective in reducing crown fire potential because they lower crown bulk densities (i.e., tree crowns), thus decreasing fire intensities (Graham et. al. 1999). One example of successful fuels treatments, which occurred on the Blacks Mountain Experimental Forest, observed that past thinnings had reduced crown fire (Cone fire) to a surface fire (Peterson et. al 2005). Another example, after the Hayman fire in Colorado, stated that on gentle slopes, and during less extreme fire weather, crown fires diminished to surface fires in stands with low stem densities and low surface fuels (Peterson et. al 2005).

Alternatives 3 and 4 would create desired surface fuel conditions of approximately 8-10 tons per acre (Fuel Model 8), which is consistent with the Shasta-Trinity Land and Resource Management Plan (LRMP). In addition, proposed treatments would result with a minimum of approximately 40 trees per acre, and a height to live crown of approximately 25 feet. If a fire occurred under these conditions, the results would be a low rate of spread, flame length, and fireline intensity within proposed units (Table G, Fuel model 8). Fuel treatments can reduce fireline intensities, reduce crown fire potential, and improve suppression capabilities (Peterson et. al 2005; USDA 2004). This provides safer conditions for firefighters, and can increase the effectiveness of fire suppression by slowing fire growth and limiting spotting (Finney 2003).

Alternatives 3 and 4 would implement prescribed fire by burning tractor and roadside piles; burning concentrations; and broadcast burning. This would take place post-harvest operations and before fuels treatments were completed. Burning would be utilized to reduce activity fuels[11] in addition to natural fuels. This would occur during the spring and fall so that fire behavior would be more manageable to firefighters due to wet weather conditions. In addition, this would occur under an approved burn plan[12].

Alternatives 3 and 4 would create smoke from burning vegetation after harvesting operations were completed. Burning would occur on permissible burn days and under an approved smoke permit issued by the North Coast Unified Air Quality Management District (Eureka, California). In addition, smoke management information such as projected tonnage to burn, type of burning, and smoke contingency actions would be documented in a Burn Plan[13]. There would be approximately ten days of burning, in which smoke would be present; and this would occur over an estimated two-month period.

B. Fire Behavior: Indirect Effects

Table H. Estimated fuel model increase in 20-30 years and resulting fire behavior within the Browns analysis area[14] (14,069 acres).

Browns Analysis Area	Fuel Structure	Fuel Model (2005)	Fuel Model (2025)	Area Affected (acres)	Area Affected (%)	Flame Length (ft)	Rate of Spread (ch/hr)	Fireline Intensity (btu/ft/sec)
	Brush	6	6	2274	16	8.3	53.5	563
	Timber	8*	9	4707	33	4.4	15.7	140
	Timber	9	10	6653	47	7.6	15.8	460
	Timber	10						

*Desired condition

The indirect effects of **Alternative 1** on fire behavior are predicted to either stay the same[15] or increase in 20-30 years (Table H). Surface fuel loadings would accumulate in addition to living vegetation, which add to available fuels for future consumption. Research suggests that for this forest type the normal fuel accumulation (excluding areas of disease, insects, and windthrow) is approximately 0.6 tons/acre/year (Skaggs 1996). At this rate, fuel models 8 and 9 would increase to

[11] Fuels generated from harvesting operations.
[12] Refer to the Shasta-Trinity Burn Plan guidelines (version 5) for requirements on safety, smoke, weather, etc.
[13] Refer to the Shasta-Trinity Burn Plan (version 5) format, Appendix D (Smoke Management Plan). A project specific burn plan would be created before implementing prescribed fire, which would be signed by the District Ranger and Forest Supervisor.
[14] The remaining 435 (4%) acres are comprised of grass, water, or are barren, and were not considered in this analysis.
[15] The reason fire behavior would stay the same is because there is no representative fuel model (for natural fuels) to input into Behave Plus, which would reflect what conditions would be like in 20 years. This does not mean that fuel loadings and vegetation would not grow and increase fire behavior.

the next level; however, fuel models 6 and 10 would remain fixed since they are at their highest position within this classification system for natural fuels (13 Fire Behavior Fuel Models)(Table H).

Alternative 1 would allow more than half of the analysis area to result in extreme fire behavior (crowning and spotting) (FM 6 and FM 10), which creates unsafe conditions for firefighters and the public. Indirect attack would need to occur since fireline intensity would be too hot for firefighters to work near. This would increase the amount of acres burned and reduce fireline construction rates, thus making containment more difficult.

The indirect effects of **Alternatives 3 and 4** on surface fire behavior would be an increase within proposed treatment units in approximately 20-30 years (Table H, Fuel Model 9). This is due to natural fuels accumulations; however, these effects are still lower that what would occur from Alternative 1. Despite the increase in surface fire behavior, it is likely that crown fire would remain low since ladder fuels (small diameter trees) would be reduced by proposed treatments. Scientific literature suggests that fuels and vegetative treatments can reduce extreme fire behavior (crowning and spotting) within forested stands (Agee and Skinner 2005; Graham et al. 2004; Martinson and Omi 2003; Graham et al. 1999).

Alternatives 3 and 4 may cause grass, brush, and small diameter trees to grow since more light would reach the forest floor. One theory suggests an open understory would result in an altered microclimate near the ground, resulting in lower fuel moistures and higher wind speeds (Agee et al. 2000; Graham et al. 2004; Martinson and Omi 2003; Graham et al. 1999). This condition can increase the chance of ignition and increase surface fire behavior. However, thinning trees in general can reduce crown fire potential because it lowers crown bulk densities (i.e., tree crowns) (Graham et.al. 1999); and leaves larger trees that have higher base crowns. Therefore, reducing canopy fuels may increase and decrease fire hazard simultaneously (Martinson and Omi 2003). Clearly, there is a tradeoff between a decrease in crown fire potential and increased surface fire behavior.

An increase in surface fire behavior would occur in the two-acre regeneration units, since the overstory would be removed. It is predicted that fire behavior within these small, isolated patches would result from fuel model 6 (Table G), which causes unsafe conditions for firefighters; requires indirect attack; and reduces fireline construction rates. However, this is not expected to effect fire behavior across the landscape; only in regeneration units, which would last for approximately 15-20 years until trees grew tall enough to shade out the understory. Conversely, within thinned stands, it is foreseeable that the remaining co-dominant and dominant trees would shade out the new growth; therefore, this altered microclimate is estimated to last approximately 3-5 years.

C. Fire Severity: Direct Effects

Table I. Probability of mortality by alternative within the Browns analysis area using FOFEM, version 5.0.

Douglas-fir	**Diameter (inches)**	**Mortality**
Alternative 1 (Current conditions)	NA	High

Douglas-fir	Diameter (inches)	Mortality
Alternatives 3, 4 Proposed treatments (2' flame length) (Fuel Model 8) (Adjusted[16])	16	6%
	18	5%
	20	4%
	22	3%
	24	3%

Trees 2-14 inches in diameter were not modeled in FOFEM for alternatives 3 and 4 because they would be removed through proposed treatments. Low- 0-33%, Moderate- 34-66%, High- 67-100

Alternative 1 would result in high mortality rates. The First Order Fire Effects Model (FOFEM) was not used to predict mortality for this alternative because fire professionals on the Forest (Shasta-Trinity) determined that the model did not accurately predict tree mortality in the larger trees (16 inches-diameter and greater). This is because it does not consider ladder fuels, such as brush and small diameter trees, which allows fire to move up into the crowns of larger trees, thus causing higher mortality. An example of this is from the Oregon fire (2001), which occurred approximately five miles from the proposed project area. This fire burned through similar vegetation, topography, fuels, and weather, in which standing vegetation suffered high mortality (Wideman 2002).

Alternatives 3 and 4 would result in low tree mortality rates for trees 16 inches-diameter and greater (Table I). FOFEM was used to predict mortality because fire professionals on the Forest (Shasta-Trinity) determined that the model resulted in reliable outputs. Both alternatives would thin out suppressed and intermediate trees (2-14 inches); therefore, leaving larger trees (16-40 inches dbh) that can better tolerate fire. In addition, if a fire were to move through the stand after proposed treatments, there would be no ladder fuels allowing fire to burn the crowns of larger trees. The difference is **Alternative 3** would treat more acres than **Alternative 4**, thus reducing tree mortality rates over a greater area. Surface fuel management can limit fireline intensity and lower potential fire severity effects (tree mortality) (Agee et.al. 2000).

D. Fire Severity: Indirect Effects

The indirect effects from **Alternative 1** on tree mortality rates are predicted to range from low to high in approximately 20-30 years (Table J). However, only trees 24 inches in diameter and greater fell into the low category, therefore, the majority of trees would suffer moderate to high mortality. This is because natural fuel accumulations would add to the current fuel model approximately 12 tons per acre by the end of 20 years. Consequently, this raises fireline intensity, which increases mortality rates. In addition, fuel ladders would allow fire to move up into tree crowns, thus causing high mortality. Scorch heights would reach higher up the trunk damaging tree crowns, and fireline intensity would be greater at the boles damaging the cambium layer. This is shown in Table J by

[16] One limitation to the FOFEM model is that is assumes a continuous fire. Since post-treatment fuels continuity would be discontinuous, wildfire would only burn in concentrated areas. Mortality rates predicted by FOFEM were then adjusted by multiplying them to the estimated proportion of area burned (Reinhardt 2004), which is approximately 50 percent.

increasing the fuel model to ten and the flame length to eight feet. FOFEM was used to predict mortality because fire professionals on the Forest determined that the model resulted in reliable outputs.

Table J. Mortality rates, by alternative, for Douglas-fir within the Browns analysis area in 20 to 30 years using FOFEM, version 5.0.

Douglas-fir	Diameter (inches)	Mortality (percent)
Alternative 1 (20-30 years) (8' flame length) (Fuel Model 10)	2	100
	4	100
	6	100
	8	99
	10	99
	12	98
	14	96
	16	96
	18	93
	20	84
	22	61
	24	33
Alternatives 3, 4 (20-30 years) (5' flame length) (Fuel Model 9)	2	100
	4	100
	6	81
	8	40
	10	39
	12	20
	14	15
	16	11
	18	9
	20	7
	22	6
	24	5

Low- 0-33%, Moderate- 34-66%, High- 67-100%

The indirect effects from **Alternatives 3 and 4** would be low to high mortality rates[17] in 20 to 30 years (Table J). Surface fuel loadings would increase (from post-treatment loadings) by approximately 12 tons per acre. Table J reflects this increase by raising flame length to five feet. However, unlike alternative 1, the majority of trees would fall into the low to moderate category, therefore allowing more trees to survive a wildfire. Surface fuel management can limit fireline

[17] FOFEM was used to predict mortality because fire professionals on the Forest determined that the model resulted in reliable outputs.

intensity and lower potential fire severity[18] (tree mortality). Larger, more fire tolerant trees (16-inches and greater) would dominate the stand and few small trees would grow in the understory, excluding areas of disturbances, because co-dominate and dominate trees would shade out new vegetation. The difference between alternatives is the amount of acres effected-**Alternative 3** would treat approximately 791 acres and **Alternative 4** would treat approximately 568 acres In addition, if a wildfire were to move through the stand 20 to 30 years after proposed treatments, there would be fewer small diameter trees allowing wildfire to burn the crowns of larger trees. Changes in fire behavior from fuel treatments can increase the survivability and resilience of low-elevation forests (Finney 2003).

E. Summary: Direct and Indirect Effects

Alternative 1 provides no action in the Browns analysis area. The current fuel profile and vegetative structure would sustain a surface and crown fire if it were to occur during 90th percentile weather. Flame lengths would be greater than four feet high- a condition that hinders fire fighters from safely suppressing wildfire. As a result, fire induced mortality to conifers would be moderate to high. In addition, fire behavior and mortality rates are predicted to increase in approximately 20 to 30 years.

Alternative 1 would decrease fire fighter and public safety since approximately 63 percent of the Browns analysis area would result in a high flame length, rapid rate of spread, fireline intensity, and crown fire. Suppression tactics would require indirect attack; thus increasing the total area burned, and reducing fireline construction rates. In 20 to 30 years, this condition is predicted to increase, as well as effect more area.

Alternatives 3 and 4 would reduce surface fuels and standing vegetation to desired conditions. However, **Alternative 3** would treat approximately 226 acres more than alternative 4. If a fire occurred under 90th percentile weather conditions, flame length, rate of spread, and fireline intensity would be low; thus increasing firefighter safety and increasing fireline construction rates. However, after 20 years has passed fire behavior is expected to increase.

Alternatives 3 and 4 would result in low tree mortality rates since the remaining trees would be larger, more fire tolerant, in addition to less trees per acre. The difference being, **alternative 3** would have low mortality rates over a greater area than alternative 4. These rates are predicted to have a slight (does not move rates into a higher category) increase in 20 years, at which time the majority of trees would still fall into the low category.

Alternatives 3 and 4 would cause brush and grass to grow in the understory of regeneration units, which would increase the chance of fire ignition and surface fire behavior. Fire behavior would be comparable to fuel model 6, which creates unsafe conditions for firefighters and the public; requires indirect attack; increases the amount of acres burned; and reduces fireline construction rates. This condition could last for approximately 15-20 years; however, it is not expected to effect fire

[18] Agee, James K.; Bahro, Berni; Finney, Mark A.; Omi, Philip N.; Sapsis, David B.; Skinner, Carl N.; van Wagtendonk, Jan W.; Weatherspoon, Phillip C. 2000. *The use of fuelbreaks in landscape fire management.* Forest Ecology and Management 127 (2000) 55-66.

behavior across the landscape. Thinned stands would also experience an increase in surface fire behavior; however, it would last for a shorter duration (3-5 years). However, the tradeoff between increased surface fire behavior, and reduced crown fire potential is reasonable.

Alternative 3 would treat more acres of fuel model 10 (approximately 39 acres) compared to alternative 4 (approximately 17 acres); therefore having the greatest benefit since fuel model 10 produces extreme fire behavior, which creates unsafe conditions for firefighters and the public; requires indirect attack; increases the amount of acres burned; reduces fireline construction rates; and results in high fire severity effects to vegetation.

F. Cumulative Effects

This fire and fuels analysis has been completed in accordance with the CEQ memorandum of June 24, 2005, regarding “guidance on the consideration of past actions in cumulative effects analysis.” In addition, this analysis incorporates guidance identified in the R5 white paper titled “Analysis of Cumulative Effects in NEPA” dated 8/4/2005.

1. Effects Analysis

To analyze cumulative effect(s) on fire and fuels, the unit of measure used to quantify the effect(s) is the amount of acres resulting with a change in fire behavior and tree mortality. This is an appropriate unit of measure because it shows how much of the landscape would be effected. One theory suggests that more than 20 to 30 percent of the landscape must be changed from a fast spread rate to a slow spread rate before it can be substantially reduced (Finney 2003). The direct and indirect effects of implementing the alternatives considered have been disclosed in the previous section of this report. This cumulative effects analysis quantifies the output effect(s) as a sum of the direct and indirect impacts of the alternatives considered; in addition to past, present, and foreseeable future actions (which are independent of the alternatives considered).

2. Bounding the Effects

Geographic Boundary

The geographic area considered for the cumulative effects analysis is based on topographic features, and is shown on a map in Appendix D (Fire and Fuels Specialist Report, Browns Project File). This was chosen because topography is a major factor in fire behavior; and is commonly used when managing wild and prescribed fires for this fire regime (Taylor and Skinner 2003). These areas are effective barriers to fire spread due to factors such as high humidity, lack of vegetation, and gentle slopes.

The proposed project would create an additive effect to past, present, and future actions. From a fire and fuels standpoint, these effects are positive because the more acres with vegetation and surface fuels treatments, the greater a reduction in overall fire behavior and fire severity effects across the landscape.

Time Bounding

The period used to analyze cumulative effects on fire behavior is approximately 20-30 years in timber stands and ten to 20 years in brush fields. It is estimated to take this long for vegetation to grow back; and for surface fuel loadings to somewhat resemble that of its current degraded condition. Although the proposed project would not occur in brush fields, these were used to calculate total area with desired conditions (Table L) because they result in the same fire behavior effects as would proposed treatments.

Baseline

A baseline was established for the comparison of environmental effects in order to assess a possible change in conditions. Its purpose is to act as an anchor point for adding the increment of past, present, reasonably foreseeable and proposed project effects. Further discussion of baseline determination is located in the Fire and Fuels Specialist Report under the Affected Environment section. The baseline for assessing cumulative effects is the current condition (2005) because it considers how conditions have changed over time; and how they are likely to change in the future with or without proposed actions. The current condition was compared with the estimated effects from proposed projects, in addition to past and foreseeable actions, to see if there is a benefit to fire behavior and fire severity.

Table K. A summary of management actions considered in the evaluation of cumulative effects for the proposed Browns project.

Geography	Acres	Past Projects	Present Projects	Foreseeable Projects
Fire and Fuels	6,276	**Fuels Projects:** Musser Hill FMZ- 554 ac. 2004 Musser Hill- 117 ac. 2005 China Gulch FMZ- 10 ac. 2001 Browns Roadside FMZ- 178 ac. 2004 **Timber:** Pre-commercial Thinning- 55 ac. 2004	**Proposed Project:** Alternative 1- 0 ac. Alternative 3- 793 ac. Alternative 4- 568 ac.	**Fuels Projects:** Bear FMZ- 136 ac. 2006 Finley FMZ- 62 ac. 2006 Lil. Browns FMZ- 151 ac. 2006 Musser Wildlife Burn-282 ac. 2006 Croften Wildlife Burn- 78 ac. 2006 Bear and Rush Shaded Fuel Break (RCD)- 18 ac. 2006 Plantation Prune-80 ac. 2007 **Timber:** USFS Pre-commercial Thin- 69 ac. 2007

The above table is a subset of the Cumulative Effects Table 4.9 (Browns EIS) and is bounded by a smaller area, therefore acres shown here will be different.

Reasons for projects not considered in this analysis are listed in Appendix D of the Browns Fire and Fuels Specialist Report (Browns Project File).

3. Projects Considered

Table L. Summary of proposed acres treated, from alternatives and other management actions, which benefit fire behavior[19] and fire severity (tree mortality) within the Browns cumulative effects analysis area.

Past Actions (acres)	Present Actions (acres)	Future Actions (acres)	Sum of Effects lasting 10-20 years (acres)	Total Area with Desired Conditions (6,276 acres)	Sum of Effects lasting 20-30 years (acres)	Total Area with Desired Conditions (6,276 acres)
Fuels - 859 USFS Timber- 55	Alternative 1 0	Fuels- 807 USFS Timber - 69	1790	29%	1313	21%
Fuels - 859 USFS Timber- 55	Alternative 3 793	Fuels- 807 USFS Timber - 69	2583	41%	2106	33%
Fuels - 859 USFS Timber- 55	Alternative 4 568	Fuels- 807 USFS Timber - 69	2358	38%	1881	30%

Musser Hill, Musser Hill Wildlife Burn, and Croften Wildlife Burn acres were taken out of the sum of effects within the 20-30 year time period calculation since these areas contain at least 75% brush. Fuel treatments in these areas would not last as long as treatments which occur in timber stands.

Alternative 1 would result in no change from existing conditions. Currently, past and foreseeable projects make up approximately 29 percent (includes brush stands) of the cumulative effects analysis area (Table L); and 21 percent in timber stands. This alone is a reduction in fire behavior across the landscape because more than 20 percent has been treated. Finney (2003) states that more than 20-30 percent of the landscape must be changed from a fast spreading fuel type to one with a slower spread rate before fire growth can be substantially reduced. This would allow firefighters to safely suppress fire in past and future treatment areas, such as wildlife burns, fuel management zones (FMZ's), and mastication units.

The effectiveness of past and foreseeable treatments would last approximately ten to 20 years (includes all projects); and 20-30 years in timber stands (excludes brush treatments). Generally, brush grows faster than trees; therefore, fuel treatment efficacy is for a shorter duration. This is reflected in Table L -Sum of Effects (20-30 years) column, by taking out treatment acres in brush stands.

Alternative 1 would increase tree mortality rates in 20 to 30 years. Since many untreated stands are currently overstocked with small diameter trees, high severity effects would occur (Table J). However, past and foreseeable treatment areas would result in low mortality rates, which comprise approximately 21 percent of the cumulative effects analysis area (Table L).

Alternative 1 would treat no acres near private industrial timberland (SPI). This alternative would have a negative effect to private land because there would be no buffer from wildfire impacts, and no place for firefighters to work safely.

The cumulative effects of **Alternatives 3 and 4** would decrease fire behavior and fire severity across a greater area (compared to Alternative 1). Furthermore, proposed units would be more strategically located within the middle of past and foreseeable fuels reduction projects. This is

[19] Beneficial effects to fire behavior and tree mortality result from fuel model 8, which is the desired condition for fire suppression and fire severity effects to vegetation. In addition, it reflects the desired fuel loadings stated in the LRMP pg. 4-65.

important because Finney (2003) states random patterns of fuels treatments are unlikely to affect the overall growth rate or size of a fire until large areas of the landscape are treated.

Both alternatives would create more protection across the landscape by increasing the amount of acres treated; and consequently become strategically located. For **Alternative 3**, this would occur over approximately 41 percent of the landscape, and **Alternative 4**-approximately 38 percent for an estimated 10-20 years (Table L). At the end of this time, the amount of area resulting with desired conditions would begin to decline (Table L, 20-30 years column).

Alternatives 3 and 4 would produce smoke, which adds to the smoke likely to occur from private landowners within the Weaver Basin (the valley in which the town of Weaverville is located). This is foreseeable, since burning is a common practice in Trinity County. However, it is unknown as to when or how much landowners will burn. Smoke from the proposed project is expected to remain in the area for about one to two days each time burning occurs. There would be approximately ten days of burning over an estimated two-month period. Permissive burn days are determined by the North Coast Unified Air Quality Management District (Eureka, California); therefore, smoke emissions from proposed burning would not exceed acceptable levels[20].

Other benefits from implementing Alternatives 3 and 4:

- **Alternative 3** would result in desired fire behavior (Table G, fuel model 8) and severity effects (Table I) on approximately 296 acres in the Blue Rock and China Gulch area (combined) that border private industrial timber land; where as, Alternative 4- approximately 13 acres. This would provide safe conditions for suppression, and would allow more trees to survive a wildfire. In addition, this would create a buffer from wildfire impacts to Forest Service land if a fire were to spread from private land.
- **Alternatives 3 and 4** would either border or be adjacent to future and existing fuel management zones (FMZ). FMZ's would benefit both alternatives by slowing or possibly stopping fire growth before it entered proposed treatment units. Future and existing FMZ's would be more strategically located within the Browns cumulative effects analysis area. They are intended to reinforce a defensible location, such as a ridgetops or roads, to facilitate suppression action through indirect attack (Finney 2001). In addition, a successful FMZ would change the fire behavior as it entered the fuel-altered zone thus promoting safer conditions (Agee, *et. al.* 2000). The difference between alternatives is that **Alternative 3** would lye adjacent to the China Gulch FMZ; where as, alternative 4 would not.
- Both **Alternatives 3 and 4** would lower fire behavior and fire severity effects in proposed units that are adjacent to approximately 105 acres of plantations; therefore allowing firefighters to slow or stop a fire before it entered, and provide a safe place for them to work.

4. Conclusion of Cumulative Effects on Fire and Fuels

The sum effects of **Alternative 1** would be no change in fire behavior and severity effects, across the landscape from current conditions. Currently, past and foreseeable projects make up approximately

[20] Acceptable levels (given by the North Coast Unified Air Quality Management District) fluctuate day to day, which is determined by atmospheric conditions, and local complaints (Green 2006).

29 percent of the analysis area, in which fire fighters could safely suppress a wildfire; as well as, resulting in low fire severity effects. This would last approximately ten to 20 years, after which the amount of area would decline to 21 percent.

The sum effects of **Alternative 3** would be a reduction (from current conditions) in fire behavior and severity across 41 percent of the landscape for ten to 20 years. After this time, the total area affected would be reduced to 34 percent. The resulting desired condition would create a safe environment for firefighters to work in; as well as, reduce tree mortality rates so that more trees would survive a wildfire. Proposed actions would border or lye adjacent to past and foreseeable fuels reduction projects; which collectively, provide strategic locations for firefighters to slow or possibly stop fire spread. In addition, this alternative would treat more acres than alternative 4 that are adjacent to homes and private-industrial timberland (SPI); therefore, providing a buffer from wildfire affects to both private and federal land.

The sum effects of **Alternative 4** would be a reduction (from current conditions) in fire behavior and severity across 39 percent of the landscape for ten to 20 years. After this time, the total area affected would be reduced to 30 percent. The resulting desired condition would create a safe environment for firefighters to work in; as well as, reduce tree mortality rates. This alternative would treat fewer acres adjacent to homes and private, industrial timberland (SPI) than alternative 3; therefore, it does not provide as much of a buffer from wildfire impacts to both private and federal land. In addition, alternative 4 would tie into a smaller portion (than alternative 3) of FMZ's. This results in fewer opportunities for firefighters to slow or stop a wildfire because FMZs and proposed units, collectively, provide more area that is defensible.

V. Other Individuals Consulted

Lindsay Large, Trinity River Management Unit - Timber Marking Crew Leader
Michael Rubenstein, Timber Prep. Officer
Mike Archibald, Trinity River Management Unit - GIS planner
Steve Graves, Trinity River Management Unit - Fuels officer
Sam Frink, Silviculturist and Inter-disciplinary Team Leader
Julie Titus, Forest Fuels Officer
Ralph Phipps, Shasta-Trinity Forest Environmental Coordinator
Joe Millar, Shasta-Trinity Forest Fire Management Officer
George Chapman, Trinity River Management Unit - Fire Management Officer

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VII. Appendices – Available in Project File

Appendix G: Browns Project Hydrologist Report

March 14, 2006

James Fitzgerald Digitally signed by James Fitzgerald
DN: CN = James Fitzgerald, C = US, O = USDA Forest Service, OU = Shasta Trinity National Forest
Date: 2006.03.27 06:05:32 -08'00'

/s/ Jim Fitzgerald
Trinity Zone Hydrologist

Summary

This analysis shows that neither Alternative 3 nor 4 of the Browns Project will further degrade the long-term water quantity or quality of Rush, Little Browns, East Weaver Creeks, and the upper-middle Trinity River. This analysis recognizes that the surface water quality and beneficial uses within and downstream of the project area are presently degraded by excess sediment and hydrologic alteration. Field inventory and project analysis focused on reducing the risk of direct, indirect, and cumulative impacts from sediment. All three alternatives were analyzed to quantify their short and long term effect on the magnitude, frequency, timing, and duration of peak flood flows, mass wasting, surface, and fluvial erosion. The Equivalent Roaded Area model was used to estimate the probability of negative cumulative watershed effects. The results indicate that negative water quality impacts from excess sediment delivery are possible in Little Browns Creek. Hence, a sediment budget was developed and the results were compared to Trinity River TMDL sediment targets to quantify the risk of further degrading water quality. Results indicate that the short and long-term sediment increases from the Browns Project are unlikely to further degrade local and regional water quality. Browns Project and other foreseeable actions will likely increase the short-term chronic and acute sediment yield of Little Browns Creek 20 and 42 percent, respectively. However, within 10 to 20 years after project implementation, the sediment yield will likely decrease to the 2005 amount.

Project Name

Browns Project

Downstream Watersheds

Streams draining the project area are within the Upper-Middle Trinity River basin and directly contribute water and sediment to Rush, Little Browns, and East Weaver Creeks.

Beneficial Uses and Water Quality Objectives Within and Downstream of Project Area

The designated beneficial uses for the Trinity River and tributaries within the project area are established in the Water Quality Control Plan for the North Coast Region and are listed below (NCRWQCB, 2001):

- municipal and domestic supply (MUN);
- agricultural supply (AGR);
- groundwater recharge (GWR);
- freshwater replenishment (FRSH);
- hydropower Generation (POW);

- water contact recreation 1 and 2 (REC-1 and REC-2);
- commercial and sport fishing (COMM);
- cold freshwater habitat (COLD);
- wildlife habitat (WILD);
- migration of aquatic organisms (MIGR); and
- spawning, reproduction, and/or early development (SPWN).

The following is a list of the applicable water quality objectives that apply to the tributaries draining the Browns Project area:

- general objective (anti-degradation);
- suspended material;
- settleable material;
- oil and grease;
- sediment;
- turbidity;
- pH;
- temperature;
- toxicity; and
- chemical constituents.

These pollutants cannot be above a level that adversely effect human, plant, animal, or aquatic life (NCRWQCB, 2001). As a Water Quality Management Agency the Forest Service must demonstrate that the proposed management activities will not further degrade local and regional water quality (USDA Forest Service, 2000). For the Shasta Trinity National Forest, sediment and turbidity are the most common water quality concerns.

In 1992, the Trinity River and the watersheds draining the Browns Project area were listed as water quality impaired due to sediment under the Clean Water Act Section 303(d) (NCRWQCB, 2001). A water quality management plan or Total Maximum Daily Load (TMDL) was developed and approved by the EPA (2001) to reduce the amount of sediment in the Trinity River. The TMDL used existing data and reports to determine which subwatersheds nested within the Trinity River watershed are producing excess sediment (e.g., De la Fuente, et al., 2000 and GMA, 2001). The TMDL sets sediment load allocations, by subwatershed, that specify the amount of sediment reduction needed to meet the water quality objectives.

EPA (2001) concludes that the limiting factor to beneficial uses is excess sediment transported and/or deposited in the Trinity River. The California State water quality objectives for sediment are listed in Table 1. Fine and coarse sediment are considered negative to the designated beneficial uses to include: spawning gravel quality and permeability; pool depth and frequency, and other geomorphic indicators (e.g., channel stability).

Table 1. Sediment water quality objectives applicable to the Browns Project.

Parameter	Water Quality Objective
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of Material that causes nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface water shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution with which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.

The TMDL sediment source analysis shows that the majority of the management related sediment sources result from roads, legacy mining, and timber harvest (GMA, 2001). The Weaver-Rush watersheds were analyzed as a subset of the TMDL analysis area. According to the TMDL, fine and coarse sediment sourced from these watersheds needs to be reduced 42 percent to meet water quality objectives (EPA, 2001). The TMDL targets eliminating controllable sediment discharge sources which are sites or locations, both existing and those created by proposed land use activities, within the project area that meet the all of the following conditions (NCRWQCB, 2001):

- is discharging or has the potential to discharge sediment to waters of the state in violation of water quality requirements;
- was caused or affected by human activity; and
- may feasibly and reasonably respond to prevention and minimization management measures (i.e., Best Management Practices).

CWE Analysis Watershed Condition Class and CWE Risk Matrix: The Cumulative Watershed Effects (CWE) process is used to demonstrate that the Browns Project will not degrade local and regional water quality. CWE result from the combination of changes in surface and mass failure erosion rates, instream sedimentation rates, and peak streamflows within watersheds in response to management activities (Haskins, 1983). The Federal Register defines a cumulative effect as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency or person undertakes such other action (40 CFR 1508.7).

The Forest Plan LMP established Threshold of Concern (TOC) for 5th Field Hydrologic Unit Code (HUC) subwatersheds and defines Watershed Condition Class (WCC) (USDA Forest Service, 1994). The WCC are defined as follows:

- Watershed Condition Class I: ERA less than 40 percent TOC;
- Watershed Condition Class II: ERA between 40 and 80 percent TOC; and
- Watershed Condition Class III: ERA greater than 80 percent TOC.

Table 2. CWE analysis risk matrix.

Rating	Magnitude	Geographic Extend	Duration and Frequency
1	**Indicator:** Watershed Condition Class I **Effect:** not measurable	Negligible Effects	Negligible Effects
2	**Indicator:** Watershed Condition Class I or II, or 1-15% sediment increase over background **Effect:** Small sediment increase; no impact to fish or water quality	Impacts are minor locally and result in minimal offsite impacts	Short-term, one-time effect
3	**Indicator** Watershed Condition Class II or III, or 15-30% increase of sediment over background **Effect:** Moderate increase in sediment – minor stress on fish and minor increase in turbidity	Impacts are moderate immediately offsite but do not translate to watershed scale impacts	Moderate; intermittent effect
4	**Indicator:** Watershed Condition Class III, or 30-50% sediment increase over background **Effect:** Substantial increase in sediment; major stress on fish and large increase in turbidity	Impacts are large immediately offsite but do not translate to watershed scale impacts	Long-term, Intermittent effect
5	**Indicator:** ERA exceeds TOC, Or >50% sediment increase over background **Effect:** Significant increase in sediment; Fish mortality and degraded water quality	Impacts are large on a watershed scale and likely have direct impacts on beneficial uses; fish mortality and degraded water quality	Long term; chronic

The following summarizes the FSM 2521.1 - Watershed Condition Classes. The CWE analysis process is used to evaluate watershed condition and assign one of the following three classes.

1. **Class I Condition**. Watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. The drainage network is generally stable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are predominantly functional in terms of supporting beneficial uses.
2. **Class II Condition**. Watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Portions of the watershed may exhibit an unstable drainage network. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are at risk in being able to support beneficial uses.
3. **Class III Condition**. Watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. A majority of the drainage network may be unstable. Physical, chemical, and biologic conditions suggest that soil, riparian, and aquatic systems do not support beneficial uses.

To interpret the CWE analysis results, the Condition Classes are defined in terms of thresholds established by the Forest Plan (USDA Forest Service, 1994), the Trinity River TMDL sediment targets (EPA, 2001), and the Endangered Species Act. Table 2 summarizes the five classes of CWE risk in terms of Watershed Condition Class and sediment yield increase over background. The sediment yield over background is calculated using the following equation:

$(Q_t – Q_b)/Q_b$

Q_t = total sediment delivery per flood event
Q_b = background sediment delivery per flood event

CWE Analysis Limiting Factor Analysis: A Limiting Factor Analysis identifies those factors most critical to beneficial uses and water quality. Increased peak flood flow and fine and coarse sediment yield, and their associated impacts on the fisheries and fisheries habitat of Rush, Little Browns, Weaver, and the Trinity River, are the identified limiting water quality factors.

Within the context of the limiting factors, the equivalent roaded area (ERA) model and sediment budget analysis (Haskins, 1983, Reid, 1998, and Reid and Dunne, 1996) are used to evaluate how this project could affect the relationship between rainfall runoff, sediment delivery, sediment yield, and channel stability. This analysis evaluates the impacts of wildland and prescribed fire, timber harvest, plantation management, and roads on the frequency, timing, magnitude, geographic extent, and duration of peak flood flows, and fine and coarse sediment delivery and yield.

This analysis considers the direct effects on individual watersheds within the assessment area as well as indirect effects on the Upper-Middle Trinity River. It also attempts to account for the spatial and temporal variability of climate, land disturbance, runoff processes, and sediment yield. Some of the disturbance causing variables of this system cannot be forecast with any certainty to predict the effects on the impacted variables. Therefore, a risk analysis is used to predict the past, present, and future condition and is used to develop mitigation measures and monitoring requirements.

Browns Project CWE Analysis Overview

The Shasta-Trinity CWE analysis process is used to characterize and quantify the current and potential condition of water quality and quantity for the Browns Project. This CWE analysis compares the Forest Plan Threshold of Concern (TOC) and Watershed Condition Class to the existing Equivalent Roaded Area (ERA). For areas with a high risk of negative cumulative watershed effects, a sediment budget was developed to further analyze the potential impacts from this project. Watersheds that are identified as at risk are analyzed to determine which actions need to be taken to maintain or improve watershed condition.

Geographic Boundary: The Browns Project analysis area includes four 7^{th} Field HUC watersheds (Table 3 and Plate 1). Within the 7^{th} Field HUC watersheds are 11 - 8^{th} Field HUC watersheds. The topographic boundaries defining a given watershed are used to geographically bound the analysis area because land disturbances within a given watershed directly and indirectly impact downstream water quantity and quality. Upland disturbances that change the magnitude, frequency, timing, and duration of rainfall, runoff, and sediment delivery strictly follow watershed boundaries.

Table 3. List of 7th Field HUC watersheds and activities considered for the Browns Project Cumulative Watershed Effects Analysis.

7th Field HUC	7th Field HUC Watershed Name	Drainage Area (acres)	Activities Analyzed
18010211060101 & 02	Rush Creek	14388	mining, roads, and timber
18010211060401	E Weaver Creek	8892	mining, roads, timber, and urban
18010211060403	L Browns Creek	4989	mining, roads, timber, and urban

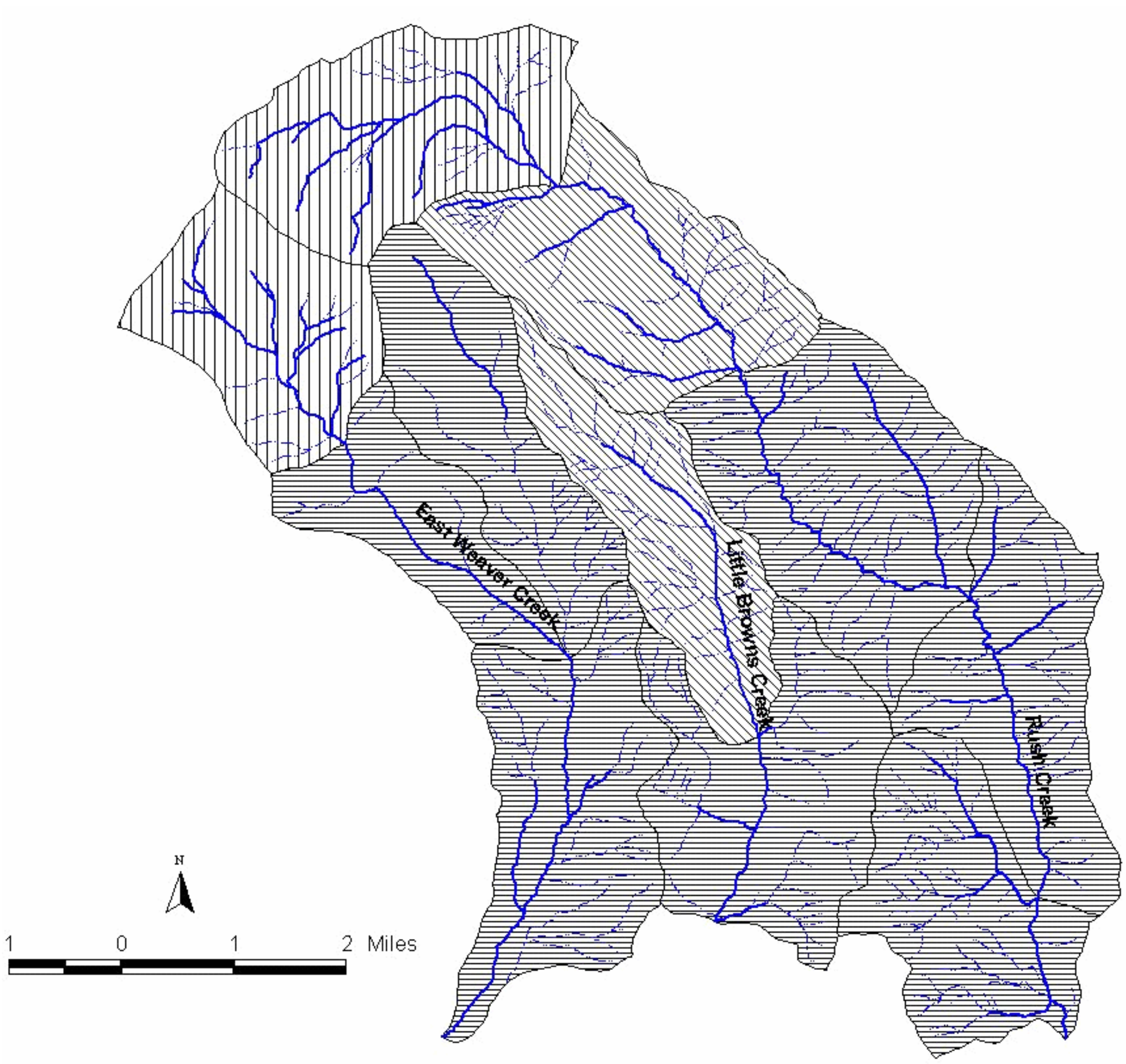

Plate 1. Map illustrating the Browns Project area 7th and 8th Field HUC watersheds and the existing Watershed Condition Class. Vertical lines = WCC I, diagonal lines = WCC II, and horizontal lines = WCC III.

This analysis evaluates the potential direct and indirect effects of each individual activity on Rush, Little Browns, and East Weaver Creeks (Table 3) and assumes that activities near perennial fish bearing streams have a greater risk of risk directly impacting water quality. For example, a timber sale unit adjacent to Little Browns Creek has the greatest risk of controllable sediment discharge. Activities that impact upslope intermittent, ephemeral, and unstable areas have the greatest risk of indirectly impacting water quantity and quality. For example, a timber sale unit within an active landslide has the greatest risk of indirectly impacting downstream water quality.

Time Frame: This CWE analysis compiled a land use history to quantify the past and present impacts. For this project, placer and strip mining impacts that occurred before 1940 are presently directly and indirectly impacting stream channel stability. In addition, the existing roads, urban, and timber harvest activities are directly impacting the analysis area.

The timeframe of the proposed action potential impacts depends on the recovery period of a given activity. The longest lasting impacts are from road construction and use and do not recover with time unless specific measures are taken to reduce runoff and controllable sediment discharge. Improvements to road stability reduce the additive and compound impacts, but recovery is very slow. Most direct disturbances caused by timber harvest recover within 10 to 30 years depending on the type of activity. Fuels treatments and fire suppression actions tend to recover in five to 10 years. Watershed restoration activities tend to recover in one to three years.

This analysis assumes that it will take three years to complete timber harvest activities, whereas fuel treatments and watershed restoration activities will take up to 10 years to complete. This analysis uses Best Management Practices and mitigation measures to prevent the direct, indirect, and cumulative effects of short and long-term land use activities associated with this and other connected Forest Service projects. Treatments like soil ripping and road decommissioning will help prevent direct and indirect impacts caused by road construction and timber harvest for about 20 years following project implementation.

The timeframe of impacts caused by foreseeable actions is 20 years after project implementation. It is difficult to predict what activities will occur on private land, however, road and timber activities are very likely to continue for the reasonably foreseeable future. It is also likely that watershed restoration activities will continue. For example, Trinity County is planning to improve fish migration through Roundy Road at Little Browns Creek, which will have a direct beneficial effect on overall watershed condition.

CWE Analysis Results: The ERA based CWE analysis indicates that several of the bounded subwatersheds are in a degraded condition (Table 4). Additional impacts from this project were mitigated to maintain the present watershed condition. This analysis indicates the proposed activities could further degrade the condition of Little Browns Creek. As a result sediment budget was developed for this watershed to better understand and quantify the existing condition and the potential effects of the proposed action on upland erosion, sediment yield, and beneficial uses. The sediment budget estimates the natural, present management, and potential management caused short and long term sediment delivery.

Table 4. The existing Watershed Condition Class for the Browns Project area.

8th Field HUC	6th Field HUC Watershed Name	Drainage Area (acres)	Forest Plan TOC (%)	Existing ERA (%)	WCC (existing)
1801021106010101	Rush Creek	2860	16	0.5	I
1801021106010102	Rush Creek	2997	16	10.3	II
1801021106010201	Rush Creek	3470	16	14.0	III
1801021106010202	Rush Creek	2676	16	27.4	III
1801021106010203	Rush Creek	2384	16	22.7	III
7th Field watershed	**Rush Creek**	**14388**	**16**	**14.5**	III
1801021106040101	E Weaver Creek	2148	16	0.7	I
1801021106040102	E Weaver Creek	1567	16	17.3	III
1801021106040103	E Weaver Creek	2291	16	10.9	II
1801021106040105	E Weaver Creek	2886	16	13.7	III
7th Field watershed	**E Weaver Creek**	**8892**	**16**	**10.3**	II
1801021106040301	L Browns Creek	2151	16	14.5	III
1801021106040302	L Browns Creek	2838	16	17.2	III
7th Field watershed	**L Browns Creek**	**4989**	**16**	**15.7**	III

CWE Analysis Methods

The ERA and sediment budget methods are used to account for rainfall runoff and upland sediment inputs. Rainfall runoff for background, existing, and potential conditions are modeled using the Haskins (1983) method. Sediment delivery from surface, fluvial, and mass failure erosion sources, in-channel fluvial bank erosion, and inner gorge mass failure is estimated Reid and Dunne (1996) methods (Figure 1). The type and amount of upland rainfall, runoff, and erosion are qualified and quantified using the existing and field inventory data. This analysis accounts for the chronic runoff and sediment input caused by frequent high intensity rainfall. Sediment delivered from surface and fluvial erosion is classified as chronic erosion and is quantified for the Q_2 flood event. Sediment delivery from mass wasting and bank erosion is classified as acute and is assumed to occur infrequently as a result of large flood events (i.e., > Q_{25}).

The sediment budget accounts for the short and long-term sediment input to the drainage network and the episodic nature of large flood events. Chronic sediment sources tend to deliver fine sediment on an annual basis raising the suspended sediment load during bankfull flood events. For example, road surface erosion during rainstorms is a common source of chronic sediment. Acute sediment sources are typically triggered by large flood events and deliver more sediment to the drainage network than can be transported. For example, debris flows and other mass failures are common acute sediment sources in steep stream channels.

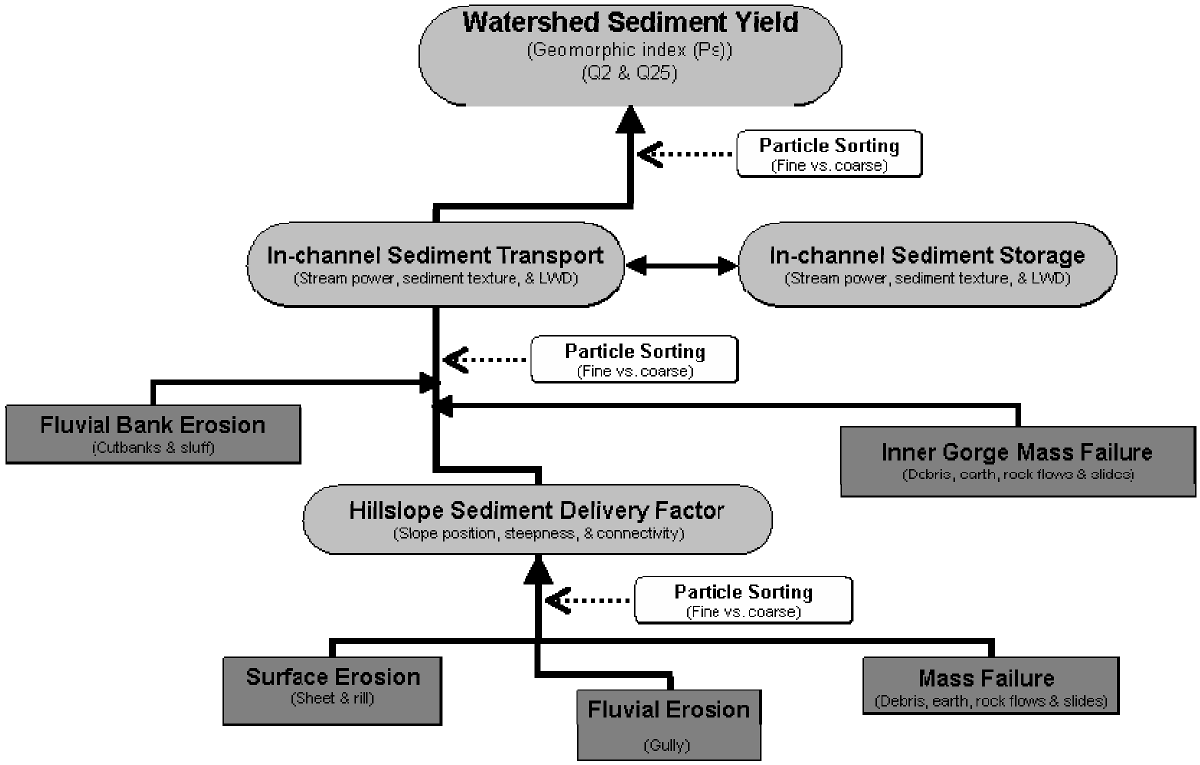

Figure 1. Flow chart illustrating sediment budget process.

For the Browns project area, the two major natural disturbance processes causing runoff and erosion are infrequent floods (i.e., $>Q_{25}$) coupled with severe and large wildland fires. These are infrequent events, but when they overlap in time on erodible bedrock and soils, landscape scale watershed disturbances can occur. Large flood events cause accelerated mass wasting, surface, and fluvial erosion and sediment delivery to the stream network. Most of the sediment delivered to the stream network is coarse, and it can take decades to centuries for the network to route and redistribute this sediment. The spatial and temporal distribution of coarse sediment transport and storage depends on the available stream power, particle size, particle attrition rates, and sediment storage potential. A sediment budget accounts for inputs from surface, fluvial, and mass failure, in-channel fluvial bank erosion, and inner gorge mass failure (Figure 2) (Reid and Dunne, 1996), and it is quantified using the following mass balance equation:

$$Q_s = I +/- \Delta S$$

Q_s = sediment yield
I = sediment input
ΔS = change in sediment storage

Sediment yield (Q_s) is the total amount of in-channel suspended and bed-material load passing a given point in the stream network per flood event. For this analysis, the sediment yield per Q_2 and Q_{25} flood events was quantified using the chronic and acute sediment input (I) from upland sources and the sediment transport and storage potential (i.e., Geomorphic Index) of the stream network (Figure 1).

Typical sedimentary events are classified for this analysis that includes chronic (Q_2) and acute (Q_{25}) upland erosion and sediment delivery to the stream network (NCASI, 1999). These events are presumed to be a function of bedrock geology, soil type, ground cover, slope stability, slope position, and slope steepness. Land-types are classified by mapping individual polygons with similar erodibility, proximity to the drainage network, and potential to deliver sediment. The land-types are mapped using the Region 5 Bedrock Geologic Map, 10 meter DEM generated slope position, and 10 meter DEM generated slope steepness (see Appendices A and B for coefficients and data). GIS is used to generate the land-type polygons, and sediment source inventory data are used to refine the polygon's erosion rate and sediment delivery potential. For a given land-type, the percent of the eroded sediment delivered to the drainage network is estimated for undisturbed and managed conditions. Frequent chronic upland erosion is assumed to represent the average annual sediment budget for fine sediment, whereas the infrequent acute upland erosion is assumed to represent the long-term sediment budget for coarse sediment.

In-channel sediment transport and storage are estimated using a geomorphic index and are presumed to be a function of stream power and drainage network efficiency. For a given watershed, the relief ratio, drainage density, length of transport (3-20% slope) and response channels (<3% slope), bankfull discharge (Q_2), and flood prone discharge (Q_{25}) of a given watershed are used to quantify the geomorphic index. This index is used instead of a sediment deliver ratio (NCASI, 1999) and is calculated using the following equation from Geier and Loggy (1995):

$$P_s = (L_{ST}/A*(E_{max}-E_{min}/L_b)*Q_x/Q_y)/(L_R+(0.5*L_S)/A)$$

Ps = geomorphic index

A = watershed drainage area (miles^2)

L_B = total basin length measured along valley (miles)

L_{ST} = total length of stream channels (miles)

L_R = total length of response stream channels (miles)

L_S = total length of source stream channels (miles)

E_{max} = maximum watershed elevation (feet)

E_{min} = minimum watershed elevation (feet)

Q_x = 2 or 25 year flood event of the subwatershed (cfs)

Q_y = 2 or 25 year flood event of the analysis area watershed (cfs)

The background sediment yield is defined as the background sediment delivery (i.e., I) to stream network from surface, fluvial, mass, and bank erosion caused by natural disturbance processes (i.e., floods and fire). It is estimated using the amount of natural upland erosion multiplied by the sediment delivery factor (i.e., geomorphic index) (Figure 2). The background yield is calculated using the bedrock geology layer, stream channel order and slope. Erosion rates per rock and channel type are used to calculate the yield for each watershed within the analysis area (Appendix A for erosion rates), and are based on modeled and measured rates published in the Trinity River TMDL (EPA, 2001 and

GMA, 2001) and sediment budget literature. For the Q_2 flood event, erosion rates were adjusted to fit GMA (2001) the measured sediment yield of Little Browns and Weaver Creek. Very few measurements are available for the Q_{25} flood event.

The existing and potential management related sediment delivery is defined as the sediment input to the stream network from mass wasting, surface, and fluvial erosion caused by management activities or controllable sediment discharge sources (NCRWQCB, 2001) (i.e., roads, mining, and timber harvest). It is estimated using the amount of management related mass wasting, surface and fluvial mass erosion from known and potential sources. The management related sediment yield is defined as the sediment delivery and transport to a specified point usually near the outlet of a given watershed. Like the natural sediment yield, the amount of sediment delivery is multiplied by the geomorphic index (i.e., sediment yield factor) (Figure 1).

Management related sediment delivery and yield caused by the present land condition and the proposed action are calculated by intersecting the past and proposed timber harvest units, fuel treatment units, and roads with the mapped land-type and multiplying the area with the disturbed erosion rates (Appendix A). The short and long term sediment delivery rate is estimated and varies by type, location, and timing of the actions. The unit erosion rate is multiplied by the geomorphic index. This prevents including erosion sources that do not fit the controllable sediment discharge source definition.

The amount of sediment delivered from controllable sediment discharge sources associated with road decommissioning treatments was quantified using results from treatment effectiveness monitoring. Trinity Zone monitoring results indicate that the majority of erosion from road decommissioning treatments is from stream-road crossings (USDA, 2005). To predict the amount of short-term sediment generated from this alternative the following regression equation was used (Madej, 2001):

$$V = (20.8+0.041*(A)*(S))+(0.009*V_e)$$

V = volume eroded from crossing (m^3)
A = drainage area (km^2)
S = channel slope
V_e = volume excavated (m^3)

Drainage area above the crossing and channel gradient are used as surrogates for stream power. The equation predicts that more erosion occurs as stream power and stream-road crossing volume increase (Madej, 2001).

The total sediment yield at the outlet of each subwatershed is proportioned in to suspended sediment load (< 0.062 mm), fine bed-material load (0.062-2 mm) and coarse bed-material load (> 2 mm). Based on the measured texture of upland soils, the less than 16 percent of the land surface available for erosion is fine material less than 0.062 mm, 15 percent is between 0.062 and 2 mm, and 60 percent are greater than 2 mm (Table 5). The bed-material of the stream channel is coarser than the upland soils indicating that the fines are transported out of the project area and the coarser material is stored for a longer period of time (Table 5). The source of coarse sediment is from mass wasting and inner-gorge failures. The total sediment yield, described above, is proportioned using these sediment texture values.

Table 5. Measured hillslope soil and bed-material texture for project area.

Upland Soil Map Unit								Little Browns Creek	
Forbes	**Particle Size (mm)**	**Holland**	**Particle Size (mm)**	**Nuens**	**Particle Size (mm)**	**Soulajule/ Chawanakee**	**Particle Size (mm)**	**Bed-Material Texture**	**Particle Size (mm)**
D16	0.062	**D16**	0.062	**D16**	0.062	**D16**	0.062	**D16**	12.0
D50	0.062	**D50**	2	**D50**	2	**D50**	2	**D50**	32.0
D84	>3	**D84**	>2	**D84**	>2	**D84**	>2	**D84**	64.0

CWE Analysis Level and Confidence

For the Browns Project, a Level 3 CWE analysis was completed that relied on field verified data and information. This level of CWE analysis uses the Haskins (1986) ERA model as a tool to identify at risk or "red flag" watersheds. The model attempts to analyze spatial and temporal impacts and uses slope position, steepness, and adjacency to riparian reserves of the different disturbances (e.g., roads and harvest unit) to evaluate potential CWE. For at risk watersheds, a sediment budget was developed to quantify short and long term sediment inputs to impaired streams, identify controllable sediment discharge sources, and develop mitigation measures.

For the Browns Project, the confidence in analysis is medium to high. About 45% of the available information was ground verified. Ground verification focused on past timber harvest, road condition, mine impacts, and other public uses.

CWE Analysis Core Data Sources

The CWE analysis uses corporate and field extensive data and information to characterize the past, present, and future watershed condition within and downstream of the project area. The following is a list of the core data sources used to analyze the Browns Project:

- Watersheds (5^{th}, 7^{th}, and 8^{th} Field HUC watersheds)
- Streams (perennial fish bearing (Class I), perennial non-fish (Class II), intermittent, and ephemeral (Class III)
- Wetlands (springs, meadows, and ponds)
- Bedrock geology
- Geomorphology
- Soils
- Stream Condition Inventories(SCI)
- Active mass wasting feature inventories
- Road condition inventories
- Water quality monitoring data

- Road layer (includes FS and private system and unclassified roads and trails)
- Forest Service harvest history layer
- Fuel Treatment and Fire history layer
- Private land harvest history layer

Timber Harvest Data: The timber harvest disturbance and erosion are calculated using the land area, rate, type and method of timber harvest on public and private lands. The timber harvest ERA uses disturbance factors to quantify the short and long-term impacts from the type of harvest (e.g., thinning from below), the yarding method (e.g., tractor), the site preparation method (e.g., tractor pile and burn), and future actions (e.g., planting and prescribed burning). The disturbance factor coefficients by activity are listed in Appendix A. The timber harvest data used for the Browns Project are stored as part of the project record.

The public land harvest history relies on data from the Forest Service FACTS database stored and maintained in GIS and past information gathered from Forest Service Foresters (e.g., Mike Archibald and Jose Perry). The FACTS data were updated to reflect public land harvest as of fiscal year 2005. Of the units listed in the database, all were inspected from aerial photos and 22% were field inventoried to verify the recovery of past treatments. Most of the activities were found to be recovering or fully recovered, however, five of the units have initiated active landslides.

The private land harvest history was developed using harvest history data summarized as part of the Trinity River sediment TMDL. These data were gathered from Timber Harvest Plans filed with CDF, DWR (1980), and aerial photos from 2000 (EPA, 2001). Several errors and gaps in the TMDL data were identified after comparing the GIS data to the aerial photos. Forest Service Foresters Chris Losi and Lindsy Large, corrected the private harvest data using 2003 aerial photos and field verification. About 80% of the units were field verified and several corrections were made to the harvest data. This effort greatly improved the CWE model accuracy. For example, initially the total watershed area clearcut was 459 acres (TMDL data), which increased to 3,666 acres after aerial photo and field verification.

To calculate the timber harvest disturbance, each harvest unit's map area was multiplied by the corresponding disturbance factor that depends on the treatment types and yarding method. Timber harvest prescriptions vary from clear cut to thin from below. Flat ground is mainly mechanically harvested (e.g., tractor skidding), and steep ground is cable yarded (e.g., skyline). The treatment type disturbance factors account for reduced canopy and ground cover. The factors assume that harvest reduces evapotransporation and increases runoff and groundwater recharge for 10 to 40 years. The yarding method disturbance factors account for soil disturbance associated with skid trail, cable corridors, and landings.

Road Data: The road disturbance and erosion are calculated using the area of land disturbed by the road prism. The road disturbance calculation uses data from the Forest Service road database stored and maintained in INFRA and GIS. The road layer was updated as part of the Browns Project and Browns Project Roads Analysis Process. The existing road disturbance was calculated using the updated road layer that includes existing and new classified and unclassified Forest Service roads and trails, user created ATV trails, private roads and trails, county roads, and state and federal highways. The road data are stored in Excel and GIS and is too large to include with this report.

Several errors and gaps in the road data set were identified and corrected after comparing the corporate data to field inventory data and the 1998 aerial photos. For example, about 35 miles of private road were mapped from the 1998 aerial photos. On Forest System Lands, unmapped classified and unclassified roads and trails were mapped.

To calculate the road disturbance, the road length is multiplied by road width. The road length is summarized using GIS data. Road width varies depending on the road and surface type, and maintenance level (Appendix A). Road width accounts for the average prism width, pullouts, and landings.

Fire and Fuels Data: Watershed disturbances caused by wildland and prescribed fires and their impact on the hydrologic balance, sediment yield, and beneficial uses is analyzed as part of the CWE analysis. The fire disturbance is calculated using the known wildland and prescribed fire history for the project area. For this analysis accounts for large and severe fires that cause watershed scale disturbances and result in measurable excess runoff or erosion are accounted for. Each fire is characterized according to how severe it burned and when it burned. A burn severity map is drawn to calculate the disturbed watershed area. Fire disturbance factors and recovery rates for different vegetation types and burn characteristics are used to estimate the likely-hood of negative cumulative effects.

Typically, runoff and erosion caused by vegetation and duff layer removal are assumed to be recovered, or within the natural range of variation, after five to 10 years. For example, chaparral or brush fires typically have a high rate of fuel consumption, are large, and damage the soil, however, the ground disturbances recover within two to five years. Within coniferous vegetation types, the rate of disturbance recovery depends more on the type of burn, for example, a low severity under-story burn is fully recovered within two to five years, whereas, a high severity crown fire may not recover for 30 or more years.

Fire history data, stored in GIS, was used to calculate the fire disturbance. The Oregon Fire was the most recent large fire and burned in the western portion of the Browns Project area.

Field Inventory Data: Field extensive data are used to help verify present and potential watershed condition. The following types of field data were collected as part of the Browns Project and other monitoring and are documented in the project record:

- Inventory of channel stability;
- Inventory of landslide prone terrane;
- Inventory of needed restoration and mitigation measures;
- Location, type, and condition of riparian reserves; and
- Instream water quality data; and
- Road restoration and upgrade opportunities.

Stream channel stability was measured to help verify the CWE model and characterize the existing and potential condition of channels draining the project area. Standard methods are used to measure channel stability (Montgomery and Buffington, 1993 and USDA Forest Service, 2003). See the Browns Project Fisheries Report for the results of stream channel condition inventories.

Road condition inventories were completed to assess the present condition of roads and prescribe road upgrade and maintenance recommendations. Several roads (about 31 miles) that are diverting stream flow, eroding and delivering sediment to the stream system, were identified for decommissioning. Roads used as the main timber sale haul routes were inventoried for proper drainage and culvert sizing. Almost 200 different sites were inventoried. Pre-harvest road improvements were identified as well as long-term needs that will be implemented later.

CWE Analysis Disturbance Factors and Recovery Rates

ERA and sediment budget disturbance factors erosion rates for the project area were developed using the coefficients described by Haskins (1983), other Region 5 National Forests, and scientific literature (Appendix A).

All mechanical ground disturbances from project activities are assumed to be fully recovered after 10 to 40 years. Ground disturbances caused by wildland and/or prescribed fire are assumed to be recovered in five to 10 years. Roads and landings do not recover with time unless specific mitigation or restoration occurs (Haskins 1986). Once a road is decommissioned or a landing is rehabilitated they are assumed to reduce the ERA and sediment delivery rate. Mass wasting features triggered by management activities are field inventoried and assigned a recovery coefficient.

CWE Analysis Land Use History

The existing watershed condition, qualified and quantified using the ERA model and sediment budget, is a result of the following land use history. The first significant land use within the Browns Project area was placer and strip gold mining. Starting in 1848, large areas of land were dedicated to mining and most of the project area, including wilderness areas, were explored and mined for gold and other minerals (O’Brien, 1965). The impacts of gold mining are still imprinted on the landscape and stream network. The project area has several mining ditches and ponds that are still hydrologically connected to the stream network. Impacts from strip mining are common as well. Typically, headwater stream channels were hydraulically excavated leaving a void that resembles a landslide scar. Larger streams, like Weaver Creek, were placer mined. Entrenched channels and adjacent gravel piles are still present.

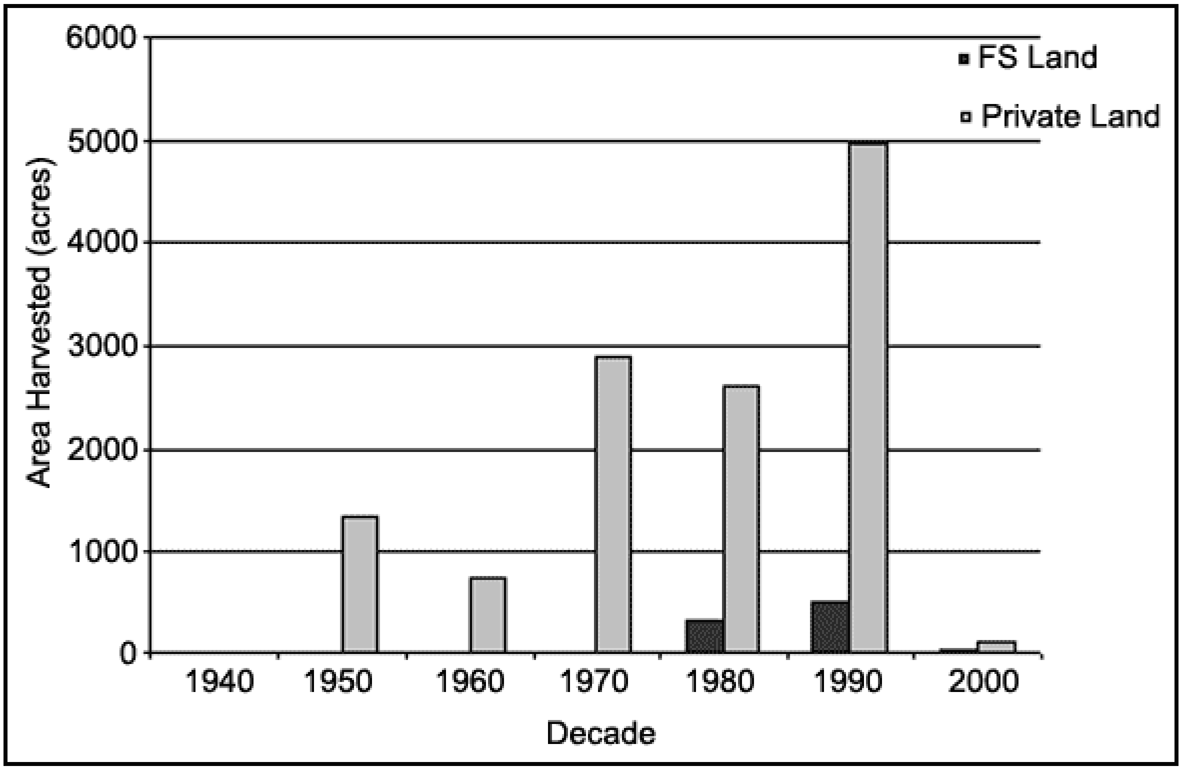

Figure 2. Bar chart showing timber harvest history by decade and land ownership.

Since the peak of gold mining, lands within the project area have mainly been used for public and private timber harvest and urban development. About 310 miles of road and trail have been built for access to towns, recreational areas, mining claims, power lines, and timber lands. About 13 miles of Highways 299 and 3 dissect the project area and parallel Weaver and Little Browns Creeks, respectively. About seven miles of County Road 204 parallels Rush Creek as well. There are about 109 miles of private road, and about 99 miles of Forest Service road. Most of these roads are sources of sediment and constrict and divert stream channels. There are several known fish barriers within the project area on public and private lands. The Trinity County Planning Department completed a fish passage survey and found several full barriers on Little Browns and Weaver Creeks.

Timber has been harvested within the project area since the 1800s. Timber harvest outputs peaked in the 1990s (Figure 2). Plate 2 illustrates the timber harvest history since the 1940s on public and private lands. Since 1940 about 12,818 acres of private land and about 864 acres of public land have been timber harvested which is 37 percent of the analysis area. This does not include cutting of small areas that were not tracked by the Forest Service or private. Most of the erosion from past timber harvest is limited to areas that became unstable after vegetation removal.

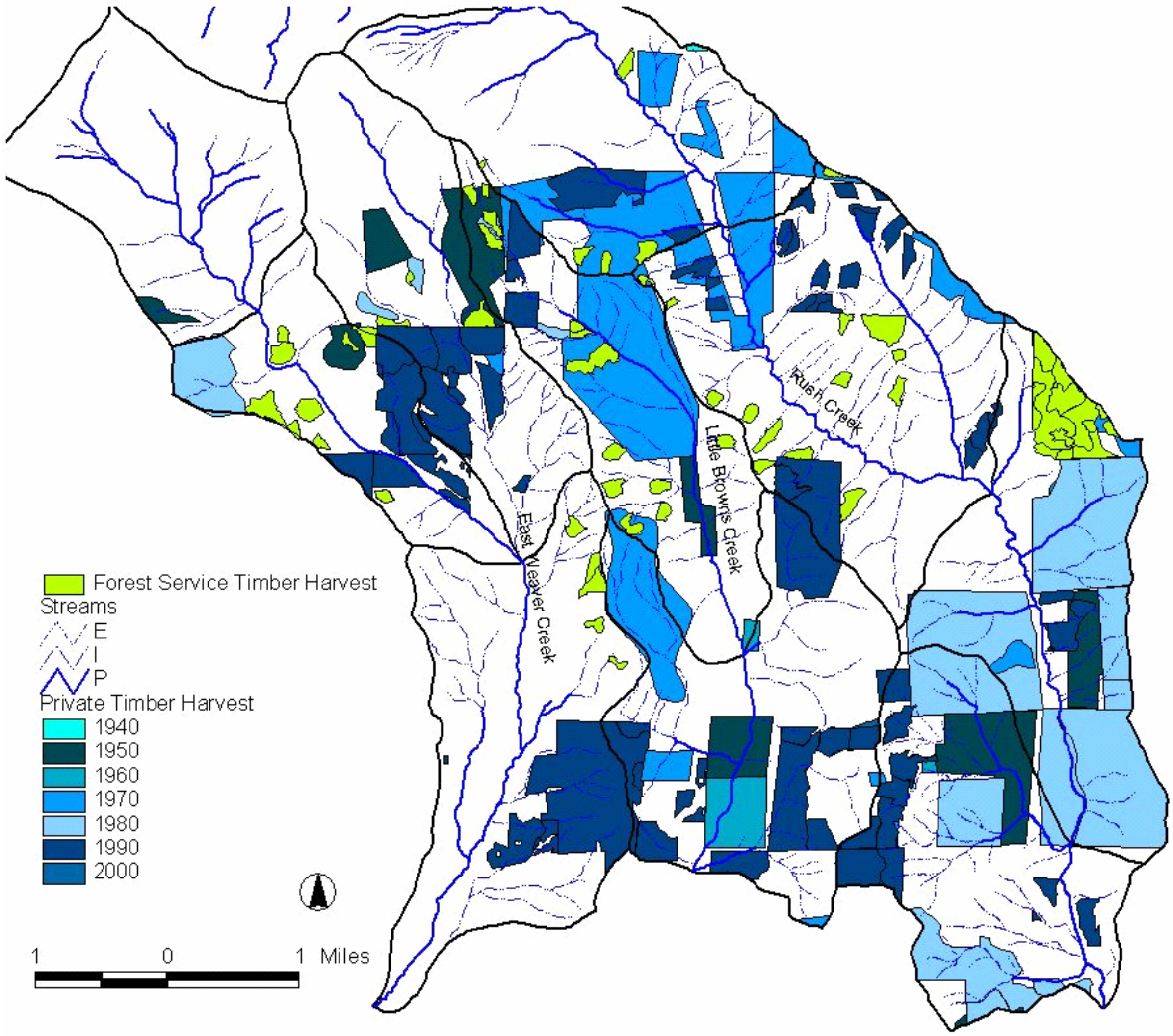

Plate 2. Map illustrating the timber harvest history by land ownership and decade.

Weaverville is the main town within the project area and is developed around the confluence of West and East Weaver Creek. There are several homes spread throughout the project area with associated roads mainly in Rush and Little Browns Creeks. Streams draining the town of Weaverville have been heavily modified by urban development and effectively function as canals. Erosion from roads and development sites are sources of sediment and other pollutants (e.g., oil and grease).

Environmental Consequences

The direct, indirect, and cumulative environmental consequences of implementing the Browns Project alternatives have been evaluated using the CWE analysis process. This analysis considers the background and present watershed condition from known land use activities to include: timber harvest activities, road construction and use, mine operations, wildland fire/fuel treatments, and urban development. The future watershed condition is estimated by factoring the potential impacts from the proposed action, connected actions (e.g., fuels treatments), and foreseeable actions.

Alternative 1: Based on the results of the existing condition CWE analysis, most of the streams draining the Rush and Weaver Creek watersheds are in a degraded condition and are not supporting beneficial uses. This conclusion is supported by De la Fuente et al. (2000) who determined that Rush and Weaver are impaired (Category III) based on an analysis of the stream and watershed condition indicators. The water quality and channel conditions were rated as functioning at risk. The EPA (2001) has set TMDL sediment targets for the project area that focus on eliminating chronic and acute controllable sediment discharge sources.

The existing ERA and WCC are listed for each 8th Field HUC subwatershed within the analysis area (Table 6 and Plate 3). For the Browns Project analysis area, CWE analysis results indicate a moderate increase in sediment with minor increases in turbidity and a minor stress on fish (Table 2 and Table 6). The geographic extent of the sediment impacts are moderate, immediately offsite, and do not translate to watershed scale impacts. The duration and frequency of sediment delivery is moderate, relative to background, and is having an intermittent effect on beneficial uses (Table 2 and Table 6).

The Browns Project area has a long history of land use to include mining, water diversion, road construction, timber harvest, and urban development. In the 1800s, the stream system was altered by mining. Flow diversion, tributary damning, and placer mining all significantly modified the stream network, and the present network configuration is a result of these legacy impacts. Road network and timber harvest disturbances have increased peak flood flows and sediment delivery and yield. Old and new roads are causing chronic and acute erosion, constricting stream channels, and blocking fish migration. In addition, urban development and domestic water use have increased storm runoff and sediment delivery and reduced summer base streamflow.

Rush Creek has a WCC of three, and the ERA increases downstream (Table 6 and Plate 3). The headwaters of Rush Creek drain wilderness and are in WCC one, whereas, the lower portion has been heavily managed and exceeds the TOC by a factor of two. The road network and rate of timber harvest are the main causes of the high ERA. There are several management related mass wasting features contributing large volumes of sediment to Rush Creek. Until these features stabilize, they deliver large pulses of sediment during large flood events and chronically erode during frequent high intensity rainfall.

East Weaver Creek has a WCC of two, however, one of the subwatersheds (1801021106040102) is in WCC three (Table 6 and Plate 3). The headwaters of East Weaver Creek drain wilderness and have a WCC of one. The ERA increases downstream with roads and urban development as the main causes of the high ERA. Roads, urban development, and domestic water uses are significantly altering water quality and quantity in lower Weaver Creek. Along Highway 299, runoff, channel constriction/diversion, and road-cut instability have reduced the channel stability of Weaver Creek and increased sediment delivery.

Little Browns Creek has a WCC of three (Table 6 and Plate 3). Smaller than the other three 7th field watersheds, the ERA of this watershed is almost equal to the TOC (i.e., 16%). The road network, rate of timber harvest, and urban development are the main causes of the high ERA. Highway 3 has impacted stream channel stability significantly in subwatershed (1801021106040301) were Highway 3 occupies three quarters of the original valley bottom. There are several management related active mass wasting features chronically and acutely delivering sediment to Little Browns Creek.

Table 6. Summary of Alternatives 1 and 3 CWE analysis results for short term (1-5 years) and long term (5 to 20 years) effects.

8th Field HUC	7th Field HUC Watershed Name	Drainage Area (acres)	Forest Plan TOC (%)	Existing ERA (%)	Alt 3 (1-5 years)	Alt 3 (5-20 years)	WCC (existing)	Short Term WCC (Alt 3)	Long Term WCC (Alt 3)
1801021106010101	Rush Creek	2860	16	1	1	0	I	I	I
1801021106010102	Rush Creek	2997	16	10	12	10	II	II	II
1801021106010201	Rush Creek	3470	16	14	15	11	III	III	II
1801021106010202	Rush Creek	2676	16	27	27	12	III	III	II
1801021106010203	Rush Creek	2384	16	23	23	10	III	III	II
7th Field watershed	**Rush Creek**	**14,388**	**16**	**14**	**15**	**8**	III	III	II
1801021106040101	E Weaver Creek	2148	16	1	1	1	I	I	I
1801021106040102	E Weaver Creek	1567	16	17	18	8	III	III	II
1801021106040103	E Weaver Creek	2291	16	12	12	7	II	II	II
1801021106040105	E Weaver Creek	2886	16	14	13	10	III	III	II
7th Field watershed	**E Weaver Creek**	**8892**	**16**	**10**	**11**	**6**	II	II	II
1801021106040301	L Browns Creek	2151	16	14	14	8	III	III	II
1801021106040302	L Browns Creek	2838	16	17	25	15	III	III	III
7th Field watershed	**L Browns Creek**	**4989**	**16**	**16**	**20**	**12**	III	III	II

Alternative 3: This alternative, as described in the Proposed Action, includes mitigation measures designed to prevent further degrading the water quality and beneficial uses of watersheds draining the Browns Project area. This analysis evaluates the direct and indirect impacts of the proposed harvest activities, new road construction, road drainage improvements, and road decommissioning, and it evaluates the cumulative effects of proposed action combined with connected actions to include fuel treatments and plantation management.

As designed, Alternative 3 will not cause any long-term direct or indirect impacts that further exacerbate runoff and sediment delivery. During project implementation, however, the probability of sediment delivery increases where new road construction, road decommissioning, and timber harvest activities dissect streams. Short-term sediment delivery is probable at stream road or skid trail crossings. The potential impacts will be localized (i.e., less than ¼ mile downstream), minor, and last for two to three years.

Small (i.e., < two percent) short-term increases in ERA are shown for Rush Creek (Table 6 and Plate 3). These increases result from the proposed fuels treatments and will recover within five years of project implementation. Long-term the ERA is predicted to decrease and the WCC should improve from a III to a II. This improving trend is based on the reasonably foreseeable activities on public and private lands. Unforeseen actions on private land could change the long-term WCC trend, especially in lower Rush Creek: for example, timber harvest activities that were not reasonably foreseeable at the time of this analysis.

Small (i.e., < one percent) increases in ERA are shown for East Weaver Creek (Table 6 and Plate 3). These increases result from the proposed fuels treatments and are short term. These impacts will recover within five years of project implementation. Long-term the ERA is predicted to decrease and the WCC is maintained at II. At the 8th Field HUC scale, the WCC will improve from III to II for subwatersheds 1801021106040102 and 1801021106040105.

A substantial increase in ERA was predicted for Little Browns Creek, and the results indicate a "red flag" condition. In subwatershed 1801021106040302 the ERA is predicted to increase eight percent. As a result, a sediment budget was completed to better understand and predict CWE within and downstream of Little Browns Creek and is described below.

One of the purposes of this alternative is to maintain and improve the long-term watershed condition. The mitigation measures, listed in FEIS Appendix C, are designed to minimize the short-term impacts of timber harvest and road construction and improve long-term watershed condition. However, the watershed condition will not improve significantly as a result of this project (Table 6 and Plate 3).

The mitigation measures applicable to reducing peak flood flows and chronic erosion are focused on disconnecting the road network from the stream channel by reducing road-stream crossing diversion and improving road drainage. In addition, disturbed areas will be de-compacted to improve infiltration and vegetation recovery at the watershed scale. For example, in critical areas identified on the Timber Sale Contract map, landings, skid trails, and unclassified roads will be sub-soiled up to 18 inches to improve soil quality.

The mitigation measures applicable to reducing chronic and acute sediment sources are focused on controlling existing erosion sources and preventing new ones. The main mitigation measure is to decommission about 31 miles of existing roads, trails, old temporary roads, and old skid trails that are discharging sediment. Decommissioning entails removing culverts, ripping and out sloping the road surface, and closing road junctions. Other activities may occur depending on site conditions. The goal is to control surface runoff and erosion leaving the road unavailable for future use. See FEIS Appendix C for a list of roads. The short-term sediment input from road decommissioning activities was quantified. The total amount of short-term erosion predicted for the Browns Project is about seven tons, which is substantially less than the existing input from background and controllable sediment discharge sources.

Alternative 4: This alternative is the same as Alternative 3, but does not include new road construction and associated timber harvest and fuel treatments. Proposed activities that depend on new roads will no be implemented as part of Alternative 4, to include connected mitigation measures. This analysis evaluates the direct and indirect impacts of the proposed harvest activities, road drainage improvements, and road decommissioning, and it evaluates the cumulative effects of proposed action combined with connected actions to include fuel treatments and plantation management.

If Alternative 4 is implemented, then the direct, indirect, and cumulative long-term impacts from peak flood flows and fine/coarse sediment yield increases are not significant (Table 7). Overall, this alternative will have less impact than Alternative 3 due to the lack of new roads and less timber harvest area. This alternative will cause substantially less ground disturbance in Little Browns Creek (Table 7).

Table 7. Summary of Alternatives 1 and 4 CWE analysis results for short term (1-5 years) and long term (5 to 20 years) effects.

8th Field HUC	7th Field HUC Watershed Name	Drainage Area (acres)	Forest Plan TOC (%)	Existing ERA (%)	Alt 4 (1-5 years)	Alt 4 (5-20 years)	WCC (existing)	Short Term WCC (Alt 3)	Long Term WCC (Alt 3)
1801021106010101	Rush Creek	2860	16	1	1	0	I	I	I
1801021106010102	Rush Creek	2997	16	10	12	10	II	II	II
1801021106010201	Rush Creek	3470	16	14	15	11	III	III	II
1801021106010202	Rush Creek	2676	16	27	27	12	III	III	II
1801021106010203	Rush Creek	2384	16	23	23	10	III	III	II
7th Field watershed	**Rush Creek**	**14,388**	**16**	**14**	**15**	**8**	III	III	II
1801021106040101	E Weaver Creek	2148	16	1	1	1	I	I	I
1801021106040102	E Weaver Creek	1567	16	17	18	8	III	III	II
1801021106040103	E Weaver Creek	2291	16	12	12	7	II	II	II
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7th Field watershed	**E Weaver Creek**	**8892**	**16**	**10**	**11**	**7**	II	II	II
1801021106040301	L Browns Creek	2151	16	14	12	6	III	II	I
1801021106040302	L Browns Creek	2838	16	17	23	13	III	III	III
7th Field watershed	**L Browns Creek**	**4989**	**16**	**16**	**19**	**10**	III	III	II

Little Browns Sediment Budget: A sediment budget was completed for Little Browns Creek within the Browns Project analysis area. The sediment budget was completed for Alternative 3 because it includes new road construction and associated timber harvest, whereas Alternative 4 has no new road construction and less timber harvest. The analysis area does not include the lower portion of the Little Browns Creek watershed (Plate 4). Most of the land south of the analysis area is in private ownership and is complicated by multiple land use activities.

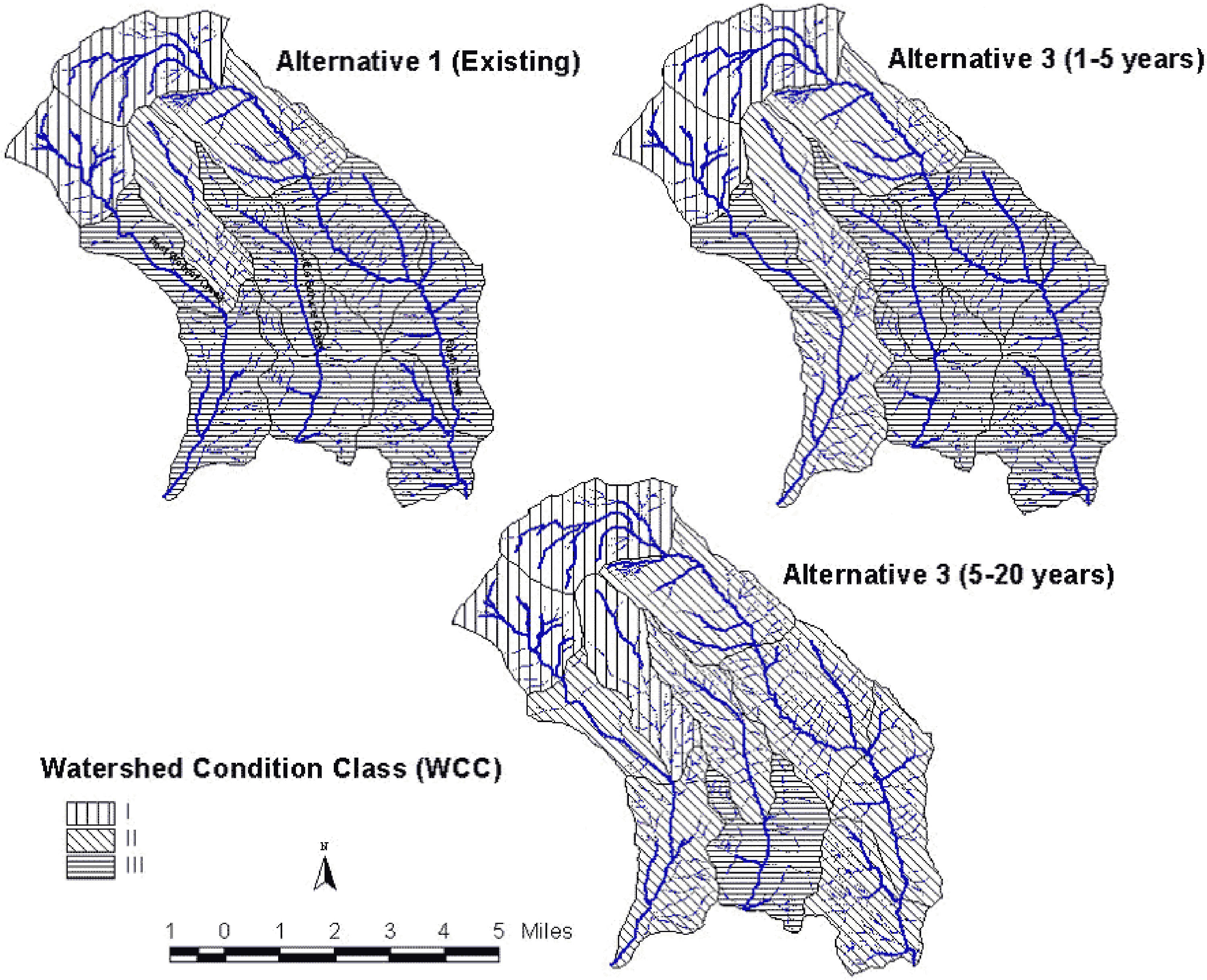

Plate 3. Map of Browns Project showing WCC for the existing, 1 to 5 year, and 5 to 20 year time periods.

The results indicate that the short and long-term sediment delivery increases from the Browns Project are unlikely to further degrade local and regional water quality. There will be a moderate increase in sediment with a minor increase in turbidity and a minor stress on fish. The geographic extent of the predicted impacts are moderate, immediately offsite, and do not translate to watershed scale impacts. The duration and frequency of the impacts are moderate and may have intermittent effects to water quality (Table 2 and Table 8).

The sediment budget for the existing conditions indicates that the percent over background sediment delivery is 13 percent per Q_2 flood event and 36 percent per Q_{25} flood event, lower than the 167 percent above background calculated as part of the Trinity River TMDL (EPA, 2001). This difference is likely results from the refinement of the public and private land harvest history. The percent above background sediment yield is predicted to increase to 25 percent per Q_2 flood event and 72 percent per Q_{25} flood event for the first five years following project implementation (Table 8). The sediment yield is predicted to return to 2005 amounts within 10 to 20 years following project implementation (Table 8). This prediction is based on the sediment delivery from the reasonably foreseeable actions listed below. If other actions occur on private land, the long-term sediment delivery amount could be different.

Sediment delivered from project activities will likely have a coarse sand to fine gravel texture (Table 5). Less than 16 percent of the soil available for erosion is less than 0.065 mm which suggests that large turbidity increases are unlikely.

Sediment delivery from the Browns Project represents less than half of the short-term sediment delivery and less than a quarter of the long-term sediment delivery. Mitigation measures designed to reduce and prevent erosion are predicted to save 162 tons per Q_2 flood event and 952 tons per Q_{25} flood event (Table 8). The mitigation measures lower the predicted sediment delivery from the Browns Project by about half.

The sediment budget results indicate that roads and private timber harvest activities are producing about 44 and 55 percent of the existing management related sediment yield, respectively (Table 8). Within 20 years after completing the Browns Project, a small portion of the management related sediment will result from this project, whereas private timber harvest is predicted to produce over half of the management related sediment delivery. The remainder is associated with sediment delivery from roads.

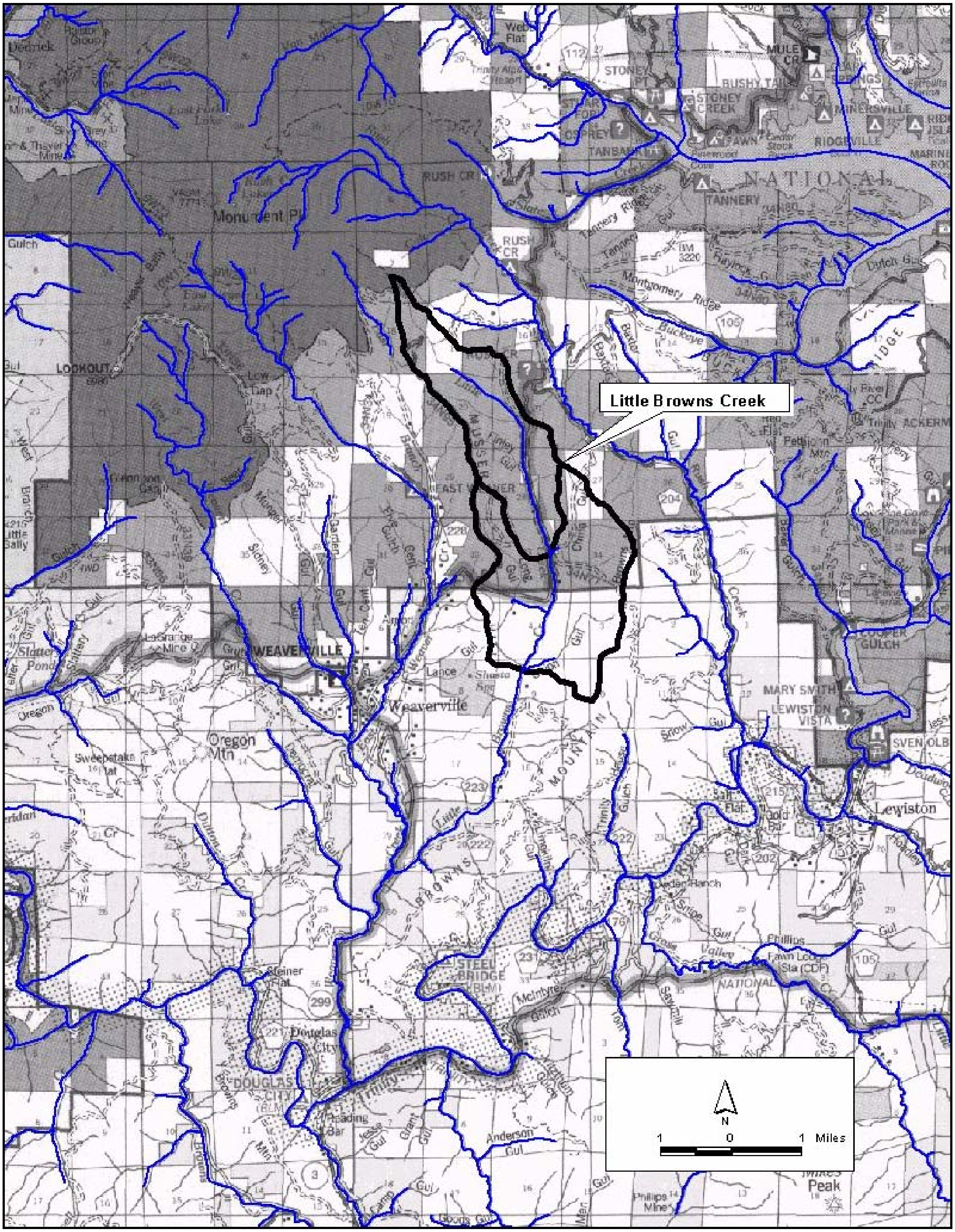

Plate 4. Little Browns Creek location map showing watershed relative to Weaverville and Trinity River.

Table 8. Summary of Little Browns Creek sediment budget.

Existing Condition Sediment Source Category	Q_2	Q_{25}
Background Upland Erosion (tons)	3572	6831
Background Bank Erosion (tons)	1893	4269
Road Erosion (tons)	304	1764
Fuels Erosion (tons)	4	4
PCT Erosion (tons)	1	1
Private Timber Erosion (tons)	363	2101
FS Timber Erosion (tons)	23	138
Fire Erosion (tons)	0	0
Existing Condition Sediment Yield		
Total Erosion (tons)	6161	15107
Geomorphic Index (Ps)	0.22	0.92
Total Sediment Yield (tons)	1328	8998
Existing % Above Background Sediment Yield	13	36

Alternative 3 Sediment Source Category (short-term 1-5 years)	Q_2	Q_{25}
Road Erosion (tons)	323	1875
Fuels Erosion (tons)	2	3
PTEIR Erosion (tons)	375	2184
Private Timber Erosion (tons)	370	2149
FS Timber Harvest Erosion (tons)	12	69
Alt 3 Timber Harvest Erosion (tons)	455	2697
Mitigated Erosion (prevented) (tons)	162	952
Alternative 3 Sediment Yield (short-term 1-5 years)		
Total Erosion (tons)	6839	19124
Geomorphic Index (Ps)	0.22	0.92
Total Sediment Yield (tons)	1474	11390
Alt 3 % Above Background Sediment Yield (tons)	25	72

Alternative 3 Sediment Source Category (long-term 5-20 years)	Q_2	Q_{25}
Road Erosion (tons)	161	922
Fuels Erosion (tons)	1	7
PCT Erosion (tons)	0	0
PTEIR Erosion (tons)	308	1760
Private Timber Erosion (tons)	94	549
FS Timber Erosion (tons)	6	35
Alt 3 Timber Harvest Erosion (tons)	182	1079
Alternative 3 Sediment Yield (short-term 5-20 years)		
Total Erosion (tons)	6217	15452
Geomorphic Index (Ps)	0.22	0.92
Total Sediment Yield (tons)	1340	9203
Alt 3 % Above Background Sediment Yield (tons)	14	39

Foreseeable Actions

This CWE analysis evaluated the past, present, and future watershed condition. To account for future condition, reasonably foreseeable actions within the project area were analyzed. These projects include precommercial thinning, road construction and maintenance, fuels reduction projects, watershed restoration, and private timber harvest. These actions were quantified as part of the ERA model and Little Browns Creek sediment budget.

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Appendix A: Browns Thin CWE analysis ERA disturbance factor and sediment budget erosion rate tables

Table 1. CWE analysis land-type slope factor. Used to weight disturbed area (disturbance factor x total disturbance area) from timber harvest, fuels treatments, and roads.

Slope Code	Slope Factor
Lowest	1.5
Mid	1.2
Ridge	0.8

Lowest = valley bottom

Mid = middle of hillslope

Ridge = near top of ridge

Table 2. ERA forest system lands timber harvest and site preparation disturbance factors, from FACTS database.

RX	Dist Factor	Description
4111/420	0.30	Patch clearcut/tractor skidder
4111/430	0.17	Patch clearcut/Single span skyline
4111/480	0.12	Patch clearcut/hele
4112/420	0.30	Strip clearcut/tractor
4113.1/420	0.30	Stand clearcut/tractor reserve trees
4113.1/430	0.20	Stand clearcut/cable reserve trees
4113/420	0.30	Stand clearcut/tractor skidder
4113/430	0.20	Stand clearcut/Single span skyline
4113/480	0.12	Stand clearcut/helecopter
4131/420	0.20	Shelterwood seed cut/tractor skidder
4131/430	0.15	Shelterwood seed cut/Single span skyline
4131/480	0.08	Shelterwood seed cut/hele
4143/420	0.22	Overstory removal/tractor skidder
4143/430	0.16	Overstory removal/Single span skyline
4143/480	0.08	Overstory removal/hele
4151/420	0.20	Individual tree selection/tractor
4151/430	0.15	Individual tree selection/cable
4152/420	0.30	Group selection/tractor
4220/420	0.18	Thinning/tractor
4220/430	0.12	Thinning/cable
4230/420	0.18	Salvage/tractor
4230/430	0.11	Salvage/cable
4232/420	0.27	Sanitation/tractor
4260/0	0.15	human fire

Table 3. ERA private land timber harvest disturbance factors.

RX	Dist Factor	Description
C/CC	0.2	cable clearcut
C/Selection	0.15	cable select cut
C/STSS	0.18	cable sanitation salvage
C/SWR	0.18	cable shelterwood removal
H/CC	0.08	helicopter cleacut
H/Selection	0.03	helicopter select cut
H/STSS	0.075	helicopter sanitation salvage
H/SWR	0.07	helicopter shelterwood removal
T/CC	0.35	tractor cleacut
T/Selection	0.3	tractor select cut
T/STSS	0.25	tractor sanitation salvage
T/SWR	0.28	tractor shelterwood removal

Table 4. ERA fuels treatment codes and disturbance factors.

Fuel Treatment Codes	Disturbance Factor
Broadcast Burn	0.075
Hand Thin 200'	0.01
Masticate	0.05
Prune	0.015
Thin and Prune	0.03
Thin/masticate; pile/under burn; prune.	0.13

Table 5. ERA disturbance factors for proposed action harvest.

Slope Code	Disturbance Factor	Timber Harvest code	Disturbance Factor	Site prep code	Disturbance Factor
Lowest	1.5	R/C	0.20	H/BB	0.09
Mid	1.2	R/T	0.30	H/BC	0.04
Ridge	0.8	RR/C	0.20	T/BB	0.15
Lowest = valley bottom Mid = middle of hillslope Ridge = near top of ridge		RR/T	0.35	T/BC	0.10
		Th/C	0.15	WTY/BC	0.02
		Th/T	0.25	H = hand work T = tractor WTY = whole tree yard BB = broadcast burn BC = burn concentrations	
		C = cable yarding T = tractor R = regeneration harvest RR = riparian reserve thinning Th = thin heavy at > 8000 MBF			

Table 6. List of road widths used to calculate road area by road type.

Road Type Code	Road Type Description	Road Width (feet)
BL	Paved road	50
IP	Paved road	50
OT	Paved road	50
PT	Private trail	15
PV	Private road	50
SY	FS system road	45
TR	FS trail	15
UC	Unclassifed road	35
NR	New road	35

Table 7. Sediment budget background and disturbed erosion rates.

Formation Description	MAPUNIT	Natural Erosion Rate (tons/acre/ Q2)	Natural Erosion Rate (tons/acre/ Q25)	Disturbed Erosion Rate (tons/acre/ Q2)	Disturbed Erosion Rate (tons/acre/ Q25)
mica schist; impure marble; amphibolite	Da	0.05	0.1	0.1	0.8
gneiss & amphibolite in contact aureole of Shasta Bally batholith	Da?	0.05	0.1	0.1	0.8
Sector-collapse avalanche deposit of Shasta Valley block facies	df	0.85	2.5	1	6
coarse to fine-grained; foliated to massive hornblende schist	Ds	0.45	0.65	0.7	2
peridotite (part-to-total serpentinized); cm? tr?	Dum	0.4	1	0.8	2
biotite (&hb) quartz diorite - lesser granodiorite	Kqd_sb	2	10	3.5	15
unconsolidated gravels & conglomerate; fanglomerate; lucustrine; fluvial	Tw	1.35	2.5	1.35	8

Table 8. Sediment budget land-type upland sediment delivery factors.

Sed Delivery Code	Sed Delivery Factor
1/LOWEST	0.75
1/MID	0.42
1/RIDGE	0.08
2/LOWEST	0.83
2/MID	0.50
2/RIDGE	0.17
3/LOWEST	0.92
3/MID	0.58
3/RIDGE	0.25
4/LOWEST	1.00
4/MID	0.67
4/RIDGE	0.33

Sediment Delivery Code = factor that represents the delivered percent of hillslope erosion.

1 = slopes <35%

2 = slopes 35 to 45%

3 = slopes 45 to 65%

4 = slopes >65%

Lowest =lower hillslope and highly connected to stream network

Mid = middle hillslope and moderately connected to stream network

Ridge = upper hillslope and not connected to stream network

Table 9. Sediment budget road condition factors and erosion rates.

Q2 Surface type, cond, and div pot	Erosion rates (tons/ac/yr)	Q25 Surface type, cond, and div pot	Erosion rates (tons/ac/yr)
N/S/AGG	0.8	**N/S/AGG**	8
N/S/NAT	1	**N/S/NAT**	34
N/S/PAV	0.6	**N/S/PAV**	2
N/US/AGG	1	**N/US/AGG**	20
N/US/NAT	1.2	**N/US/NAT**	55
N/US/PAV	0.8	**N/US/PAV**	5
Y/S/AGG	1.1	**Y/S/AGG**	22
Y/S/NAT	1.2	**Y/S/NAT**	57
Y/S/PAV	1	**Y/S/PAV**	6
Y/US/AGG	1.3	**Y/US/AGG**	37
Y/US/NAT	1.5	**Y/US/NAT**	75
Y/US/PAV	1.2	**Y/US/PAV**	7

Appendix H: Wildlife Management Indicator Species

Appendix H: Wildlife Management Indicator Species

Introduction and Shasta-Trinity National Forest LRMP Requirements for MIS

NFMA Requirements for MIS

The Shasta-Trinity National Forest Land and Resource Management Plan was written under the 1982 implementing regulations for the National Forest Management Act. The National Forest Management Act ("NFMA") directs the Forest Service to manage for viable populations of native and non-native desired species. Under 36 CFR 219.19 we are mandated to "…**maintain viable populations of existing native and desired non-native vertebrate species in the planning area… In order to estimate the effects of alternatives (management actions) on fish and wildlife populations, certain vertebrate and/or invertebrate species present in the area shall be identified as management indicator species (MIS) and the reasons for their selection will be stated. These species shall be selected because their population changes are believed to indicate the effects of management activities."**

In addition, 36 CFR 219.19 section a(6) also states that "**population trends of the management indicator species will be monitored and relationships to habitat changes determined.**"

Changes in 2005 to the 1982 implementing regulations also provided that we could comply with our regulations "…by considering data and analysis relating to habitat unless the plan specifically requires population monitoring or population surveys for the species." As noted below, the Shasta-Trinity LRMP allows for monitoring of either population trend or habitat components.

The 2005 regulations also state that "[S]ite-specific monitoring or surveying of a proposed project or activity area is not required…"

LRMP Requirements for MIS

For terrestrial analysis, the Shasta-Trinity Land and Resource Management Plan (LRMP) identified nine wildlife habitat assemblages or their key habitat components for MIS analysis (USDA 1995, Pages 3-24). We consider an "assemblage" to be that collection of vegetation, species and conditions that characterize either a habitat type such as late-seral or a habitat component such as snags and downed logs. Key habitat components are those primary vegetative and conditional characteristics of the assemblage such as vegetation, density, seral stage, proximity to water, etc.

The LRMP states that the Forest "[U]se appropriate indicator species or habitat components to represent the assemblages" (USDA 1995, Page 5-16), allowing the forest to monitor either the population trends of appropriate indicator species or their habitat components. The LRMP did not, at that time, select individual species to represent these assemblages.

The Forest Wildlife Monitoring Plan in the LRMP also requires the Shasta-Trinity National Forest to survey for occupancy, reproductive success, population stability and growth, [and] ecological health" relative to the appropriate assemblage or assemblage representative. These factors are evaluated at the Forest Plan level. For more detailed information regarding the requirements of the

Shasta-Trinity National Forest LRMP relative to Management Indicators, please see the Shasta-Trinity National Forest Management Indicator Report.

Analysis at Appropriate Scales

Forest planning occurs at two levels: Forest and project. At the Forest level, the Forest Service develops a Forest Plan, which is a broad, long-term programmatic planning document for an entire National Forest. The Forest Plan looks at the Forest not only as a management unit, but also at its role in land and resource conservation within the larger context. Each Forest Plan includes goals and objectives for individual units of the forest and provides standards and guidelines for management of forest resources. The LRMP commits the Forest to complete Management Indicator monitoring at the Forest level using population trend or key habitat components. Key habitat components are used as a proxy for individual species trends when necessary.

The Forest monitors population trend data of selected species at various scales, each appropriate for the species and practical for data management. These scales include the feature (Bald Eagles on Shasta Lake for example), Forest (Peregrine Falcons for example), bioregional (Breeding Bird Survey data for example), the State (Mule Deer for example) and the range (northern spotted owl, for example).

To serve as management indicators, monitoring data at the larger scale is appropriate for management indicators for the following reasons:

1. Species populations do not always uniformly increase or decrease across their range. Bird population for instance typically show variable patterns of increasing and decreasing throughout their range as individuals shift from one area to another or breeding becomes more or less successful in one region. Looking at population trends from a larger scale helps determine the significance of trends.
2. Forests are somewhat arbitrary administrative boundaries that do not reflect the ecological conditions which control animal distribution. More ecologically similar units based on ecological and vegetative similarities such as the Breeding Bird Survey (BBS) strata or the Bird Conservation Units are more likely to reflect real trends.
3. The Forest is highly variable in habitat distribution. For example, at least four BBS strata cross the Forest. The larger scale enables us to look at more ecologically homogeneous areas relative to the species.

Assessing these population trends at larger, strata and range-wide scales aid us in understanding the larger context of variations in population trends. For example, the Hairy Woodpecker provides a reasonable indicator of snag components in late-seral forests. In northern California, its populations are increasing in some BBS strata and decreasing in others (http://www.mbr-pwrc.usgs.gov/bbs/htm03/trn2003/tr03930.htm). However, the range-wide data indicates an overall increasing population trend for this species (http://www.mbr-pwrc.usgs.gov/cgi-bin/plotpgm0.pl?/sula/jrs/bbs05/htmind/03930.sur). The distribution of increasing and decreasing trends at smaller scales may indicate *shifts* of populations or local advantages and disadvantages shifting with conditional changes. A look at larger scale increasing trends may tell us that bioregional decreases are less significant or on the other hand, may provide management a clue as to why species could be declining in one area yet increasing in another.

Project Level Analysis

For project-level Management Indicator analysis, we select and justify our selection of one or more appropriate species or their habitat components to represent each Assemblage for which habitat may be affected by the project. The representative species are based on their occurrence within the project area, their likelihood to have their breeding be affected by the project actions and the availability of data on their habitat and population trends.

Project-level effects on Management Indicators are analyzed and disclosed as part of environmental analysis under the National Environmental Policy Act (NEPA). This entails examining the impacts of the proposed project alternatives on management indicator *habitat* and relating these project-level impacts to broader scale (generally national forest, and, in some cases, bioregional) population and/or habitat trends. The appropriate approach for relating project-level impacts to broader scale trends depends on the terms in the LRMP. As stated above, under the 2005 National Forest System Land Management Planning Rule (2005 Planning Rule) (70 Federal Register 1060, January 5, 2005), national forests with LRMPs developed under the 1982 planning rule, including the Shasta-Trinity NF, “may comply with any obligations relating to MIS by considering data and analysis relating to habitat unless the plan specifically requires population monitoring or population surveys for the species” (36 CFR 219.14(f)).

Hence, where the Shasta-Trinity NF LRMP requires population monitoring or population surveys for a management indicator, the project-level effects analysis for that management indicator must be informed by population monitoring data, which are gathered at the bioregional scale. Population monitoring and survey data are not generally gathered for site-specific projects, consistent with the 2005 planning rule, which states, “Site-specific monitoring or surveying of a proposed project or activity area is not required, but may be conducted at the discretion of the Responsible Official” (36 CFR 219.14(f)). For its selected terrestrial assemblages, the Shasta-Trinity NF LRMP does not require population monitoring or surveys; for these management indicators, project-level management indicator effects analysis can be informed by habitat monitoring and analysis alone. The Shasta-Trinity NF LRMP requirements for MIS analyzed for the Browns Project are summarized above.

Therefore, adequately analyzing project effects to Management Indicators, including Threatened, Endangered, and Sensitive (TES) species that are also management indicators, involves the following steps:

- Identifying which management indicator assemblages have habitat that would be either directly or indirectly affected by the project alternatives; these management indicator assemblages are potentially affected by the project.
- Identifying the LRMP monitoring requirements for this subset of Forest management indicators.
- Analyzing project-level effects on management indicator habitats or habitat components.

- Discussing forest scale habitat and/or population trends for each management indicator potentially affected by the project.
- Relating project-level impacts on management indicator habitat to habitat and/or population trends for the affected management indicator at the forest scale.

These steps are described in detail in the Pacific Southwest Region's draft document "MIS Analysis and Documentation in Project-Level NEPA, R5 Environmental Coordination" (USDA 2006). This Management Indicator Report documents application of the above steps to select and analyze Management Indicators for the Browns Project.

Selection Process for Browns Project MIS

The MIS used for the Browns Project analysis were selected from the forest-wide list of nine MIS assemblages (comprehensive lists of vertebrate species associated with specific habitat types or components) in the LRMP (pages 3-11, 3-24 and 3-25,) using the process described below:

1. MIS Assemblages whose habitat ***is not*** **in or adjacent to** the project area **and** would not be affected (either directly or indirectly) by the project and thus are excluded from analysis.
   a. All habitat types associated with the nine MIS assemblages lie within or in the vicinity of (i.e., arguably adjacent to) the Browns Project area.
2. MIS Assemblages whose habitat ***is*** **in or adjacent to** the project area **and would not be affected** (either directly or indirectly) by the project and thus are excluded from analysis.
   a. **Openings and Early Seral Stage Assemblage**: Based upon field reviews and habitat mapping, existing openings and early seral stage habitat would not be affected by either of the action alternatives. These open habitat types are not vulnerable to negative "edge effects" related to adjacent proposed actions.
   b. **Riparian Assemblage**: Based upon field reviews and habitat mapping, riparian habitat would not be affected by either of the action alternatives. While actions are proposed within 'riparian reserves,' the habitat type in these areas is indistinguishable from the adjacent forest habitat and is not riparian habitat (i.e., characterized by vegetation such as willows, cattails, etc.). Riparian habitat does not occur near enough (roughly 300 feet) to proposed actions to be negatively impacted by "edge effects."
   c. **Chaparral Assemblage**: Based upon field reviews and habitat mapping, existing chaparral habitat would not be affected by either of the action alternatives. This open habitat type is not vulnerable to negative "edge effects" related to adjacent proposed actions.
   d. **Cliffs, Caves, Talus, and Rock Outcrops Assemblage**: Based upon field reviews, these habitat types would not be affected by either of the action alternatives. They do not occur within areas proposed for treatment or near enough (roughly 300 feet) to be negatively impacted by "edge effects". Surface rock does occur scattered throughout the areas proposed for treatment but does not represent talus or rock outcrop habitat with the

associated interstitial spaces or crevices that provide microhabitat areas (e.g., cooler and moister conditions than surrounding areas) or cover for wildlife species.

e. **Multi-Habitat Assemblage**: This habitat assemblage was created not to address the biodiversity on the Shasta-Trinity National Forest, but rather the hunting public's desire to enhance game species' populations (e.g., the LRMP page 3-25 lists black bear, dear, elk, turkey as members of this assemblage). Historically, timber harvest was dominate by clear-cutting that converted forested habitat to open shrub-dominated "forage" habitat (albeit relatively short-lived; but replenished with the next timber sale) that benefited species in this assemblage such as deer. The small (<2 acres) openings that would be created with the proposed landings in Alternatives 3 and 4 (totaling 39 and 25 acres respectively) would not result in a detectable impact on populations of species in this assemblage. Therefore, this assemblage will not be further analyzed.

3. MIS assemblages whose **habitat would be affected** (either directly or indirectly) by the project and thus will be carried forward for analysis.

   a. **Late Seral Assemblage:** Based upon field reviews and habitat mapping, late seral habitat (late-successional/old-growth) would be measurably affected by either of the action alternatives. Snags /logs and individual hardwoods, while not "habitat types" in isolation, are important components of late seral (late-successional habitat (see below). **NOTE:** The terms "late seral" or "late seral stage" used in the LRMP are synonymous with the term **late-successional** in the context of this document. Late-successional is the term used in the NWFP and most other supporting documents.

      - **Snag and Down Log Assemblage**. Both action alternatives would affect existing and future snag and log densities as components within late-succession habitat.
      - **Hardwood Assemblage**. Both action alternatives would affect existing and future hardwood density as a component of late-successional habitat. Hardwood habitat (i.e., oak woodland or areas dominated by hardwoods) would not be affected.

   b. **Aquatic Assemblage**: Based upon field reviews and stream surveys, aquatic habitat may be measurably affected by either of the action alternatives due to an increased potential for sediment delivery into streams. Aquatic habitat not related to flowing streams (e.g., ponds, lakes etc.) would not be affected.

Selection of MIS to Represent the Assemblages Associated With Potentially Affected Habitat

Again, based upon field reviews and habitat mapping, only late-succession (late seral stage) habitat (and the associated snag/log and hardwood components) and aquatic habitat would likely be measurably affected by either of the action alternatives.

The **northern spotted owl** (*Strix occidentalis caurina*) was selected as the Browns Project MIS for primarily the late seral stage assemblage but also for the associated snag & down log and hardwood assemblages for the rational described below:

- On the Shasta-Trinity National Forest, the northern spotted owl is strongly associated with late seral (late-successional and especially old-growth) conifer forest habitat that includes snags/logs and hardwoods as important components (Thomas et al. 1990, USDI 1990). Owls use snags for nesting sites and both snags and logs provide habitat for owl prey species. Hardwoods provide structural diversity and lower (cooler) roosting sites important to owls for thermoregulation in the heat of the summer.
- A well recognized relationship exists between effects to habitat and owl populations. The loss or adverse modification of suitable habitat was a primary reason for the spotted owl being listed as threatened under the Endangered Species Act (Act) of 1973, as amended (USDI 1990).
- The wealth of information on the demography of the northern spotted owl is unique. For no other threatened or endangered species do we have such extensive information on population trends and the factors affecting them. Reported demographic studies are among the most significant achievements in conservation biology (Courtney et al. 2004).
- The project would affect snag/log and hardwood densities *only* within late-successional habitat. Snags/logs and hardwoods are essential components of this habitat type. Analyzing these components out of context from a habitat type would be inappropriate and in many cases misleading. For example, regeneration harvesting could remove many snags/logs and hardwoods while maintaining only a few in newly created open habitat (i.e., plantations). This would indicate a positive effect for these assemblages if the chosen indicator species was also associated with a more open habitat type (e.g., the acorn woodpecker). To then claim a positive effect for the snag/log and hardwood assemblages would be misleading. That is to say, the true issue is the effect to snag/log/hardwood-associated species **within the context of** the affected habitat type (i.e., late-successional).
- Northern spotted owl pairs occupy large home ranges. Maintaining a viable owl population would therefore provide large areas of habitat for a larger population of species associated with late-successional forest habitat (and snag/logs, hardwoods within forest habitat) whose home ranges are smaller. Conversely, negative trends detected for the spotted owl may indicate worse trends (as measured by numbers of individuals affected) for species with smaller home ranges.

The **winter-run steelhead** (*Oncorhynchus mykiss*) was selected as the Browns Project MIS for both fish and the aquatic wildlife assemblages because of their strong association with aquatic habitat and a well recognized relationship between effects to habitat due to sedimentation and their breeding success. For example, the steelhead’s breeding biology (depositing their eggs in the stream-bottom gravel), renders their eggs and early life stages more sensitive to sedimentation and suffocation than would be the yellow-legged frog that deposits their eggs on vegetation, rocks, etc. in the water column. The MIS analysis for the steelhead is included in Chapter 4.

Project Level Effects Analysis

Northern Spotted Owl Habitat Relationships

The northern spotted owl is strongly associated with conifer stands that include the following characteristics: a multi-layered, multi-species (*including hardwoods*) canopy dominated by large overstory trees; moderate to high canopy closure; a high incidence of trees with large cavities and other types of deformities; *numerous large snags*; an abundance of large dead wood on the ground (*logs*); and open space within and below the upper canopy for spotted owls to fly (Thomas et al. 1990, USDI Fish and Wildlife Service 1990a). Nest sites are usually located within stands of old-growth and late-successional (late seral) forest dominated by Douglas-fir containing structures such as cavities, broken tree tops, or mistletoe (*Arceuthobium* spp.) brooms (Forsman et al. 1984, Blakesley et al. 1992, LaHaye and Gutierrez 1999). In redwood forests along the coast range of California, spotted owls may be found in younger forest stands with structural characteristics of older forests (Thomas et al. 1090). In the vicinity of the Browns Project these habitat characteristics are essentially restricted to old-growth, and to a lesser extent other late seral (mature late-successional) conifer stands. Recent landscape-level analyses suggest that a mosaic of late-successional habitat interspersed with other vegetation types may benefit spotted owls more than large homogeneous expanses of older forests (Zable et al. 2003, Franklin et al. 2000, Meyer et al. 1998) presumably by providing more foraging opportunities. Foraging habitat is the most variable of all habitats used by territorial spotted owls (Thomas et al. 1990). Descriptions of foraging habitat have ranged from complex structure (Solis and Gutierrez 1990) to forests with lower canopy closure and smaller trees than nesting/roosting habitat (Gutierrez 1996).

Definition of Spotted Owl Nesting, Roosting and Foraging Habitat

Appendix D part 1 (the Brown Project Wildlife Biological Assessment) includes an attachment that provides habitat definitions and the assumptions used to analyze late-successional and old-growth habitat. Table 1 displays the crosswalk between the two main stand attributes used (size class and canopy closure; e.g., 4G) and habitat specific to the spotted owl. Figure 1 displays a visual generalization of relative owl habitat quality related to size class and canopy closure.

Old-growth (4N/G) provides “high quality” owl nesting/roosting habitat. Younger densely to moderately canopied late-successional stands provide “moderate” quality owl nesting/roosting habitat (3G) and foraging habitat (3N) respectively. There is a clear distinction between old-growth and late-successional habitat. Late-successional (late seral) is defined simply as conifer stands at least 80 years old regardless of other stand attributes such as level of decadence or canopy closure. Old-growth is a subset of late-successional and is defined as a forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; a high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground (NWFP ROD page F-4).

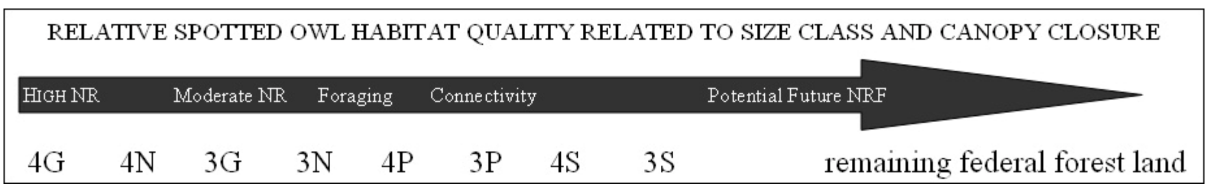
Definition of Connectivity (Dispersal) Habitat

Connectivity habitat is defined as conifer stands meeting at least “11-40” conditions (i.e., an average conifer of at least 11 inches diameter at breast height and at least 40 percent canopy closure) (Thomas et al. 1990). In this analysis, functional connectors are defined as those that lead to outside dispersal habitat leading to main drainages, had at least marginally suitable dispersal habitat, not less than 200 feet wide (generally over 300 feet wide), with gaps no more than 400 feet (generally less than 200 feet). This definition was based upon the habitat capability models for fisher and marten (Freel 1991). Field reviews in the project area and vicinity suggest that, in addition to nesting/roosting/foraging habitat, the following size class/canopy closures generally provide suitable connectivity habitat: 4P, 4S, 3P, 3S, 2G and 2N.

Table 1. Spotted owl nesting/roosting (NR), foraging (F) and connectivity habitat related to late-successional (late seral) and old-growth habitat analysis and definitions presented in the Browns Project wildlife biological assessment.

Nesting/Roosting (NR)	4G & 4N (high quality NR; old-growth), and 3G (moderate quality NR)
Foraging (F)	3N
Connectivity (dispersal habitat)	(the above plus) 4P, 4S, 3P, 3S, 2G and 2N
Capable (potential future NRF)	all remaining Federal Forest Land

Figure 1. General spotted owl nesting/roosting (NR), foraging (F) and connectivity habitat quality related to size class and canopy closure described in Appendix D, can be listed from higher to lower quality as follow



Spotted Owl Habitat Quantity (Spatial Scale)

Describing habitat conditions in the terms of quantity requires a boundary or spatial scale. Four scales were used to analyze spotted owl habitat: 1) the spotted owl **Action Area**, 2) a spotted owl **Home Range,** 3) a spotted owl **territory (or “core area”)** and 4) the **Weaverville 5th Field Watershed**. The definitions for these areas and the rational for their inclusion follow:

- The 16,266-acre **spotted owl Action Area** is the *primary area* analyzed for this project-level MIS analysis. It was established by a 1.3 mile buffer around all areas proposed for treatment (i.e., proposed harvest units, roads and landings). This 16,266-acre area was deemed appropriate for the following reason: Based on available radio-telemetry data (Thomas et al. 1990), the U.S. Fish and Wildlife Service (FWS) estimated the median annual home range size for the northern spotted owl in California. Because the actual configuration of a home range is rarely known, the estimated home range of a northern spotted owl pair in California is represented by a 1.3-mile circle (3,340 acres) centered upon an owl activity center (e.g., nest site). Suitable habitat within a home range would likely be utilized to some extent within any given year by territorial owls. Therefore, any effects to habitat, both positive and negative, due to the Browns Project would likely affect any current or potential future owl activity centers in the area. That is to say, habitat affected by the Browns Project would fall with the home ranges of any owls nesting in the owl Action Area.

- This analysis includes the individual **home range** (see above) and **territory** (“core area”) associated with one known owl activity center (state ID# TR150) that would experience effects to existing habitat due to the Browns Project. The FWS uses a 0.7-mile radius circle to delineate the area most heavily used (territory or “core area”) by owls during the nesting season. These areas assisted the FWS during project consultation related to possible impacts to individual owl pairs.
- The 54,000-acre **Weaverville 5thField Watershed** was analyzed specific to the 15% S&G. This watershed encompasses the project area and the NWFP ROD establishes the 5th field watershed as the appropriate context for landscape-level analyses for the 15% S&G. Of the 20,533 acres of federal forest land in the watershed, approximately 15,418 acres (75 percent) are currently late-successional forest (see Appendix D). Old-growth currently comprises 2,300 acres (11.2%) of the 20,533 acres of federal forest land in the watershed.

Nesting, Roosting and Foraging Habitat Quantity

The owl Action Area includes 814 acres of high quality NR habitat (i.e., old-growth), 2,136 acres of moderate quality NR habitat (dense mature stands), and 527 acres of foraging habitat (moderately dense mature stands) (see. Table 2 “Existing Available Habitat” columns). Table 2 also presents this information related to the home range and territory (core area) of the one known owl activity center (state ID# TR150) in the project vicinity.

Connectivity Habitat Quantity

Based upon habitat mapping, aerial photograph interpretation, and field reviews, the 5,848 acres of connectivity through the Forest Service portions of the Action Area provide good connectivity. However, connectivity habitat through the entire 16,266-acre Action Area appears to be relatively discontinuous in privately owned areas, over which we have no control, due to intensely managed timber industry land, residential land (including the town of Weaverville) along with naturally occurring harsh, sparsely vegetated areas.

Effects to MIS Spotted Owl Habitat

The actions proposed in Alternatives 3 and 4 would have direct short-term (<30 years) negative effects and indirect long-term (>30 years) net benefits to spotted owl habitat.

Direct Short-Term Effects to Owl NRF Habitat (<30 years)

Alternatives 3 and 4 would affect owl habitat in the short-term in four general ways related to key characteristics of late-successional and old-growth habitat:

- **REDUCTION IN OVERALL CANOPY CLOSURE:** This is the major short-term impact of the action alternatives. A moderate to dense canopy closure moderates environmental extremes (e.g., temperature, rain/snow fall, etc.). This effect is related to thinning, regeneration (landings), and road construction.

- **SIMPLIFICATION IN VERTICAL STRUCTURE:** Multiple canopy levels provided by understory conifers and hardwoods provide lower (cooler) roost sites in the hot summer months and provide perch sites for foraging and eating. This effect is related to thinning, regeneration, and new road construction. The proposed thinning and riparian prescriptions target viable understory hardwoods for retention.
- **REDUCTION IN SMALLER DIAMETER (<24" DBH) SNAGS AND LOGS:** Snags can provide owl nest sites and both snags and logs provide habitat for owl prey species. Few large (>24"dbh) snags or logs would be removed by the proposed fuels treatments. Long-term experience suggests that spotted owls would not likely use snags less than 24"dbh for nest sites.
- **REDUCTION IN POTENTIAL NESTING OPPORTUNITIES:** Larger decadent (broken-topped) conifers and snags provide typical nest sites for spotted owls. This effect is related to regeneration, and new road construction (i.e., removal, see effects intensity below) within existing NR habitat. The proposed thinning and riparian prescriptions target larger conifers and snags for retention.

Alternatives 3 and 4 would affect approximately 545 and 457 acres of existing NRF habitat respectively. Effects to existing NRF habitat are analyzed at three categories of intensity (see below). Table 2 presents the amount (acres) of each habitat type that would be affected, segregated by relative habitat quality, effects intensity (described below) and the three spatial scales: 1) the owl Action Area, and 2) the home range and 3) territory (core area) of the one known owl activity center (state ID# TR150) that would experience effects to existing habitat.

Effects Intensity

- **Removed** indicates the habitat would no longer function as late-successional habitat at any level resulting from *regeneration prescriptions* and *road construction*. Long-term experience with similar treatments indicates that regenerated areas should recover to connectivity habitat conditions in roughly 35 to 40 years after the first commercial thinning. Foraging habitat and nesting/roosting habitat conditions should develop in roughly 80 years and 100+ years respectively.

  Alternative 3:
  - 2 acres high quality nesting/roosting habitat (4G)
  - 15 acres moderate quality nesting/roosting habitat (3G)
  - 10 acres foraging habitat (3N)

  Alternative 4:
  - zero acres high quality nesting/roosting habitat (4G)
  - 9 acres moderate quality nesting/roosting habitat (3G)
  - 9 acres foraging habitat (3N)

- **Downgraded** indicates a temporary reduction (about 30 years) owl nesting/roosting habitat down to foraging habitat resulting from *thinning prescriptions* within existing moderate quality nesting/roosting habitat (3G). There would be a reduction in overall canopy closure from and existing 70-90% down to approximately 40-60% and a reduction in smaller diameter (≤19" diameter at breast height) recruitment snags and logs (live trees that will provide for snags and logs into the future). The retention of large predominant (legacy) conifers, larger snags (>19") and viable hardwoods would maintain snags and decadent conifers large enough to provide owl nest sites and contribute to vertical structure. Visual estimates based upon field reviews indicate that the LRMP S&G of 1.5 snags and 5 tons of course woody material (i.e., logs) would be met at a 40-acre average. Thinning within existing owl foraging habitat would maintain foraging habitat conditions.

  Alternative 3:
  - zero acres high quality nesting/roosting habitat (4G)
  - 275 acres moderate quality nesting/roosting habitat (3G)
  - zero acres foraging habitat (3N)

  Alternative 4:
  - zero acres high quality nesting/roosting habitat (4G)
  - 210 acres moderate quality nesting/roosting habitat (3G)
  - zero acres foraging habitat (3N)

- **Degraded** indicates some habitat components (e.g., smaller snags, canopy closure ≥ 60%, and vertical structural complexity) may be somewhat reduced but the habitat would continue to function at the current level resulting from *thinning* within high quality NR (4G) and foraging habitat (3N) and *riparian reserve prescriptions* within NRF habitat. The retention of large predominant (legacy) conifers, larger snags (>19") and viable hardwoods would maintain snags and decadent conifers large enough to provide owl nest sites and contribute to vertical structure.

  Alternative 3:
  - 59 acres high quality nesting/roosting habitat (4G)
  - 22 acres moderate quality nesting/roosting habitat (3G)
  - 162 acres foraging habitat (3N)

  Alternative 4:
  - 52 acres high quality nesting/roosting habitat (4G)
  - 22 acres moderate quality nesting/roosting habitat (3G)
  - 155 acres foraging habitat (3N)

Indirect Long-Term (≥30 years) Effects to Owl NRF Habitat

The thinning (including riparian reserve) prescriptions within existing NRF habitat and other conifer stands not currently NRF would result in a net increase of forest stands with old-growth (nesting/roosting habitat) characteristics after about 30 years. For example, in approximately 30 years Alternative 3 would result in an increase of conifer habitat with old-growth characteristics to 1,201 acres from the existing 814 acres within the owl Action Area (Figure 2).

The proposed thinning within the overcrowded conifer stands would improve the health of these forest areas by making more water, nutrients, and sunlight and growing space available to the remaining trees (conifers as well as hardwoods). In addition, the smaller trees that would be removed act as fuel ladders because their crowns are closer to the ground and allow flames to move into the canopy that could lead to loss of NRF habitat. Long-term experience with thinning conifer stands indicates that within about 30 years the thinned (degraded) old-growth would have recovered and thinned late-successional stands (including stands that are currently below owl foraging habitat conditions) would have redeveloped a moderate to dense canopy closure. The conifers would have developed larger, fuller crowns with larger lateral branches. These trees would ultimately provide recruitment for larger snags and logs. Small diameter (<19” dbh) snags and logs would be rare because of the past removal of smaller diameter recruitment trees. Understory hardwoods would have persisted in the stands adding to vertical structural complexity. Most of the preexisting large snags and logs would still be present.

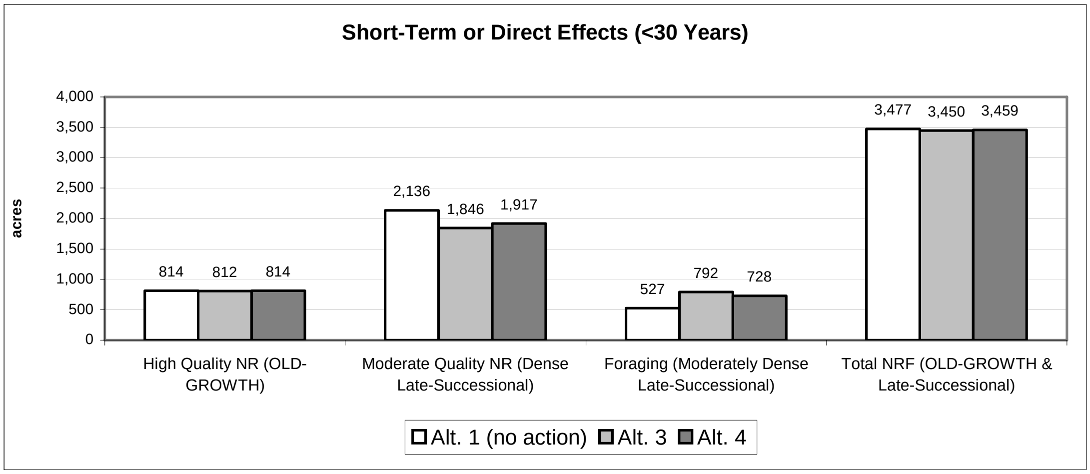
Effects to Connectivity

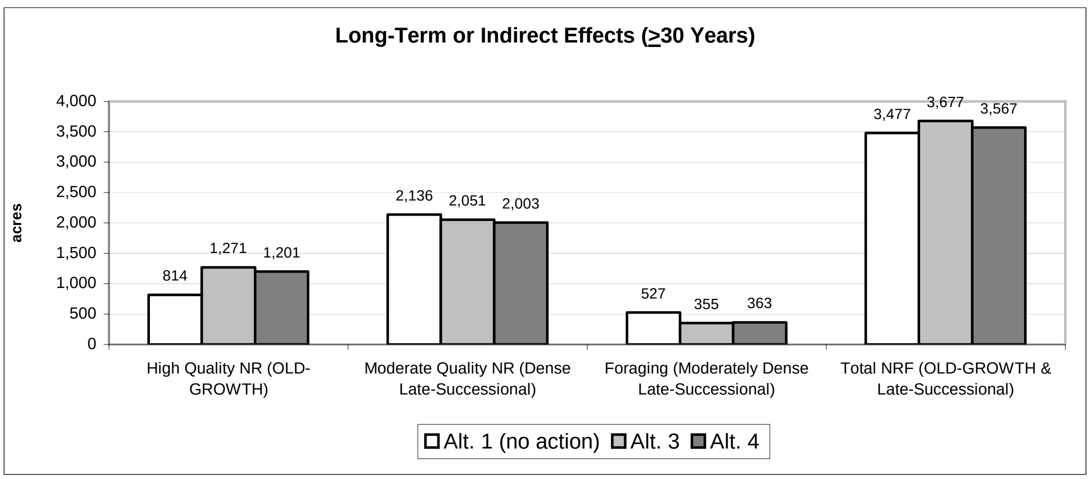
Only regeneration units (i.e., landings) and road construction would take existing connectivity habitat below 11-40 conditions. The small size of the landings (2 acres and, at the most, roughly 300 feet at their widest) and the narrow impacts from the roads (roughly 30 feet wide) would not likely reduce the free movement of owls through Forest Service portions of the Action Area. Additionally, proposed thinning prescriptions in mature conifer stands would result in a long-term (≥30 years) net increase in high quality owl NRF habitat in the long-term (i.e., high quality connectivity habitat). Private residential property and heavily managed private timberland in the Action Area will likely continue to limit connectivity in the Action Area.

Table 2. Browns Project Alternatives 3 and 4 effects (acres) to spotted owl nesting/roosting (NR) and foraging (F) habitat within the *spotted owl "Action Area*" and within the *home range* and the *territory* or *"core area"* of the one known owl activity center (state ID# TR150) that would experience effects to existing habitat. The percent of the existing available habitat within these areas that would be affected is in shaded cells.

Spotted Owl "Action Area"												
Effects Intensity to Habitat	**Old-Growth (high quality NR habitat)**			**Dense Late-Successional (moderate quality NR habitat)**			**Mod. Dense Late-Successional (foraging habitat)**			**Total NRF Habitat**		
	Existing Available Habitat	**Alt. 3**	**Alt. 4**	**Existing Available Habitat**	**Alt. 3**	**Alt. 4**	**Existing Available Habitat**	**Alt. 3**	**Alt. 4**	**Existing Available Habitat**	**Alt. 3**	**Alt. 4**
Removed	**814**	**2**	**0**	**2,136**	**15**	**9**	**527**	**10**	**9**	**3,477**	**27**	**18**
		O.2%	0%		0.7%	0.4%		**1.9**%	**1.7**%		**0.8**%	**0.5**%
Downgraded		**0**	**0**		**275**	**210**		**0**	**0**		**275**	**210**
		0%	0%		12.9%	9.8%		0%	0%		7.9%	6.0%
Degraded		**59**	**52**		**22**	**22**		**162**	**155**		**243**	**229**
		7.2%	6.4%		1.0%	1.0%		30.7%	29.4%		7.0%	6.6%
TOTAL		**61**	**52**		**312**	**232**		**172**	**164**		**545**	**457**
		7.5%	6.4%		14.6%	10.9%		32.6%	31.1%		15.7%	13.1%
Spotted Owl Home Range												
Removed	**245**	**1**	**0**	**1,183**	**12**	**9**	**288**	**10**	**9**	**1,716**	**23**	**18**
		O.4%	0%		1.0%	0.8%		3.5%	3.1%		1.3%	1.0%
Downgraded		**0**	**0**		**222**	**180**		**0**	**0**		**222**	**180**
		0%	0%		18.8%	15.2%		0%	0%		12.9%	10.5%
Degraded		**26**	**52**		**18**	**18**		**162**	**154**		**206**	**198**
		10.6%	6.3%		1.5%	1.5%		56.3%	53.5%		12.0%	11.5%
TOTAL		**27**	**52**		**252**	**207**		**172**	**163**		**451**	**396**
		11.0%	6.3%		21.3%	17.5%		59.7%	56.6%		26.3%	23.1%
Spotted Owl Territory or "Core Area"												
Removed	**138**	**0**	**0**	**315**	**3**	**2**	**18**	**0**	**0**	**471**	**3**	**2**
		0%	0%		1.0%	0.6%		0%	0%		0.6%	0.4%
Downgraded		**0**	**0**		**88**	**81**		**0**	**0**		**88**	**81**
		0%	0%		27.9%	25.7%		0%	0%		18.6%	17.2%
Degraded		**10**	**10**		**7**	**7**		**5**	**5**		**22**	**22**
		7.2%	7.2%		2.2%	2.2%		27.8%	27.8%		4.7%	4.7%
TOTAL		**10**	**10**		**98**	**90**		**5**	**5**		**113**	**105**
		7.2%	7.2%		31.1%	28.6%		27.8%	27.8%		24.0%	22.3%

Figure 2. Short-term (direct) and long-term (indirect) effects to spotted owl nesting/roosting (NR) and foraging (F) habitat within the spotted owl Action Area. The short-term graph displays the immediate before (i.e., the no action alternative) and after project implementation comparison. Old-growth (high quality NR) is displayed separately to focus on the old-growth concern apart from overall owl habitat (late-successional).





Overall Baseline/Threshold/Desired Habitat Conditions

The Northwest Forest Plan is the current conservation strategy for the spotted owl (and other species associated with late-successional and old-growth forest ecosystems) on Federal lands. It is designed around the conservation needs of the spotted owl and based upon the designation of a variety of land-use allocations whose objectives are either to provide for population clusters [i.e., demographic support (relating to the dynamic balance of a population especially with regard to density and capacity for expansion or decline)] or to maintain connectivity between population clusters. Several land-use allocations are intended to contribute primarily to supporting population clusters: Late-Successional Reserves (LSRs), Managed Late-Successional Areas (MSLAs), Congressionally Reserved Areas (CRAs; e.g., wilderness areas), Managed Pair Areas and Reserve Pair Areas. The remaining land-use allocations [Matrix, Adaptive Management Areas (AMAs), Riparian Reserves (RRs), Connectivity Blocks, and Administratively Withdrawn Areas (AWAs)] provide connectivity between habitat blocks intended for demographic support.

All actions proposed in the Browns Project lie within the Hayfork Adaptive Management Area. As such, the area's main assigned biological role in the overall strategy for maintaining viable populations of species associated with late-successional forest ecosystems (as described in the Northwest Forest Plan FSEIS, the subsequent ROD, and the Shasta-Trinity LRMP) involves three main factors: **1)** connectivity; **2)** the 15% S&G; and **3)** maintaining and protecting the best owl habitat as close as possible around known (as of January 1, 1994) owl activity centers (see LRMP page 4-63).

1. **Connectivity** does not necessarily mean that LSRs etc. have to be physically joined in space. However, conditions between these areas must be compatible with the movement of species associated with late-successional forest habitat, such that they are both capable of moving through these habitats and inclined to do so (see discussion above and Chapter 3).

   Both Alternatives 3 and 4 maintain adequate connectivity through in the short-term and improve connectivity in the long-term on Forest Service land (see discussion above and in Chapter 3).

2. **The 15% S&G** addresses biological and structural diversity across the landscape, regardless of land use allocation, specific to species associated with late-successional forest habitat.

   Both Alternative 3 and 4 fully meet the 15% S&G in the short-term, help protect existing and developing late-successional habitat form wildfire, and accelerate the development of forest stands with old-growth characteristics in the long-term.

3. **Maintaining habitat around known owl activity centers** is intended to preserve an intensely used portion of the breeding season home range. Management around these areas should be designed to reduce the risk of natural disturbance such as intense wildfire.

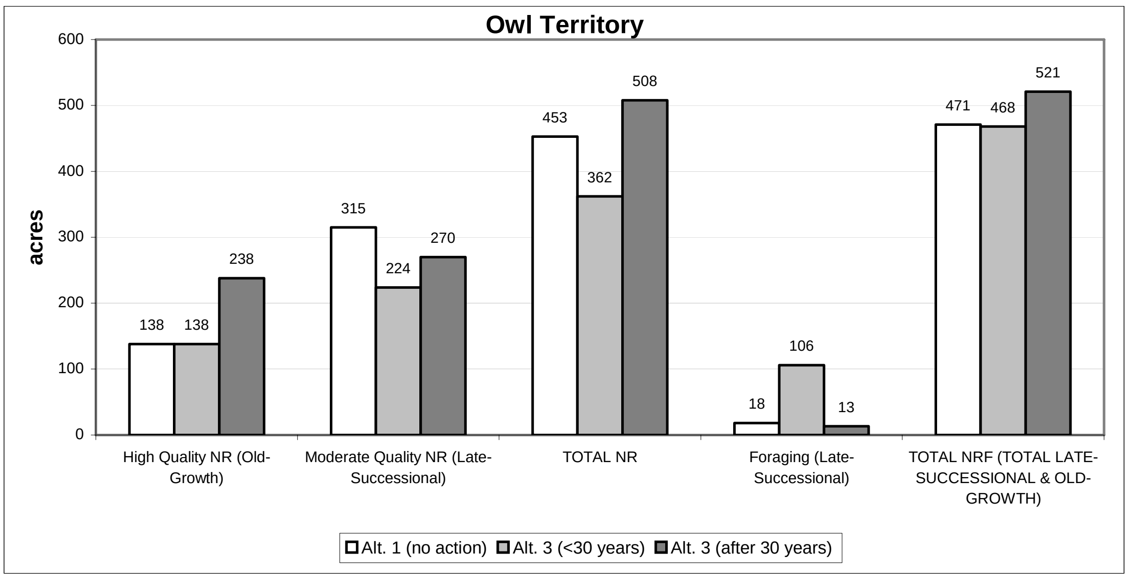
   The one known owl activity center (last confirmed presence in 1998) occurs in the Action Area. A 100-acre protected area has been established around this activity center comprised of the best available contiguous habitat. Alternatives 3 and 4 reduce the risk of intense wildfire around this area.

Individual Owl Activity Center Baseline/Threshold/Desired Habitat Conditions

Within the 0.7 mile radius area around the activity center, nesting spotted owls in northern California focused their activities in habitat within these core areas that ranged from about 167 to 454 acres, with a mean of about 409 acres or about half the core area (Bingham and Noon 1997). Other research has demonstrated that spotted owl abundance and productivity decrease when suitable habitat within 0.7 miles of an activity center falls below 500 acres (O'Halloran 1989, Simon-Jackson 1989, Thomas et al. 1990). The one known owl activity center (i.e., historic, last confirmed presence in 1998) in the Action Area currently has 471 acres of NRF habitat in the core area. This is well above the mean and higher range of focused habitat use reported by Bingham and Noon (1997) but somewhat below the 500 acre threshold reported by O'Halloran, Simon-Jackson and Thomas (1989, 1989 and 1990 respectively)(Table 2).

Alternatives 3 and 4 avoid the 100-acre protected area around activity center (state ID TR150) but would remove 3 acres and 2 acres of NRF habitat within the core area leaving 468 and 469 acres respectively. This is above the mean and higher range of focused habitat use reported by Bingham and Noon (1997) but below the 500 acre threshold reported by O'Halloran (1989), Simon-Jackson (1989) and Thomas (1990) (Table 2). Alternatives 3 and; to a lesser extent, since fewer acres would be treated, Alternative 4; would improve owl habitat conditions in the long term (Figure 3).

Figure 3. Current owl habitat conditions (Alternative 1, no action), conditions from just after implementing Alternative 3 through about 30 years and conditions after about 30 years within the Spotted Owl Territory (state ID TR150). We expect no significant changes in habitat conditions in 30+ years with Alternative 1.



Cumulative Effects

The Shasta-Trinity National Forest has no foreseeable projects that would remove or downgrade existing owl NRF habitat within the owl Action Area. Appendix D (the Brown Project Wildlife Biological Assessment) includes an attachment that presents an analysis of current forest conditions within the Weaverville Watershed (that encompasses the Action Area) that incorporates past actions that led to those conditions. Mid-mature conifer forest dominates Federal land within the roughly 16,266-acre action area because of fire and historic timber harvest activities. Over time, older conifer forest habitat within the action area will likely be restricted to Federal land (approximately 6,431 acres of NRF and potential/capable habitat). Existing non-conifer areas such as hardwood and shrub dominated habitats and riparian vegetation would remain largely intact on both federal and private lands. The action area includes approximately 8,400 acres of private property that is either intensively managed for timber production or is residential (including the town of Weaverville).

On March 30, 2005, Dr. Danielle Chi (Wildlife Biologist, U.S. Fish and Wildlife Service, USFWS, Red Bluff Field Office) and Ron Clementsen (Forest Plan Program Leader, U.S. Fish and Wildlife Service, USFWS, Red Bluff Field Office), Laura Finley (Wildlife Biologist, Endangered Species Program, U.S. Fish and Wildlife Service, Yreka Field Office), Kelly Wolcott (Forest Wildlife

Biologist, Shasta-Trinity National Forest) and Tom Quinn (Browns Project Wildlife Biologist, Trinity River Management Unit, Shasta-Trinity National Forest) met to discuss cumulative effects related to the Browns Project and forest management on private lands in the project area vicinity. Laura Finley provided maps and brief descriptions of all the private timber harvest plans (THPs) for projects in the owl Action Area for which the Yreka FWS office provided "technical assistance". Our inspections of 2003 aerial photographs of the THP areas indicated that the projects had been implemented and are accounted for (85% ground verified) in the Browns Project Hydrology report completed by Jim Fitzgerald (hydrologist, Shasta-Trinity National Forest). The meeting further revealed that the definition of spotted owl habitat used in the THP process is very much broader than the definition used in this document. Areas considered suitable owl habitat on private land during the THP process would largely barely qualify as connectivity habitat using the definitions of owl habitat used in this document. In this light, the description of cumulative effects on private property related to owl habitat is accurate (i.e., little owl habitat will occur on private property).

Forest Scale Habitat and/or Population Trends

In order to provide for a viable population of spotted owls throughout their historic range, including the Shasta-Trinity National Forest, the Shasta-Trinity National Forest LRMP (USDA 1995, Pages 3-27) established a network of Late-Successional Reserves (LSRs) in concurrence with the *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (ROD) issued on April 13, 1994.

The Forest Monitoring Action Plan (USDA 1995, Pages 5-18) commits us to review project plans and implementation to ensure compliance with the ROD and to determine population and habitat condition trends for the owl. In order to comply with this and to promote the conservation and recovery of the northern spotted owl, the Forest monitors habitat characteristics across the Forest, collaborates with the Bureau of Land Management and researchers in determining population trends across the range of the owl and conducts direct counts of breeding pairs in samples of suitable habitat. The following summarizes much of the extensive literature on the population trends of the northern spotted owl.

Courtney et al. (2004, Table 3) report the most current estimated rate of population change (PC) for the northern spotted owl where a stable population is indicated by PC = 1, a declining population by PC < 1, and an increasing population by PC > 1. PC ranged from 0.896 to 1.005 and was <1.0 on 12 of 13 range-wide study areas. However, in only four of these 12 were 95% confidence intervals for PC < 1. Evidence for owl population decline was weak on the three study areas closest to the Browns Project Area (i.e., Klamath, NW California and Hoopa study areas).

The wealth of information on the demography of the northern spotted owl is unique. For no other threatened or endangered species do we have such extensive information on population trends and the factors affecting them. The demographic studies reported here are among the most significant achievements in conservation biology. Yet, the information is still far from complete, and inadequate to make critical assessments. While northern spotted owl populations appear to be in decline, it is not possible to determine whether this decline is greater than that predicted at the time of the NWFP (Courtney et al. 2004).

Table 3. Estimated rate of population change (PC) for Northern Spotted Owls, with standard error and 95% confidence interval (as reported in Courtney et al. 2004, Table 8.5). The three study areas closest to the Browns Project Area are shaded.

	PC[1]	Standard Error	95% Confidence Interval	
			Lower	Upper
CALIFORNIA				
NW California	0.985	0.013	0.959	1.011
Hoopa	0.980	0.019	0.943	1.017
Simpson	0.970	0.012	0.947	0.993
OREGON				
Coast Ranges	0.968	0.018	0.932	1.004
H.J. Andrews	0.978	0.014	0.950	1.005
Warm Springs	0.908	0.022	0.866	0.951
Tyee	1.005	0.019	0.967	1.043
Klamath	0.997	0.034	0.930	1.063
S. Cascades	0.974	0.035	0.906	1.042
WASHINGTON				
Wenatchee	0.917	0.018	0.882	0.952
Cle Elum	0.938	0.019	0.910	0.976
Rainer	0.896	0.055	0.788	1.003
Olympic	0.956	0.032	0.839	1.018

[1]A stable population is indicated by PC = 1, a declining population by PC < 1, and an increasing population by PC > 1.

The following conclusion [cited from pages 33 and 34 of the U.S. Fish and Wildlife Service's Formal Consultation for the Browns Project (refer to 1-12-2005-F-12), often referred to as the "Biological Opinion"] documents the relationship between the Browns Project and the conservation and recovery strategy of the northern spotted owl in the context of the Endangered Species Act (Act) of 1973, as amended (USDI 1990). This opinion was based on Alternative 3; Alternative 4 would have less impact:

> After reviewing the current status of the northern spotted owl, the environmental baseline, the effects of the Proposed Action (i.e., Alternative 3), and the cumulative effects, it is the Service's biological opinion that implementation of the Browns Project discussed herein is not likely to jeopardize the continued existence of the northern spotted owl. The Service reached this conclusion based on the following factors:
>
> 1. Removal of 2 acres of high quality NR habitat, 15 acres of moderate quality NR habitat, and downgrading 275 acres of moderate quality NR habitat will not result in a significant decrease (i.e., only 9.9 percent) in habitat availability within the action area, and thus is not anticipated to impact the ability of the action area to provide for owl populations.

2. Proposed habitat removal represents an insignificant decrease in suitable spotted owl habitat range-wide, and does not exceed the amount of suitable habitat expected to be harvested during the first decade of NWFP implementation (i.e., 196,000 acres).

The Browns Project is not anticipated to compromise the conservation and recovery strategy established by the NWFP, or contribute to an appreciable reduction in the likelihood of survival and recovery of the northern spotted owl in the wild by reducing the owl numbers, reproduction, or distribution.

The full "Biological Opinion" is included as Appendix D (part 2) of the Browns Project EIS.

Relationship of Project Impacts to Forest Level Trends

Since 1991, wildfire and timber harvesting reduced late-sucessional habitat from 741,850 acres down to about 688,972 acres (about a 2 percent decrease). Alternatives 3 and 4 would affect about 793 and 568 acres of late-successional forest (0.1% and 0.08% of the existing 688,972 acres of late-successional habitat) respectively; this includes the intensities 'downgrade' and 'degraded' (see definitions above) that would still qualify as late-successional forest after treatment. Alternatives 3 and 4 would remove about 27 and 23 acres respectively (less than 0.004 percent) of the existing late-successional forest on the STNF. Only Alternative 3 would remove 2 acres of old-growth (high quality MIS spotted owl habitat). Given the small percentage of available habitat affected by either alternative, the Browns project will not alter the current forest-wide trend in habitat or populations for the MIS spotted owl or other species associated with late successional habitat or the associated snag/log and hardwood components.

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