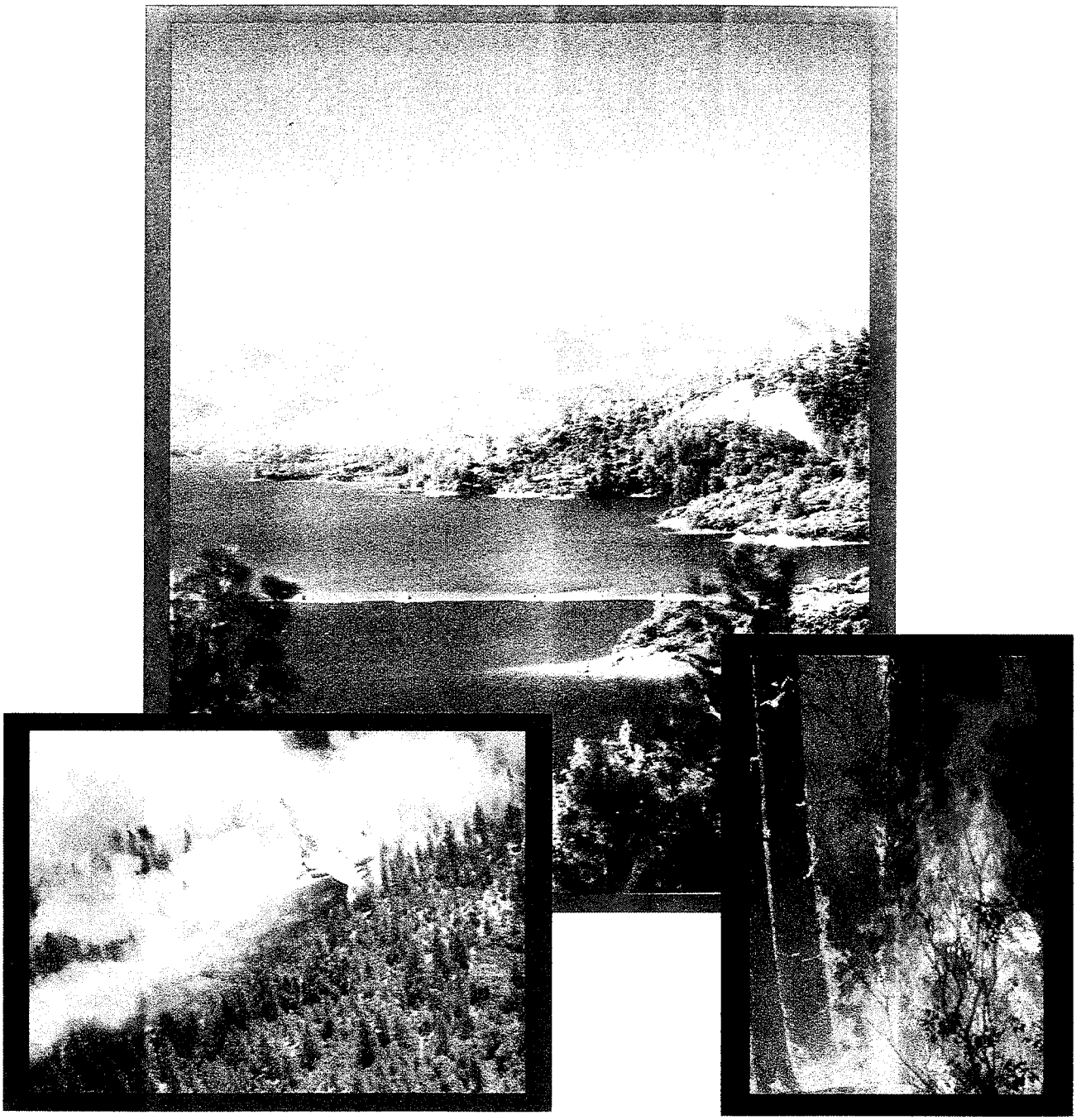
UPPER CLEAR CREEK WATERSHED FUEL INVENTORY REPORT



Prepared by the Western Shasta Resource Conservation District
for Agreement No. 11330-0-J100A between WSRCD & USFWS and Agreement No. 99-N16 between WSRCD and CALFED.

2001

BACKGROUND

The Upper Clear Creek watershed lies just east of the Trinity-Shasta County boundary and extends from the Whiskeytown Dam to the headwaters of Clear Creek near Slate Mountain. In April of 1999 the Upper Clear Creek Watershed Analysis was completed. One of the project recommendations identified in the Watershed Analysis was the need to conduct a fuel inventory for the watershed.

In the summer of 2001, the Western Shasta Resource Conservation District (WSRCD) in cooperation with U.S. Fish & Wildlife Service (USFWS) and Calfed completed the fuel inventory. The goal of this inventory was to identify high fuel loading areas and collect data that could be used as a tool to develop a strategic fuels management plan for the watershed.

U.S. Fish & Wildlife Service provided $16,807.00 for the fuel inventory, and Calfed provided $3,335.00. This final report was prepared as part of Agreement No. 11330-0-J100A between WSRCD & USFWS and Agreement No. 99-N16 between WSRCD and Calfed.

PROJECT LOCATION

The Clear Creek watershed is located in Shasta County, California, approximately six miles west of the town of Redding. The watershed lies along the eastern flank of the Trinity Mountains, just east of the Trinity-Shasta county line (see Figure 1). The Whiskeytown Dam hydrologically divides the watershed into both upper and lower watershed areas. The Upper Clear Creek Watershed drains an area of approximately 200 square miles, between Slate Mountain and Whiskeytown Dam, the Lower Clear Creek Watershed drains an area of approximately 49 square miles between Whiskeytown Dam and the Sacramento River. The Upper Clear Creek Watershed encompasses approximately 123,518 acres.

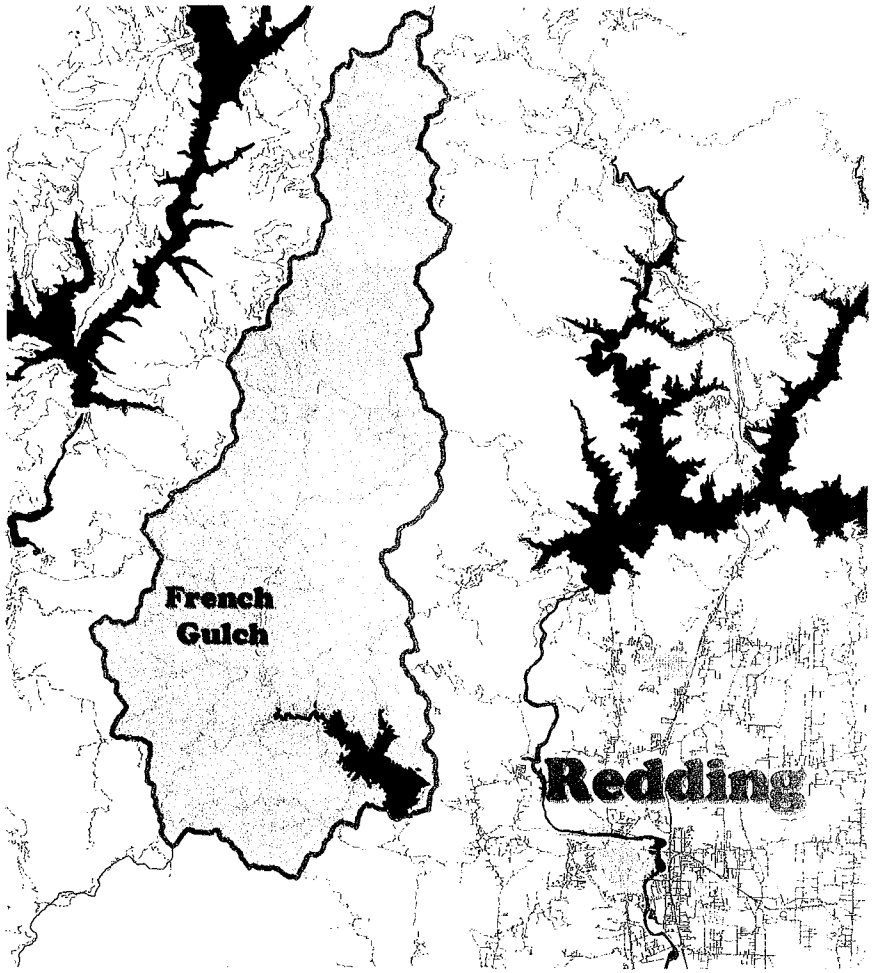
FUEL INVENTORY METHODOLOGY

The fuel models were identified based on the publication "Aids to Determining Fuel Models for Estimating Fire Behavior" (Anderson, 1982). Fuels have been classified into 13 fuel models from four vegetation types- grass, shrubs, timber, and slash (see Appendix A). Fuel models represent what type of fuel will most likely support the fire. Fuel models 1-3 are grass or grass dominated, 4-7 are shrub dominated, 8-10 are timber litter, and 11-13 are slash dominated.

Color, infrared and true color aerial photographs at a scale of 1:40,000 were used to identify the fuel types. A minimal mapping unit of 10 acres was used for the inventory. Fuel types were identified through the infrared photos. Green vegetation appears red or magenta due to the high near-infrared reflectance given off by healthy leaf tissue. Different leaf structures give off varying amounts of infrared radiation so the differences between a healthy broadleaf versus a healthy needleleaf tree can be identified on infrared photos. Each vegetation type is distinguishable by color and textural patterns.

Figure 1. Location Map

Upper Clear Creek Watershed



10 0 10 Miles

Prepared By:

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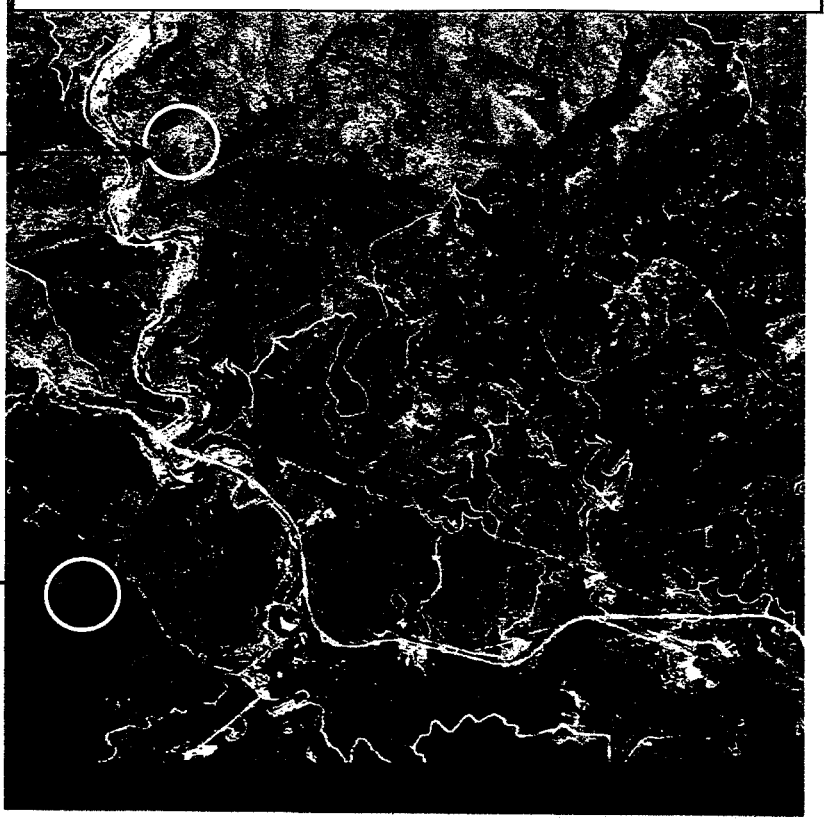
RESOURCE CONSERVATION
DISTRICT

Figure 2: Example of a color infrared photo distinguishing between two fuel models, 4 and 8.

The gray hue was identified as Fuel Model 4, vegetation primarily composed of chamise and some manzanita.

The dark magenta was identified as Fuel Model 8, primarily broadleaf trees.



The information gathered from the photos was digitized onto a base map of Digital Orthophoto Quarter Quads (DOQQS) for the inventory area (see Figure 3). Areas of uncertainty were ground truethed. This process produced the ability to recognize key characteristic patterns for each classification type and apply those patterns to similar types in areas unknown.

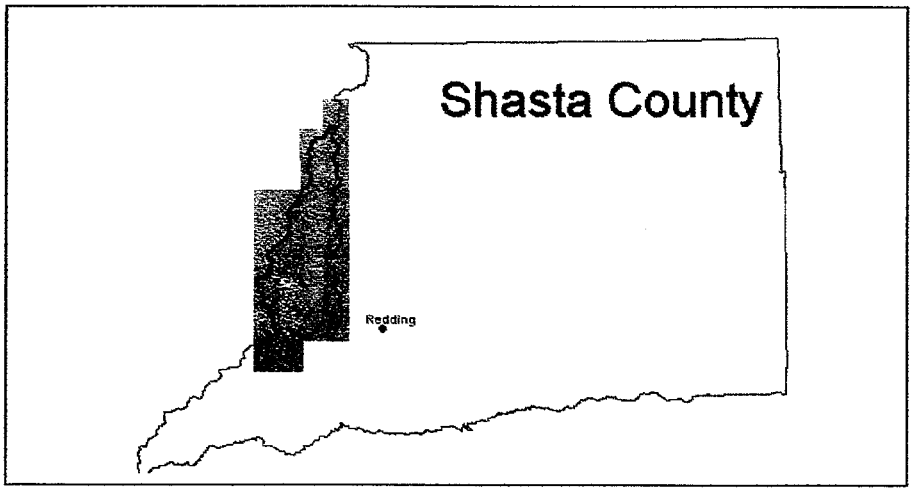


Figure 3: Base map for inventory, DOQQS covered the inventory area.

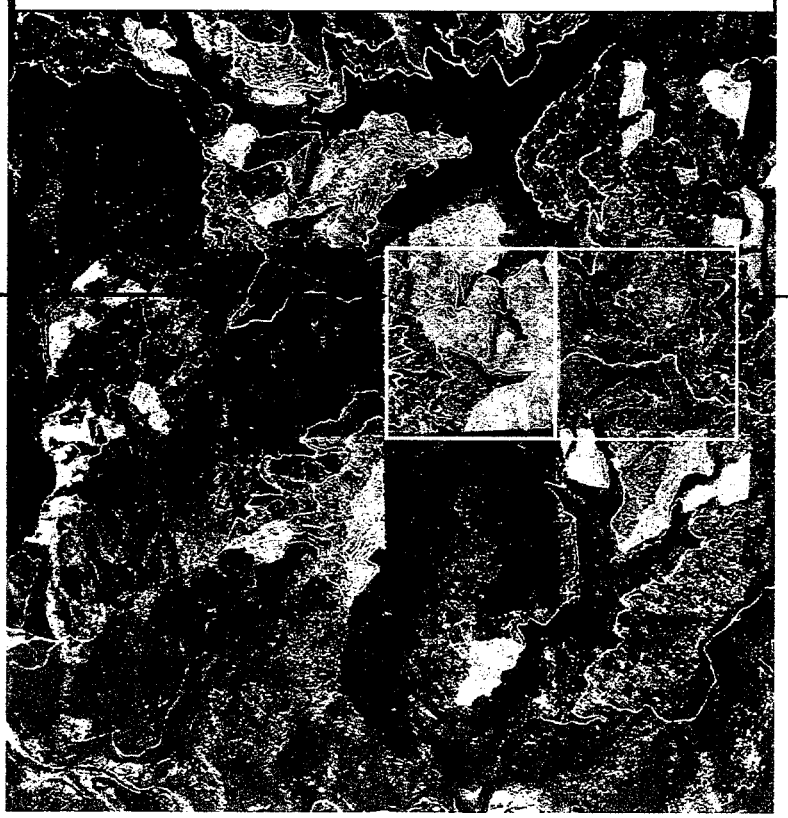
ANALYSIS

Insect infestations/disease, harvesting/manipulation of vegetation, prescribed burning, wildfires, and weather alter fuels in the watershed.

Harvesting/Manipulation of Vegetation

An important consideration during the fuel inventory was the land use in the Upper Clear Creek Watershed. Approximately 19,512 acres (15%) of the watershed are occupied by private Timber Production Zones. Public lands administered by the Bureau of Land Management (BLM) include those zoned as timberland, The U.S. Forest Service (USFS) administers land in the watershed zoned as agricultural forest. The color infrared photos used in the inventory were taken in July of 1989. During the past eleven years, numerous timber harvest plans have been applied in the watershed. For this reason, the majority of the ground truething was done in these areas. In Figure 4, as a result, the fuel type changes on a more frequent rotation than it would if depending solely on succession.

Figure 4: Color infrared photo showing timber operations at various stages in the watershed.



This section appears to have been cut around 1989 when photo was taken.

This section appears to have been cut prior to 1989 and then replanted.

The timber/slash models change to a grass model, then brush model, then back to timber slash model, depending on the number of years since the manipulation. For example, a timber/slash 0-

2 years after manipulation will typically be a grass model. If the site is replanted, years 2-10 could be a brush model, depending on the condition of the site. The brush model may differ depending on the slope. For example, a north slope tends to be a more mesic site, vegetation tends to grow more rapidly. A site on a north slope will go from a grass model to a brush model typically within 2 years. A south slope, typically drier and experiencing more exposure, will remain in a grass model longer. One example in the watershed showed this to be a minimum of 6 years.

Figure 5: Photo taken of an area that has been harvested 5 years prior. The fuel type went from a timber model to the grass model that you see now.

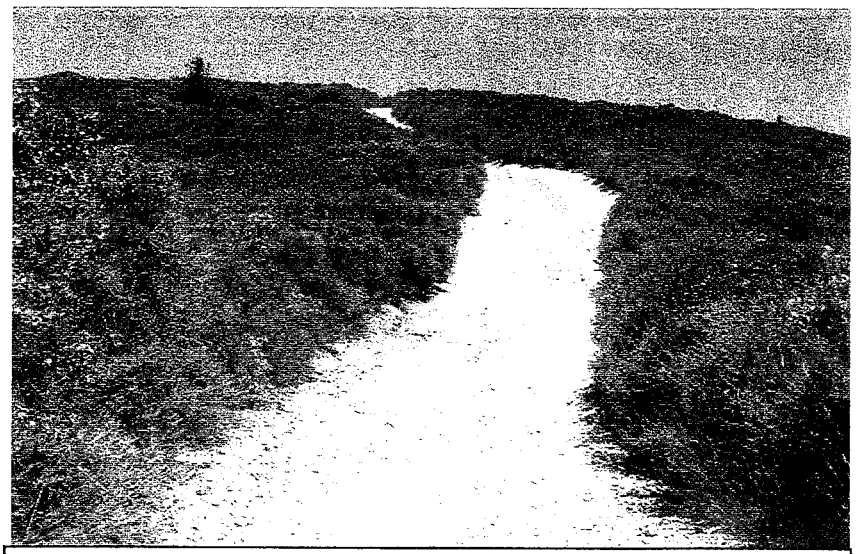


Figure 6: Photo taken of a south slope in the watershed. Major fuel type is chamise intermixed with manzanita, Fuel Model 4

Vegetation is also removed to decrease the threat of a catastrophic fire. Shaded fuelbreak projects have been implemented in the watershed on both private and federally owned land. An example of a shaded fuelbreak is shown in the photo below (Figure 7).

Fig. 7 Photo depicts a fuelbreak along a ridge in the Lower Clear Creek Watershed, the Kanaka Fuelbreak.

Prescribed Burning/Wildfires

Fires, both lightning and human caused, contribute to the changing fuels in the watershed. Large wildfires have burned a total of 14,353 acres of the watershed (TetraTech, 1999). The largest of these wildfires burned 3,545 acres in the French Gulch area in 1955. Recently, the Tower fire, originating in the Whiskeytown Recreation Area burned a total of 50 acres. The fuel type prior to the fire appeared to be a Timber litter, the fuel type now is a brush-shrub type (see Figure 8).

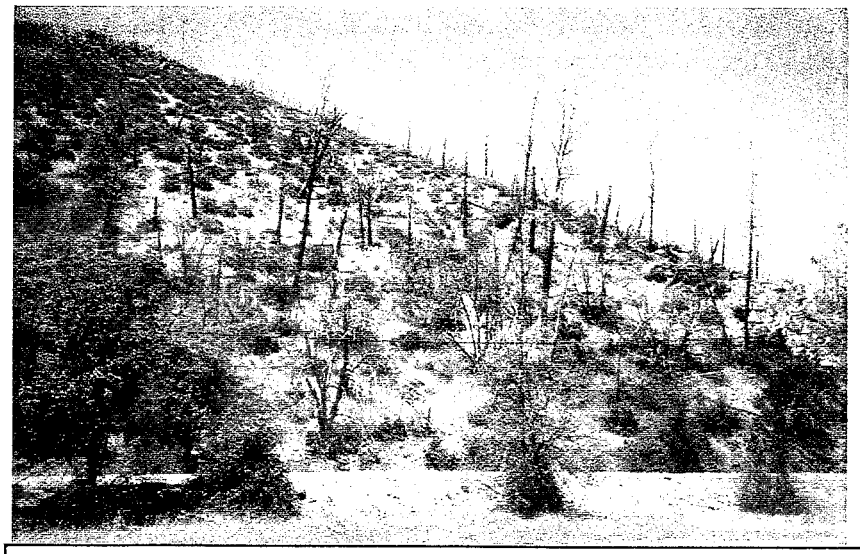


Figure 8: Photo taken 2 years after the Tower fire. South slope, regrowth is mainly chamise, manzanita, and grasses.

Brush models may also differ depending on the slope they grow on. After a fire on south slopes, for example, brush models are likely to stay in a grass model for the first 3 years. After 3 years of regrowth, brush will start to return, resulting in a decrease in windspeeds and adding to fuel loading. Brush models on north slopes typically have a higher fuel moisture, the fire is less severe, these two factors provide for faster regrowth conditions than the south slopes. In the Upper Clear Creek Watershed brush models on north slopes typically returned immediately, bypassing the grass model phase experienced on south slopes.

Fuel Model Key for the Upper Clear Creek Watershed

If the carrier of the fire is Grass, it will either be Fuel Models 1, 2, or 3.

Fuel Model 1 is not likely to be found in the Upper Clear Creek Watershed in areas greater than 10 acres, (10 acres is the minimum mapping area).

Fuel Model 2 is most likely the Grass Model that will be mapped in the Upper Clear Creek Watershed. Fire spread is primarily through the fine fuels (Fine Fuels- Fuels that are less than ¼ inch in diameter such as grass, leaves, draped pine needles, fern, tree moss, and some kinds of slash which, when dry, ignite readily and are consumed rapidly.) Grass is usually under an open timber or brush overstory. Litter from the overstory is involved, but grass carries the fire.

Fuel Model 3 is not likely to be found in the Upper Clear Creek Watershed. This Grass Model is generally used for stands of grass that average about 3 feet tall. The fire is generally carried through the upper heights of the grass stand by wind and may cross over standing water.

If the carrier of the fire is Brush, it will either be Fuel Models 4, 5, 6, or 7.

Fuel Model 4 is likely to be found in the Upper Clear Creek Watershed. Fire intensity and fast spreading fires involve the foliage and live and dead fine woody materials in the crowns of a nearly continuous secondary overstory. Besides flammable foliage, there is dead woody material in the stand that significantly contributes to the fire intensity. In the watershed dominant stands of chamise or manzanita with chamise are representative of Fuel Model 4. In the upper portion of the watershed areas with slash that has red needles will also be classified as a Fuel Model 4.

Fuel Model 5 is likely to be found in the Upper Clear Creek Watershed. Fire is generally carried in the surface fuels made up of litter cast by the shrubs and the grasses or forbs in the understory. Short, green shrubs are representative of Fuel Model 5. Fires are generally not very intense as surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Young green stands will little or no deadwood such as laurel, vine maple, alder, or even manzanita are examples. Short shrub species such as pine mat, and squaw carpet are also included in Fuel Model 5. A burned area (burned within the last 5 years) where brush regen is dominant this fuel model will be considered. *On a south slope, consider using Fuel Model 6.*

Fuel Model 6 is likely to be found in the Upper Clear Creek Watershed. Fires carry through the shrub layer where the foliage is more flammable than Fuel Model 5, but require moderate winds

(>8 m.p.h.) at midflame height. Fire will drop to the ground at low windspeeds or openings in the stand. Shrubs are older, but not as tall as shrub types of Fuel Model 4, nor do they contain as much fuel as Model 4. Scrub oak occurring in unbroken stands in the watershed is designated Model 6. Dominant stands of manzanita including those mixed with any species except chamise, are designated as Fuel Model 6.

Fuel Model 7 is not likely to be found in the Upper Clear Creek Watershed. Fires burn through the surface and shrub strata equally. Fire can occur at higher dead fuel moisture contents due to the flammable nature of live foliage. Examples are Palmetto-gallberry stands in Florida, and Alaskan Black-Spruce and shrub combinations.

If the carrier of the fire is Timber Litter it will be Fuel Models 8, 9, or 10.

Fuel Model 8 is likely to be found in the Upper Clear Creek Watershed. Fires are slow burning with low flame heights, although an occasional "jackpot" or heavy fuel concentrations may cause a flare up. Closed canopy stands of short needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and some twigs since little undergrowth is present in the stand. Predominate Live Oak is representative of Fuel Model 8, as litter is more compact and spreads more slowly, also if Douglas fir is secondary. If Black Oak or Pine is present as secondary consider using Fuel Model 9.

Fuel Model 9 is likely to be found in the Upper Clear Creek Watershed. Fires run through the surface litter faster than Fuel Model 8 and have higher flame height. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning activity. Both long needle conifer and hardwood stands are representative.
The upper 1/3 of the Upper Clear Creek Watershed is primarily Fuel Model 9. On south slopes the cover is typically a 0 or 1, on north slopes the cover is typical of a 2.

Fuel Model 10 may be present in the Upper Clear Creek Watershed. The fires burn in the surface and ground fuels with greater fire intensity than other timber litter models. Dead-down fuels include greater quantities of 3-inch or larger limb wood resulting from over-maturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation leading to potential fire control difficulties. Any forest type may be considered when heavy down materials are present; examples are insect or diseased stands, wind-thrown stands, over-mature situations with deadfall, and cured light thinning or partial-cut slash.

If the carrier of the fire is Logging Slash, the fuel model will either be 11, 12, or 13.

Fuel Model 11 may be present in the Upper Clear Creek Watershed. Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential.

Fuel Model 12 may be present in the Upper Clear Creek Watershed. Rapidly spreading fires with high intensities capable of generating firebrands can occur. The visual impression is dominated by slash and much of it is <3 inches in diameter. Heavily thinned conifer stands, clear-cuts and

medium or partial cuts are represented. The >3 inch material is represented by encountering 11 pieces, 6 inches in diameter along a 50-foot transect.

Fuel Model 13 may be present in the Upper Clear Creek Watershed. Fire is generally carried by a continuous layer of slash. Large quantities of >3 inch material are present, the <3 inch fuel is generally only 10 percent of the total load. If red needles are attached consider using a Fuel Model 4.

The following table, Table 1, gives representative rates of spread and flame length for each of the 13 fuel models with a windspeed of 5 m.p.h. and a moisture content of 8 percent.

Table 1

Fuel Model	Rate of Spread Chains/hour*	Flame Length Feet
1	78	4
2	35	6
3	104	12
4	75	19
5	18	4
6	32	6
7	20	5
8	1.6	1.0
9	7.5	2.6
10	7.9	4.8
11	6.0	3.5
12	13.0	8.0
13	13.5	10.5

* 1 Chain = 66 feet

In addition to the fuel model type, two other characteristics were identified during the inventory, ladder and crown descriptions.

Fuel Ladder

A fuel ladder provides vertical continuity between vegetation strata, the presence of a fuel ladder will allow a fire to carry from a ground fire, to a crown fire. The fire will "climb" up the ladder until it reaches the top strata of vegetation. For example, a fire starts in the grass, climbs up to the brush, climbs from the brush to the trees and into the tree crowns. Table 2 lists the description of fuel ladder indices used in the inventory.

Crown

The crown is defined as the spacing between tops of trees or brush, usually expressed as the percent of area covered by tree crowns in the canopy region as viewed from above. (A crown fire is a fire that advances from top-to-top of trees or shrubs more or less independently of the surface fire.) The crown provides horizontal continuity between the tops of vegetation. Table 3 lists the description of crown cover used in the inventory.

Table 2: Fuel Ladder

0	No Fuel Ladder Present
1	Fuel ladder present but spatially limited, there is open areas where fire may not carry, percent of area described is less than 51 - 75% of total area.
2	Fuel ladder widespread throughout vegetation, no break in strata from ground to surface to crown, percent of area covered is 75% or more.

Table 3: Crown

0	No horizontal continuity, percent of area covered is less than 50%.
1	Horizontal continuity, present but spatially limited, there is open areas where a crown fire may not carry, percent of area covered is 51% - 75% of total area.
2	Horizontal continuity, widespread, strata would support a crown fire, no break in vegetation, percent of area covered is 75% or more.

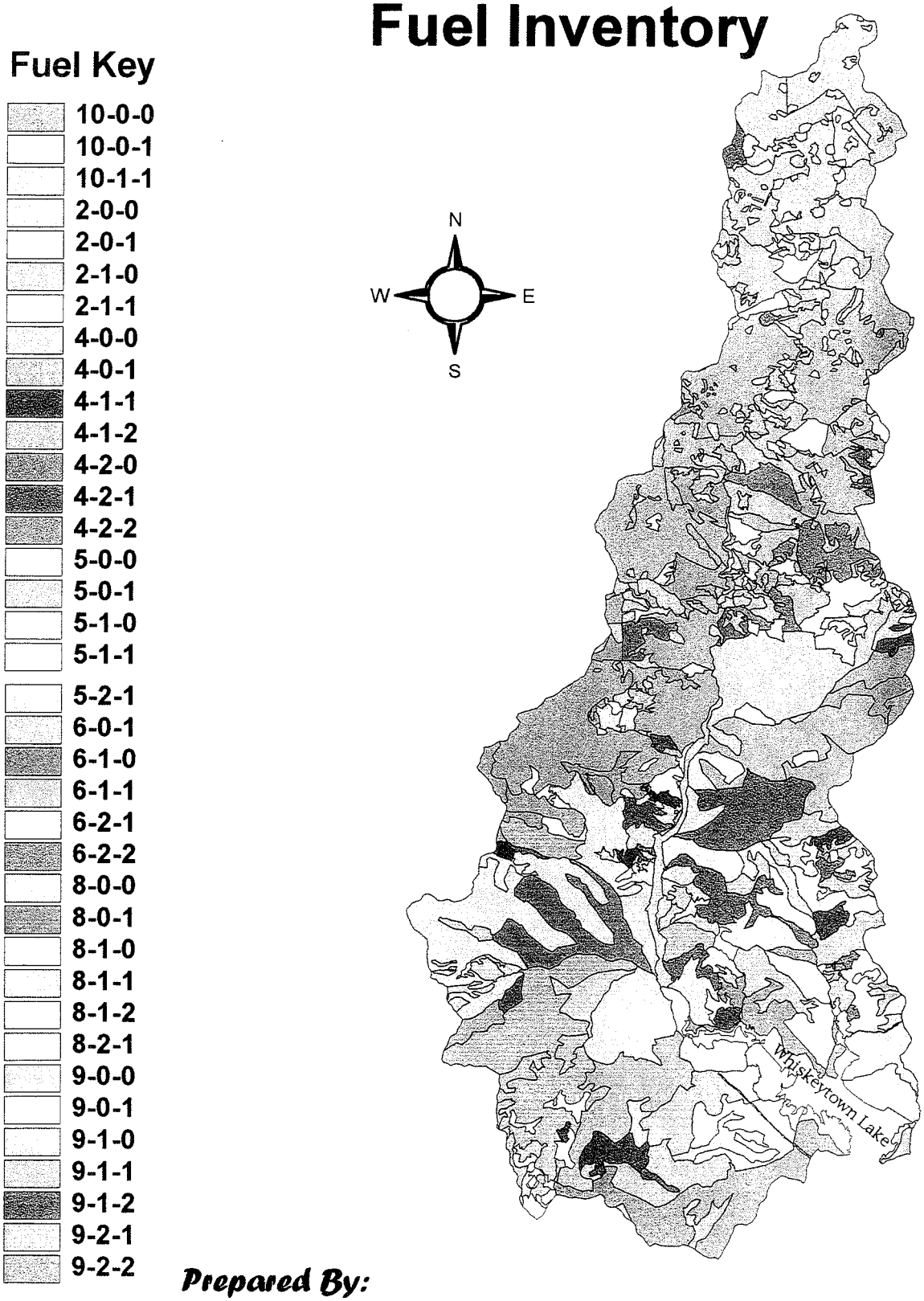
FUEL INVENTORY RESULTS

A total of 7 different fuel-model types were identified in the watershed (See Figure 9). Fuel model 9 is the largest, comprising 49% of the watershed, or approximately 61,906 acres. This fuel model type was predominantly found in the upper portion of the watershed where the majority of the vegetation type is managed for the timber value. Fuel model 8 is the second largest, at 26%, or approximately 32,806 acres. The following table depicts the fuel model inventory results (Table 4).

Table 4

Fuel Model	Acres
2	4,912
4	10,555
5	7,000
6	8,036
8	32,806
9	61,906
10	618

Figure 9. Upper Clear Creek Watershed Fuel Inventory



REFERENCES

Anderson, Hal. 1982. "Aids to Determining Fuel Models for Estimating Fire Behavior." 1982, U.S. Department of Agriculture, Forest Service (Ogden, Utah). General Technical Report INT-122.

Sapsis, Dave. "CDF Fire Plan Hazard Assessment Methods." California Department of Forestry and Fire Protection, Sacramento, page 15.

Western Shasta Resource Conservation District. 1999. "Upper Clear Creek Watershed Analysis." Tetra Tech, Inc., San Francisco, CA.