Grass Valley Creek Watershed

Fire Management Plan

Prepared for: Bureau of Land Management

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Acronyms

BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CDF	California Department of Forestry & Fire Protection
CEQA	California Environmental Quality Act
CFIP	California Forestry Incentive Program
CRMP	Coordinated Resource Management Plan
DG	Decomposed Granite
DFG	California Department of Fish & Game
DOI	U.S. Department of Interior
EIS	Environmental Impact Study (under NEPA)
EQIP	Environmental Quality Incentive Program
ESA	Federal Endangered Species Act
FSA	Farm Service Agency
GIS	Geographic Information System
GPA	Geographic Priority Area
GPS	Global Positioning System
GVC	Grass Valley Creek
GVC FMP	Grass Valley Creek Fire Management Plan
KMP	Klamath Mountain Province
LGVC	Little Grass Valley Creek
LRMP	Land & Resource Management Plan
LSR	Late Successional Reserve
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRA	Whiskeytown National Recreation Area
NRAC	Natural Resources Advisory Council
NRCS	Natural Resources Conservation Service
RCD	Resource Conservation District
RMP	BLM Resource Management Plan
ROD	Record of Decision
SCS	Soil Conservation Service (now NRCS)
SPI	Sierra Pacific Industries
S-T NF	Shasta-Trinity National Forest
TCRCD	Trinity County Resource Conservation District
THP	Timber Harvest Plan
TPL	Trust for Public Lands
TRC&DC	Trinity Resource Conservation & Development Council
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
WRTC	Watershed Research & Training Center

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Fire Management Plan

CHAPTER 1. INTRODUCTION & OVERVIEW

Purpose

In 1993 the Trinity River Task Force funded the Bureau of Land Management (BLM) to purchase approximately 60% of the lands in the Grass Valley Creek watershed for 9.1 million dollars. The primary purpose for this purchase was to prevent further degradation of anadramous fish habitat in Grass Valley Creek and the Trinity River caused by sedimentation from eroding granitic soils exposed by poor roading and logging practices. With the purchase of these lands came the responsibility to reduce erosion and sedimentation into the Trinity River, which is BLM's "Resource Condition Objective" for the Grass Valley Creek watershed [BLM Redding Resource Management Plan and Record of Decision (RMP), June 1993]. This responsibility has been fulfilled to date by extensive rehabilitation and/or decommissioning of roads and landings, stabilization of watercourses, and revegetation of eroding slopes.

> Large fires have occurred in the project area in the past and despite all efforts, will probably occur again. The mix of residential development, timberlands, hot summer weather with strong afternoon winds, and high ignition risk make fire and fuel management an important concern of area residents and land managers.

The purpose of the Grass Valley Creek Watershed Fire Management Plan (GVC FMP) is to portray past and current fire and fuel conditions, current fire access and infrastructure, and to identify management practices and projects that will promote forest succession and health while protecting the primary resources of soil and water, and associated resources of wildlife and fisheries, from the deleterious effects of high severity, stand replacing fires in and immediately adjacent to the Grass Valley Creek (GVC) watershed. This plan addresses residential property protection, fire control access and safety, fuel management, and forest health opportunities in the watershed. Development of this plan was recommended in Alternative A (adopted by a consensus of participants) in the "Grass Valley Creek Watershed Coordinated Resource Management Plan" (GVC CRMP), completed in March 1995 by the Bureau of Land Management, Redding Resource Area. Participants in that plan included private landowners and representatives from the Bureau of Land Management, Natural Resources Conservation Service (NRCS), U.S. Bureau of Reclamation (BOR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (DFG), California Department of Forestry and Fire Protection (CDF), and the Trinity County Resource Conservation District (TCRCD). Development of a "prescribed fire and fire management" plan is also one of the fire management objectives in the "BLM/CDF/USFS Cooperative Fire Protection Agreement and Operating Plan for the CDF Northern Region (2002)".

The GVC FMP is coordinated with and incorporates information from the "Grass Valley Creek Watershed Analysis" (GVC WA), completed in March 1995 by the Bureau of Land Management, Redding Resource Area, the "10 Year Revegetation Plan for the Grass Valley Creek Watershed (1996-2007)" completed in December 1996 by the TCRCD (Christina Veverka et. al.) in cooperation with BLM, and the "Grass Valley Creek Watershed Restoration Project Report" completed in February 1998 by the TCRCD and NRCS. It is also coordinated with "Recommendations on Trinity County Values at Risk from Fire and Pre-Fire Fuels Treatment Opportunities drawn from Community Meetings 1999/2000", a report to the Trinity County Fire Safe Council from the TCRCD and Watershed Research and Training Center (WRTC). The Trinity County Fire Safe Council is a coalition of organizations that collaborate to promote fire safe communities in Trinity County. The Fire Safe Council is composed of representatives from the BLM, USFS, Shasta-Trinity and Six

Rivers NFs, NRCS, CDF, Trinity County Board of Supervisors, TCRCD, Trinity Resource Conservation and Development Council (TRC&DC), WRTC, Natural Resources Advisory Council (NRAC), South Fork Trinity River Coordinated Resource Management Plan Group (South Fork CRMP), Trinity County Fire Chiefs Association, and Trinity County Association of Realtors.

In 1999 the TCRCD received a grant from the State of California, funded under Proposition 204, to develop a countywide fire plan and to implement community fuel reduction projects. It is working closely with the Fire Safe Council and with Yvonne Everett, Ph.D., Professor of Natural Resources Planning at Humboldt State University, in developing the fire plan. The GVC FMP will become a part of that plan by reference.

The Grass Valley Creek Watershed Fire Management Plan contains recommendations that agency and individual landowners can follow to reduce the danger of wildfires degrading resource lands or burning homes or other structures. Recommendations to establish shaded fuel breaks, thin overstocked forests, reduce ladder fuels, apply prescribed fire, and execute other management practices and projects that reduce fire spread and intensity should reduce the likelihood of high severity fires and facilitate control of low and moderate severity fires to prevent them from increasing in intensity or becoming crown fires. In support of these goals, the plan extends into public and private lands that are adjacent to the watershed boundary (see ‘Plan Area’ map).

This plan is a compilation of knowledge and recommendations from a wide variety of sources, including area residents, fire and resource management experts from BLM, USFS, NRCS, BOR, USFWS, DFG, CDF, Whiskeytown National Recreation Area (Whiskeytown NRA) and the private sector, and technicians and support personnel from the TCRCD. A Bureau of Land Management Jobs-in-the-Woods grant to the Trinity County Resource Conservation District funded this plan.

Location

The planning area is in eastern Trinity County, approximately one mile south of the town of Lewiston and four miles east of Douglas City. It borders Shasta County along its eastern and southern edge and is bisected by State Highway 299. The plan area encompasses approximately 23,505 acres in the Grass Valley Creek watershed, and additional acreage adjacent to it, in Sections 27-35, T33N, R8W, MDB&M; Sections 25-27, 34-36, T33N, R9W, MDB&M; Sections 18, 19, 30-32, T32N, R7W, MDB&M; Sections 1-28, 34-36, T32N, R8W, MDB&M; Sections 1-3, 11 & 12, T32N, R9W, MDB&M; Sections 5 & 6, T31N, R7W, MDB&M; Sections 1-3 & 11, T32N, R8W, MDB&M [All legal descriptions hereafter are within the Mount Diablo Base & Meridian (MDB&M), so that portion of the legal description will be omitted.].

Grass Valley Creek flows northwesterly into the Trinity River about six miles downstream from the old Lewiston Bridge. It is joined by Little Grass Valley Creek, which parallels Highway 299 from Buckhorn Summit, just west of Trinity Dam Boulevard, by Phillips Gulch at Fawn Lodge, and by Sawmill Gulch upstream a mile and a half from its confluence with the Trinity River.

Ownership

The Bureau of Land Management, Redding Resource Area, administers the majority (61%) of the ownership in the watershed (96% of the public lands) (see ‘Ownership’ map). BLM has a goal of acquiring available unimproved lands within the watershed and is currently in the proposal stage of acquiring another 500 acres.

The U.S. Bureau of Reclamation (BOR) administers four parcels in and around the Grass Valley Creek reservoir. The State of California administers two small parcels of land, one the Ellen Pickett State Forest.

SPI is the second largest landowner, with 18% of the watershed. Its properties, which are primarily in the northwestern portion of the watershed, are zoned Timberland Production Zone (TPZ), which requires long-term forest management for timber production.

Crane Mills Inc., Roseburg Resources Company, and Trans-Wood Company own between them less than a section of forestland, zoned as TPZ, which is managed for long-term timber production.

There are 75 private residential parcels with a total of about 90 residences within the GVC watershed as well as 61 vacant parcels, a total of 136 residential parcels (15% of the watershed). These are owned or co-owned by 156 individuals (67 of whom live in the watershed) and 16 trusts. The 'Trinity County Assessor's Parcels by Book & Page' map shows the parcels in the watershed and the Assessor's Secured Property list is in Appendix B. There are 64 private, rural residential lots ranging from ¼ acre to about 3½ acres in size. In the Redding Lodge of the International Order of Odd Fellows (IOOF) camp there are 72 lots with about 20 full time residents.

Topography

The Grass Valley Creek drainage is a relatively long, narrow watershed with a northwest-southeast orientation. It is about 4 ½ miles wide at the widest point and 12 miles long and encompasses 37 square miles (23,505 acres). The headwaters of Grass Valley Creek are on Shoemaker Bally at 5955 feet elevation and the headwaters of Little Grass Valley Creek are on Buckhorn Bally at 5015 feet. Elevations within the planning area range from 1740 feet at the mouth of Grass Valley Creek to 5955 at the highest point, on Shoemaker Bally at the southeast edge of the watershed. Most of the watershed is between 2500 and 4000 feet in elevation.

GVC Watershed Ownerships

Ownership Type	Acres
Bureau of Land Management	14,291
Sierra Pacific Industries	4270
Residential (vacant)	1894
Residential (occupied)	1715
Resource (private)	412
Ownership Not Verified	341
State of California	326
Bureau of Reclamation	256
Total	23,505

The topography of the watershed is highly dependent upon geology and soil type. Soils in the eastern two-thirds are primarily derived from granitic rocks and the landscape is consequently highly dissected by short sub drainages with relatively short, steep slopes. Soils in the western one-third are primarily derived from ultramafic rocks and the landscape is considerably less dissected by sub drainages. Slopes are moderately steep along the major streams and steep in the upper drainages, typically ranging from 50 to 75%. The majority of the watershed (60%) has slopes less than 40%.

Climate and Fire Weather

Northern California has a Mediterranean climate characterized by long, dry, hot summers and wet winters. The Grass Valley Creek watershed averages 45 inches of rain per year in the lower watershed and 75 inches in the upper watershed, with about 2 inches falling during June through September. Most of the rain occurs between October and May, with occasional intense summer thunderstorms capable of producing heavy precipitation of short duration. Accompanying lightning strikes can cause multiple fire starts.

In winter, freezing temperatures occur throughout the watershed and snow may fall over the entire planning area, with several inches accumulating at lower elevations and several feet accumulating above 3500 feet. Snow generally lasts a few days to a few weeks at lower elevations, but may persist on north facing slopes above 3500 feet until the middle of May (GVC WA). High intensity "rain on snow" events, which cause high levels of erosion and increased flow volumes, have occurred in 1955, 1964, 1972, 1978, 1983, 1986, 1995, and 1997. Should a catastrophic fire occur in the watershed, the frequency of these events could exacerbate the resultant impacts to soils.

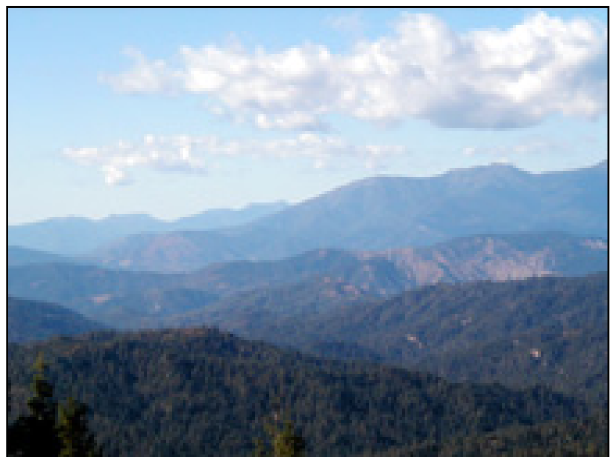
Summer, temperatures at lower elevations may peak in the upper 90s to lower 100s ^{0}F for several days or even weeks at a time, with very low relative humidity and fuel moisture. Extreme fire danger can occur as early as June and is common in August and September.

Strong, pressure-gradient winds from the west and northwest (gusting from west to north) are common in the plan area during mid-day to late afternoon and early evening during the summer. To the east of the watershed, strong, gusting down slope winds blow at night from the west, across Whiskeytown Lake, past the visitor center, and down Clear Creek. Mild down canyon winds occur in the plan area at night as cooler, heavier air flows towards Grass Valley Creek from the higher elevations. During thunderstorms, strong, erratic winds occur in conjunction with intense downpours of rain.

There is a BLM RAWS weather station (Lowden, CA; NESS Identifier 325064BE) on SPI land in the NE ¼, SW ¼, Section 25 in T33N, R9W, MDB&M that can be used for current weather information. This station, which is at 3120 feet elevation, was installed in late 1999 and is maintained by BLM.

Past Fires and Present Threats

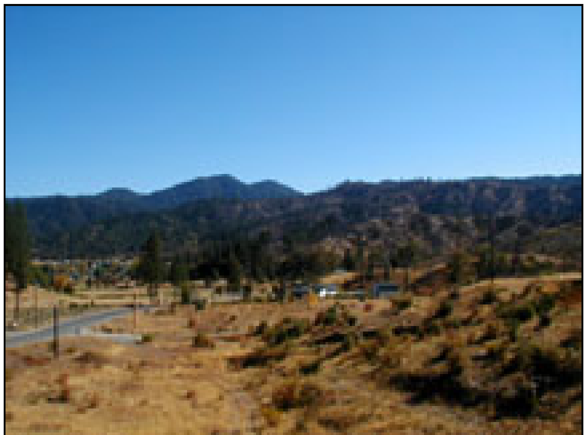
No records were found showing the year, size, location, or cause of past fires within the GVC watershed, but on the ground evidence substantiates their occurrence (see 'Fire History & Fire Regime', pgs. 53 & 54). Large, fast moving fires have occurred in the vicinity of the plan area within the past decade and can be expected to occur within the watershed at any time.


Oregon Burn in background, Browns Burn in midground, Lowden Burn in foreground.

Three large human-caused fires have occurred in the past decade within six miles of the watershed. The Browns Fire, visible from Weaverville and Lewiston, started on a logging operation on July 15th, 1994 and burned almost 1600 acres in a matter of hours, threatening dozens of homes in its first day and killing trees on public and private lands. The Lowden Fire started on July 2, 1999 when a controlled burn jumped a road west of Lewiston, burned about 2000 acres in 3 days and destroyed 23 homes, an estimated loss of $2.8 million ($3-5.4 million by some estimates). The suppression costs for this fire were approximately $3.5 million. The Oregon fire, ignited mid-afternoon on August 28, 2001 by a vehicle on highway 299 just west of Oregon Mountain pass, burned over 1100 acres during the first three hours and went on to consume about 1680 acres in five hours before it was fully controlled at 1720 acres five days later. This fire, which destroyed 13 homes, burned into Weaverville and threatened the high school, sheriffs department, hospital, U.S. Forest Service Ranger Station, and residential areas. Estimated losses were $3.5 million.

Further southeast, the Barker Fire in the Hayfork Valley, an arson fire started in 1993, burned approximately 5600 acres between Hayfork and Douglas City in a matter of two days. The suppression costs for this fire were approximately $1.5 million. In 2001, just after the Oregon Fire was suppressed, the Hyampom fire started just west of the Hayfork Valley and burned 1300 acres in 5 days, at an estimated suppression cost of $4.5.

All of these fires had at least one thing in common; they moved rapidly eastward, fanned by the strong winds that blow from the coast most hot summer afternoons. These winds, which are relatively predictable, are caused by the low-pressure gradient created by solar heating in the Central Valley, which causes cooler air to flow in from the coast. Fire suppression at the front of fires pushed by these winds is largely futile until they die down in the evening.



Lowden Burn with Hoadley Peaks in background.

A mosaic of vegetation types, sizes and densities covers Grass Valley Creek watershed. These include conifers, mixed hardwoods and conifers, and hardwoods ranging in size from seedlings/saplings to large sawtimber in dense to open stands, young to mature shrubs ranging from two to six feet tall in dense brushfields to scattered patches, and annual/perennial grasslands. Dense but narrow zones of riparian vegetation are found along perennial creeks. Patches of bare ground and rocky areas are found throughout the watershed, but mostly on granitic soils.

Fire access into and within the watershed is limited, in part due to past decommissioning of roads to reduce sedimentation into Grass Valley Creek and the Trinity River, in part because of dense brushfields in portions of the watershed, and in part because of steep slopes found throughout the watershed. These conditions, in conjunction with the variable mosaic of vegetation, lend themselves to a full range of fire behaviors, severities, and sizes. Anything from creeping to swiftly moving ground fires, spotting fires, individual and group tree torching, to crown fires can be expected. Low severity fires can be expected where vegetation is sparse (often on south- to west-facing slopes), in stands of large trees with little understory or ground fuel, in annual grassland, or in riparian areas. Moderate to high severity fires can be expected on steep slopes (especially on upper slopes), where vegetation is denser (often on north- and east-facing slopes), in dense brushfields, and in stands with a high component of ladder and ground fuels. Fires can be expected to attain any size in this watershed and can result in accelerated erosion, especially in areas of decomposed granitic soils.

There are many possible fire scenarios in and around the GVC watershed. Four that are likely to occur are as follow. In the first scenario, humans start a fire in the lower, most populated portion of the drainage (northwest) during late morning to late afternoon on a hot summer day when the westerly winds from the coast are increasing in speed. These winds would cause the fire to move rapidly toward the east and/or southeast into the mid watershed area. Whether this fire became a crown fire would depend upon the extent of ground and ladder fuels it encountered and the spacing between the crowns of overstory trees and shrubs to the east and southeast of the point of ignition. The Highway 299 corridor has areas of relatively dense, continuous forest and shrub cover, so a high severity crown fire could develop there.

The second scenario is a fire started by human causes along Highway 299. This fire, pushed by westerly winds, would tend to move up slope in an easterly direction, threatening homes along the 299 corridor and burning into the upper watershed and adjacent watersheds. Whether this fire became a crown fire would depend upon the extent of ground and ladder fuels it encountered and the spacing between the crowns of overstory trees and shrubs to the east and southeast of the point of ignition. The 299 corridor has areas of relatively dense, continuous forest and shrub cover, so a high severity crown fire could develop there. The upper watershed has a mosaic pattern of bare areas, brushfields, open forests, and stringers of denser forests, so fire in that area would likely be a mosaic of low, moderate and high severity. A crown fire could develop in dense brushfields and forests. In less dense vegetation, spotting and torching of individual trees and groups of trees would be likely.

The third scenario is a fire started by human causes along the banks of the Grass Valley Creek reservoir. This fire, pushed by westerly to southwesterly winds, would tend to move up slope in an easterly to southeasterly direction, threatening homes near Buckhorn Summit and forests and brushfields in the upper watershed before it burned into the adjacent watersheds. It is unlikely that this fire would develop into a widespread tree crown fire south of Highway 299 as vegetation is generally in a mosaic pattern of bare areas, brushfields, open forests, and stringers of denser forests. It would more likely take the form described in the previous scenario.

The fourth scenario is a fire started by human causes along County Line Road or Hoadley Peaks Road or a lightning fire in the mid to upper drainage. Either of these fires, pushed by what would here be westerly to northwesterly winds, would tend to burn upslope in an easterly to southeasterly direction into the upper watershed and adjacent watersheds. It is unlikely that these fires would develop into widespread tree crown fires south of Buckhorn Summit as vegetation is generally in a mosaic pattern of bare areas, brushfields, open forests, and stringers of denser forests. It would more likely take the form described in the previous scenario. In the area north of Buckhorn Summit, where forested areas are denser and more continuous, it is more likely that a crown fire would develop.

A variation on this scenario is multiple lightning strikes igniting fires throughout the region. Since the upper watershed is remote, with minimal access, it is possible that small fires would rank low for immediate suppression, allowing them to grow and even merge before suppression crews arrived. Sometimes suppression resources are limited or are out of the area on other fires, so none are available for small, remote fires. These situations occurred with the 1998 Kanaka Fire in the Whiskeytown NRA that burned 2100 acres and the 1999 Megram Fire in western Trinity and eastern Humboldt Counties that burned approximately 138,000 acres.

To the east of the upper watershed is the Whiskeytown National Recreation Area, a remote area with limited water and access routes. A fire burning in that direction would threaten resource lands. A fire burning south from the GVC watershed would spread to remote brush and timberlands on private property. A fire burning to the north could carry into the town of Lewiston. Fires burning to the west could threaten resource lands and scattered home sites in the Indian Creek, Vitzhum Grade, Poker Bar Road, Steelbridge Road, and Douglas City areas.

Less likely scenarios are fires igniting outside the watershed boundaries and burning into the watershed, from the Indian Creek drainage to the west or the Willow Creek or Crystal Creek drainages to the east. Only a few fires have occurred in the Indian Creek drainage during the past three decades, but if one were to occur there and be pushed by the westerly winds, it could burn through relatively dense brush into the western portion of the GVC watershed. Periodically, especially during the fall when fuels are generally at their driest, winds blow from the northeast to east, which would push a fire starting to the north or east of the watershed, in areas that have limited access, into the watershed.

Fire Hazard Severity: Hazard, Risk and Values at Risk

Fire hazard severity is the combination of three inter-related factors: hazard, risk, and values at risk. The combination of fire risk and hazard provide the fire planner with the ability to predict fire starts, rates of spread, intensity, and other fire behavior. However, it is values at risk that are of primary concern.

Fire Hazard

Fire hazard is the interaction of fuels (vegetation, buildings, and other flammables), topography (fires tend to burn more intensely on south and west aspects, steep slopes, up slopes, on upper slopes, and in narrow draws), and weather (temperature, humidity, wind speed and direction, time since last rain). The interaction of these factors affects the rate of spread and intensity of a fire.

The GVC watershed has, in some areas, dense and highly flammable fuels, such as brushfields and overstocked forests with well developed ladder fuels. Due to the northwest-southeast orientation of Grass Valley Creek and the abundance of dissected sub drainages, there are many steep southeast- to west-facing slopes and narrow draws. These are all areas that tend to increase the intensity and rate of spread of fires (rate of spread increases four times for every 25% increase in slope). Weather during fire season is generally hot and dry, often with periods of strong winds and long intervals between significant rains. These conditions lend themselves to a high fire hazard in and around the watershed.

Fire Risk

Fire risk is the chance that a fire will start in a particular area. Although lightning is an important cause of forest fires, human starts are the most common source of ignition. The greatest numbers of human activities with fire starting potential are found close to home. Common causes of fire include children experimenting with fire, smoking, chain saws, grass mowers, burning yard debris, improperly disposed of barbecue coals and wood stove ashes. House fires sometimes spread to the forest. Arson is an increasing cause of fire. Roads, hiking trails, campgrounds and picnic areas are also high risk areas for fires ignited by smoking, vehicles (parking in tall grass or faulty exhaust systems), warming fires, or camp stoves and lanterns. A number of severe fires have started on logging operations by chain saws, logging equipment, warming fires, or smoking. Power lines periodically start fires when winds or trees dislodge wires.

There are a few areas in the watershed with concentrations of homes, some with moderate to heavy fuel loads in the vicinity. Although many roads in the watershed are gated, Highway 299, four County roads, and one road (County Line Road) of multiple ownership are open to public use and receive light to heavy traffic. There are no picnic areas, campgrounds, nor designated hiking trails in the watershed, but fishermen hike on the gated Dam Access Road to the Grass Valley Creek reservoir. Logging takes place on SPI and other industrial lands and on some private lands. Thunderstorms with lightning are not uncommon during the summer. These conditions lend themselves to localized and variable degrees of risk of fire starts, with well-traveled roads, residential areas, logging operations, and areas of heavy fuels on exposed ridges posing the greatest risk.

Grass Valley Creek Fire Hazard Severity

The Fire Hazard Severity rating in the GVC watershed is 'Very High' because:

- Flammable structures are interspersed along the 299 corridor, with concentrations near the mouths of Grass Valley Creek and Little Grass Valley Creek
- Some of the residential areas are on, or bordered by, steep slopes with flammable vegetation
- Roads into some homes are not adequate to accommodate 2-way fire engine traffic
- State Highway 299 and four county roads are well traveled during fire season, increasing risk of human starts
- There is limited access for fire suppression forces in most of the watershed
- Summer conditions include hot, dry and windy weather, especially in the afternoon
- Thunderstorms, with lightning strikes, are common during the summer months
- Wildland vegetation is dense in many places, with areas of continuous fuels, including dead fuel on the ground
- Fire ladders exist in many areas

Values at Risk

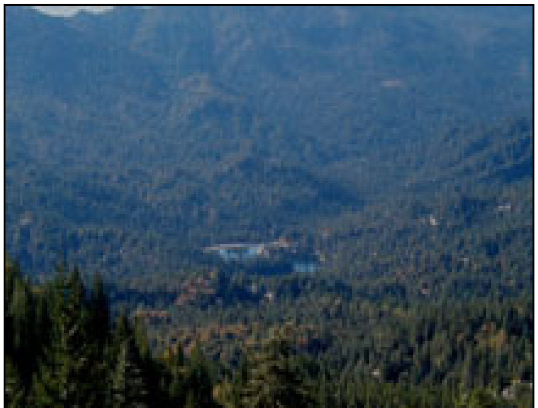
Values at risk are the life, property and natural resources that either can not be replaced or require substantial costs to replace. Residents in the planning area value human life, homes and private property, aesthetics, clean air and water, and the natural resources that surround them. Approximately 70 people live in the Grass Valley Creek watershed and another 88 people are absentee landowners. Review of Trinity County Assessor's Office records (see Assessor's Secured Property List of owners and property values in Appendix B) indicates that the total value of the land and improvements of the Grass Valley Creek residential parcels is approximately $10.4 million (land $5.1 million, improvements $5.3 million). This is probably a conservative estimate. Adding the value of home contents, vehicles, boats, and other valuables, the overall monetary value within the communities is probably closer to $14 million.

As the resource manager for much of the GVC watershed, BLM's primary objective is to maintain watershed values, including soils, forest and non-forest vegetation, wildlife, fish habitat, and recreational opportunities (RMP pgs. 1, 24, 28, 29, 39, 40, 42, & 43). In pursuit of this objective, BLM managers place a high value on human life, private homes and property in the vicinity of its lands, aesthetics, and clean air and water (RMP pgs. 14 &

26). Millions of tax dollars have been invested in watershed restoration and protection projects, including revegetation, road and landing rehabilitation and decommissioning, the Hamilton sediment ponds, the Grass Valley Creek reservoir, and fuel breaks along roads. The primary objective of these projects was to reduce sedimentation into the Trinity River to protect fish habitat (GVC CRMP and WA).

There are significant stands of small to mid-sized conifers and hardwoods on BLM lands. Conifers are commercially valuable for timber production and both conifers and hardwoods are valuable for wildlife habitat, watershed protection, enhancement of air and water quality, moderation of climate, and aesthetics. No dollar value has been computed for these benefits, but their value is obviously quite high.

Although the GVC reservoir is shown on the 'Values at Risk' map as a 'site at risk', it obviously would not burn. But damage to the watershed could accelerate erosion, causing the reservoir to fill more rapidly than planned. This reservoir was created at great expense to reduce sedimentation into the Trinity River to protect anadramous fish habitat. It is of value for that purpose, for the trout fishery it supports, as habitat for a variety of wildlife species, and as a recreation site.



Grass Valley Creek Reservoir

A multi-purpose relay station on South Hoadley Peak is a 'site at risk' from wildfire. Its continuing and uninterrupted operation is critical to communications by public safety agencies and private communications companies, so it is of high value. This station has been partially protected by the recent installation of an underground electrical supply up Lewiston Turnpike and Hoadley Peaks Road, but the facilities are inadequately protected from fire.

There are a number of electrical transmission lines operated by PG&E and the Trinity County PUD that traverse portions of the watershed (mainly along the Highway 299 corridor, Trinity Dam Blvd., Lewiston Road, and into the IOOF camp) that are valuable to the owners and to the customers they supply.

Forested land zoned Timber Production Zone (TPZ) is managed for commercial values by SPI, Crane Mills Inc., Roseburg Resources Company, Trans-Wood Company, and some private non-industrial landowners. There are significant stands of small to mid-sized conifers and hardwoods on private lands. Conifers are commercially valuable for timber production and both conifers and hardwoods are valuable for wildlife habitat and watershed protection, two resources required to be protected in California during forestry operations. The land value of the privately held parcels managed for timber production is $900,000, which doesn't include the value of trees. Harvested trees (logs) are assessed for value and taxed at the time of harvest. Actual values that are at risk are therefore much higher than reflected by the above dollar value.

Fire Fighting Resources

The Grass Valley Creek watershed is served by a variety of fire control resources from a number of agencies. The watershed is within the State Responsibility Area and the Direct Protection Area for CDF. The California Department of Forestry and Fire Protection is the initial responder to wildland fires in this area and responds to any reported fires during the fire season as per the 'BLM/CDF/USFS (Mendocino NF) Cooperative Fire Protection Agreement and Operating Plan for the CDF Northern Region (2002)'. This agreement is updated annually. As per this plan, BLM and the Mendocino National Forest will provide assistance as needed. The Department of Interior, Whiskeytown National Recreation Area will also provide assistance as needed.

Two lookouts and aerial reconnaissance flights primarily provide fire detection. The Forest Service lookout on Weaver Bally provides early fire detection and is generally staffed from late May or early June (depending upon snow conditions) to late September or early October (depending on budget constraints). Weaver Bally lookout is located about 7 miles to the northwest of the plan area and looks directly into the Grass Valley Creek area. On a clear day the lookout can spot a fire in the area while it is still relatively small. The Forest Service has replaced some of its lookouts with reconnaissance flights, which occur during periods of critical fire potential, such as after a lightning storm has passed through the area or when active fires are burning.

The State lookout on Bully Choop, located 2 miles south of the plan area, can see directly into the GVC watershed. On a clear day the lookout can spot a fire in the area while it is still relatively small. It is generally staffed from the first week in June (depending upon fire weather conditions) to late September or mid October (depending on budget constraints and fire weather). It also acts as a radio relay station for various agencies.

The California Department of Forestry and Fire Protection, Shasta-Trinity Unit, maintains a battalion chief (Bill Britton 623-5822), two fire captains, and two foresters at their Weaverville Station on Washington Street. During fire season, a 500-gallon engine with a 3-4-person crew is stationed there, with 2 engines 14 miles southwest at Fawn Lodge, 1 in Hayfork, and 2 in Shasta. CDF engines are funded for use on wildland fires on private lands, but if staffed they respond to any fire or other emergency year-around. The CDF Trinity River Conservation Camp at Trinity Mountain has five 15-17 person crews that can cut fire line and mop-up fire. They are also available year round to do project work.

Automatic Dispatch (Fire Season)

During high fire danger dispatch periods (i.e. average summer days), any wildland fire report in the Grass Valley Creek watershed triggers the following series of automatic fire equipment dispatches:

- 1 CDF Battalion Chief
- 6 closest CDF or USFS wildland fire engines (see below)
- CDF engine 2475 (Weaverville)
- CDF engine 2466 & 2481 (Fawn Lodge)
- CDF engine 2468 (Hayfork)
- CDF engine 2478 or 2464 (Shasta)
- CDF bulldozers 2441 & 2440 (Redding)
- 2 CDF Trinity River Fire Crews
- 4 LVFD engines and 1 water tender
- USFS engine 32 (Junction City)
- USFS engine 41 (Mule Creek)
- USFS engine 42 (Coffee Creek)
- Helitack 506 or CDF helicopter
- 1 air attack and 2 retardant air tankers
- 2 closest water tenders, usually LVFD or private

If the fire cannot be contained with these resources, additional resources are sent, if available. If a fire can be contained with fewer resources, resources are to return to their stations.

The USFS will assist CDF in wildland fire suppression if needed. The USFS has a division chief, battalion chief, and chief fire prevention technician stationed in Weaverville, a Model 62 engine with a 500-gallon tank stationed about 18 miles north at Mule Creek Guard Station and a Model 61 engine with a 500-gallon tank stationed about 39 miles north at Coffee Creek Work Station. The stations with engines have a 7-person crew on duty 7 days a week from June 1st to mid October, with a minimum of 5 people required for each engine. A Model 42 engine with a 500 gallon tank is stationed about 11 miles west at Junction City and has a 5 person crew on duty 7 days a week, with a minimum of 3 people required for the engine. There is a 20 person, Type I fire crew stationed at Hayfork. The USFS water tender at Big Bar can respond if needed and in 2003 a tender will be stationed at Mule Creek. A contract, Type II helicopter with a Helitack crew of 14 people is stationed at the Trinity River Conservation Camp during fire season.

The USDI, Whiskeytown National Recreation Area has two engines, a 20-person hand crew, and a 7-person fire module that will respond to fires in the watershed as needed. Dispatch of these resources is handled by CDF from the Interagency Dispatch Center in Redding.

Aerial resources available for fire suppression include USFS 'Helitack 506', Forest Service and CDF retardant air tankers, a USFS lead plane and CDF air attack, CDF helicopters based in Tehama and Humboldt Counties, and the Forest Service Redding smoke jumper corps. The Forest Service helicopter, located at Pettijohn Mountain (Trinity River Conservation Camp) in Trinity County, can be on a fire in the Grass Valley Creek area within 5-10 minutes of detection. This helicopter can deploy 2-5 fire fighters (14 total) on scene and begin water bucket drops (400-gallon capacity) almost immediately. The retardant bombers, lead plane, air attack and smoke jumper planes are all stationed at Redding Airport and can be on scene within 15-20 minutes of dispatch. Additional retardant planes are located at Rohnerville Airport in Humboldt County and Chico Airport. Planes from both of these airfields can respond within 35-45 minutes to this area.

The Redding smokejumpers are not normally used on a fire where road access is readily available, such as the northwestern portion of the Grass Valley Creek watershed. But they could be used in the portions of the watershed with limited access.

The initial responder to structural fires is the Lewiston Volunteer Fire Department (LVFD), which will assist CDF with wildland fires. The LVFD has a fire station on Texas Avenue, with a total of four fire engines (Type I 500-gallon, Type II 800 gallon, Type II 1000 gallon, Type III 260 gallon 4X4) equipped for structural and wildland fires, one Type II 3200-gallon water tender, and one rescue unit. Jesse Cox (778-3965) is the Fire Chief.

There are seven water sources suitable for filling helicopter buckets. The Bureau of Reclamation maintains the Grass Valley Creek reservoir, about eight miles up Grass Valley Creek, and the lower Hamilton pond (see caution below) on GVC just upstream from its confluence with the Trinity River. The Trinity River has sections of slow water suitable for filling buckets. For fires approaching the watershed from the west, there is a suitable pond just north of the confluence of Indian Creek and the South Fork of Indian Creek, and Union Lake is just east of Douglas City. For fires approaching from the east, Whiskeytown Lake is the closest suitable source. Rainbow Lake can be used for fires approaching from the south and Lewiston Lake for those approaching from the north. All of these water sources are invaluable for fighting fire and should be maintained for such use, with the cautionary note below.

High voltage powerlines cross over the upper Hamilton pond and lower voltage lines are to the west and north of the lower pond and along Lewiston Road. There are also tall trees to the west of the ponds. Helicopters should use only the lower Hamilton pond, should approach and leave only over the meadow to the east, should not use this pond during windy weather, and should use it only at the discretion of pilots. A person qualified to assess for safety hazards to helicopters should make a preattack assessment of this water source.

Upper Hamilton Pond (note powerlines)

There are a number of engine and water tender drafting locations in and close to the watershed, as shown on the 'Fire Access and Infrastructure' map. These locations may not be inclusive of all drafting spots and are subject to change, depending upon monthly and yearly fluctuations in flow and changes in stream channels. Some of these locations are at stream crossings and may require temporary barriers to pond water for drafting.

There is an 875-gallon concrete water tank at the crossing of County Line Road and Grass Valley Creek in Section 31, T32N, R7W that has an outlet fitted for filling engines. There are two 2½-inch gate valves on the outlet, with a downstream bell reducer followed by a male to female reducer followed by a male to female 1½-inch i.d. firehose fitting. The supply, which is currently disconnected, is from GVC, which in late October 2002 was running 21 gpm (may flow less during hot weather) after five or more months without rain. There are two supply lines, the upper a 1¾-inch PVC pipe going 150 feet up the creek and the lower a 2¼-inch PVC pipe going directly to the creek. Inlets need to be constructed for both of these lines to make them serviceable. It would be advisable, but not necessary, to reinforce the foundation on the road side of the tank, patch the inside of the tank, and improve the access road.

Engines and tenders can always draft water from Grass Valley Creek reservoir at the dam, accessed via the gated Dam Access Road. The lower Hamilton Pond has truck access and a high volume pump suitable for filling engines and tenders, which will be ready for such use in the summer of 2003. Access is through a gated road running south from Lewiston Road to the east of GVC.

Water for the IOOF camp is pumped from Grass Valley Creek. The pump house is wood with a metal roof, the pump is electrical, and electrical lines supplying the pump are above ground. Underground pipes carry water to a 72,000-gallon cinder block water storage tank with a metal roof. This tank has about a 20-foot clearance to flammable vegetation, which includes some brush. An underground pipe supplies domestic water to the residents and water for fire fighting to three fire hydrants. The system is operated and maintained by residents. It can be used to fill engines and water tenders in an emergency. The IOOF community also has its own fire truck, which can draft water if needed.

Transportation System (Fire Access)

Before BLM acquired the lands it administers, road rehabilitation and decommissioning projects had been identified by NRCS and were being implemented by the TCRCD. Many miles of road were decommissioned, leaving a sparse road system for fire and administrative access. This limited road system by necessity limits the types and extent of fire control, fuel modification, timber sale, watershed rehabilitation, and other administrative work that can be done in the watershed.

Seven entities, private landowners, SPI, Trinity County Road Department, California Department of Transportation (CALTRANS), BLM, TCRCD, and the Whiskeytown NRA do road maintenance. The Bureau of Land Management classifies roads by levels (five) of maintenance, depending upon level of use and management objectives. It is initiating a new system for classifying, numbering, and naming roads, so the information listed below will need to be updated to conform to this system.

Road conditions can change rapidly due to landslides, culvert failures, surface rutting, rock falls, and/or tree breakage or uprooting. This is especially true in areas of decomposed granite, where soils are highly erosive. It is therefore recommended that the road system be driven periodically to assess road conditions and to identify sections that need repair. Unless otherwise noted, all roads described below are currently drivable by either 2-wheel or four-wheel drive vehicles. The ‘Fire Control Access and Infrastructure’ map and the road descriptions below should be updated before each fire season and copies should be made available to fire stations with suppression responsibilities in and around the watershed.

Only a few of the roads listed below are officially named and signed on the ground. Other names are those commonly used by residents and/or resource managers. These common names are so noted in the individual road write-ups. To facilitate rapid-fire access and limit confusion, it would behoove all landowners to erect road signs at road junctions.

Roads Originating from State Highway 299

State Highway 299 is the main road that bisects the watershed and parallels Grass Valley Creek for much of its length. This is a two-lane highway, with three sections of four lanes for passing. It is a heavily traveled road during the summer tourist season and during hunting season in the fall. Highway 299 is maintained and snow plowed by CALTRANS, which has a variable width, dedicated right-of-way.

Named Roads Originating from Highway 299 (listed from west to east)

Poker Bar Road and Connecting Roads (listed from south to north)

Poker Bar Road (signed) is a paved, two-lane County road with variable easements maintained by the Trinity County Road Department.

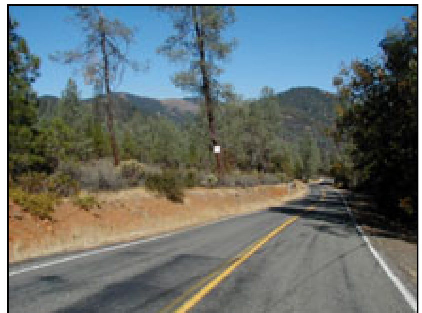
Old Highway (Old Lewiston Road) (signed) is a paved, two-lane County road with variable easements maintained by Trinity County. This road ties in at the east end with Lewiston Road.

A single-lane dirt road with turnouts intersects Poker Bar Road about half way to the Trinity River. It traverses BLM lands to access private property in Section 27, T33N, R9W near the mouth of Tom Lang Gulch. This is a Level 2 road maintained by BLM up to the private property boundary.

Lewiston Road and Connecting Roads (listed from south to north)

Lewiston Road (signed) intersects 299 just east of the northwest corner of the GVC watershed and runs for about one mile through that portion of the watershed. It is a paved, two-lane county road that carries mostly local traffic to the subdivision at the mouth of Grass Valley Creek and to Lewiston. There is a minor amount of tourist traffic on this road during the summer. Lewiston Road is maintained and snow plowed by the County Road Department.

Old Highway (Old Lewiston Road) (signed) is a paved, two-lane County road with variable easements maintained by Trinity County. This road ties in with Poker Bar Road at the west end.



Lewiston Road

Three private dirt roads intersect with Lewiston Road to access the subdivision at the bottom of GVC on the west side of the creek. Ohio Lane (not signed) is a single-lane gravel road. South Ponderosa Road (not signed) is a single-lane gravel road. Ponderosa Pines Road (signed) is a single-lane, paved road. Lowden View Road (not signed) off of Ponderosa Pines Road is a single-lane gravel road. Pine Flat Road (not signed) intersects with Ponderosa Pines road within the subdivision. These are all single-lane dirt roads in good condition. All of these roads are in good condition and are maintained by the property owners.

Wellock Road (signed) is a paved, 1 ½-lane County road with turnouts maintained by the County. This road intersects with Lewiston Road west of the bridge over Grass Valley Creek.

Dirt Road (signed) is a gated, single-lane dirt road that intersects with Lewiston Road between Wellock and Coffin Roads west of the bridge over GVC. It runs south parallel to GVC to access private property. The property owners maintain this road.

Coffin Road (signed) is a gated, single-lane gravel road with turnouts that intersects with Lewiston Road east of the bridge over GVC. It runs south parallel to GVC to access private property. The property owners maintain this road.

Oak Ranch Road (signed) is a single-lane gravel road with turnouts that intersects with Lewiston Road to the northeast of Coffin Road. It accesses a couple of houses and is maintained by the property owners. It is drivable to the boundary between Sections 26 and 35, where a private drive spurs off to a house on the top of the ridge. The main road continues on through SPI and other private lands to Fawn Lodge, but is now overgrown with brush and impassable over a portion of its length.

There is a gated, double-lane gravel road (not signed) with turnouts to Hamilton Ponds that is maintained by the TCRCD with funds from the BOR. One of the ponds has a high volume water pump with truck access that will be ready for filling water tenders and fire engines in the summer of 2003.

A private, single-lane gravel road to Lowden Ranch intersects with Lewiston Road east of the road to Hamilton ponds. This road used to be open all the way through Snipe Gulch and around the ridge to Fawn Lodge but is no longer open past the ranch house. The property owner maintains this road.

Timber Trails

Timber Trails (signed) is the single-lane gravel road that accesses the private parcels to the west of Fawn Lodge and north of GVC. At one time it continued on through SPI and private land to Oak Ranch Road and Lewiston Road near the Hamilton Ponds, but is no longer a through road due to heavy brush in the roadway (see Oak Ranch Road description above).

Trinity Dam Boulevard and Connecting Roads (listed from south to north)

Trinity Dam Boulevard (signed) intersects 299 across from the IOOF camp. It is a paved, two-lane county road that carries local traffic to Lewiston and points north. During the summer season it is heavily traveled by tourists accessing Trinity River and Lake and Lewiston Lake. Trinity Dam Boulevard is maintained and snow plowed by the Trinity County Road Department, which has a deeded right-of-way of variable widths.

Twin Oaks Road (signed) is a single lane road about ½ mile northwest from the junction of Trinity Dam Boulevard. and Highway 299 that accesses residences. The spur road to the east is known as Dead Mule Road (not signed). The property owners maintain these roads.

Carr Place (signed) is a gated, single lane dirt road about one mile north from the junction of Trinity Dam Boulevard and Highway 299 that accesses a residence. The property owner maintains it.

What is commonly known as Upper Phillips Gulch Road (not signed) is a gated, single-lane dirt road with turnouts that begins in Sec 31, T33N, R8W at Trinity Dam Boulevard and parallels the north side of Phillips Gulch for about two miles, ending in Sec 28, T33N, R8W. After about one-half mile there are occasional fallen trees across the road and some deep rolling dips that would obstruct passage by a lowboy. There are a couple of short drivable spurs off of this road. The first goes northeast to a landing in a draw near the GVC watershed boundary and the second goes northeast to the watershed boundary. These are Level 2 roads maintained by the TCRCD, with funds from BLM, on a periodic basis as there is currently little use. When SPI hauls over this road it maintains it.

What is commonly known as Lower Phillips Gulch Road (not signed) off of Trinity Dam Boulevard, beginning in Sec 31, T33N, R8W, is a gated, single-lane dirt road that travels through BLM lands and ends on California Department of Forestry lands at Fawn Lodge. The road surface is good but some dead trees have to be removed. In Sec 25, the road spurs off into SPI lands where it eventually accesses the Lowden fire in the northern part of Sec 25. The BLM portion of the road is a Level 2 road maintained by BLM on a periodic basis as there is currently little use. SPI maintains the roads on its property and the BLM portion when it is hauling over it.

Clark Creek Road

Clark Creek Road (not signed) intersects 299 just east of Trinity Dam Boulevard near the mid-north boundary of Sec 5, T32N, R8W. It accesses several private parcels north of 299. This is a single-lane gravel road with turnouts that has a good surface. The property owners maintain it.

Shingle Shanty Road

Shingle Shanty Road ("Shingle Shanty" sign), a 1½ lane surfaced road, accesses the private parcels, known as Shingle Shanty, northwest of the Dam Access Road. The property owners maintain this road.

Dam Access Road and Connecting Roads (listed from north to south)

The road commonly known as the Dam Access Road (not signed), which begins in Sec 14, T32N, R8W, is a gated, 1½-lane chip sealed road (to the dam) that accesses the Grass Valley Creek reservoir. It is in good condition and is passable by 2-wheel drive vehicles all the way to Grass Valley Creek below the dam. From there to its end it is a 4-wheel drive road due to large waterbars. This is a Level 2 road maintained by the TCRCD, with funds from the BOR, on a periodic basis as there is currently little use.

The spur road in Sec 14, T32N, R8W, northeast of the Dam Access and Mainline Roads junction, is no longer passable because the first stream crossing has washed out.

What is commonly known as Mainline Road (not signed) connects with the Dam Access Road in Sec 14, T32N, R8W just west of Little Grass Valley Creek. It is a gated, single-lane dirt road that is passable to 2-wheel drive vehicles until it crosses Grass Valley Creek at the cement bridge in Sec 26, T32N, R8W. From that point, the road becomes 4-wheel drive until its junction with County Line South Road in Sec 2, T31N, R8W. The road has some steep and narrow sections before it reaches County Line South Road, which can be traveled in 2-wheel drive, though it is not advisable. This is a Level 2 road maintained by the TCRCD, with funds from BLM, on a periodic basis as there is currently little use.

Just north of the second gate on Mainline Road is a single-lane, graveled road that accesses the upper end of the Grass Valley Creek reservoir. This is a Level 2 road maintained by BLM on a periodic basis as there is currently little use.

What is commonly known as Corral Creek Road (not signed), which ends in the Indian Creek drainage, spurs off of Mainline Road in the SW ¼ of Sec 26, T32N, R8W. It has difficult crossings in Draws 1, 47, 59, and 61 where the road is gradually washing out. At Draw 69, on the boundary of Sec 33 & 34, T32N, R8W, Corral Creek Road has washed out and becomes impassable. This is a Level 2 road maintained by BLM on a periodic basis as there is currently little use.

The low standard road along the west watershed boundary runs northwest off of Corral Creek Road in Sec 27, T32N, R8W. It is passable to 4-wheel drive vehicles for the first ¼ mile, although brush is growing in the middle and sides of the road. After that it is passable only to ATV travel. This road is currently not maintained by BLM.

The road that spurs due east off Mainline Road ¼-mile northeast of the BLM gate in the SW ¼, SW ¼ Section 35, T32N, R8W, outside the watershed boundary, has a good road base, but needs brushing to be passable. It ends in the SE ¼ Sec 35, T32N, R8W at a washed out stream crossing. This is a Level 2 road that is currently not maintained by BLM.

The short spur to the west just northeast of the BLM gate in the SW ¼, SW ¼ Section 35, T32N, R8W ends at a landing in the draw. This is a Level 2 road is currently not maintained by BLM.

The road commonly called the 18/19 Road (not signed) spurs off the Dam Access Rd just below the dam in the SW ¼ of Sec 15, T32N, R8W, parallels GVC on the north side, and ends at the landing on the north side of Grass Valley Creek in the SW ¼ of Sec 16, T32N, R8W. It is a gated, 4-wheel drive, single-lane dirt road with significant rolling dips at the crossings. This is a Level 2 road maintained by the TCRCD, with funds from BLM, on a periodic basis as there is currently little use.

County Line Road and Connecting Roads (from north to south)

What is commonly known as County Line Road (not signed) starts at Highway 299 just east of Buckhorn Summit. It is a single-lane dirt road with turnouts that runs south, roughly along the boundary between Trinity and Shasta Counties, tying into Crystal Creek Road at Coggin's Park, Mainline road to the east of Bully Choop, Indian Creek Road to the west of Bully Choop, and eventually Highway 36 between the Wildwood Store and Platina. It is a lightly to moderately traveled road, getting most of its use during the summer and the fall hunting season. This is a Level 2 road maintained by Whiskeytown NRA, BLM, and CDF on a periodic basis.

The commonly known Green Gate Road (not signed) spurs off of County Line Road in the NE 1/4 of Sec 24, T32N, R8W and reconnects with County Line Road in Sec 30, T32N, R7W. It is strictly a 4-wheel drive, gated dirt road. Brushing and crossing work is needed. It is narrow so only pickups can maneuver it and has three draws that are sharply down-cutting the road surface, making passage even more difficult. A chain link gate near the private land in Sec 30 blocks passage through to County Line Road. This is a Level 2 road maintained by BLM on a periodic basis as there is currently little use.

The spur road in Sec 25, T32N, R8W, off Green Gate Rd has been decommissioned.

The short driveway to private land in Sec 30 is in good condition and is maintained by the property owners.

The spur road to the south off the switchback just south of the Green Gate Road on County Line Road in Sec 24, T32N, R8W has a good road base but needs brushing. It is a single-lane dirt road about 1/3-mile long. This is a Level 2 road maintained by BLM on a periodic basis as there is currently little use.

North of the switchback is a gated, single-lane dirt road that runs north from County Line Road to the watershed boundary and beyond into private lands, where it ends. This is a Level 2 road maintained by BLM on a periodic basis on its lands. The private landowners past BLM maintain the road when hauling logs.

Just north of Coggins Park is the gated (lower end at paved road, upper end near Coggins Park) Crystal Creek Road (signed at Highway 299), which is a single-lane dirt road with turnouts (see description below). This road is maintained by the Department of the Interior, Whiskeytown NRA.

There are three spurs on private land to the southwest of Coggins Park and west of County Line Road. The northern most spur has a good road base and could be recommissioned with only a little brushing and watercourse crossing work. The property owners maintain this road. The southern two spurs are not at all passable in their current condition.

South of these roads is a gated single-lane dirt road with turnouts (signed “Shasta Bally”) that once connected to the top of Shasta Bally. The first 1 ½ miles are passable by 2-wheel drive pickup, but a poor road surface, steep grades, and deep waterbars make 4-wheel drive advisable. At the 2-mile point the road becomes impassable to the top of Shasta Bally due to a washout at a creek crossing and has been permanently converted to a trail. The road and trail are maintained by the Department of the Interior, Whiskeytown NRA.

The spur road south of County Line Road, in Sec 31, T32N, R 7W and Sec 6, T31N, R 7W, that goes up to the watershed boundary east of Shoemaker Bally is passable only with an all terrain vehicle. A crossing has washed out within the first 200 feet. After that the road base is in good condition, but it needs brushing and is narrow. After the road crests the ridge, it becomes passable. It was used regularly during BLM’s fuelbreak work on the ridge between Trinity and Shasta Counties. This is a Level 2 road maintained by BLM on a periodic basis as there is currently little use.

In the southwest corner of the watershed, about ¼ mile north of the junction of County Line Road and the watershed boundary, is a gated, single-lane dirt road with turnouts that runs west through private land into SPI lands. This road ties in with Mainline Road at the BLM gate in the SW ¼, SW ¼ Section 35, T32N, R8W. The property owners, including SPI, maintain this road.

Hoadley Peaks Road and Connecting Roads (from south to north)

What is commonly known as Hoadley Peaks Road (signed) starts at Highway 299 100 yards east of Buckhorn Summit. It is a single-lane, mostly graveled, partly chip sealed, and partly dirt County road with turnouts that runs north along the boundary between Trinity and Shasta Counties. It connects with the Lewiston Turnpike and the road to French Gulch northeast of North Hoadley Peak. It is a moderately traveled road, getting most of its use during the summer and fall hunting season, but also throughout the year to access the communications relay station on South Hoadley Peak. This is a Level 2 road maintained by Trinity County, BLM and SPI on a periodic basis as there is currently little use.

The spur to the communications relay station on South Hoadley Peak is a single-lane, graveled road. This is a Level 2 road maintained by BLM on a periodic basis. This road is used often for maintenance of the facilities.

Unnamed Roads Originating from Highway 299 (listed from west to east)

The gated road up Sawmill Gulch to SPI lands starts in the SW ¼, Section 35, T33N, R9W. Although this road also accesses BLM lands, BLM has no access rights. The road is maintained by SPI.

The gated dirt road that runs south from 299 at the passing lane west of Fawn Lodge starts in the S ½, Section 35, T33N, R9W and accesses private and SPI lands. This road is maintained by the landowner to the boundary with SPI, and by SPI from there on.

The single-lane dirt road across (south of 299) from Fawn Lodge that starts in the S ½, Section 36, T33N, R9W, quickly turns into a 4-wheel drive track. It is currently not maintained by the landowner.

The road just east of Fawn Lodge on the north side of 299 starting in the S ½, Section 31, T33N, R9W is a single lane dirt road that goes all the way over the ridge and down to Phillips Gulch. It does not cross the creek to tie in with Lower Phillips Gulch Road. This road is maintained by BLM and the private property owners.

Information on road conditions for the SPI roads in Sections 1, 2, 3, 11, & 12 in T32N, R9W, Sections 6, 7, 8, 17, & 18 in T32N, R8W, Sections 31 in T33N, R8W, and Sections 25, 35 & 36 in T33N, R9W can be obtained from Tom Walz, SPI, Weaverville, CA. These roads are maintained by SPI.

The gated road into the IOOF camp is a well maintained, chip sealed, 1 ½-lane road with turnouts that ends in Section 8, T32N, R8W. The camp residents maintain it to the south section line of Section 5. From there it is maintained by the owners of the property in Section 8.

The road just west of Buckhorn Station and south of 299 that accesses private and BLM lands in Walt's Creek in Sections 5 & 6, T32N, R8W has two entry points. The eastern, gated road crosses Little Grass Valley Creek with a culvert. The western gated road crosses the creek with a bridge (which may soon be pulled). The two roads converge on BLM lands just after the creek crossing, where they merge into a single-lane dirt road with rolling dips at the crossings. The road ends in Section 9. It is maintained by BLM and the property owner.

Two gated dirt roads intersecting with 299 south of Buckhorn Station access private property in Section 4, T32N, R9W. These are short roads maintained by the landowner.

The gated dirt road that intersects 299 near the border of Sections 3 and 4, T32N, R9W, is short as it was decommissioned.

The gated road into Tom Ludden's place, Tri-L Ranch, in Section 10 to the south of 299 is a single-lane dirt road that ends approximately ½ mile into his property. The property owner maintains this road.

The gated road that accesses the private parcel just northwest of the Dam Access Road, in Sec 14, T32N, R8W, is a single-lane dirt road that ends at a residence. The property owner maintains this road.

The gated, single-lane dirt road north of 299 about 1/3 mile west of Buckhorn Summit accesses Trans-Wood Company property in the E ½, NW ¼, Section 14, T32N, R8W.

The gated, single-lane dirt road south of 299 about 100 yards west of Buckhorn Summit into the Gribble property accesses sediment basins that are cleaned yearly by the TCRCD. The road to these basins is maintained on a regular basis by the TCRCD.

Roads Originating in Adjacent Watersheds

There is a gated SPI road up Tom Lang Gulch that starts at Highway 299 and accesses the block of SPI lands in the northwestern portion of the watershed. The property owners maintain this road.

Lewiston Turnpike (signed "Turnpike Road" on the opposite side of Trinity Dam Blvd.) is a single-lane gravel County road with turnouts maintained by the Trinity County Road Department. This road is located on the north side of Hoadley Gulch. At the west end it ties in with Trinity Dam Boulevard in Lewiston north of the Plug and Jug. At the east end it ties in with Hoadley Peaks Road to the northeast of North Hoadley Peak.

Crystal Creek Road (signed) is a paved, two-lane road that accesses the Crystal Creek Regional Boys Camp (Juvenile Detention Facility) 4 miles from Highway 299. There is a gate 2 miles up the road from Highway 299. Just west of the camp is a gated, single-lane dirt road with turnouts, also known as Crystal Creek Road (not signed), that runs 7 miles to access County Line Road just northwest of Coggins Park. This road is gated at the paved road on the lower end and one one-quarter mile east of County Line Road at the upper end. This road is maintained by the Department of the Interior, Whiskeytown NRA.

Shasta Bally road (signed with "Shasta Bally") is a gated, single-lane dirt road with turnouts. It originates at a road up Brandy Creek on the Whiskeytown NRA, climbs to the top of Shasta Bally, and then continues as a road and trail on to County Line Road. The first 1 ½ miles on the western end is passable by 2-wheel drive pickup, but in spots has a poor road surface, steep grades, and deep waterbars that make 4-wheel drive advisable. At the 2-mile point the road becomes impassable to the top of Shasta Bally due to a washout at a creek crossing and has been permanently converted to a trail. The road and trail are maintained by the Department of the Interior, Whiskeytown NRA.

A gated, single-lane dirt road with turnouts starts on SPI lands on Indian Creek Road in Section 29, T32N, R8W (just west of Cannonball Flat) and ends in the north part of that section. This road is maintained by SPI. A single-lane dirt road with turnouts spurs off of this road to access BLM lands in Section 28 southeast of Art's Peak. This spur road is maintained by SPI to the boundary with BLM. From there it is a rarely used Level 2 road that was maintained to the burn in the mid-southern portion of Section 28 only to facilitate rehabilitation work.

What is commonly known as Joseph Gulch Road (not signed) is a private, gated, single-lane dirt road starting on Indian Creek Road in Sec 30, T32N, R8W, that goes to the top of the watershed boundary and on into private and SPI lands to the north and east. It has only a few turnouts. The property owners maintain this road.

What is commonly known as Mule Gulch Road (not signed) is a private, gated, single-lane dirt road starting on Indian Creek Road in Sec 25, T32N, R9W. It traverses private and then SPI lands as it climbs to the top of the watershed boundary, and then continues northwest through SPI lands. It has only a few turnouts. The property owners maintain this road.

What is commonly known as Fretas Gulch Road (not signed) is a gated, single-lane dirt road with turnouts starting on Indian Creek Road on BLM lands in Sec 26, T32N, R9W and ending on private property in Secs 23 and 24. It was built by a private landowner to BLM specifications and is maintained by that landowner under agreement with BLM.

What is commonly known as Spring Gulch Road (not signed) is a single-lane dirt road starting on Indian Creek Road in Sec 27, T32N, R9W that continues into Secs. 14, 15, and 16. At the beginning of the road are two unimproved fords, one across Indian Creek and one across Spring Gulch, which effectively makes this a 4-wheel drive road only. There is a cutbank slump near the old Phillips Mine in the southeast ¼ of Section 14 that needs to be removed to allow access past that point. There is a SPI gate near the section line between 15 and 16 where the road enters SPI lands. This road is rarely maintained by BLM, although waterbars were repaired in the first mile in 2002 by the TCRCD. This is a Level 2 road maintained by BLM on a periodic basis, as there is currently little use.

CHAPTER 2. NATURAL RESOURCES

In order to understand the effects of past human-caused and natural disturbances in the GVC watershed and to assess the likely effects of future planned and unplanned disturbances, it is necessary to understand as fully as possible the condition of the existing natural resources. The following overview of vegetation, geology, soils, wildlife and fisheries and past human use of the land was compiled from aerial photographs, maps, published literature, personal interviews with resource managers from a variety of agencies who are familiar with the GVC watershed, and field work by RCD personnel and the writer of this document.

Wildlife Habitat Vegetation Types

Vegetation in the plan area is influenced by aspect, elevation, soil type and depth, proximity to water, past timber harvesting method and intensity, and past fire history. Vegetation habitat typing was done using the Wildlife-Habitat Relationships (WHR) classification system ("A Guide to Wildlife Habitats of California", CDF&G, CDF, USFS, Oct. 1988), 6/22/00 WAC, Inc. color aerial photographs at a scale of 1:24,000, and field reconnaissance to verify the types ('Primary' & 'Secondary WHR Habitat' maps and Appendix C). Wildlife-Habitat Relationships types were delineated by Kenneth Baldwin, digitized by Phil Towle, Trinity Community GIS, Hayfork, CA, field verified by Kenneth and Randi Anderson (TCRCD) and mapped by Randi and Kelly Sheen (TCRCD.

Acres by Vegetation Type

WHR Habitat Type	Acres
Montane Hardwood-Conifer (MHC)	7867
Sierra Mixed Conifer (SMC)	5102
Douglas-fir (DFR)	4669
Montane Hardwood (MHW)	2193
Montane Chaparral (MCP)	1111
Montane Riparian (MRI)	811
White Fir (WFR)	464
Closed-Cone Pine-Cypress (CPC)	362
Ponderosa Pine (PPN)	329
Barren (BAR)	276
Annual Grass (AGS)	254
Lacustrine (LAC)	37
Klamath Mixed Conifer (KMC)	21
Wet Meadow (WTM)	9
Total	23,505

Wildlife habitat vegetation types generated through the above process were compared to types in, and supplemented with information from, the GVC WA, a 1995 vegetation survey of the eastern two-thirds of the watershed on BLM lands ("Plant Communities of the Grass Valley Creek Watershed", Christina Veverka, BLM 1995), and stand information from a 1996 John Hancock Company THP (2-96-337-TRI) in Sections 6, 7, 8, 17, & 18, T32N, R8W. Vegetation types derived from LANDSAT imagery from the Klamath Bioregional Assessment Project (Larry Fox et. al., College of Natural Resources and Sciences, Humboldt State University, Arcata, California 95521, 1997) were also compared for consistency with the above.

The WHR classification system uses a three-part code to identify vegetative habitat. The first step in classification is to determine whether the habitat is dominated by trees, shrubs, or herbaceous plants (see below). Then the specific habitat is determined and assigned a three-letter code. To complete the habitat identifier, a code is assigned for size (or maturity in the case of shrubs) and canopy closure.

Habitat Subdivision	Decision Rules
Conifer (DFR, WFR, PPN)	>10% tree canopy cover (cc) + >50% cc by one conifer species
Mixed Conifer (SMC, KMC)	>10% tree cc + >50% cc by conifers + 3 or more conifer species, each <50% cc
Montane Hardwood-Conifer (MHC)	>10% tree cc + >33% & <50% cc by both hardwoods & conifers
Montane Hardwood (MHW)	>10% tree cc + >50% cc by hardwoods + <50% cc by conifers
Montane Riparian (MRI)	>10% tree cc + riparian tree species along stream corridors
Montane Chaparral (MCP)	<10% tree cc + >10% cc by shrubs
Annual Grassland (AGS)	<10% tree cc + <10% cc by shrubs + >10% grass cc

Habitat Subdivision	Decision Rules
Wet Meadow (WTM)	<10% tree cc + <10% cc by shrubs + >10% grass cc
Barren (BAR)	<10% plant cover
Lacustrine (LAC)	>98% open water

STANDARDS FOR TREE SIZE & CANOPY CLOSURE							
Size Code	Size Descriptor	Conifer Crown Diameter	Hardwood Crown Diameter	Quadratic Mean DBH	Canopy Closure Code	Canopy Closure Descriptor	Canopy Closure
1	seedling tree	n/a	n/a	<1"	S	sparse cover	10-24%
2	sapling tree	n/a	<15'	1"-6"	P	open cover	25-39%
3	pole tree	<12'	15'-30'	6"-11"	M	moderate cover	40-59%
4	small	12'-24'	30'-45'	11"-24"	D	dense cover	60-100%
5	med/large tree	>24'	>45'	>24"			
6	multi-layered tree	Class 5 trees over a layer of class 3 or 4					
		trees; total canopy exceeds 60% closure					

STANDARDS FOR SHRUB SIZE & CANOPY CLOSURE					
Size Code	SizeDescriptor	Crown Decadence	Canopy Closure Code	Canopy Closure Descriptor	Canopy Closure
1	seedling shrub	sprouts <3 years old	S	sparse cover	10-24%
2	young shrub	none	P	open cover	25-39%
3	mature shrub	1-25%	M	moderate cover	40-59%
4	decadent shrub	>25%	D	dense cover	60-100%

STANDARDS FOR HERBACEOUS SIZE & CANOPY CLOSURE					
Size Code	Size Descriptor	Plant Height	Canopy Code	Canopy Closure Descriptor	Canopy Closure
1	short herb	<12"	S	sparse cover	2-9%
2	tall herb	>12"	P	open cover	10-39%
			M	moderate cover	40-59%
			D	dense cover	60-100%

Timber harvesting has had the greatest influence on currently existing vegetation patterns and erosion problems in the watershed. Harvesting began in the late 1940s (evident in 1952 aerial photography) and continues to this day on most privately owned lands. Most of the watershed was heavily logged during the '50s, with at least 70% of the merchantable volume removed (Trinity River Basin Main Stem Watershed Study, Timber Harvest Map, 1979). A study by James Komar of the Soil Conservation Service in Weaverville, CA found that "Silvicultural prescriptions often left little or no residual canopy to provide litter recruitment, resulting in the baring of steep hillsides, erosion of soil "A" horizons, and conversion to brushfields" ("Proceedings of the Conference on Decomposed Granitic Soils: Problems and Solutions", Sari Sommarstrom Ph.D., Editor, Redding, CA, 10/21-23/92, University Extension, U.C. Davis).

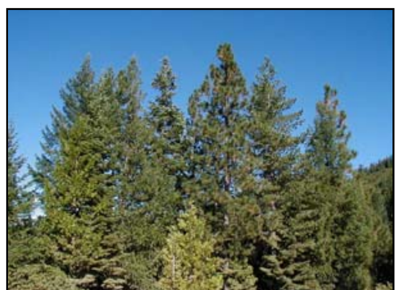
Since passage of the Z'berg-Nejedly Forest Practice Act of 1973, approximately 50 Timber Harvest Plans have been approved by CDF for the watershed. These harvests covered about 16,000 acres of the 17,500 acres of commercial forest (68% of the watershed, 91% of the commercial forest). The primary silvicultural systems used were selection and overstory removal, with tractor logging used almost exclusively. (GVC WA)

Research for the GVC WA determined that the silvicultural systems used since the '70s removed "some or all of the merchantable overstory timber. On north and east-facing slopes, post-harvest timber stands still contain fairly dense canopies that provide good protection from erosion by supplying organic litter to armor the soil surface. Stands on south and west-facing slopes often contain significantly fewer trees per acre, and a heavy harvest of timber may significantly reduce the future supply of soil-protecting organic litter. Attempts at revegetating disturbed areas on south and west-facing slopes have proven to be less successful than on other aspects." In general, these conditions were observed throughout the watershed during fieldwork done to develop the 'WHR Habitat' maps and the 'Primary' & 'Secondary Fuel Model' maps, and were most pronounced in areas of decomposed granitic soils.

Southeast to west aspects are hotter and drier than northwest to east aspects. On these aspects, species that can tolerate less soil moisture and hotter summer temperatures, such as ponderosa and sugar pine and white and canyon live oak tend to form a larger component of the stands. Montane Hardwood-Conifer and Montane Hardwood stands predominate on these sites. Microclimates are cooler and moister adjacent to watercourses and in canyon bottoms and north- and east-facing aspects, supporting dense Sierran and Klamath Mixed-Conifer and Douglas-fir stands dominated by Douglas-fir, ponderosa pine, sugar pine, and California black oak. At higher elevations White Fir stands are more abundant, with white fir and sugar pine being the primary tree species and red fir and white pine being minor species. Montane Riparian vegetation, composed of white alder, willow, cottonwood, and Oregon ash, occurs as narrow bands bordering Grass Valley Creek and tributary streams. The standard wildlife habitat vegetation type descriptions, as displayed in "A Guide to Wildlife Habitats of California", CDF&G, CDF, & USFS, Oct. 1988, are displayed in Appendix C. The types as uniquely found in the planning area are briefly described below.

Sierran Mixed-Conifer (SMC) Forest Habitat

This forest type occupies 25% of public lands in the planning area, 14% of industrial forest lands, and 22% of the residential and non-industrial forest lands. The Sierran Mixed-Conifer type is generally on Dunning Site Class I-III sites (productive timberlands) and is moderately to well stocked (40-100% crown closure, with many 20-40% stands in the upper watershed). The species mix in this type is variable, depending to some extent on elevation and aspect. Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) are the most abundant overstory species at lower elevations and white fir (*Abies concolor*) and sugar pine (*Pinus lambertiana*) tend to dominate at higher elevations. Incense cedar (*Calocedrus decurrens*) is found throughout the watershed, but tends to be more common on non-granitic soils. California black oak (*Quercus kelloggii*) and canyon live oak (*Quercus chrysolepsis*) are common hardwoods found in this forest, with a minor component of Oregon white oak (*Quercus garryana*), Pacific madrone *(Arbutus menziesii)*, and Pacific dogwood (*Cornus nuttallii*). Canyon live oak is found at all elevations and tends to dominate on hotter, drier slopes, while the other oaks are more common at mid to low elevations. Pacific madrone tends to be sparse and localized at lower elevations and dogwood tends to be found in riparian zones or on cooler north and east facing aspects. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type. The SMC type exhibits stability in spite of frequent natural fires and is a fire-adapted vegetation complex in this dry summer climate.



Sierran Mixed Conifer (SMC)

There is very little SMC habitat on residential and non-industrial forest lands. Some residential lands have been logged as recently as 2000. Harvesting in the 1990's mostly used shelterwood removal, sanitation, and salvage prescriptions. This left a mosaic of clumps and patches of conifers mixed with montane hardwood stands. The conifer clumps and patches characteristically have a moderately open overstory of pole to small sawtimber size trees, with a variable density understory of seedlings and saplings.

The SMC forest habitat on industrial forest lands varies depending upon the type and year of harvest. Most of the stands within the plan area have been harvested at least once. There are a few small clear cuts that have stands of primarily sapling-size ponderosa pine and Douglas-fir. On most of these properties the forest has been selectively logged and has a moderately dense overstory of small to medium-size sawtimber with scattered seedlings, saplings, and poles in the understory.

Virtually the entire SMC forest habitat on public lands was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM. This forest tends to be found in draws, on north slopes, at higher elevations, and/or in the mid to upper watershed. It tends to be moderately dense to dense, primarily small sawtimber (~65%) and pole (~30%) size trees with sapling understory trees scattered throughout the forest as individuals and/or in groups. Particularly in the upper watershed and along the eastern watershed boundary south of Buckhorn Summit it is often found in light to moderately dense (10-40% crown closure) stands of primarily seedlings, saplings, and poles with a variable density shrub ground cover.

Klamath Mixed-Conifer (KMC) Forest Habitat

This forest type occupies less than 1% of public forest lands in the planning area. The Klamath mixed-conifer type is generally on Dunning Site Class II-III sites (productive timberlands) and is moderately to well stocked (40-100% crown closure). Like the SMC type, the species mix in this type is variable, depending upon elevation and aspect. Douglas-fir and ponderosa pine are the most abundant overstory species at lower elevations and white fir and sugar pine tend to dominate at higher elevations. Incense cedar is found throughout the watershed, but tends to be more common on non-granitic soils. California black oak and canyon live oak are common hardwoods found in this forest, with a minor component of Oregon white oak, Pacific madrone, and Pacific dogwood. Canyon live oak is found at all elevations and tends to dominate on hotter, drier slopes, while the other oaks are more common at mid to low elevations. Pacific madrone tends to be sparse and localized at lower elevations and dogwood tends to found in riparian zones or on cooler north and east facing aspects. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type. The Klamath mixed-conifer type exhibits stability in spite of frequent natural fires and is a fire-adapted vegetation complex in this dry summer climate.

There is no KMC habitat on residential and non-industrial forest lands.

There is no KMC habitat on industrial forest lands.

On public lands the forest tends to be moderately dense to dense, with pole and small sawtimber size trees and sapling understory trees scattered throughout the forest. Virtually all public lands were harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM

Douglas-fir (DFR) Forest Habitat

This forest type occupies 12% of public lands in the planning area, 45% of industrial forest lands, and 18% of the residential and non-industrial forest lands. The Douglas-fir type is generally found on Dunning Site Class II-III sites (productive timberlands) and is moderately to well stocked (40-100% crown closure) with primarily pole (~40%) and small sawtimber (~50%) size trees. The DFR type is found mostly on cooler, moister sites, such as northwest to east aspects and bordering streams and draws, at low to mid elevations. There is a band of this type from Fawn Lodge east along the Highway 299 corridor, along GVC to the dam, along some of the tributaries to Little GVC, and on SPI lands south of GVC.

Douglas-fir (DFR)

Douglas-fir and ponderosa pine are the most abundant overstory species, with Douglas-fir occupying at least 50% of the canopy. The percentage of incidental overstory species, which include sugar pine, incense cedar, and white fir, varies with elevation and aspect. California black oak and canyon live oak are common hardwoods found in this forest, with a minor component of Oregon white oak, Pacific madrone, and Pacific dogwood. Canyon live oak is found at all elevations and tends to dominate on hotter, drier slopes, while the other oaks are more common at mid to low elevations. Pacific madrone tends to be sparse and localized at lower elevations and dogwood tends to found in riparian zones or on cooler north and east facing aspects. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type. This type exhibits stability in spite of frequent natural fires and is a fire-adapted vegetation complex in this dry summer climate.

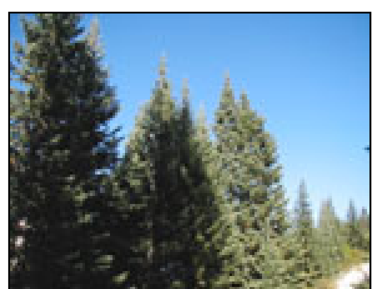
The DFR habitat is found on some of the residential and non-industrial forest lands in this area. Some residential lands have been logged as recently as 2000. Harvesting in the 1990's mostly used shelterwood removal, sanitation, and salvage prescriptions. This left a mosaic of clumps and patches of conifers mixed with montane hardwood stands. The conifer clumps and patches characteristically have a dense to moderately open overstory of pole to small sawtimber size trees, with a variable density understory of seedlings and saplings.

The DFR forest on industrial forest lands varies depending upon the type and year of harvest. Most of the stands within the plan area have been harvested at least once. There are a few small clear cuts that have stands of primarily sapling-size ponderosa pine and Douglas-fir. On most of these properties the forest has been selectively logged and has a moderately dense overstory of pole to small size sawtimber with scattered seedlings and saplings in the understory.

On public lands the DFR forest is found primarily in the Little GVC drainage west of Buckhorn Summit and in the Phillips Gulch drainage. It tends to be moderately dense to dense, with pole and small sawtimber size trees and sapling understory trees scattered and clumped throughout the forest. Virtually all of this forest was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM.

White Fir (WFR) Forest Habitat

This forest type occupies 2% each of public and industrial forest lands and 1% of the residential and non-industrial forest lands. The WFR type is generally found on Dunning Site Class II-III sites (productive timberlands) and is either poorly stocked (40% of type with 10-40% crown closure) or moderately to well stocked (60% of type with 40-100% crown closure). It is found at higher elevations in the most southern portion of the watershed from the area around County Line Road south to the watershed boundary. White fir is the most abundant overstory species, occupying at least 50% of the canopy. Some stands have such a large component of sugar pine that they could probably be designated that way, were there a sugar pine type. In general, sugar pine, Douglas-fir, and especially incense cedar and ponderosa pine are minor components of this type. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type. The WFR type exhibits stability in spite of frequent natural fires.


White Fir (WFR)

The WFR habitat is found on some of the undeveloped parcels in the southwest corner of the watershed. Most of this habitat was last logged by tractor and skidder in 2000, using a shelterwood removal prescription. This left a mosaic of clumps and patches of conifers. The conifer clumps and patches characteristically have a moderately open overstory of pole to small sawtimber size trees, with a variable density understory of seedlings and saplings.

The WFR forest on industrial forest lands is found only in the southwest corner of the watershed. This stand has been selectively logged at least once and has a moderately open overstory of small to medium-size sawtimber with scattered seedlings, saplings, and poles in the understory.

On public lands the WFR forest is in the very south end of the watershed. It tends to be moderately dense to dense, with small to medium sawtimber size trees and sapling understory trees scattered throughout the forest. It is often associated with an intermixed ground cover of sparse to dense brush. Virtually all of this forest was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM.

Ponderosa Pine (PPN) Forest Habitat

This forest type occupies less than 1% of public lands, 1% of industrial forest lands, and 3% of residential and non-industrial forest lands in the planning area. The Ponderosa Pine type is generally found on Dunning Site Class II-III sites (productive timberlands) and in sparse to poorly stocked (~40% with 10-40% crown closure) and moderately to well stocked (~60% with 40-100% crown closure) stands of pole (~25%) and small sawtimber (~70%) size trees. The PPN type is found mostly on warmer, drier sites, such as southeast- to west-facing slopes at low to mid elevations. Ponderosa pine and Douglas-fir are the most abundant overstory species, with ponderosa pine occupying at least 50% of the canopy. Incidental overstory species include sugar pine, incense cedar, and white fir. Canyon live oak and California black oak are common hardwoods found in this forest, with a minor component of Oregon white oak, Pacific madrone, and Pacific dogwood. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type. The PPN type exhibits stability in spite of frequent natural fires and is a fire-adapted vegetation complex in this dry summer climate.

Ponderosa Pine (PPN)

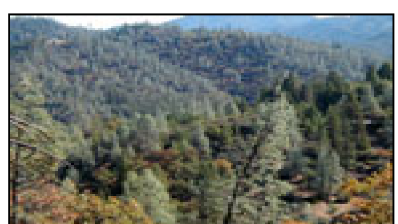
The PPN habitat type is found on some of the residential and non-industrial forest lands along the Highway 299 corridor and Lewiston Road. Harvesting in the 1990's mostly used shelterwood removal, sanitation, and salvage prescriptions. This left a mosaic of clumps and patches of conifers mixed with montane hardwood stands. The conifer clumps and patches characteristically have a moderately open overstory of pole to small sawtimber size trees, with a variable density understory of seedlings and saplings.

The PPN forest on industrial forest lands varies depending upon the type and year of harvest. Most of the stands within the plan area have been harvested at least once. There are a few small clear cuts that have stands of primarily sapling-size ponderosa pine and Douglas-fir. On most of these properties the forest has been selectively logged and has a moderately dense overstory of pole to small size sawtimber with scattered seedlings and saplings in the understory.

On public lands the PPN forest tends to be poorly to moderately stocked with pole and small sawtimber size trees, with sapling understory trees scattered throughout the forest. Virtually all of this forest was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM.

Closed-Cone Pine-Cypress (CPC) Forest Habitat

This forest type occupies less than 1% of public lands, 2% of industrial forest lands, and 4% of residential and non-industrial forest lands in the planning area. The CPC type is generally found on Dunning Site Class IV-V sites (marginally productive timberlands) and is sparsely to moderately stocked (20-50% crown closure). Gray pine *(Pinus sabiniana)* is the most abundant overstory species, occupying at least 50% of the canopy. Incidental overstory species



Closed-Cone Pine-Cypress (CPC)

include ponderosa pine (*Pinus ponderosa*) and occasional Douglas-fir. Oregon white oak (*Quercus garryana*) is often found in this habitat type as an understory tree and often has a moderately dense to dense crown cover. Greenleaf manzanita (*Arctostaphylos patula*), buckbrush (*Ceanothus cuneatus*), and associated shrub species are also found as a moderately dense to dense ground cover.

There was some uncertainty regarding classification of this forest habitat type. The description in A Guide to Wildlife Habitats of California did not quite match what was on the ground, but neither did any other type description, with the possible exception of the Blue Oak-Digger Pine type. That type was actually closer to what was often found on the ground, if white oak were substituted for blue oak, and probably functions in much the same way for similar wildlife species. But its range was outside of Trinity County, so it was not used.

The CPC type is generally found in relatively large blocks on private and SPI lands south and west of the IOOF camp, BLM lands on either side of Trinity Dam Boulevard, and on private lands in the northwest corner of the watershed. Although this type is found on granitic and other soils, it is primarily found on ultramafic soils. It is most often associated with a relatively dense ground cover of shrubs, which causes this type to have a high fuel hazard. In general the CPC type exhibits stability in spite of frequent natural fires.

Montane Hardwood-Conifer (MHC) Forest Habitat

Montane Hardwood-Conifer habitat is found on most of the residential and non-industrial forest lands and in pockets on public and industrial forest lands. This forest type occupies 39% of public lands in the planning area, 20% of industrial forest lands, and 31% of the residential and non-industrial forest lands. These stands include primarily canyon live oak (*Quercus chrysolepsis*) with a minor component of California black oak (*Quercus kelloggii*), Oregon white oak (*Quercus garryana*), and Pacific madrone (*Arbutus menziesii*) mixed with ponderosa pine and Douglas-fir as both understory and overstory trees. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type.

Montane Hardwood-Conifer (MHC)

The MHC habitat type is found on some of the residential and non-industrial forest lands along the Highway 299 corridor, Trinity Dam Boulevard, and Lewiston Road. Harvesting in the 1990's mostly used shelterwood removal, sanitation, and salvage prescriptions. This left a mosaic of clumps and patches of conifers mixed with montane hardwood stands. The conifer clumps and patches characteristically have a moderately open overstory of pole and small sawtimber size trees, with a variable density understory of seedlings and saplings.

The MHC forest on industrial lands varies depending upon the type and year of harvest. Most of the stands within the plan area have been harvested at least once. There are a few small clear cuts that have stands of primarily sapling-size ponderosa pine and Douglas-fir. On most of these properties the forest has been selectively logged and mostly has a sparse to moderately dense overstory of pole size trees with scattered seedlings and saplings in the understory. Scattered MHC stands have a greater proportion of small sawtimber size trees.

On BLM lands the MHC forest type south and east of Shingle Shanty is primarily pole size and tends to be poorly to moderately stocked, with many stands in the upper watershed having a secondary vegetation type of Montane Chaparral. Northwest from the end of the 18/19 Road and from Shingle Shanty, the MHC type is primarily poorly to well stocked with small sawtimber size trees, with smaller understory trees scattered throughout the forest. Virtually all of this forest was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM.

Montane Hardwood (MHW) Forest Habitat

Montane Hardwood habitat occupies 10% of public lands in the planning area, 6% of industrial forest lands, and 10% of the residential lands. These stands include primarily Oregon white oak (*Quercus garryana*), with a minor component of California black oak (*Quercus kelloggii*) and Pacific madrone *(Arbutus menziesii)*. Ponderosa pine and Douglas-fir are found scattered throughout this forest habitat as both understory and overstory trees. Past harvesting and fire exclusion have contributed to the diversity of stands in this habitat type.

The MHW habitat type is found on some of the residential and non-industrial forest lands along the Highway 299 corridor and Trinity Dam Boulevard and in the northwest corner of the watershed. Harvesting in the 1990's in this type was primarily by selection and sanitation/salvage prescriptions. This left a scattering of mostly pole size conifers intermixed with pole size hardwoods in moderately dense stands. There is a variable density understory of seedling and sapling conifers and hardwoods.

Montane Hardwood (MHW)

The MHW forest is scattered across industrial forest lands. On most of these properties the forest has been selectively logged and is mostly of pole size, with a moderately dense canopy and scattered seedlings and saplings in the understory.

Montane Hardwood (MHW)

On public lands the MHW forest is found primarily in the mid to lower watershed. There are concentrations of this type in the Little GVC drainage south of Buckhorn Summit and on the southerly aspects north of Highway 299. Many of these stands are moderately dense to dense, with mainly pole size trees and smaller understory trees scattered throughout the forest. Particularly in the upper Little GVC drainage there are more open stands of the MHW type and lower down in the drainage are scattered stands of sawtimber size hardwoods. Virtually all of this forest type was harvested beginning in the late 1940s or early 1950s and ending in 1993 on lands acquired by BLM.

Montane Riparian (MRI) Forest Habitat

This forest type occupies 4% of public lands in the planning area, 1% of industrial forest lands, and 3% of the residential and non-industrial forest lands. Montane riparian habitat is the narrow band (5-50 feet, average 15 feet) of riparian trees and shrubs growing adjacent to Grass Valley and Little Grass Valley Creeks and other perennial and seasonal streams. These stands include primarily white alder (*Alnus rhombifolia*) (60-70%) and willow (*Salix spp.*) (20-30%). Other common species are Oregon ash (*Fraxinus latifolia*), black cottonwood (*Populus tricocarpa*), Fremont cottonwood (*Populus fremontii*), white poplar (*Populus alba*), Oregon bigleaf maple (*Acer macrophyllum*), black locust (*Robinia pseudoacacia*), ponderosa pine, Douglas-fir, incense cedar, California hazel (*Corylus cornuta californica*), poison oak (*Toxicodendron diversilobum*), and Himalayan berry (*Rubus discolor*).

Montane Riparian (MRI)

It is likely that riparian zones were historically dominated by conifers, but heavy timber harvesting and roading in these zones has removed much of this cover (GVC WA). In granitic soils these zones are subject to severe erosional changes in channel width and location from local and off-site disturbances.

Montane Chaparral (MCP) Shrub Habitat

This shrub type occupies 5% of public lands in the planning area and 4% each of industrial forest and residential and non-industrial forest lands.

Montane Chaparral is a shrub dominated habitat composed of 1- to 8-foot tall, young to mature shrubs usually growing in moderately dense to dense brushfields. The species composition of these brushfields is variable and apparently dependent on elevation, aspect, soil type, proximity to water, and past site disturbance. This type is found in both successional and climax form ("Plant Communities of the GVC Watershed", Christina Veverka, BLM).

Fire and other disturbances continually act on the forest environment of the Grass Valley Creek watershed to perpetuate its diverse ecosystem.

Montane Chaparral (MCP)

Shrub fields at lower elevations are composed of a mix of species, including greenleaf manzanita (*Arctostaphylos patula*), whiteleaf manzanita (*Arctostaphylos viscida*), buckbrush (*Ceanothus cuneatus*), deerbrush (*Ceanothus integerrimus*), and Lemmon's ceanothus (*Ceanothus lemmonii*). At mid to upper elevations and on all aspects on granitic soils are found dense brushfields of primarily tanoak (*Lithocarpus densiflorus var. echinoides*) with occasional patches of greenleaf manzanita. Also found on similar sites are brushfields of primarily greenleaf manzanita. Brushfields on soils derived from ultrabasic rock are generally sparse and dominated by greenleaf and whiteleaf manzanita, Fremont silktassel (*Garrya fremontii*), coffeeberry (*Rhamnus californica* ssp. *occidentalis*), and birchleaf mountain mahogany.

In many locations there are sapling and pole-size commercial conifers emerging from these brushfields as individuals or in groups. White fir and sugar pine are the main species at higher elevations and Douglas-fir at lower elevations. The presence of commercial conifers in brushfields on granitic soils is an indicator that these brushfields are disturbance related, with fire and logging being the most likely causes. Brushfields on ultramafic soils tend to have fewer, if any, commercial conifers growing in them and are probably not fire successional types but rather a result of the chemical and nutrient imbalances found in these soils.

Most of these 'successional' brushfields appear to be fairly old. They are visible on 1957 aerial photos, although not always as dense as at present, and had young white firs and other conifer species in them that are visible on aerial photos flown in 2000, an indication that fire has not burned in them in the interim. The GVC WA estimated these brushfields to be 90 years old.

At higher elevations (3500 feet and above) are found climax brushfields with a greater variety of shrubs, with greenleaf manzanita, pine manzanita (*Arctostaphylos parryana pinetorum*), and bush chinquapin (*Chrysolepis sempervirens*) predominating and mountain whitethorn (*Ceanothus cordulatus*), pinemat manzanita (*Arctostaphylos nevadensis*), bitter cherry (*Prunus emarginata*), ocean spray (*Holodiscus microphyllus*), tanoak, birchleaf mountain mahogany (*Cercocarpus betuloides var. betuloides*), serviceberry (*Amelanchier alnifolia*), and squawcarpet (*Ceanothus prostratus*) as a lesser component.

Montane Chaparral (MCP)
in upper watershed

Annual Grassland Habitat (AGS)

Annual Grassland habitat is rarely found in the watershed. This herbaceous type occupies less than 1% each of public and industrial forest and 3% of residential and non-industrial forest lands in the planning


Annual Grassland (AGS)

area. This habitat is found on flats near the mouth of Grass Valley Creek and in scattered locations on flats along GVC below the dam and on Little GVC. This type is primarily composed of short (under 12 inches) annual grasses, with some intermixed perennial grasses and forbs.

Wet Meadow Habitat (WTM)

Wet Meadow habitat is rarely found in the watershed. This herbaceous type occupies less than 1% each of public, industrial forest, and residential and non-industrial forest lands in the planning area. This habitat is found at high elevations in the south end of the watershed and on a flat on SPI lands to the west of the IOOF Camp. This type is primarily composed of long (over 12 inches) perennial grasses, sedges, and intermixed forbs.

Barren Habitat (BAR)

Barren habitat is primarily non-vegetated or sparsely vegetated areas of granitic soil and/or granitic rock. This type occupies less than 1% each of BLM, industrial forest, and residential and non-industrial forest lands in the planning area. This habitat is primarily found on south- to west-facing slopes in openings in the tree or shrub canopy, but can also be found on north to east slopes. It appears to be related primarily to past removal of vegetation and disturbance to soils, which removed the "A" horizon and left soil conditions that are not conducive to revegetation.

Lacustrine Habitat (LAC)

Lacustrine Habitat is at least 98% open water, and includes dammed riverine channels such as Grass Valley Creek Reservoir and the Hamilton Ponds on public lands.

Geology

Grass Valley Creek watershed is mountainous with steep slopes and narrow V-shaped valleys. The elevation varies from 5950 feet at the summit of Shoemaker Bally to 1740 feet at the confluence of GVC and the Trinity River. The GVC Watershed lies within the Klamath Mountains Geomorphic Province. Flat-topped ridges and glacial peaks characterize this province. The major rocks in the watershed range from 330 to 125 million years in age (Devonian to Jurassic). Undivided granitic rocks (gr) underlie approximately 75% of the planning area, mostly in the eastern portion (refer to the 'Geology' map). The next most prevalent geologic type, ultramafic rocks, mostly serpentine (um), is found mainly in the northwestern portion of the watershed. Relatively minor types found on the western edge or in the northwestern portion of the watershed are gneiss (pJgn), Copley greenstone (Dc), Bragdon formation (Mb), Weaverville formation (Tw), Alluvium (Qal), High-level surfical deposits (Qt) (GVC WA) (Preliminary Geologic Map of the Weaverville Quadrangle, CA by William P. Irwin, Department of the Interior, U.S. Geological Survey, 1963) (Trinity River Basin, Main Stem Watershed Study, Department of Water Resources, 1979).

Undivided granitic rocks (gr) and ultramafic rocks, mostly serpentine (um) are plutonic rocks from the Cretaceous and older period. Gneiss (pJgn) is from the pre-Jurassic period. Copley greenstone (Dc) and the Bragdon formation (Mb) are rocks of the Eastern Klamath Subprovince. The Weaverville Formation (Tw) is composed of Oligocene(?), weakly consolidated, undivided continental sedimentary rocks, chiefly sandstone, mudstone, claystone, and pebble and cobble conglomerates, with inclusions of light-colored tuffs. The alluvium (Qal) type is composed of sand and gravel in present streambeds and on low terraces related to them. This type includes debris from placer mining and colluvium. High-level surfical deposits (Qt) are composed of sands and gravels, which are generally remnants of high-level terraces and not necessarily related to present streambeds. Locally this type includes alluvium and colluvium.

For several reasons the watershed area underlain by the Shasta Bally batholith is highly susceptible to weathering and subsequent erosion when exposed to air. A complex set of fractures has created numerous springs in the batholith and an abnormally high water table. The biotite component in parts of the batholith is 13%, which is high compared with biotite's normal two to five percent presence in igneous rock. Physical breakdown of the batholith because of unloading and fracturing has resulted in numerous fractures and joints, which expose the inner pluton to water induced chemical weathering. The water reacts with the biotite to form hydrobiotite and hydrobiotite reacts with the water to form vermiculite, chlorite, or kaolinite. Vermiculite is an expandable clay and in the presence of water will expand to twice its volume. This expansion causes the rock to break down into monocrystalline, coarse granular fragments, resulting in high susceptibility to erosion. Erosion is further facilitated by the coarse-grained structure of the rock. (GVC WA)

Soils

Soil is the medium in which vegetation is rooted and provides the nutrients and retains the water upon which it depends. Fire, whether prescribed or uncontrolled, timber harvesting or other vegetation manipulations, roading, off road vehicle use, or other natural or human caused disturbances can have slight to profound effects on the stability and fertility of soil. The effects of disturbances depends upon complex interactions of multiple factors, including the type, degree, duration, location, and extent of disturbance, the time elapsed between disturbances, the resiliency of vegetation to recovery, the climate, the elevation and topography, and the structural and chemical nature, bedding plane, organic content, and water content of the soil.

Soil conditions in the GVC watershed are quite variable, ranging from highly erodible soils derived from granitic rocks to soils with chemical imbalances derived from ultrabasic rocks to a variety of soils derived from sedimentary, metasedimentary, and metavolcanic rocks, mica schist, or alluvium. These soils were delineated and their characteristics determined through a soil survey completed in 1985 by the then Soil Conservation Service (SCS, now Natural Resources Conservation Service, NRCS). This survey, "SCS, Soil Survey of Trinity County, Weaverville Area, 1998", was published through the National Cooperative Soil Survey, a joint effort of Federal, State, and local agencies. Information on specific soil types (pgs. 30-36 below) came from that survey (see 'Soils' map). The full soil interpretations are unavailable electronically so are not included in this plan. The survey handbook should be consulted for a full description and interpretation of each soil type.

In 1986 the SCS did a sediment study in the GVC watershed. It found that "70% of the sediment produced by the watershed was caused by accelerated erosion occurring as a result of land management activities, primarily timber harvesting. Of this total, the single largest contributor was logging roads and landings" (GVC WA). Tractor logging was the primary method used to skid logs to landings and evidence from 1952 and later aerial photos show a myriad of skid trails, which also contributed to sediment loads.

Since the 1986 SCS study, the NRCS and Trinity County RCD have done extensive restoration work in the watershed, particularly in areas of decomposed granitic soils ("Grass Valley Creek Watershed Restoration Project: Restoration in Decomposed Granite Soils", TCRCD & NRCS, Feb. 1998 and "10 Year Revegetation Plan for the Grass Valley Creek Watershed 1996-2007", TCRCD & BLM, Dec. 1996). Revegetation and monitoring continue to be done by the RCD.

Granitic Soils

It has been determined that disturbances to granitic soils resulted in the greatest losses of soil in the GVC watershed, which is not too surprising considering that granitic soils are found on 17,335 acres (74%) of the watershed. In 1991 and 1992 a comprehensive inventory of sediment sources in the GVC watershed was conducted by the Weaverville Field Office of the Soil Conservation Service (now NRCS). It found that "the steep slopes, shallow soils and non-cohesive nature of granitic parent material leaves this watershed inherently susceptible to soil erosion". It also found that "soil erosion and sediment have been exacerbated by a significant reduction in the quantity and quality of vegetative cover and from the alteration of hydrologic processes in the watershed over the past five decades".

An erosion monitoring study on the Shasta-Trinity NF showed that erosion rates on soils formed from granitic rocks ranged from 2.1 to 330 cu. ft./ac. (avg. 75.6) while those on soils derived from ultramafic, volcanic, and metasedimentary rocks ranged from 1 to 10.3 cu. ft./ac. (avg. 2.4). This and many other studies on the effects of disturbance on granitic soils are presented in "Proceedings of the Conference on Decomposed Granitic Soils: Problems and Solutions", Sari Sommarstrom Ph.D., Editor, Redding, CA, 10/21-23/92, University Extension, U.C. Davis. The following information is in part drawn from these studies.

Studies on granitic soils in other locations have shown that up to 90% of landslides were associated with road construction. A study in the Scott River watershed north of the Trinity River divide found that road initiated landslides were "extremely sensitive to road location and construction practices" and that 57% of sediment delivered to the Scott River was from roads (4% from skid trails). Another study showed that surface erosion of logging roads was 220 times greater than erosion from undisturbed slopes, while harvesting and log skidding only increased erosion rates by 0.6 times. This study concluded that "forest roads are the primary cause of increased sedimentation from timber harvest activities on steep, granitic soils". (Proceedings)

In 1974 a study was made on the Umpqua National Forest in Oregon of landslides on clearcuts initiated since 1965. It was found that 90% of the debris slides had their source at headwalls in the granitic soils of the highly dissected landscape. Units on slopes of less than 60% showed no evidence of slope failure.

Experience in these soil types suggests that when timber harvesting is done, helicopters should be used. A 6-year study of erosion rates on comparable soils in southern Idaho following logging by downhill skyline yarding systems found that erosion rates on logged areas increased 60% over unlogged areas and logging caused statistically significant increases in erosion on southern, but not northern aspects. Since passage of the Z'berg-Nejedly Forest Practice Act of 1973, logging systems used in the GVC watershed have been almost evenly divided between helicopter and tractor, with very little cable. (Proceedings)

Some of the most dramatic erosional losses in granitic soils have followed high intensity wildfires. The amount of erosion in both harvested and non-harvested forests appears to increase as slope gradient and burn intensity increase. However, in one study average erosion for any particular slope and burn intensity was 60% higher on harvested lands. This appeared to be due to greater burn intensities in heavier fuels on logged lands, which exposed more soil, as well as increased soil protection from needle fall on uncut lands. Another study reported that clearcut watersheds burned at triple the intensity of uncut watersheds, which also increased soil water repellency, a more serious phenomenon on coarse-textured granitic soils than on finer textured, non-granitic soils. Increased raindrop impact on exposed soils, increased overland flow due to decreased soil permeability, and increased dry ravel combined to accelerate erosion. Mass erosion may also be accelerated, especially on slopes in excess of 60%. (Proceedings)

Erosional losses are also directly related to slope aspect. Studies have shown that vegetation recovers faster on north and east facing slopes. Some studies have shown a cessation of erosional losses on north and east aspects within three years following a fire in a clearcut watershed while active erosion was still occurring ten years after a comparable fire in a clearcut, south facing watershed. Coarse-textured granitic soils with low water holding capacity coupled with hot, dry summers slowed vegetation recovery and thus delayed protection of the soil surface. (Proceedings)

These findings have also been observed in the GVC watershed by a number of resource professionals who have worked in the watershed. The 1991 sediment study by the SCS found the following: "Our results reveal that sparsely-vegetated south- and west-facing DG slopes produce disproportionately high sediment yields: 65% of total sediment production was derived from southerly-facing sites (44% from southwest-facing sites). These areas tend to be brittle environments because of extremely droughty conditions, shallow and coarse-textured soils, and physical weathering of the soil (frost-heaving). Even when cover is established, the capacity of these sites to support this vegetative cover is a fragile balance that is easily disturbed. Wide-scale disturbance of this brittle environment results in significant changes to the site". A report by the RCD Revegetation Project Manager in 1992 stated that "Many south-facing slopes harvested for timber over 40 years ago have remained unvegetated and continue to affect the hydrology by increasing runoff". (Proceedings) The GVC WA found that "Removal of vegetation, primarily associated with timber operations, results in the loss of soil cover and is often the cause of severe and persistent surface erosion. Recovery from this vegetation, cover, soil-loss sequence is very slow and may take decades. The majority of the severely eroding areas identified by the Assessment of Sheet and Rill Erosion study ["An Assessment of the Extent of Sheet and Rill Erosion in the Shasta Bally Batholith", SCS, June 1993] are on the hot and dry south and west facing slopes."

Experience in the Lake Tahoe basin has shown that most decomposed granitic soils are low in key nutrients, particularly nitrogen, phosphorus, and sulfur, and in microorganisms that convert organic or atmospheric nitrogen into a form usable by plants. These coarse-textured soils, which have relatively few clay or silt-size particles, have a low capacity to hold nutrients (Proceedings). There are many areas in the GVC watershed where topsoil (the "O" & "A" horizons) have eroded away following the extensive logging since the late 40s, exposing infertile subsoil. Despite extensive revegetation efforts by the RCD since the early '90s, many of these areas are still sparsely vegetated.

As observed in the GVC watershed and in numerous studies in other watersheds, sheet and rill erosion, which can severely effect soil productivity and the ability of vegetation to reestablish on disturbed sites, is often not immediately obvious. Rills, small channels perpendicular to the slope, form during storm events, especially where soils are shallow. These coarse-textured soils cannot maintain a perpendicular wall and relatively soon after storm events the rills break down and fill in. Sheet erosion, which causes soil particles to move over an entire area, also helps to mask rill erosion, as does soil creep from repeated freezing and thawing and dry ravel.

The main granitic soil types in the watershed are the Valcreek-Minersville complex (map symbol 203), Valcreek-Minersville-Choop complex (map symbol 204), Tallowbox-Minersville complex (198 & 199), and Minersville sandy loam (177). Other significant granitic soil types are the Valcreek-Choop complex (map symbol 202) and the Minersville Variant-Choop complex (178). Relatively minor (in area) granitic soil types are the Choop fine gravelly loamy coarse sand (125), Choop-Rock outcrop complex (126), and Haploxerolls (148).

Granitic Soils	
Map Unit	**Acres**
125	436.81
126	99.25
148	405.74
177	2455.22
178	450.58
198	808.84
199	5352.82
202	696.88
203	978.16
204	5650.46

The Valcreek-Minersville complex (203) is on 30-75% slopes and is composed of 50% Valcreek and 30% Minersville on sheltered slopes. This soil complex is found on 978 acres, or 4.2% of the watershed. Valcreek soil is moderately deep and excessively drained, with pale brown to very pale brown gravelly to very gravelly loamy coarse sands in the first 16 inches. Effective rooting depth is 20-40 inches. Permeability is rapid and available water capacity is very low. Runoff is rapid to very rapid and the hazard of water erosion from tractor yarding is severe to very severe. The hazard of soil damage from compaction is slight and from fire is moderate. Although this soil is suited for timber production, with a mean site index of 75 for ponderosa pine, it is understocked with conifers. Tree seedling mortality is severe and plant competition is moderate.

Minersville soil is deep and well drained, with pale brown to very pale brown sandy loams in the first 30 inches. Effective rooting depth is 40-60 inches. Permeability is moderately rapid and available water capacity is low or moderate. Runoff is rapid or very rapid and the hazard of water erosion is very severe. The hazard of soil damage from compaction or fire is moderate. This soil is well suited for timber production, with a mean site index of 101 for Douglas-fir. Tree seedling mortality is severe and plant competition is slight.

The Valcreek-Minersville-Choop complex (204) is composed of 35% Valcreek on exposed slopes, 25% Minersville on sheltered slopes, and 20% Choop on exposed ridgetops. This soil complex is found on 5650 acres, or 24.1% of the watershed. Characteristics for Valcreek and Minersville soils are as described above under the Valcreek-Minersville complex (203).

Choop soil is shallow and excessively drained, with dark grayish brown to gray to pale brown fine very gravelly loamy coarse sands in the first 16 inches. Effective rooting depth is 10-20 inches. Permeability is rapid and available water capacity is very low. Runoff is rapid or very rapid and the hazard of water erosion is very severe. This soil is marginally suited for timber production and better suited for watershed, wildlife habitat, and recreational uses.

The Tallowbox-Minersville complex (198 & 199), is composed of 55-60% Tallowbox on exposed slopes and 20-25% Minersville on sheltered slopes. Soil unit 198 is found on 809 acres, or 3.5% of the watershed and unit 199 is found on 5353 acres (22.8%). Tallowbox soil is moderately deep and well drained, with dark grayish brown, light brownish gray, and pale brown gravelly coarse sandy loams in the first 23 inches. Effective rooting depth is 20-40 inches. Permeability is moderately rapid and available water capacity is low to very low. Runoff is rapid to very rapid and the hazard of water erosion is very severe. The hazard of soil damage from compaction is moderate and from fire is severe. This soil is suited for timber production, with a mean site index of 89 for ponderosa pine. Tree seedling mortality is severe and plant competition is moderate. Characteristics for Minersville soils are as described above under the Valcreek-Minersville complex (203).

The Minersville sandy loam (177) is on slopes of 50-75%. This soil is found on 2455 acres, or 10.5% of the watershed. It has characteristics as described above under the Valcreek-Minersville complex (203).

The Valcreek-Choop complex (202) is on 30-75% slopes. This soil complex is found on 697 acres, or 3% of the watershed. It has characteristics as described above under the Valcreek and Choop soils.

Minersville Variant-Choop complex (178), 50-70% slopes, is 60% Minersville Variant fine gravelly loamy coarse sand and 20% Choop fine gravelly loamy coarse sand. This soil complex is found on 451 acres, or 1.9% of the watershed. Minersville Variant is found mostly on north-facing, concave slopes and is moderately deep and well-drained, with dark grayish brown, fine gravelly loamy coarse sand, brown and light brownish gray very gravelly loamy coarse sand for about 43 inches. Effective rooting depth is 20-40 inches. Permeability is rapid and available water capacity is very low. Runoff is very rapid and the hazard of water erosion is very severe. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for timber production, with limitations due to steep slopes, erosion hazards, and very low available water capacity. This soil has a mean site index of 52 for White fir. Tree seedling mortality is severe and plant competition is moderate.

Choop soil is as described above under the Valcreek-Minersville-Choop complex (204).

Choop fine gravelly loamy coarse sand (125) is found on 50-75% mountain slopes. This soil is found on 437 acres, or 1.9% of the watershed. This soil is shallow, excessively drained soil on mountains with a surface layer of dark grayish brown or gray fine gravelly loamy coarse sand about 5 inches deep. Effective rooting depth is 10-20 inches. Permeability is rapid and available water capacity is very low. Runoff is very rapid and the hazard of water erosion is very severe.

Choop-Rock outcrop complex (126) is found on 50-90% slopes on mountains. This soil complex is found on 99 acres, or 0.4% of the watershed. Choop soil is shallow and excessively drained, with the top 12 inches a very dark grayish brown or dark brown fine gravelly loamy coarse sand. Effective rooting depth is 10-20 inches. Permeability is rapid and available water capacity is very low. Runoff is rapid or very rapid and the hazard of water erosion is very severe.

Rock outcrop consists of cliffs, ledges, and knobs of exposed bedrock on upper mountain slopes and ridgetops.

Haploxerolls, 2-9% slopes (148) are very deep and well drained soils on alluvial fans and stream terraces. These soils are found on 406 acres, or 1.7% of the watershed. The top 10 inches are grayish brown fine gravelly coarse sandy loam. Effective rooting depth is 60 inches or more. Permeability is moderately rapid and available water capacity is low or moderate. Runoff is moderately rapid or rapid and the hazard of water erosion is slight. The hazard of soil damage from compaction is moderate and from fire is slight. This soil is suited for timber production or home site development, with a mean site index of 138 for Douglas-fir. Tree seedling mortality is moderate and plant competition is severe.

Ultramafic Soils

These soils are found on 2748 acres, or 12% of the watershed. The main ultramafic soil types are the Weitchpec Variant-Bamtush Variant complex (211 & 212) and the Dubakella stony loam (141). Relatively minor (in area) ultramafic soil types are Dubakella cobbly clay loam (140), and the Etsel-Weitchpec complex (144).

Ultramafic Soils	
Map Unit	**Acres**
140	215.91
141	520.22
144	8.84
211	486.68
212	1516.52

The Weitchpec Variant - Bamtush Variant complex (211 & 212) is found on 9-75% slopes of mountains dissected by perennial streams. Soil unit 211 is found on 487 acres, or 2.1% of the watershed and unit 212 is found on 1517 acres (6.5%). Weitchpec Variant is deep and well drained with a 9-inch surface layer of brown and light yellowish brown gravelly loam. Effective rooting depth is 40 to more than 60 inches. Permeability is moderately slow. Runoff is rapid and the hazard of water erosion is severe. Hazard of damage to soil from compaction is slight and from fire slight. The mean site index for Douglas-fir is 100. Seedling mortality is moderate and plant competition is moderate.

Bamtush Variant complex is a very deep and well drained, very gravelly loam. The surface layer is a yellowish red very gravelly loam about 6 inches deep. Effective rooting depth is more than 60 inches. Permeability is moderate. Runoff is rapid and the hazard of water erosion is moderate. The hazard of damage to soil from compaction is slight and from fire is moderate. Although this soil is suited for timber production, limitations are imposed by slopes of 30-75%, which can have moderate or severe hazard of erosion, low available water capacity, and the potential for mass movement. The mean site index is 101 for Douglas-fir. Seedling mortality is severe and plant competition is moderate.

Dubakella cobbly clay loam (140) is found on 50-75% mountain slopes and is a moderately deep well drained soil. This soil is found on 216 acres, or 0.9% of the watershed. The surface layer is reddish brown, cobbly clay loam about 5 inches deep. Effective rooting depth is 20-40 inches and permeability is slow. Runoff is very rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is slight and from fire slight. This soil is used for timber production, though limitations are imposed by severe erosion hazard, the potential for mass movement, steep slopes, and low available water capacity. The mean site index is 71 for Jeffrey pine. Seedling mortality is severe and plant competition is moderate.

The Dubakella stony loam (141) is on 30 to 50% slopes. This soil is found on 520 acres, or 2.2% of the watershed. Found on mountain spur ridges, it is a moderately deep, well drained soil. The surface layer is reddish brown stony loam about 5 inches deep. Effective rooting depth is 20-40 inches. Permeability is slow. Runoff is rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is moderate and from fire slight. The limitations affecting timber harvest are the severe hazard of erosion and the stony surface. The main tree species are Oregon white oak and gray pine. Seedling mortality is moderate and plant competition is moderate

The Etsel-Weitchpec complex (144) is found on 50-75% mountain slopes dissected by perennial streams. This soil complex is found on 9 acres, or <0.1% of the watershed. Etsel soil is shallow and somewhat excessively drained. The surface layer is brown very gravelly loam about 6 inches deep. The effective rooting depth is 14-20 inches. Permeability is moderate. Runoff is very rapid and the hazard of water erosion is severe. Available water capacity is very low. Etsel soil is suitable as watershed.

Weitchpec soil is moderately deep and is well drained. The surface layer and subsoil are brown and light brown gravelly loam about 10 inches deep. Effective rooting depth is 20-40 inches. Runoff is very rapid and the hazard of water erosion is severe. The hazard of soil damage from fire and compaction is moderate. This soil is used for timber production, with limitations due to steep slopes, severe erosion hazard, and a nutrient imbalance. The mean site index for Douglas-fir is 81. Seedling mortality is severe and plant competition is moderate.

Other Soils

These variable soil types are found on the remaining 3398 acres, or 14% of the watershed. The most significant of these, in area, are the Goulding-Holkat Variant-Marpa-Variant (145) and the Holkat-Hoosimbim complex (153 & 154). Relatively minor soil types (in area) are Atter-Dumps, dredge tailings-Xerofluvents complex (102), Barpeak-Sheetiron complex (109), Brownbear-Bamtush complex (112), Brownscreek-Dougcity complex (117), Haploxerolls, warm (147), Jafa gravelly loam (166), Musserhill-Weaverville complex (181 & 182), Sheetiron-Barpeak complex (191), and the Xerofluvents-Riverwash complex (217).

Other Soils	
Map Unit	**Acres**
102	19.21
109	8.50
112	9.94
117	28.26
145	405.52
147	44.44
153	294.88
154	2277.73
166	38.71
181	64.33
182	85.84
191	61.69
217	33.58

The Atter-Dumps, dredge tailings-Xerofluvents complex (102) soils are on alluvial fans, stream terraces, and flood plains that have been altered by dredging operations. This soil complex is found on 19 acres, or <0.1% of the watershed. This complex is made up primarily of Atter soil (50%), Dumps (20%), and Xerofluvents (15%). Atter soil is on alluvial fans and stream terraces and is very deep, with light brownish gray and pale yellow extremely gravelly loamy sand in the top 8 inches. Effective rooting depth is 60+ inches. Permeability is rapid and available water capacity is very low. Runoff is slow and the hazard of water erosion from tractor yarding is slight. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for watershed, wildlife habitat, and recreational uses. In some areas it is used for home site development or timber production (mean site index of 109). Tree seedling mortality is severe and plant competition is moderate.

Another component of the Atter-Dumps, dredge tailings-Xerofluvents complex, Dumps, are scattered throughout the unit. Dumps and dredge tailings consist of nearly barren mounds deposited along stream channels by dredge mining activities. Tailings are mostly rounded cobbles and pebbles, with some stones and pockets of loam or clay loam. Permeability is rapid and available water capacity is very low. Runoff is moderate and the hazard of water erosion is slight. The hazard of soil damage from compaction is slight.

Xerofluvents consist of well-drained soils that formed in alluvium derived from mixed rock sources. Color and texture vary, but typically there is a surface layer of variegated brown gravelly sand about 5 inches deep over gravelly to extremely gravelly sand to loam. Effective rooting depth is 60+ inches. Permeability is moderate or rapid and available water capacity is very low to low. Runoff is moderate and the hazard of water erosion is slight to moderate. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for watershed, wildlife habitat, and recreational uses.

The Brownbear-Bamtush complex (112) is found on 30-50% mountain slopes. This soil complex is found on 10 acres, or <0.1% of the watershed. Brownbear soil is moderately deep and well drained. The surface layer is brown very gravelly loam about 4 inches deep. The effective rooting depth is 20-40 inches. Permeability is moderate and available water capacity is low. Runoff is rapid and the hazard of erosion is moderate. The hazard of soil damage from compaction and from fire is slight. These soils are used for timber production (mean site index of 94 for DF). Tree seedling mortality is severe and plant competition is moderate.

Bamtush soil is very deep and well drained. The surface layer is yellowish brown and light brown gravelly loam about 13 inches deep. The effective rooting depth is 60 inches or more. Permeability is moderately slow and available water capacity is low. Runoff is very rapid and the hazard of erosion is severe. The hazard of soil damage from compaction is slight and from fire is moderate. These soils are used for timber production (mean site index of 123 for DF). Tree seedling mortality is severe and plant competition is moderate.

The Brownscreek-Dougcity complex (117) is found on 50-75% mountain slopes. This soil complex is found on 28 acres, or 0.1% of the watershed. Brownscreek soil is moderately deep and well drained. The surface layer is strong brown gravelly loam about 6 inches deep. The effective rooting depth is 20-40 inches. Permeability is moderate and available water capacity is low. Runoff is very rapid and the hazard of erosion is severe. The hazard of soil damage from compaction and from fire is moderate. These soils are used for timber production (mean site index of 104 for PP, 119 for DF). Tree seedling mortality and plant competition is moderate.

Dougcity soil is very deep and well drained. The surface layer is yellowish brown and light brown gravelly loam about 13 inches deep. The effective rooting depth is 60 inches or more. Permeability is moderately slow and available water capacity is low. Runoff is very rapid and the hazard of erosion is severe. The hazard of soil damage from compaction and from fire is moderate. These soils are used for timber production (mean site index of 115 for DF). Tree seedling mortality and plant competition is moderate.

Goulding-Holkat Variant-Marpa Variant complex (145) is found on 50-75% mountain slopes. This soil complex is found on 406 acres, or 1.7% of the watershed. Goulding soil is shallow and somewhat excessively drained. The surface layer is brown very gravelly loam about 6 inches deep. The effective rooting depth is 10-20 inches. Permeability is moderate and available water capacity is very low. Runoff is rapid and the hazard of erosion is severe. The hazard of soil damage from compaction is slight and from fire moderate. These soils are used to produce wood products. Seedling mortality is severe and plant competition is moderate.

Holkat Variant soil is moderately deep and is well drained. The surface layer is light brownish gray clay loam about 11 inches deep. The effective rooting depth is 20-40 inches. Permeability is moderate and available water capacity is low. Runoff is rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is moderate and from fire slight. This soil is used for wood products. Seedling mortality is slight and plant competition is moderate.

Marpa Variant soil is moderately deep and is well drained. The surface is light brownish gray gravelly clay loam about 10 inches deep. The effective rooting depth is 20-40 inches. Permeability is slow, available water capacity is low, runoff is rapid, and the hazard of water erosion is severe. The hazard of damage to soil from compaction is moderate and from fire slight. This soil is used for timber production, with limitations from severe erosion hazard and steep slopes. The mean site index for ponderosa pine is 83. Seedling mortality is moderate and plant competition is moderate.

Haploxerolls, warm 0-2% slopes (147) are very deep and well drained soils found on stream terraces. These soils are found on 44 acres, or 0.2% of the watershed. The top 7 inches are brown fine sandy loam. Effective rooting depth is 60 inches or more. Permeability is moderately rapid or rapid and available water capacity is low or moderate. Runoff is slow and the hazard of water erosion is slight. This soil is used for home site development or pasture.

The Holkat-Hoosimbim complex (153), 30-50% slope is composed of 45% Holkat and 35% Hoosimbim gravelly loam found on mountains dissected by perennial streams. This soil complex is found on 295 acres, or 1.3% of the watershed. Holkat soil is moderately deep and well drained, brown loam, light yellowish brown gravelly loam, and light brown gravelly loam in the first 35 inches. Effective rooting depth is 20-40 inches. Permeability is moderate and available water capacity is low. Runoff is rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is moderate and from fire is slight. This soil is suited for timber production, with a mean site index of 87 for Douglas-fir. Tree seedling mortality and plant competition are moderate.

Hoosimbim soil is deep and well drained, with yellowish brown gravelly loam, brown and light brown very gravelly sandy clay loam, and reddish yellow extremely gravelly sandy clay loam in the first 42 inches. Effective rooting depth is 40-60 inches. Permeability is moderate and available water capacity is low or moderate. Runoff is rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for timber production, with a mean site index of 102 for Douglas-fir. Tree seedling mortality is moderate and plant competition is severe.

The Holkat-Hoosimbim complex (154) is composed of 50% Holkat and 30% Hoosimbim. Holkat soil is moderately deep and well drained, brown loam, light yellowish brown gravelly loam, and light brown gravelly loam in the first 35 inches. Effective rooting depth is 20-40 inches. Permeability is moderately rapid and available water capacity is low. Runoff is very rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction or fire is moderate. This soil is suited for timber production, with a mean site index of 87 for Douglas-fir. Tree seedling mortality and plant competition is moderate.

Hoosimbim soil is deep and well drained, with yellowish brown gravelly loam, brown and light brown very gravelly sandy clay loam, and reddish yellow extremely gravelly sandy clay loam in the first 42 inches. Effective rooting depth is 40-60 inches. Permeability is moderately rapid and available water capacity is low or moderate. Runoff is rapid and the hazard of water erosion is severe. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for timber production, with a mean site index of 102 for Douglas-fir. Tree seedling mortality is moderate and plant competition is severe.

Jafa gravelly loam (166), 2-9% slopes, is very deep and well drained soil found on terraces. This soil is found on 39 acres, or 0.2% of the watershed. Brown gravelly loam and light brown gravelly clay loam and strong brown gravelly sandy clay loam are found to a depth of 78 inches or more. Effective rooting depth is more than 60 inches. Permeability is moderately slow and available water capacity is moderate. Runoff is medium and the hazard of water erosion is slight. The hazard of soil damage from compaction is moderate and from fire is slight. This soil is suited for timber production or home site development, with a mean site index of 96 for ponderosa pine. Tree seedling mortality is slight and plant competition is severe.

The Musserhill-Weaverville complex (182) soils are found on hills dissected by perennial streams and are made up primarily of Musserhill soil (45%) and Weaverville soil (35%). This soil complex is found on 86 acres, or 0.4% of the watershed. Musserhill soil is moderately deep, with brown gravelly loam in the top 5 inches. Effective rooting depth is 20-40 inches. Permeability is moderately slow and available water capacity is low. Runoff is rapid and the hazard of water erosion from tractor yarding is severe (moderate for cable yarding). The hazard of soil damage from compaction is moderate and from fire is slight. This soil is suited for wood products, timber production (but the main tree species are white oak and gray pine, indicating a poor site), or home site development. Tree seedling mortality is severe and plant competition is moderate.

The other major component of the Musserhill-Weaverville complex, Weaverville soil, is very deep, with reddish brown loam in the top 4 inches. Effective rooting depth is 60+ inches. Permeability is moderately slow and available water capacity is high to very high. Runoff is rapid and the hazard of water erosion from tractor yarding is severe (moderate for cable yarding). The hazard of soil damage from compaction is moderate and from fire is slight. This soil is well suited for timber production, with a mean site index of 107. Tree seedling mortality is severe and plant competition is moderate.

Sheetiron-Barpeak complex (191), 50-90% is found on south and west facing mountain slopes. This soil complex is found on 62 acres, or <0.3% of the watershed. These soils are composed of 55% Sheetiron very gravelly loam and 25% Barpeak very gravelly loam. Sheetiron soil is moderately deep and well drained, with yellowish brown very gravelly loam and light yellowish brown extremely gravelly loam in the first 24 inches. Effective rooting depth is 20-40 inches. Permeability is moderate and available water capacity is very low. Runoff is very rapid and the hazard of water erosion is very severe. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for timber production, with a mean site index of 80 for Douglas-fir and 104 for ponderosa pine. Tree seedling mortality is severe and plant competition is moderate.

Barpeak soil is very deep and well drained, with yellowish brown very gravelly loam, brown very gravelly sandy loam, light yellowish brown and brown extremely gravelly sandy loam, and pink extremely gravelly clay loam to a depth of 68 inches or more. Effective rooting depth is 60 inches or more. Permeability is moderate and available water capacity is very low or low. Runoff is very rapid and the hazard of water erosion is very severe. The hazard of soil damage from compaction is slight and from fire is moderate. This soil is suited for timber production, with limitations due to steep slopes, erosion hazard, and the very low available water capacity. This soil has a mean site index of 116 for Douglas-fir and 110 for ponderosa pine. Tree seedling mortality is severe and plant competition is moderate.

Xerofluvents-Riverwash complex (217) is on 0 to 5% slopes and is found on flood plains and stream terraces. This soil complex is found on 34 acres, or 0.1% of the watershed. This soil complex is about 45% Xerofluvents and 35% Riverwash. Xerofluvents are as described above under the Atter-Dumps, dredge tailings-Xerofluvents complex (102). Xerofluvents-Riverwash is used for wildlife and fish habitat. It is not appropriate for timber harvest as it can be detrimental to fish habitat.

Riverwash consists of nearly barren, unstabilized, stratified sandy, silty, clayey, stony, cobbly, or gravelly alluvium derived from mixed rock sources. Areas of Riverwash are flooded, channeled, and reworked nearly every winter.

Wildlife and Fisheries

Wildlife

With its variety of habitats, there are numerous wildlife species known or suspected to occur in the area including Pacific fisher (special status species), elk, black-tailed deer, black bear, coyote, gray fox, weasel, bobcat, mountain lion, pine marten, ring-tailed cat, muskrat, mink, skunks, raccoon, gray squirrel, ground squirrel, northern flying squirrel, yellow-pine chipmunk, dusky footed wood rat, gophers, shrews, moles, red tree voles, mice, and bats. In the late 1990s elk were released in the Lewiston area north of the watershed and have migrated into the GVC watershed and use portions of it heavily.

Some special status bird species known to occur in the area include bald and golden eagle, osprey, northern goshawk, northern spotted owl, and willow flycatcher. Other bird species include: red-tailed hawk, Cooper's hawk, great horned owl, pygmy owl, turkey, hairy woodpecker, Downy woodpecker, pileated woodpecker, flicker, raven, Steller's jay, California and mountain quail, blue grouse, great blue heron, belted kingfisher, merganser, wood duck, teal, mallards, hummingbirds, flycatchers, swallows, varied thrush, chickadees, nuthatches, warblers, towhees, sparrows, finches, blackbirds and numerous other species.

Special status amphibians include the foothill yellow-legged frog, California red-legged frog, and tailed frog. Other species include the western toad, bull frog, and Pacific tree frog. Among the reptiles are the western pond turtle (special status species), racer snake, gopher snake, garter snake, common and mountain kingsnake, and the western rattlesnake.

Wildlife populations, the abundance of species, and species occurrence are in great part determined by the type, extent, arrangement, and age of vegetative communities. In general, vegetation in earlier successional stages will support a greater number of species and an overall greater biomass while later successional stages will support fewer species but greater populations of those species. It is generally recognized that wildlife habitat has changed substantially since intensive logging began in the late 1940's. What were once primarily dense old-growth conifer and hardwood forests are now primarily early to mid seral forests, some of which are now mixed conifer-hardwood forests and some of which have more open canopies. On south- to west-facing slopes forest habitat is probably much more open, has a greater brush component, and has more area in bare, mineral soil. There are probably too few snags and logs to provide extensive habitat for species dependent upon this habitat element. (Refer to the GVC WA for more information on the number of species associated with various vegetation types.)

Fish and Water Quality

The BLM portion of the GVC watershed is required to be managed under the Aquatic Conservation Strategy of the Record of Decision, which requires protection and enhancement of aquatic habitats. In highly impacted watersheds, such as GVC, rehabilitation is needed to enhance natural recovery processes. Rehabilitation by the TCRCD has been ongoing for over a decade and has included placement of instream structures, channel work, road and landing removal and rehabilitation, and extensive revegetation.

As of 1984, GVC was known to provide habitat for seven species of fish. Grass Valley Creek reservoir is a Class I waterbody (CDF Forest Practice Rules) and a DFG 'Wild Trout Management Area', as it supports a population of native red-band rainbow trout. For 1.2 miles above the reservoir and from the dam to the mouth, GVC is a fish bearing Class I waterbody, supporting chinook and coho salmon, steelhead, rainbow and brown trout, Klamath small-scale sucker, and lamprey. Anadramous fish are found in a total of 10.7 miles of stream. Steelhead trout are found as far as the dam and coho and chinook are found 7 and 7 ½ miles, respectively, up from the mouth. Steelhead are also found up to 3100 feet in elevation on Little Grass Valley Creek, making it a Class I fish bearing stream to that point. (GVC WA)

In general, GVC and Little GVC have good water quality during the summer. The riparian overstory canopy is moderately dense to dense along most stream reaches, which helps moderate water temperatures.

Various named and unnamed Class II streams, which do not support fish but do support aquatic life, are found in the watershed. In general, a moderate to dense overstory canopy of conifers and hardwoods shades them.

Spawning habitat was improved downstream from the GVC dam after its construction, but there are still many potential sources of sediment from tributaries to GVC and Little GVC. If sedimentation from these subwatersheds is maintained at current rates or reduced, it is likely that habitat will be maintained or even improved.

Threatened and Endangered Species

The northern spotted owl (NSO) is a federally listed threatened species. Review of the California Department of Fish and Game's Natural Diversity Database (NDDB) in late September of 2002 showed NSO activity centers located in three sections on or near SPI or other private forest lands. This does not mean owls are absent from BLM lands. No management activities requiring NSO surveys or protections have occurred on these lands since the NDDB was established. Surveying will be required prior to initiating vegetation disturbing projects and protection measures will need to be established if NSO are found.

Bald eagles, a Federal and State listed endangered species, probably fly up Grass Valley Creek on occasion and use the Grass Valley Creek reservoir. Great blue herons, golden eagles, and ospreys, species of concern, probably use the reservoir area and other parts of the planning area as well. Suitable habitat for the Pacific fisher and northern goshawk, USFS sensitive species and California species of special concern, and for the Olympic salamander and possibly the tailed frog, California species of special concern, is found in the planning area. The NDDB shows Pacific fisher in two sections in the northeastern portion of the watershed.

Cultural Resources

The planning area has probably been occupied or visited by humans for a thousand years or more. The watershed is within the territory of the Wintu Indians, who are thought to have foraged, hunted, and fished in it for 1200 years. Few artifacts have been found and the only dwelling site found was northwest of the mouth of GVC and across the Trinity River at Salt Flat. No sites within the watershed have been recorded, according to the Historical Society (GVC WA). It is likely that any prehistoric archaeological sites have been previously disturbed. Prior to 1973 there were no requirements to protect sites on private lands during logging, the majority of which had already been heavily logged. Dwelling sites and camps would have likely been located on flatter areas near water sources, areas where roads and landings were usually constructed and where logging was heavy due to the denser, larger timber found in these locations. Skid roads on ridges, common areas for travel, have undoubtedly obliterated some if not most traces of prehistoric human use.

There is historical and physical evidence of mining and ranching activity in the watershed. Refer to the Grass Valley Creek Watershed Analysis for details on these activities and sites.

Confidential archaeological reports have been prepared for timber harvest plans (THPs) on private lands in or near the planning area. These reports may be available through the CDF office in Weaverville, CA. It is probable that other historic and prehistoric resources occur in the area. Records of recorded sites are maintained at the Northeast Information Center, Department of Anthropology, Langdon 303, California State University at Chico, Chico, CA 95929-0400. A records check should be made by this center prior to any project work using state or federal funds and a field reconnaissance must be made to determine if important cultural resources exist. If resources are found, protection measures must be devised to prevent their degradation.

CHAPTER 3. LANDOWNER VALUES AND GOALS

Landowners and residents in the area are diverse, including both public and private entities, with unique values, responsibilities, and goals regarding land management. In order to assure a comprehensive plan, a general set of concerns have been identified that were used to develop public agency, industrial forest landowner, and residential landowner goals and to guide project recommendations.

Issues, Concerns and Guidelines

Bureau of Land Management Guidelines

Bureau of Land Management resource issues, concerns and guidelines were identified from the BLM GVC CRMP, GVC WA, "Redding Resource Management Plan and Record of Decision", "10 Year Revegetation Plan for the Grass Valley Creek Watershed (1996-2007), "Grass Valley Creek Watershed Restoration Project Report", "Recommendations on Trinity County Values at Risk from Fire and Pre-Fire Fuels Treatment Opportunities drawn from Community Meetings 1999/2000", meetings with BLM staff, and as a result of TCRCD work projects in the area.

Watershed Protection - BLM's sole "Resource Condition Objective" for the Grass Valley Creek watershed [BLM Redding Resource Management Plan and Record of Decision (RMP), June 1993] is to "Reduce the sediment load entering the Trinity River via Grass Valley Creek for the improvement of anadramous fisheries." Allocations, actions, and proposals are required to conform to this primary goal. One of the fire management objectives under the 'BLM/CDF/USFS Cooperative Fire Protection Agreement and Operating Plan for the CDF Northern Region (2002)' is to "Protect the Trinity River from sediment load[s] that may result from catastrophic wildfire".

Guideline: *The RMP/ROD states, under 'Land Allocations' that "Soil-disturbing activities would be conducted only when no new long-term increases to erosion would result." Land and resource management programs, projects, and fire management activities must be designed to minimize soil disturbance and prevent sedimentation into watercourses, especially in decomposed granitic soils.*

Road and Trail Protection - The RMP lists the following limitations on road use in the GVC watershed (RMP/ROD, Land Use Allocations):

Guideline: *"Limit vehicle use to designated roads and trails."*

Guideline: *BLM-administered roads and trails within the zone of decomposed granite-derived soils (most of the BLM lands) are closed to vehicle use during the rainy season and could be closed on a year-round basis at the discretion of the BLM to protect the resource values of these erosion sensitive areas.*

Forest Management - Forest management on BLM lands is operating under the "Timber Management Environmental Assessment for Sustained Yield Unit 15" (SYU-15) (Redding Resource Management Plan and Record of Decision, 1993). Under the 'Resource Condition Objective' for the GVC watershed, forest management is "restricted". Timber harvest "may only occur for the enhancement of other resources or if not in conflict with the management of natural or cultural values" (BLM RMP/ROD). Timber harvest under this prescription could include commercial thinning, sanitation/salvage, group selection, and selection harvesting. "Restricted" management requires a wide array of biological, visual, cultural, and social controls beyond what is already required by law and therefore stand rotations will be longer than considered optimum for strictly timber production.

In Chapter 4, Findings, Recommendations, and Consistency with the ROD, of the "GVC Watershed Analysis" prepared in March 1995 by BLM, in the discussion of the conflicting objectives of erosion and sediment control vs. timber production, it is stated that "Although the majority of the watershed is 'matrix' land, erosion control and sediment reduction is the primary management objective and will take precedent over all other land management decisions. Any plans for timber production will be subservient to sediment reduction and only include those practices which do not hinder this primary management objective."

One of the goals of the "GVC Watershed Coordinated Resource Management Plan" prepared in 1995 by BLM was to have a 12-year moratorium on timber harvesting, until the year 2007, to allow recovery of vegetation. This moratorium does not apply to fuel management projects, fire hazard reduction, hazard tree removal, insect damage control, or wildlife habitat management.

Within Riparian Reserves permitted uses are only those that maintain or improve the riparian ecosystem and protect stream courses and water quality. Riparian Reserves in general are removed from scheduled timber harvesting and other stand disturbance activities within 300 feet of the high water mark on fish bearing streams, such as Grass Valley Creek and Little Grass Valley Creek, 150 feet on perennial streams with no fish, and 100 feet on seasonal or intermittent streams. The only timber harvesting permitted in Riparian Reserves is for salvage and fuelwood cutting, when that will meet aquatic conservation objectives of the Northwest Forest Plan.

Guideline: *Until the year 2007, timber harvests may be conducted only for fuel management, fire hazard reduction, hazard tree removal, insect damage control, or wildlife habitat management.*

Guideline: *Timber harvests must either enhance other resources or not be in conflict with the management of natural or cultural values.*

Guideline: *Timber production will be subservient to sediment reduction and only include those practices that do not hinder this primary management objective. Stand rotations will be longer than considered optimum for strictly timber production.*

Guideline: *Use commercial thinning, sanitation/salvage, group selection, and/or selection silvicultural systems.*

Guideline: *Within Riparian Reserves limit timber harvesting to salvage and fuelwood. Harvests must maintain or improve riparian ecosystems and protect stream courses and water quality.*

Guideline: *For commercial harvests, comply with appropriate protections outlined in CDF's "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages" as revised in March of 1991 (available from CDF, Weaverville office).*

Recreational Use - The recreational Land Use Allocation for GVC (the Recreation Opportunity Spectrum designation) is Semi-primitive Motorized Recreation (RMP/ROD). This allocation, which is applied the same as on National Forests, is for areas "characterized by a predominantly natural or natural appearing environment of a moderate to large size. Concentrations of users is low, but there is often evidence of other users" (S-T NF LRMP). The following guidelines apply under this allocation:

Guideline: *"Management activities are visually subordinate to the natural landscape." (S-T NF LRMP)*

Guideline: *"Off-highway vehicle (OHV) motorized travel is permitted on roads and trails during summer months and in winter on areas rated suitable for winter OHV use." (S-T NF LRMP)*

Scenic Views - The scenic 'Land Use Allocation' for GVC is 'Visual Resource Management Class II' (RMP/ROD). The objective is to "retain the existing character of the landscape."

Guideline: *As stated in the RMP/ROD, "Changes in any of the basic elements caused by a management activity should not be evident in the characteristic landscape. The level of change should be low and must repeat the basic elements of form, line, color, and texture found in the predominant natural features existing within the landscape. Changes are seen, but do not attract the attention of the casual observer.*

Air Quality - Air quality standards are governed by Federal, State, and local regulations and implementation plans. Prescribed burns are limited by the BLM Air Quality Maintenance Requirements (BLM Manual 7723), which require a State-approved open burning permit. In light of the increasing levels of carbon dioxide in the atmosphere that are causing global warming and the poor air quality in the Redding area, downwind from the GVC watershed, prescribed burns should be minimized.

Guideline: *Prescribed burning should be minimized to prevent degradation of air quality. Whenever physically and economically feasible, alternate methods of fuel reduction should be used.*

Fuel Management - BLM land managers are aware of the potential for a large, high intensity fire and the impacts to the environment that would result. They also understand that fuel modification (thinning dense trees, pruning tree limbs, and cutting dense brush) can help to create fuelbreaks, provide safer evacuation corridors, prevent rapid crown-to-crown fire spread, improve wildlife habitat for many species, and improve forest health.

There is a concern with some managers and members of the public that wildfire defense projects (such as shaded fuelbreaks and fuel reduction burns) that remove trees, shrubs, duff, and forest litter could substantially affect views, remove excessive numbers of large trees, disrupt wildlife habitat, or accelerate erosion. The GVC WA states that "Vegetation is the key to long term sheet and rill erosion control; coniferous plant litter provides excellent surface cover and long term surface stability and erosion control."

In Chapter 3, Ecological Process and Interrelationships, in the GVC WA, in the discussion of the key question related to future timber production, it states that "Thinning stands to reduce fire hazard and improve stand health may be a management option on north and east facing slopes. Tree removal on south and west slopes would be detrimental to erosion control efforts."

Guideline: *"Wildfire presuppression projects involving manipulations of vegetation need to consider possible adverse effects on the protective soil cover, wildlife habitat, and viewsheds," especially on granitic soils.*

Guideline: *On granitic soils, limit thinning or harvesting to north and east aspects, unless such treatments on south and west slopes are in specific locations and done in a manner that will not increase erosion and will not be detrimental to existing or planned erosion control projects.*

Guideline: *The following 'fire management objective' from the 'BLM/CDF/USFS Cooperative Fire Protection Agreement and Operating Plan for the CDF Northern Region (2002)' states: "Develop a prescribed fire and fire management plan for the Grass Valley Watershed."*

Guideline: *Most land managers and members of the public will support some timber harvesting and fuel modification projects on Bureau of Land Management lands when these activities will:*

- *improve forest health, reduce the potential for stand replacing wildfires, and provide safe travel for residents and fire fighters*
- *protect and/or enhance soil stability*
- *maintain and/or enhance water quality*
- *maintain and/or enhance critical or limited wildlife habitat.*
- *protect forest views through design of fuel breaks, hazard reduction projects, and other fire defense preparations to high aesthetic standards.*

Fire Suppression - Under the 'BLM/CDF/USFS Cooperative Fire Protection Agreement and Operating Plan for the CDF Northern Region (2002)', CDF is the initial responder to wildland fires in the GVC watershed. Under this plan, the GVC watershed is listed as a ‘special management area’, where BLM has developed a suppression plan with restrictions on normal suppression and rehabilitation methods, as follow:

Guideline: *“Airtankers, helicopters, engines and hand crews are highly recommended. Dozers are restricted to existing roads, trails, and fuelbreaks. A BLM Environmental Specialist should be consulted prior to new fireline construction.”*

Guideline: *“Any fire camps or staging areas will be returned to as natural a state as possible.”*

Guideline: *“Waterbar all control lines on slopes exceeding 5 percent. Install waterbars to the following specifications: 5-20% slope, 75’ spacing; 20-40%, 50’; 40+%, 25’.”*

Guideline: *“Any roads which have been improved for motorized access as a result of suppression activities will be regraded to an outslope of at least 5% and waterbarred to specifications described above.”*

Guideline: *“Any soil material pushed into stream channels will be removed and placed at least 50’ from the bottom of the channel. Stream crossings will be mulched with straw 50’ on each side of the stream crossings.”*

Bureau of Land Management Goals

Based on the guidelines and values above, the following BLM goals were developed:

Fuel Management Goal: Plan management activities for forest stands and brushfields that will reduce the potential for high-intensity, rapidly spreading, destructive wildfires. Identify locations for shaded fuel breaks, prescribed fires, and other fuel treatments and prescribe actions to increase the fire safety of identified areas. The long-term result should be a forest that is less susceptible to catastrophic fire while protecting soil stability, water quality, scenic variety, and wildlife habitat.

Fire Management Goal: Fire management practices should minimize losses as well as keep the costs of fire prevention and suppression as low as possible. Attainment of fire management goals requires the management of hazard and risk prior to a fire, as well as fire management once a fire has started. Provide accurate fire access and infrastructure maps to fire control agencies with suppression responsibilities.

Ecosystem Maintenance and Enhancement: The following objectives should be designed into all projects:

- Maintain and/or enhance soil stability, fertility, and productivity
- Maintain and/or enhance water quality
- Maintain and/or enhance air quality
- Maintain visual quality
- Maintain and/or enhance forest health and productivity
- Maintain and/or enhance plant and animal diversity
- Maintain and/or enhance wildlife habitat for critical species

Industrial Forest Landowner Guidelines

Industrial forest landowner issues, concerns and guidelines were identified from discussions with SPI and Roseburg Forest Products land managers. Issues, concerns and guidelines are general in nature and are not intended to reflect any specific landowner's values. Landowners will apply their own values and goals to the management activities on their properties.

The primary management style of SPI land managers is timber management using primarily even-aged silviculture, with limited uneven-aged silviculture, while maintaining forest and watershed resources. The goal of management is to keep forests producing at optimum levels to maximize the return on investment. An additional goal is to create a fire-safe forest. These goals are being met by on-going timber management, including harvesting, control of conifer stocking levels, planting under-stocked timberlands, and control of competing vegetation.

The primary management style of Roseburg Forest Products land managers is timber management, using whatever site specific silviculture system and treatment that is appropriate, while maintaining forest ecosystem and watershed resources. The goal of management is to keep forests producing at optimum levels to maximize the return on investment. These goals are being met by on-going timber management, including harvesting, control of conifer stocking levels, planting under-stocked timberlands, and control of competing vegetation.

The management styles of Crane Mills Inc. and Trans-Wood Company are unknown, but are assumed to be similar to that of Roseburg Forest Products and SPI.

Forest Management - Forest management on industrial lands operates under the Z'berg-Nejedly Forest Practice Act of 1973, CDF's "California Forest Practice Rules", various other State and Federal resource protection laws, and individual company management plans.

Guideline: *For commercial harvests, comply with the protections required in the CA Forest Practice Rules for soil, watercourses, habitat for Federal and State listed threatened and endangered species and species of concern, and cultural resources.*

Guideline: *For commercial harvests, comply with appropriate protections outlined in CDF's "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages" as revised in March of 1991 (available from CDF, Weaverville office).*

Guideline: *For commercial harvests, prepare a cumulative effects analysis for the affected watershed(s). Consider including a section on fuels showing expected changes to fuel loads due to logging slash and planned mitigation measures.*

Guideline: *Following commercial harvests, comply with FPR hazard reduction requirements along public roads and private roads open to public access and within 200 feet of residences. Consider expanding hazard reduction to all roads, main ridges, and to areas of heavy slash accumulations. Notify CDF before burning slash.*

Industrial Forest Landowner Goals

Based on the guidelines and values above, the following industrial landowner goals were developed:

Fuel Management Goal: Plan management activities for forest stands that will reduce the potential for high-intensity, rapidly spreading, destructive wildfires. Identify locations for shaded fuel breaks, prescribed fires, and other fuel treatments and prescribe actions to increase the fire safety of identified areas. The long-term result should be a forest that is less susceptible to catastrophic fire while protecting soil stability, water quality, scenic variety, and wildlife habitat.

Fire Management Goal: Fire management practices should minimize losses as well as keep the costs of fire prevention and suppression as low as possible. Attainment of fire management goals requires the management of hazard and risk prior to a fire, as well as fire management once a fire has started. Provide accurate fire access and infrastructure maps to fire control agencies with suppression responsibilities.

Ecosystem Maintenance and Enhancement: The following objectives should be designed into all projects:

- Maintain and/or enhance soil stability, fertility, and productivity
- Maintain and/or enhance water quality
- Maintain and/or enhance air quality
- Maintain and/or enhance forest health and productivity
- Maintain and/or enhance wildlife habitat for critical species

Residential Forest Landowner Guidelines

Residential issues, concerns and guidelines were identified from the BLM GVC CRMP, GVC WA, and RMP/ROD, "Recommendations on Trinity County Values at Risk from Fire and Pre-Fire Fuels Treatment Opportunities drawn from Community Meetings 1999/2000", individual discussions between area residents and resource professionals, and as a result of TCRCD work projects in the area. These issues, concerns and guidelines are general in nature and are not intended to reflect any specific landowner's values. Landowners will apply their own values and goals to the management activities on their properties.

Voluntary Participation and Independence - Many residents value freedom from government regulations regarding the use of their lands. The greatest concern expressed about fire safe projects has been that they will require people to cut trees or clear vegetation beyond what they desire for aesthetics, visual screening, or other objectives. Nevertheless, residents value neighborhood voluntary action.

Guideline: *Residential forest management, particularly wildfire defense programs, should be built around education, information, and recommendations rather than inspection and enforcement. Residents are willing to contribute to fire hazard reduction, but prefer to do so directly rather than through regulation. Programs should be designed to include a large component of direct involvement by residents in the decision making and actual work rather than to provide the service through public means. This does not mean that public support is not useful as a supplement to the community effort.*

Road Improvements - Access during the winter is occasionally temporarily restricted due to accumulations of snow. Some access roads have moderate to heavy accumulations of flammable fuels in close proximity to the roadway. Others are narrow, with few turnouts, and would be difficult for fire traffic to negotiate, especially if residents are leaving the area. Some roads have no turnarounds suitable for fire engines. CDF will not protect homes if it determines that any of the above conditions will endanger its engines and crews.

Guideline: *Road improvements needed to provide safe travel for residents, fire personnel, and fire engines should be done by landowners as soon as feasible.*

Scenic Views - Retaining the forest view from homes is identified as an important value. Throughout the area retaining forest views from homes and access roads is desired for aesthetics and as a visual screen to provide privacy from neighbors and tourists.

Guideline: *When changing vegetation density and type, consider the visual impact on neighbors. Consider leaving more vegetation for visual screening where overall fire hazard will not be appreciably affected.*

Forest Management - Forest management on rural residential lands operates under the Z'berg-Nejedly Forest Practice Act of 1973, CDF's "California Forest Practice Rules", various other State and Federal resource protection laws, and in some cases individual management plans.

Guideline: *For commercial harvests, comply with the protections required in the CA Forest Practice Rules for soil, watercourses, habitat for Federal and State listed threatened and endangered species and species of concern, and cultural resources.*

Guideline: *For commercial harvests, comply with appropriate protections outlined in CDF's "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages" as revised in March of 1991 (available from CDF, Weaverville office).*

Guideline: *For commercial harvests, prepare a cumulative effects analysis for the affected watershed(s). Consider including a section on fuels showing expected changes to fuel loads due to logging slash and planned mitigation measures.*

Guideline: *Following commercial harvests, comply with FPR hazard reduction requirements along public roads and private roads open to public access and within 200 feet of residences. Consider expanding hazard reduction to all roads, main ridges, and to areas of heavy slash accumulations. Notify CDF before burning slash.*

Fuel Management - Residents are aware of the potential for a large, high intensity fire and the impacts to the environment that would result. There is also an understanding that fuel modification (thinning dense trees, pruning tree limbs, and cutting dense brush) can help to create fuelbreaks, provide safer evacuation corridors, prevent rapid crown-to-crown fire spread, improve wildlife habitat for many species, and improve forest health. During community meetings it was recommended that a fuelbreak be constructed along Highway 299 in the Fawn Lodge area.

Some residents may be concerned that wildfire defense projects, such as tree removal, will substantially affect views, remove excessive numbers of trees, or disrupt wildlife habitat. Most landowners protect deer and hunting is discouraged in the residential areas. Protection of important wildlife habitat and travel corridors is desired in any forest management on private lands.

Guideline: *All fuel and forest management projects on private land should consider both the desires of the landowner and the positive and negative effects to the surrounding lands and residents.*

Guideline: *Most residents will support some timber harvesting and fuel modification projects when these activities will:*

- *improve forest health, reduce the potential for stand replacing wildfires, and provide safe travel for residents and fire fighters*
- *maintain and/or enhance critical or limited wildlife habitat.*
- *maintain and/or enhance water quality.*
- *protect forest views through design of fuel breaks, hazard reduction projects, and other fire defense preparations to high aesthetic standards.*

Residential Forest Landowner Goals

Based on the guidelines and values above, the following residential forest landowner goals were developed:

Fuel Management Goal: Encourage management of forests and brushfields and protective measures for homes and other structures to reduce the potential for intense, fast moving, and destructive wildfires and to provide for the safe evacuation of residents. Elements of the plan should identify locations for shaded fuel breaks and other fuel treatments and prescribe actions to increase the fire safety of identified areas. The long-term result would be a landscape that is less susceptible to catastrophic fire while providing wildlife habitat, scenic variety and protection of water quality.

However, some residents are concerned that wildfire defense projects, such as tree removal, will substantially affect views, remove excessive numbers of trees, or disrupt wildlife habitat. Protection of important wildlife habitat and travel corridors is desired in any forest management on public and private lands.

Fire Management Goal: Fire management practices should minimize losses as well as keep the costs of fire prevention and suppression as low as possible. Prescribed fire could be used on public and private lands and in designated fuel breaks as a management tool to economically create and maintain desirable forest conditions. Attainment of fire management goals requires the management of hazard and risk prior to a fire, as well as fire management, which would include suppression once a fire has started.

Ecosystem Maintenance and Enhancement: In general, landowners want to develop their own fuel modification and fire management projects. But the following objectives should be designed into all projects:

- Maintain and/or enhance soil stability, fertility, and productivity
- Maintain and/or enhance water quality
- Maintain and/or enhance air quality
- Maintain visual quality
- Maintain and/or enhance forest health and productivity
- Maintain and/or enhance plant and animal diversity
- Maintain and/or enhance wildlife habitat for critical species

CHAPTER 4. FORESTRY

Foresters and ecologists have long recognized that forest conditions are the result of complex interactions between social, biotic, and abiotic factors. Altering these factors may directly affect forest health, biological diversity, and fire hazard severity. The main task of foresters is to control the composition, stocking levels, and vigor of trees and other forest vegetation while protecting and/or enhancing associated resources.

To reiterate the findings under ‘Wildlife Habitat Vegetation Types’ (pg. 18), timber harvesting has had the greatest influence on current vegetation patterns in the watershed. Harvesting began in the late 1940s and continues to this day on most privately owned lands. Most of the watershed was heavily logged during the ‘50s, with at least 70% of the merchantable volume removed. Tractor yarding was used almost exclusively (GVC WA). Silvicultural prescriptions often left little or no residual canopy to provide litter recruitment, resulting in the baring of steep hillsides, erosion of soil “A” horizons, and conversion to brushfields. This was particularly severe on southeast to west aspects.

Since passage of the Z’berg-Nejedly Forest Practice Act of 1973, approximately 50 Timber Harvest Plans have been approved by CDF for private lands in the watershed. These harvests covered about 16,000 acres of the 17,500 acres of commercial forest (68% of the watershed, 91% of the commercial forest). The primary silvicultural systems used were selection and overstory removal, with tractor and helicopter logging used almost exclusively (Proceedings). Logging removed “some or all of the merchantable overstory timber. On north- to east-facing slopes, post-harvest timber stands still contain fairly dense canopies that provide good protection from erosion by supplying organic litter to armor the soil surface. Stands on southeast to west-facing slopes often contain significantly fewer trees per acre, and a heavy harvest of timber may significantly reduce the future supply of soil-protecting organic litter. Attempts at revegetating disturbed areas on south- to west-facing slopes have proven to be less successful than on other aspects” (Proceedings). In general, these conditions are most pronounced in areas of decomposed granitic soils.

The Grass Valley Creek area can be divided into three forest management categories, public, industrial, and rural residential.

Public Forestry

The primary vegetation habitat types found on public lands are montane hardwood-conifer (38%), Sierra mixed conifer (25%), Douglas-fir (12%), and montane hardwood (10%), with lesser amounts of montane riparian (4%), white fir (2%), closed-cone pine-cypress, ponderosa pine, and Klamath mixed conifer habitat types.

The Bureau of Land Management primarily administers public lands in the planning area, with minor acreage administered by CDF and the BOR. No timber harvesting has been done on BLM lands since their acquisition in 1993 and it is believed that little to no harvesting has been done in decades on State and BOR lands. It should be noted that one of the goals of the "GVC Watershed Coordinated Resource Management Plan" prepared in 1995 by BLM was to have a 12-year moratorium on timber harvesting, until the year 2007. This moratorium does not apply to fuel management projects, fire hazard reduction, hazard tree removal, insect damage control, or wildlife habitat management.

Virtually all of the lands administered by BLM are on soils derived from granitic rocks. Research and experience have shown that accelerated erosion on decomposed granitic soils can be expected whenever they are disturbed (see 'Soils', pg. 28). Logging, which removes protective cover and can disturb the soil, is likely to accelerate erosion rates, and will likely do so for decades longer on southeast- to west-facing slopes than on northwest- to east-facing slopes. Prescribed burning of an intensity that bares the soil surface and/or creates an impermeable soil layer will also accelerate erosion rates. Care should be taken on steep slopes, especially on southeast to west aspects, to protect ground cover from disturbance.

The 1991 inventory of sediment sources in the GVC watershed conducted by the Weaverville Field Office of the Soil Conservation Service found that on steep, south- and west-facing slopes "Excessive removal of the overstory results in three significant problems on-site: 1) loss of the protective canopy cover that provides shade for understory regeneration; 2) loss of the recruitment of the litter material that acts as a sponge to absorb the impact of rainfall and slow runoff through the subwatersheds; and 3) loss of live root material that can take up and transpire water". It was found that the "removal of significant basal area through frequent timber harvest essentially forces a change in the hydrologic process of the subwatershed" that results in "accelerated sheet and rill erosion on-site and the down-cutting of stream channels to adjust to the increased runoff off-site". While some areas recovered from site disturbance rapidly, it was found that more severe sites often took far longer to recover, sometimes converting to brushfields. (Proceedings)

Slow recovery of vegetation after harvesting on southerly slopes

Silvicultural systems suitable for forest management on BLM lands, which require reduction of sedimentation into watercourses as the primary objective, must retain enough vegetative cover and duff and litter cover to protect the soil from erosion. The 1991 SCS study suggested that "forest land management in the decomposed granite portion of the Grass Valley Creek watershed must be management that places value on the retention and enhancement of a sufficient quantity and quality of ground cover on the brittle exposures so as to not overly disturb the fragile nature of the geologic and hydrologic characteristics of this watershed". It suggested that "Silvicultural systems that ensure sufficient regeneration exists beneath the overstory prior to overstory removal will lessen harvesting impacts on sediment production. Vegetation management programs that promote and enhance regeneration should be investigated further. Harvesting methods must be selected that minimize the severe impacts associated with road building and tractor yarding." The study suggested that longer rotations be used to increase the value of individual trees and that "more prudent harvesting of select trees" be employed.

These suggestions are all in accord with BLM guidelines for the GVC watershed, which "restrict" forest management under the 'Resource Condition Objective'. Timber harvest "may only occur for the enhancement of other resources or if not in conflict with the management of natural or cultural values" (BLM RMP/ROD). The GVC WA states that "Although the majority of the watershed is 'matrix' land, erosion control and sediment reduction is the primary management objective and will take precedence over all other land management decisions. Any plans for timber production will be subservient to sediment reduction and only include those practices which do not hinder this primary management objective." Timber harvest under this prescription could include commercial thinning, sanitation/salvage, group selection, and selection harvesting. "Restricted" management requires a wide array of biological, visual, cultural, and social controls beyond what is already required by law and therefore stand rotations will be longer than considered optimum for strictly timber production.

Considering these guidelines and the findings and recommendations from the plethora of studies on forest management on decomposed granitic soils, individual tree selection, sanitation/salvage, and commercial thinning are the most suitable systems for granitic soils, but group selection and shelterwood may also be appropriate in selected locations.

Individual tree selection, sanitation/salvage, and commercial thinning are specifically recommended if stands are harvested on sites that are generally more at risk for erosional losses or regeneration failures, namely southeast- to west-facing slopes, slopes greater than 40%, areas of shallow or granitic soils, areas with significant patches of bare soil, and/or moderately dense to sparsely vegetated stands (less than 60% canopy closure). Post harvest canopy cover should generally be at least 40% (80% on southeast- to west-facing aspects and 40+% slopes) of dominant and codominant trees. Hardwoods, especially oaks of larger diameter, should be retained to provide protective cover and habitat for wildlife. It should be noted, though, that the GVC WA found that "Thinning stands to reduce fire hazard and improve stand health . . . on south and west slopes would be detrimental to erosion control efforts." And that "Vegetation is the key to long term sheet and rill erosion control; coniferous plant litter provides excellent surface cover and long term surface stability and erosion control." Considering this, it is advisable to avoid all but the most minor harvesting on southeast to west aspects.

Group selection, which in essence creates mini clearcuts, may be the best way to regenerate pine stands. Traditionally, groups range in size from a few trees to a couple of acres, but on granitic soils groups should be limited in size, dependent upon vegetation type, amount of existing ground cover, steepness of slope, and aspect. In larger groups (1/2+-acre, ~150'x150') or groups on steeper slopes (40+%), residual dominant and/or codominant trees and advanced regeneration should be left, provided it has the ability to respond to increased light and moisture, to provide needle fall, some protection from rainfall impact, and root anchoring. In general, group selection should be avoided on southeast to west aspects, except possibly on benches, toe slopes and flats, but if used, group sizes should be less than ¼-acre (~105'x105'). In no case should groups, other than a few trees in size, be located within watercourse protection zones or on steep slopes (40+%). Hardwoods, especially oaks of larger diameter, should be retained to provide protective cover and habitat for wildlife.

Shelterwood may be an appropriate system for conifer, mixed conifer, and montane hardwood-conifer stands on northwest to east aspects, benches, and on flats, depending upon the level of canopy closure retained. Traditionally, shelterwood is done in two to three stages. In the first stage, the prep step, the stand is thinned, leaving larger, well-formed trees with good crowns to provide seed. This step allows the residual trees to expand their root systems to become more windfirm. In the second stage, the seed step, most of the trees are removed, leaving only the trees that will act as a seed source. When the harvest area has adequately regenerated, the residual overstory trees are harvested in what is known as the removal step.

On granitic soils the shelterwood system should be modified to insure protection of the soil. Canopy retention in the seed step should be about 50-60%, greater than what is normally considered optimal for seedling establishment and growth (about 20-40%). Rather than removing all remaining trees in the removal step, residuals should be left to provide needle fall, raindrop protection, root anchoring, and future vertical stand structure. Some of these residuals may, or may not, be removed during the next commercial thinning or harvest. This type of shelterwood is commonly known as shelterwood with reserves. Hardwoods, especially oaks of larger diameter, should be retained to provide protective cover and habitat for wildlife.

Experience in these soil types and in this watershed strongly indicates that timber harvesting be done by helicopter. Helicopter logging causes the least disturbance to ground vegetation, litter, duff, and to the soil mantle and can be used with most silvicultural systems, including shelterwood, individual and group selection, and commercial thinning. But it is the most costly logging method (250-300% more than tractor logging) and therefore requires adequate log sizes and sale volumes within economic flying distance to landings. The scarcity of roads, distance to suitable landings, and proximity of suitable harvest areas to powerlines and major roads may constrain its use, although logs can be flown several miles to landings. Champion International, the former owner of BLM lands, helicopter logged using landings adjacent to Highway 299.

Cable logging has less impact on granitic soils than tractor logging, but it can lead to accelerated erosion (see 'Soils', pg. 28). It too is constrained by the scarcity of roads and landings. The highly dissected and steep landscape makes road construction on upper slopes difficult, increases erosion hazards, and requires more setups of yarding corridors. Yarding downhill has been done in some locations, but it has increased erosion.

Experience has shown that tractor logging, as practiced in this watershed, has the most impact on soils. There may be areas of gentle slopes with adequate ground cover or dense brushfields where tractors or other ground based yarding equipment can be used with minimal soil disturbance, but it is not advisable. Tractor logging on snow has been done in some areas of California, in northern states, in Canada, and in Europe to prevent soil disturbance and is recommended if ground based equipment is used at all in this watershed.

A variety of agencies, companies, and non-profit organizations have developed recommendations for minimizing erosion in decomposed granite. Some of these can be found in the "Erosion Control" section of the "Proceedings of the Conference on Decomposed Granitic Soils: Problems and Solutions", Sari Sommarstrom Ph.D., Editor, Redding, CA, 10/21-23/92. In 1986, eleven Federal, State, and local agencies and industrial forestry companies developed "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages". This document, which was revised in 1992, can be found in the above referenced document and at the CDF office in Weaverville, CA. The mitigations outlined in the document are "intended to be used in addition to applicable forest practice rules and are not intended to supplant those rules unless they provide greater resource protection than the rules". The following are <u>some</u> of the recommendations from that and other documents found in the "Proceedings". It is suggested that the "Recommended Mitigation Measures . . " be consulted during project planning and layout and followed during and after operations.

General Recommendations

- Retain natural vegetation in areas of high erosion risk, especially on upper slopes, southeast to west slopes, steep slopes, areas with shallow soils, sparsely vegetated areas, and watercourse protection zones
- Do not harvest trees or disturb the soil mantle on slopes over 60% if it is likely to increase the risk of mass movement of soil
- Maintain a <u>minimum</u> of 70% effective ground cover, and preferably 100% cover
- Retain an intact forest floor, including duff, litter, and small and large woody material, especially on hydrophobic soils

- Avoid the use of broadcast burning for site preparation as even “cool” burns can char duff and litter, leading to its subsequent loss and increased exposure of bare soil
- Yard unmerchantable material to reduce fuel loads, pile and burn in place, and/or yard to and scatter in bare areas
- Lop and scatter logging slash on bare areas to reduce fire hazard and increase soil protection
- Revegetate areas of disturbed soil as soon as possible; avoid scalping around seedlings; plant through slash
- Comply with the CA FPR watercourse protections as outlined in Article 6 “Watercourse and Lake Protection” and specifically “Protection and Restoration in Watersheds with Threatened or Impaired Values” (FPR 936.9)
- Comply with the most recent version of CDF’s “Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages”
- As per requirements for Riparian Reserves, designate watercourse protection zones of 300 feet (slope distance) on either side of fish bearing streams 150 feet on non-fish bearing, perennial streams, and 100 feet on seasonal or intermittent streams
- Limit timber harvesting in Riparian Reserves to salvage and fuelwood cutting and only when that will maintain or improve the riparian ecosystem and protect stream courses and water quality
- Exclude equipment from designated watercourse protection zones on all watercourses
- Maintain all ground cover in ephemeral watercourses and swales where water concentrates
- Fell timber away from watercourses to minimize yarding disturbance
- Operations during the winter operating period (11/15-4/1) should be prohibited, except for tree falling, hand slash treatment, and skidding, if done on a snowpack sufficiently deep to prevent soil disturbance

Helicopter Logging

- Prevent damage to leave trees when lifting logs and approaching landings
- Follow mitigations for landings and roads in “Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages”

Cable Logging

- Consider downhill yarding to reduce need for roads
- Locate landings carefully, use more landings to reduce size, do not sidecast material
- Lay out cableways to prevent damage to the residual stand and to regeneration
- Minimize temporary spur roads
- Avoid contour yarding
- Waterbar cableways as needed following operations

Tractor Logging

- In general, avoid this logging method
- Use low ground pressure equipment
- Retain at least 45% canopy closure in tractor units
- Limit tractor operations to areas of denser vegetation
- Consider limiting tractor operations to times when there is sufficient snowpack to prevent soil disturbance
- Tractor operations should be limited to slopes less than 40% (some say 30%, some 35%, others 50%)
- Tractors should be limited to ridgetop trails and lateral contour trails
- Locate skid trails to limit ground disturbance to less than 15% of the site

- Endline logs to these trails, especially on slopes exceeding 30%
- Suspend one end of logs when skidding; consider whole tree yarding
- Waterbreaks on skid trails should be constructed at a minimum of 50-foot intervals (20 feet on steep slopes)
- Spread slash on, mulch, and/or seed skid trails with native grasses; plant sides and center of trails with trees

Roads

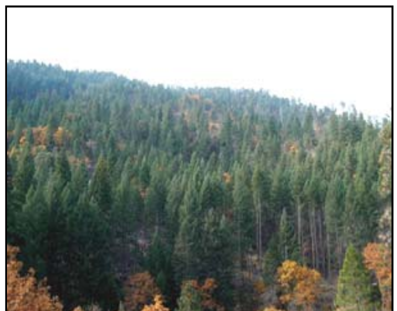
- Rock all roads with coarse, angular rock
- Install adequate waterbars at appropriate intervals
- Permanent fills should use non-decomposed granite fill material and be rock armored
- Reduce runoff of water onto large fills and into non-drainage areas
- Stabilize temporary roads and fills with straw and grass seed immediately following operations
- Outslope roads whenever possible and use ditches on insloped roads
- Increase culvert diameters by 1½ times normal sizes
- Use temporary crossings wherever possible
- Maintain drainage and erosion control structures throughout the year and especially following summer thunderstorms, which often cause the worst erosion

Industrial Forestry

The primary vegetation habitat types found on industrial forest lands are Douglas-fir (45%), montane hardwood-conifer (21%), and Sierra mixed conifer (17%), with pockets of montane hardwood (6%), closed-cone pine-cypress (2%), and ponderosa pine habitat types.

Sierra Pacific Industries, Crane Mills Inc., Roseburg Forest Products Company, and Trans-Wood Company own a large portion of the private land in the GVC watershed. The primary goals of SPI foresters and land managers is intensive timber management using primarily even-aged silviculture, with limited uneven-aged silviculture, while maintaining forest and watershed resources. An additional goal is to create a fire-safe forest. These goals are being met by on-going timber management/harvesting, control of spacing and density of conifers, and planting under-stocked timberlands.

In 1996 a timber harvest plan was approved by CDF for 738 acres of SPI lands in and adjacent to the GVC watershed. Most of this area had been high graded for ponderosa pine and Douglas-fir in the mid 1950s. Most of the acreage harvested was in Section 6 to the west of the IOOF Camp and south of the camp in Sections 7, 8, 17, and 18 in the vicinity of Mike's Peak. Silvicultural systems used were alternative (542 acres), shelterwood removal (98 acres), rehabilitation (71 acres), and commercial thin (27 acres). All logging methods were used.



SPI commercial thin in DFR type.

Much of the SPI property is on soils derived from ultrabasic rocks. These soils tend to have severe erosion hazard ratings, low available water capacity, and chemical and nutrient imbalances, which combined can cause operational problems, regeneration failures, slow growth rates, and species limitations. Experience in these soil types and in this watershed suggests that silvicultural systems that retain a partial canopy until regeneration has been established are most appropriate.

Crane Mills Inc., Roseburg Forest Products Company, and Trans-Wood Company lands are on granitic soils. The forest management and harvesting recommendations in the Public Forestry section (above) apply to these lands, with the exception of watercourse protection widths, which are as follow:

- As per the CA Forest Practice Rules, designate a minimum watercourse protection zone (WLPZ) of 150 feet (slope distance) on either side of Class I streams (fish bearing or domestic use), 100 feet on Class II streams (support aquatic life), and 50 feet on Class III watercourses (ephemerals)
- Increase WLPZ widths by at least 50% as necessary to prevent erosion if:
  - Adjacent slopes exceed 50%
  - Areas of instability are present
  - Existing vegetation is sparse or is expected to be so after harvesting
  - Excessive erosion is evident
  - The watercourse is a Class I or flows into a nearby Class I
- Exclude equipment from designated watercourse protection zones on all watercourses
- Maintain all ground cover in ephemeral watercourses and swales where water concentrates

Harvesting on all industrial properties must comply with the best management practices outlined in the current CA Forest Practice Rules.

Rural Residential Forestry

Residential development is mainly in the montane hardwood-conifer (31%), Sierra mixed conifer (22%), and Douglas-fir (18%) habitat types, with pockets of montane hardwood, closed-cone pine-cypress, and ponderosa pine habitat types. Residential timberlands have, for the most part, been managed for personal, aesthetic and wildlife values that have generally resulted in forest stand conditions similar to those that were present at the time of development. Many landowners have begun fuel treatment projects and thinning of stands has been done on some ownerships.

About five timber harvest plans have been approved by CDF in the last decade on 209 acres of rural residential lands in the GVC watershed. Most of the acreage harvested was in the vicinity of the IOOF Camp. Tractors or skidders did most of the harvesting, with 25 acres harvested by cable or helicopter.

Most of the non-industrial forest properties east of Trinity Dam Boulevard and southeast of its junction with Highway 299, in the mid to upper watershed, are on granitic soils. The forest management and harvesting recommendations in the Public Forestry section (above) apply to these properties, with the exception of watercourse protection widths, which are as follow:

- As per the CA Forest Practice Rules, designate a minimum watercourse protection zone (WLPZ) of 150 feet (slope distance) on either side of Class I streams (fish bearing or domestic use), 100 feet on Class II streams (support aquatic life), and 50 feet on Class III watercourses (ephemerals)
- Increase WLPZ widths by at least 50% as necessary to prevent erosion if:
  - Adjacent slopes exceed 50%
  - Areas of instability are present
  - Existing vegetation is sparse or is expected to be so after harvesting
  - Excessive erosion is evident
  - The watercourse is a Class I or flows into a nearby Class I
- Exclude equipment from designated watercourse protection zones on all watercourses
- Maintain all ground cover in ephemeral watercourses and swales where water concentrates

Some of the properties north of Grass Valley Creek, from Fawn Lodge downstream to the large flat near the bottom of the watershed, are not only on ultrabasic soils but are also on south- and west-facing slopes. These are particularly harsh growing sites and harvesting is best done using silvicultural systems that leave partial shade, which will somewhat lower air and soil temperatures and increase humidity so as to enhance establishment of regeneration. Resource protection requirements during harvesting operations are as found in the current CA Forest Practice Rules.

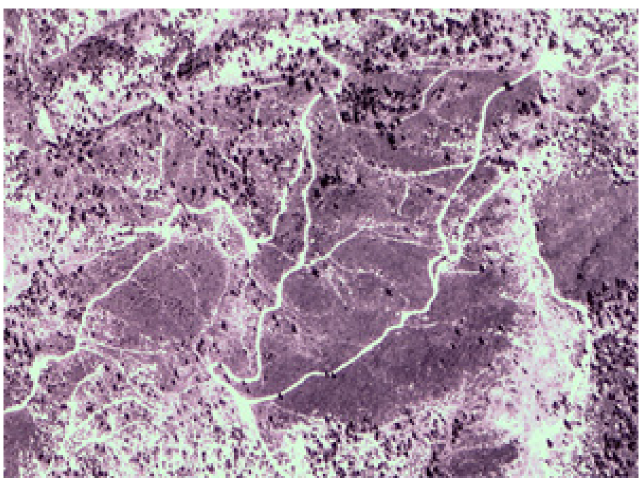
The forested properties at the bottom of the watershed are generally on soils that impose no specific limitations on silvicultural systems or logging methods. But it is recommended for aesthetic and wildlife purposes and to enhance establishment of regeneration that partial cutting be employed. Resource protection requirements during harvesting operations are as found in the current CA Forest Practice Rules.

CHAPTER 5. FIRE AND FUEL SITUATION

Fire History

Native Americans have probably been the most important influence on the timing and location of fires for the past several thousand years. Evidence suggests that the Wintu people used fire in the Trinity River area to maintain open, park-like forests, allowing easy and safe travel. In addition, regular burning provided browse for game, controlled insect pests of oak acorns, and supplied materials for basket making, arrows, medicine, and food. The park-like forests encountered by the early explorers and miners are generally acknowledged as resulting from this human use of fire.

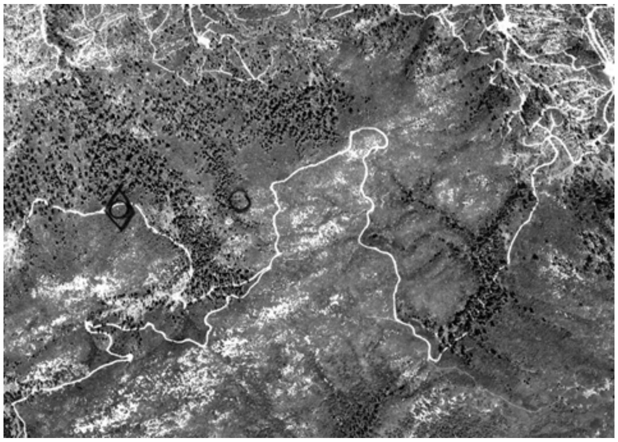
Evidence of historic burns is visible in a few large areas of shrub dominated plant communities and from observations of fire scarred trees throughout the watershed. Aerial photography taken in 1944, before logging occurred in the GVC watershed, shows some areas with less vegetation than at present, presumably the aftermath of natural wildfire or human set fires. Comparisons from 1957 and 2000 aerial photography of some brushfields on granitic soils at higher elevations show significant repopulation by white fir and mixed conifer forest, indicating the likelihood that forests once dominated these sites. As there is no evidence of logging on these sites prior to 1957, it is presumed that fire was the causative agent.



High elevation successional brushfield (1957 photo)

High elevation successional brushfield (2000 photo)

But some high elevation brushfields in the very south end of the watershed appear to be climax brush communities due to soil conditions that limit tree growth (“Plant Communities of the GVC Watershed”, Christina Veverka, BLM).



High elevation climax & successional brushfields (1957 photo)

High elevation climax & successional brushfields (2000 photo)

Although fire start records for the Shasta-Trinity National Forest date back to the 1910s, no record of fire starts has been found for the project area. Based on National Forest records, it is likely that humans have caused the majority of fire starts, as most such fires are associated with roads and residential developments. In 1999, two-thirds of the fires on the Whiskeytown NRA were arson fires. The last lightning fire on the NRA was in 1998 and there were only a few lightning strikes in 2002, although the 10-year average indicates considerably more strikes.

Suppression of all wildland fires and elimination of regular low-intensity fires over the past 85-90 years have generally resulted in denser forests and brushfields with greater amounts of dead and dry fuels than previously existed, although larger live fuels have been reduced in much of the plan area through aggressive logging from the late ‘40s until the early ‘90s (see ‘Fire and Fuel Hazard Severity’ below).

Fire Regime

The concept of fire regimes was developed by fire ecologists to classify, describe, and categorize complex patterns of fire effects that take place over long time periods, through multiple fire events, and in variable ecosystems. The purpose was to facilitate study of fire and its effects so that management guidelines could be developed. Although the concept of fire regimes is useful on a landscape level, it should be cautioned that regimes often vary greatly within a vegetation type and over time on the same area.

One system for classifying fire regimes in California uses seven key attributes of fire that are important to ecosystem function. These attributes can be classified as temporal (seasonality & fire return interval), spatial (size & spatial complexity), and magnitude (fire intensity, fire severity, & fire type).

The *season* in which fires burn is important biologically as many ecosystems include species that are only adapted to burning during a fairly limited part of the year. Burning outside of these limits can adversely affect their ability to recover from the effects of fire. Fire seasons can be classified as spring-summer-fall, summer-early fall, late summer-fall, and late summer short season. For the GVC watershed the season during which most burning occurs is typically from summer to early fall (July to October). Fires in montane conifer forests are primarily carried in the herbaceous, duff, and needle layers.

The *fire return interval* is the length of time between fires on a given area and is critical in determining the mixture of species that will survive and flourish on that area. If fire consistently does not allow a species to complete its life cycle it won’t survive. Fires that occur before a non-sprouting species has matured and accumulated a seed pool or after it has declined and the seed pool has been exhausted will likely adversely affect it. Fire return intervals can be classified as truncated long (~70-100+ yrs), long (~10-100+ yrs), moderate (1-100+ yrs), truncated moderate (~15-65 yrs), short (1-65 yrs), and truncated short (1-20 yrs).

The fire return interval for much of the GVC watershed is probably best typified as short, which includes mostly short intervals but also some infrequent long intervals. In mixed conifer forests the short intervals favor relatively fire tolerant (at younger ages) ponderosa pine, Douglas-fir, and sugar pine while long intervals favor fire sensitive species such as white fir and incense cedar. The mix of dominant species may be an indicator of the fire return interval, with open ponderosa pine stands indicating shorter intervals, Douglas-fir and sugar pine dominated stands indicating a wide range of intervals, and white fir dominated stands indicating long (over 50 years) intervals. All of these stands are found in the watershed, with montane-hardwood conifer, Sierra mixed conifer, and Douglas-fir dominated stands representing the majority of the forest types while white fir dominated stands are found only at higher elevations.

There are areas of the watershed that are probably best typified by moderate or truncated moderate fire return intervals. Moderate intervals include a wide range of intervals but most fires are within a narrower range. Fires at the extreme intervals are infrequent enough that they do not facilitate vegetation type conversion. Chaparral types, live oak forests, and upper montane forests such as red fir and white fir, all of which are found in the watershed, mostly at higher elevations, are indicators of this type of fire return interval. Truncated intervals have upper and lower limits defined by the life history of closed cone pines and cypresses, such as gray pine and knobcone pine, both of which are found at lower elevations. Fires outside of these limits result in conversion to other vegetation types.

Some fire ecologists have estimated that the fire return interval in similar ecosystems in the area prior to the arrival of European settlers was 7-15 years. Records from the Whiskeytown NRA show that no large fires have occurred there in the past 50 years, although there have been numerous small fires. In the GVC watershed there are areas with large diameter canyon live oaks, in general an indicator that fires have either not passed through the area in 50 or more years or have been of such low intensity that they have not significantly damaged the oaks. This species is highly susceptible to damage and mortality from even low-intensity ground fires and will tend to form dense sprout clumps if subjected to frequent fires. There are also areas with dense white fir forests that are 30 to 60 years old and other areas of mature white fir forests, both indicators of longer fire return intervals. The GVC WA estimates the age of some successional brushfields at 90 years. These brushfields are visible on 1957 aerial photos and had young white firs and other conifer species growing in them that are visible on aerial photos flown in 2000, an indication that no significant fire has burned through them in at least 65 years, and certainly not in the ensuing 45 years.

Fire size includes the area inside the perimeter of a fire, which is not the same as the area actually burned as fires typically burn in a mosaic pattern, leaving islands of unburned vegetation. Fire size is related to fuel continuity, fuel condition, site productivity, topography, and weather before and during the fire. Sizes can be classified as small (mostly <25 acres), truncated small (mostly <2.5 acres), moderate (mostly 25-500 acres), and large (mostly >500 acres). The GVC watershed is probably best characterized by fires of moderate size. Although no historical data was found to support this characterization, this pattern is characteristic of ecosystems that occur on complex topography, are composed of a mosaic of patches with varied productivity, fuel levels, and fuel conditions, and have limited stand size and fuel continuity.

1999 Lowden Fire (2000+ acres)

Spatial complexity is a measure of the spatial variability of fire severities within fire perimeters. Complexity can be classified as low, moderate, high, and multiple. The GVC watershed has probably experienced all of these types, but appears to be best characterized by the multiple classification. Most of the area burns in either a complex pattern of burned areas of variable fire severity and unburned areas and/or in a mostly uniform pattern of burned area and severity. This is characteristic of ecosystems with two distinct fire types, such as surface and crown fires.

Fire intensity describes a fire in terms of the energy it releases at the fire line (energy released in kWs per unit length of fire line). Intensity can be classified as low (flame lengths <3.3’, fireline intensities <350 kW min-1), moderate (3.3-10’, 1750 kW min-1), high (10-13’, 1750-3500 kW min-1), very high (>13’, >3500 kW min-1), and multiple (mostly low and high intensity fires). The GVC watershed is probably best characterized by the multiple intensity model. Burns are mostly either low intensity surface fires or high intensity crown fires, with a smaller proportion of moderate or very high intensity fires. Low intensity fires burn on the surface, occasionally consume understory vegetation, and can generally be attacked by hand crews at the fire head and flanks. Annual grasslands and oak woodlands typically burn with this pattern of intensity. Moderate intensity fires usually remain on the surface, may completely consume understory vegetation, and are too intense for direct attack at the head by hand crews. Mixed conifer forests typically burn with this pattern. High intensity fires consume some crowns and individual plants and may cause major control problems due to spotting, torching, and crowning. Most chaparral vegetation types burn with this pattern. Very high intensity fires are considered blowup situations, where spotting, crowning, and major runs are probable. Douglas-fir, white fir, and mixed conifer forests can all burn with this pattern.

Fire severity is the magnitude of effects that fires have on the environment, including effects on vegetation, soil, geomorphology, watersheds, wildlife habitat, and humans. The severity of a fire results from a combination of fire line intensity, residence time, and moisture conditions at the time of burning and vegetation and other ecosystem characteristics. It can be classified as low, moderate, high, very high, and multiple. The GVC watershed probably experiences mostly low and moderate severity fires, with high severity fires likely in chaparral types. Some fire ecologists have estimated the fire regime to have been one of frequent, low- to moderate-severity fires prior to fire suppression, which was officially initiated on the Shasta-Trinity National Forest in the 1910s and sometime thereafter in the watershed. Low severity fires generally modify vegetative structure only slightly, if at all, over most of a burn area and nearly all mature plants survive. Portions of the burn area may experience higher severity levels. Douglas-fir, ponderosa pine, and oak woodlands typically experience this severity pattern. Moderate severity fires are moderately stand modifying, with most mature plants surviving over most of the burn area. Small portions of the area may experience low severity or higher severity fire. This severity pattern is typically found in mixed conifer forests. High intensity fires top kill most of the vegetation on most of the burn area, but most plants survive and resprout. Small areas may burn at lower or higher intensities. Sprouting chaparral types typically experience this pattern.


2001 Oregon Fire
(high intensity - high severity)

Fire type describes the flaming front patterns that are characteristic of an ecosystem. Fires can be classified as ground fire, surface fire, passive/active crown fire, active/independent crown fire, and multiple fires. Most fires are a combination of two or more of these types. The main fire types in the GVC watershed are probably surface fires and passive/active crown fires, with multiple fires possible in high elevation white fir forests. Surface fires mostly burn surface fuels without burning large areas of forest canopy. There may be some torching of trees and some ground fire (in duff). Surface fires typically burn in grasslands, oak woodlands, montane hardwood-conifer, mixed conifer, Douglas-fir, and ponderosa pine forests. Passive/active crown fires can burn in dense hardwood, hardwood-conifer, and conifer forests growing in very steep, complex topography. These fires are mostly a combination of surface fires supporting extensive passive and active crown fires. Passive crown fires, commonly called torching, result from vertical flare-ups of surface fire through fuel ladders into the overstory canopy. These fires do not spread horizontally through the canopy. Active crown fires, the most common type of sustained crown fire, are dependent upon and synchronous with supporting surface fires.


Torching on the Oregon Fire.

To summarize the probable historical fire regime in the GVC watershed, based upon current vegetation types, structure, and patterns, fuel conditions, topography, and climate, most fires burned during summer to early fall (July to October). The fire return interval on most of the watershed was short (1-65 years) with some areas that were possibly moderate (1-100+ years) and truncated moderate (15-65 years).

Most fires were probably of moderate size (25-500 acres), but smaller and larger fires did occur. Most fires burned in either a complex pattern of variable fire severity with unburned areas and/or in a mostly uniform pattern of fire severity and burned area.

Fires were mostly either low intensity surface fires (<3.3 foot flame lengths) or high intensity crown fires (10-13 foot flame lengths), with a smaller proportion of moderate (3.3-10 foot flame lengths) or very high (>13 foot flame lengths) intensity fires. Most fires were low and moderate severity fires, with high severity fires likely in chaparral types. The main fire types were probably surface fires and passive/active crown fires, with multiple fire types possible in high elevation white fir forests.

Fire and Fuel Hazard Severity

The combination of moderate to high surface fuel hazard, severe summer fire weather, steepness of slopes (40% over 40%), abundance of southeast to west aspects (44% of watershed), abundance of narrow draws, high risk of fire starts, physical and aesthetic values at risk, and scarcity of access roads for suppression forces in most of the watershed results in a very high fire hazard severity rating for the watershed (refer to Chapter 1, 'Wildfire Hazard, Risk and Values at Risk' for a discussion of hazard, risk, and values at risk). This finding is supported by the CDF Fire Hazard Severity Map (1985), which shows a 'Very High' rating for the Grass Valley Creek watershed.

This rating should be qualified by observations made during field work for this plan. What is surprising is how little duff and litter there is overall, especially on granitic soils. In general, duff and litter layers are less than two inches deep and in many areas in the mid to upper watershed are non-existent. This is primarily due to previous logging and subsequent erosion, the relatively young age of trees (fewer dead limbs and tops), and sparseness of vegetation in some areas (but in most cases canopies are moderately dense to dense) (see 'Primary Fuel Model' & 'Secondary Fuel Model' maps and 'WHR Habitat' map). As would be expected, litter and duff are deepest under individual trees and shrubs, but often there are bare or mostly bare areas between them.

Ladder fuels in forested areas tend to be sparse to moderately dense, and are generally scattered or clumpy (see 'Primary' & 'Secondary Fuel Indices' maps). Forty-three percent of the watershed (also 43% of BLM) has no or relatively minor ladder fuels, 44% (40% of BLM) has moderate ladder fuels, and 13% (17% of BLM) has heavy fuel ladders. The watershed is a mosaic of forest, shrub, grass, bare, and water areas with a diversity of canopy characteristics. In the MHC, MHW, and even the conifer forest types there are a diversity of tree species, including conifers and hardwoods, which have different flammability characteristics. Taken together, these factors suggest that most fires would be limited to low to moderate intensity and severity surface fires, with passive/active crown fires possible where ladder fuels are heavy. Fires would probably not be extensive in size.

In the upper watershed are extensive brushfields with scattered and clumpy sapling, pole, and small sawtimber size trees in them. Although brushfields (MCP type) only account for ~5% of the watershed, 22% of the high (2) fuel ladder index is found there. These brushfields are more susceptible to high intensity and severity fires and passive/active crown fires due to widespread fuel ladders and horizontal continuity of fuels. Fire size would be highly dependent upon wind speed and direction. If fire spotting is heavy, and the winds are blowing into areas of heavy fuels, then fires could get quite large. Conversely, if winds are light and the fire is in one of the areas with abundant patches of bare soil, fire size would be limited.

Ladder Fuel Indices by WHR Habitat Type				
WHR Habitat	% of WHR in GVC	Ladder Fuel Indices (% each index in each WHR)		
		0	1	2
AGS	1.08	2.52	0.00	0.00
BAR	1.17	2.73	0.00	0.00
CPC	1.54	0.36	1.10	2.66
DFR	19.87	13.09	30.17	8.24
KMC	0.09	0.17	0.02	0.00
MCP	4.74	1.24	2.71	22.38
MHC	33.46	44.86	26.99	18.20
MHW	9.33	11.40	7.43	8.84
MRI	3.45	0.04	4.53	10.78
PPN	1.40	1.61	1.23	1.29
SMC	21.70	19.97	23.51	21.39
WFR	1.94	0.32	2.29	6.23
WTM	0.04	0.09	0.00	0.00

Slope Classes	
Slope %	Acres
0 – 20	4007.79
20 – 30	4567.40
30 – 40	5629.88
40 – 50	4635.92
50 – 60	2757.49
60 – 70	1272.52
>70	629.73

Empirical and scientific data indicates that wildfires tend to have the highest rates of spread, the greatest intensities, and the highest severity of damage on south to west aspects, on slopes over 40%, and on the upper one-third of slopes. These situations are mapped on the 'Aspect' map, 'Slope Class' map, 'Slope Position' map, and 'High Fire Hazard Zones' map, which includes all three parameters. Slopes over 40% are found throughout the watershed and on 40% of the area.

But it should be noted that, especially in the mid and upper watershed and especially on granitic soils, fuels tend to be much sparser on southeast to west aspects. Comparison of the 'Primary Fuel Model' map and 'Secondary Fuel Model' map with the 'Aspect' map reveals that most of the Barren fuel model (99) is on southeast to west aspects as are many WHR habitats with sparse to poor canopy closures. This is in keeping with information on revegetation failures on these slopes following logging and TCRCD revegetation efforts. So even though these slopes may be in high fire hazard zones, they may have too little vegetation to carry a high intensity fire, or any fire at all.

Slope Aspect by Ownership (% of GVC Watershed)					
Owner	Flat	NE	NW	SE	SW
BLM	0.58	19.05	9.31	6.27	25.61
BOR	0.07	0.26	0.19	0.14	0.42
CA	0.01	0.54	0.09	0.23	0.44
DWR	0.01	0.03	0.03	0.00	0.00
CM	0.01	0.54	0.12	0.02	0.04
ROS	0.00	0.11	0.08	0.11	0.28
SPI	0.24	12.06	2.58	0.83	2.45
TW	0.00	0.02	0.11	0.02	0.27
PRV	0.27	7.06	1.89	1.32	4.82
NPO	0.05	0.34	0.19	0.13	0.75

The highest fire hazard zones are concentrated along portions of the east and west watershed boundaries, on the main ridge south of Phillips Gulch, on the ridges defining Walts Creek, and on some other subwatershed ridges. Fuels in these zones primarily fit models 5, 8, and 9 (see Anderson Fuel Models below) with moderate to widespread fuel ladders and moderately dense to dense canopy closures. These zones are therefore high fuel hazard zones as well as high fire hazard zones.

The type, amount, size, arrangement, and moisture content of surface fuels is a major determinant of how easily a fire ignites, how fast it spreads, how hot it burns, and how high its flames reach. Surface fuels are vegetative materials on or near the ground, such as downed woody material (leaf litter, cones, dead branches, and logs) and grass and brush, through which fire will spread. Fire rate-of-spread is affected primarily by fuels one inch and smaller in diameter.

Many methods have been developed for modeling fuel and fire hazard severity. The California Interagency Fuel Mapping Group (CAIFMG), a consortium of State and Federal agencies, is developing regional "surface fuel" maps that span jurisdictional boundaries. The method used in this report is that used by CDF to develop fire hazard rankings for the California Fire Plan, but is only done to the point of determining surface fuel hazard rankings. Fire hazard severity can be ranked using the surface fuel hazard assessment in conjunction with weather, assets at risk and level of suppression service.

Anderson Fuel Models

Part of the process for determining surface fuel hazard is to classify surface fuels using Fire Behavior Prediction System (FBPS) models (see table 1 below) based upon those described by Hal E. Anderson in "Aids to Determining Fuel Models for Estimating Fire Behavior" (USDA, USFS General Technical Report INT-122, April 1982). These models are then used to estimate fire behavior during severe fire conditions, when wildfire control is most difficult and resource impacts are greatest.

Fuel Model Classes			
FBPS	**Description**	**FBPS**	**Description**
1	Short Grass	11	Light Slash
2	Timber/Grass	12	Medium Slash
3	Tall Grass	13	Heavy Slash
4	Tall Chaparral	14	Plantation/Burned last 15 years
5	Short Brush	15	Desert
6	Medium Brush	28	Urban
7	Southern Rough	97	Agricultural Lands
8	Short Needle Conifer/Hardwood	98	Water
9	Long Needle Conifer/Hardwood	99	Barren/Rock/Other
10	Mixed Conifer/Heavy Litter		

Fuel Model Classes table: Lists fuel model classes (FBPS) and a general description of the vegetation types that typically fall into each class. These fuel models are based on Hal Anderson's "Aids to Determining Fuel Models for Estimating Fire Behavior" (April 1982) published by the National Wildfire Coordinating Group.

Thirteen fuel models (1-13) are classified into four groups, grass and grass dominated, chaparral and shrub fields, timber litter, and slash. Differences in fire behavior between these groups are related to the fuel load and depth, the distribution among fuel particle sizes, and the arrangement of fuels. These groups can be further segregated into two groups based on the relationship between fuel load and depth. Grass and shrub groups have vertically oriented fuels that rapidly increase in depth with increasing load while timber litter and slash groups have horizontally oriented fuels that slowly increase in depth with increasing load. As fire burns best in the fuel stratum best conditioned to support the fire, situations will occur where one fuel model most accurately represents rate of spread while another best depicts fire intensity. In situations with two fuel conditions, fire spread must be adjusted to reflect the relative area occupied by each fuel.

These fuel models are refined further by applying indices for ladder fuels and crown density (see tables below). Estimates of ladder and crown fuels support assessment of crown fire potential. The ladder and crown fuel indices estimate the relative abundance of these fuels. These indices measure in a rough manner the probability that individual tree torching and/or crown fire would occur if the stand experienced a wildfire during extreme weather conditions.

Ladder Fuel Indices	
0	Fuel ladders are not present.
1	Fuel ladders are present but spatially limited, with open areas where fire may not carry. Includes <51-75% of the total area.
2	Fuel ladders are widespread throughout the vegetation, with no break in continuity from ground to crown. Includes 75% or more of the total area.

Crown Fuel Indices	
0	No horizontal continuity. Includes <50% of the total area.
1	Horizontal continuity present but spatially limited, with open areas where crown fire may not carry. Includes <51-75% of the total area.
2	Horizontal continuity is widespread, with no break in crowns. Would carry a crown fire. Includes 75% or more of the total area.

The fuel models found in the watershed are described below. Unless otherwise noted, percentages are for primary fuel models that occupy at least 70% of any given fuel model polygon, which includes 83% of the watershed. These percentages will be slightly different from those calculated from the 'Primary Fuel Model' map, which shows primary fuel models that occupy at least 50% of a polygon (includes 100% of the watershed). It is felt that fuels that cover a significant percentage of an area will have the greatest effect on fire behavior, and are thus truly primary fuels.

It should be noted that many areas (approximately 23% of the watershed) have a combination of two fuel models. These are mapped as a combination if each fuel model occupies more than 20% of the area. In general, if two models occupy an area equally, the timber model is designated the primary fuel model and the shrub or grass model as the secondary model (see 'Secondary Fuel Model' map). These combination models are charted below.

Combination fuel model (5 & 99)

Anderson Fuel Models 5, 8 and 9 describe the majority of primary fuel conditions in the watershed. Fuel Model 5 comprises 17% of the watershed, model 8 comprises 45%, and model 9 comprises 15%. The other models found in the watershed are 1 (1%), 2 (1+%), 6 (<1%), 10 (<1%), 11 (<1%), and 99 (4%).

In general, Fuel Model 5, a shrub fuel model, is found extensively as both a primary and secondary fuel in the upper watershed. It is generally associated with dense brushfields or with relatively open stands of hardwoods and/or conifers and/or with areas of bare soil. It has higher live fuel volumes than models 8 and 9. Fuel Model 8, a tree fuel model, is found extensively in the mid to lower watershed and primarily in the vicinity of watercourses in the upper watershed. It is found primarily under conifer and hardwood-conifer forests. Surface fuels are generally relatively light due to shallow duff and litter layers and moderate loadings of limbs, but there are many areas with moderately dense to dense ladder fuels. Fuel Model 9, another tree fuel model, is found in scattered patches in the mid to lower watershed and rarely in the upper watershed. It is found under conifer and hardwood-conifer forests and in riparian areas. Surface fuels are generally heavier than model 8, but still relatively light due to shallow duff and litter layers and moderate limb loadings. Fuel ladders are quite variable, ranging from non-existent to dense.


Fuel Model 1 (short grass)

Anderson Fuel Model 1 (256 acres, 1% of the watershed) is only found as a primary fuel model in this watershed. It is associated with the AGS vegetation type, which is mostly found in meadows adjacent to Grass Valley Creek and in portions of the Lowden Fire burn area north of Phillips Gulch. Typically, fuels are in the form of fine, cured or partially cured annual (some perennial) grasses and associated herbaceous fuels. Generally there are few, if any, shrubs or trees in this type. Fires tend to burn rapidly (78 chains/hour) in these fuels, with low flame heights (4 feet) and high intensities of short duration.

The only combination fuel model is a 100-50%/500-50% model on less than an acre

Anderson Fuel Model 2 (316 acres, 1+% of the watershed) is mostly found in poorly stocked (20-50% crown closure), pole and small sawtimber size stands of MHC and DFR, less often in SMC and PPN, and rarely in MHW forests. It is found in the vicinity of Lewiston Road between Highway 299 and Hamilton Ponds, along the watershed boundary north of Phillips Gulch, southeast of Buckhorn Station, west and northwest of the IOOF Camp, and between Mikes and Joes Peak. It is found as a secondary fuel model on 238 acres along Lower Phillips Gulch, Little Grass Valley Creek, and Hoadley Peaks Road.

This model is most often associated with forest stands with large components of Douglas-fir, ponderosa pine, black oak, or white oak. Typically, fuels are in the form of a shallow (1-2 inches) and compact litter of conifer needles and/or hardwood leaves, twigs, and small branches under tree canopies, interspersed with grass and herbaceous fuels in openings. There are occasional concentrations of heavier fuels where trees have died and are in various stages of decomposition, where tops or limbs have broken and fallen, where there are concentrations of shrubs, and/or where there are groups of seedling, sapling, or pole-size trees. Fire spread is primarily through fine fuels, namely grass and other herbaceous fuels that are curing or dead. Rate of spread (35 chains/hour) is not as rapid as for Model 1. Fires generally stay on the ground, burning in the herbaceous fuels and litter from shrubs and overstory trees, which tend to increase flame lengths (6 feet) and fire intensity over Model 1. Flare ups occur in fuel concentrations and there can be occasional torching of trees.


Fuel Model 2 (timber/grass)

Fuel Model 2 has 6 levels of fuel hazard that are likely to result in different fire behaviors, depending upon the spatial arrangement and continuity of ladder fuels and tree or shrub crowns. These are 200 (0.75% of the watershed), 201 (0.15%), 202 (0.17%), 210 (0.17%), 211 (0.05%), and 212 (0.05%). In general, the 200, 201, and 210 models are unlikely to facilitate crown fires. Ladder fuels tend to be sparse and discontinuous and are not well developed and the canopy is relatively open. Fires are likely to remain on the ground, with occasional torching of individual or groups of trees. The 202, 211, and 212 models are more problematic. They have better developed and/or more continuous fuel ladders (mainly understory trees) and/or denser overstory canopies, which provide access paths for fire to enter the crowns of individual or groups of trees and for fire to travel between tree crowns. Fires have more avenues to travel into and between tree crowns, so torching of individual and groups of trees is more likely. But in general, ground fuels are too light to sustain more than short runs of crown fire, so it is unlikely that large scale crown fires would develop, except under most unusual combinations of contributing factors.

There are 5 combination fuel models (see chart) totaling 92 acres. Four of these combinations are unlikely to facilitate crown fires, as there are few fuel ladders, canopies are discontinuous, and the secondary fuels have much slower rates of spread and lower flame lengths. The one combination (211/521) that has the potential to start a crown fire is found on less than one acre.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
200/1100	60	40	49.89
200/800	60	40	13.38
200/900	60	40	5.90
201/801	60	40	22.82
211/521	50	50	0.01
		Total	92.00

Anderson Fuel Model 5 (3911 acres, 17% of the watershed) is mostly found in pole-size MHC and SMC stands with less than 60% crown closure, in the MCP habitat type, and in minor amounts in openings in sparser MHW, WFR, PPN, and DFR types. It is found primarily in the upper watershed south of Buckhorn Summit and Grass Valley Creek Reservoir. There are also concentrations southwest of Hoadley Peaks, north of Highway 299 between Buckhorn Station and Lewiston Road, and on SPI lands. It is found as a secondary fuel model on 2719 acres, primarily between Shingle Shanty and Grass Valley Creek Reservoir, south of the reservoir along Grass Valley Creek and west of it to the watershed boundary, and along the watershed boundary from Corral Creek Road to north of Joes Peak.


Fuel Model 5 (short brush) - tanoak

This model is most often associated with dense brushfields (or groups or patches of shrubs under openings in forest canopies) of tanoak and/or greenleaf manzanita (for high elevation species see the MCP habitat type, pg. 26) composed of short (about 2-3 feet), young (no crown decadence) shrubs with little dead material. Typically, fuels are in the form of a shallow (1 inch) litter of leaves, twigs, occasional small branches, and scattered forbs and/or grass. There are occasional concentrations of heavier fuels where there are inclusions of seedling, sapling, or pole-size trees, especially white fir and sugar pine. Fires burn more slowly, especially at low wind speeds (<8 mph), than in the other shrub models, traveling through the light litter layer at 18 chains/hour, with low flame heights (4 feet) and intensities, except for flare ups in fuel concentrations and occasional torching of shrubs or small trees. During the 1980 Tower Fire on the Whiskeytown NRA, Carl Skinner observed the fire burning slowly through oak/manzanita dominated shrub fields on north slopes. But greenleaf manzanita has volatile chemicals in its foliage, so when moisture content is low after periods of hot, dry weather, fire spread in dense stands can be rapid and extensive.


Fuel Model 5 - greenleaf manzanita

Fuel Model 5 has 9 levels of fuel hazard that are likely to result in different fire behaviors, depending upon the spatial arrangement and continuity of ladder fuels and shrub crowns. These are 500 (1.27% of the watershed), 501 (0.93%), 502 (0.1%), 510 (1.04%), 511 (3.32%), 512 (1.07%), 520 (0.01%), 521 (1.24%), and 522 (7.67%). In general, the 500, 501, 510, and 520 models are unlikely to facilitate crown fires. Ladder fuels tend to be sparse and discontinuous and/or are not well developed and/or the canopy is relatively open. Fires are likely to remain on the ground, with occasional torching of individual shrubs or runs of fire through areas of continuous canopies. The 502, 511, 512, 521, and 522 models are more problematic. They have better developed and/or more continuous fuel ladders and/or denser canopies, which provide access paths for fire to enter the crowns of individual or groups of shrubs and for fire to travel between crowns.

There are 20 combination fuel models totaling 489 acres. Seven of these combinations (on 84 acres) are likely to facilitate crown fires in the shrub and overstory tree layer as both the primary and secondary (8, 9, & 10) fuels have moderate to widespread fuel ladders and generally dense canopies.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
500/200	50	50	14.27
500/800	50	50	3.05
500/800	60	40	27.17
500/800	70	30	16.76
501/201	50	50	4.86
501/801	60	40	15.23
501/9900	60	40	7.56
510/200	50	50	2.73
510/800	60	40	48.18
511/801	60	40	86.66
511/9900	60	40	89.37
511/9900	70	30	59.52
511/9900	80	20	29.76
512/1012	60	40	5.92
512/812	70	30	25.32
512/912	50	50	7.95
512/912	70	30	3.65
522/812	60	40	2.08
522/812	70	30	29.13
522/910	70	30	10.28
		Total	489.45

Anderson Fuel Model 6 (35 acres, <1% of the watershed) is primarily associated with sparse (<25% crown closure), small sawtimber-size CPC and PPN vegetation types, and occasionally with the MHC and KMC types. It is located primarily along the ridge west of Lewiston Road between Old Highway Road and Ponderosa Pines Road, with small areas in the Phillips Gulch drainage near Trinity Dam Boulevard. It is found as a secondary fuel model on only 12 acres, north of Upper Phillips Gulch.


Fuel Model 6 (medium brush)

This model is most often associated with moderately dense brushfields (or sometimes groups or patches of shrubs in openings in forest canopies) of buckbrush and/or greenleaf manzanita composed of moderately tall (3-5 feet) shrubs. Shrubs tend to be intermediate in age between young and mature (defined as 1-25% crown decadence), with more dead material than Model 5. Typically, fuels are in the form of a shallow (1 inch) litter of leaves, twigs, and small branches. There are occasional concentrations of heavier fuels where there are inclusions of seedling, sapling, or pole-size trees, especially ponderosa or gray pine or white oak. Fires tend to burn slowly through the litter, but can burn more rapidly (32 chains/hour) through buckbrush canopies, whose foliage is more flammable than that of shrubs in Model 5, at moderate wind speeds (>8 mph at mid-flame height). Fire will drop to the ground at low wind speeds or at openings in the canopy. Flame heights (6 feet) and intensities are higher than Model 5 fuels and flare ups in fuel concentrations and occasional torching of small trees or shrubs can be expected.

Fuel Model 6 has 2 levels of fuel hazard, 621 (0.01% of the watershed) and 622 (0.14%). They have well developed and continuous fuel ladders and moderate to dense canopies, which provide access paths for fire to enter the crowns of individual or groups of shrubs and for fire to travel between shrub crowns.

There are 2 combination fuel models totaling only 10 acres. Model 611/911 is likely to facilitate crown fires in the shrub layer, torching of overstory trees, and possibly runs of crown fire in portions of the overstory (but it is only found on 3 acres). Both the primary and secondary fuels have moderate fuel ladders and moderately dense canopies. Model 621/9900 has 40% of the area in bare areas that will not support a fire, so it is unlikely that more than short runs of crown fire would occur.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
611/911	60	40	2.68
621/9900	60	40	7.49
		Total	10.17

Anderson Fuel Model 8 (10,635 acres, 45% of the watershed) is found primarily under the canopies of pole and small sawtimber-size, moderately dense to dense (40-100% crown closure) DFR, MHC, and SMC habitat types. Lesser amounts are found in KMC, WFR, PPN, CPC, and MHW forests of similar size and density. This fuel model is found primarily north of Highway 299 as well as south of 299 to the west of Mainline Road and north of Corral Creek Road. It is found as a secondary fuel model on 1530 acres, primarily in the upper Little Grass Valley Creek drainage, in the drainages north and northeast of Joes Peak, on the north and east side of Grass Valley Creek from the reservoir to Highway 299, along 299 from Buckhorn Station to Shingle Shanty, and just west of Hoadley Peaks Road.

This model is most often associated with forest stands with larger components of Douglas-fir, white fir, and/or canyon live oak. Typically, fuels are in the form of a shallow (1-2 inches) and compact litter of conifer needles and/or hardwood leaves, twigs, and small branches under tree canopies. There are occasional concentrations of heavier fuels where trees have died and are in various stages of decomposition, where tops or limbs have broken and fallen, where there are concentrations of shrubs, and/or where there are groups of seedling, sapling, or pole-size trees. Fires tend to burn slowly along the ground in these fuels, with low flame lengths (1 foot), rates of spread (1.6 chains per hour), and intensities, except for flare ups in fuel concentrations and occasional torching of trees. Fires can burn faster under weather conditions of high temperature, low humidity, and high wind.

Fuel Model 8
short needle conifer/hardwood

Fuel Model 8 has 8 levels of fuel hazard that are likely to result in different fire behaviors, depending upon the spatial arrangement and continuity of ladder fuels and tree or shrub crowns. These are 800 (1.54% of the watershed), 801 (6.06%), 802 (10.22%), 810 (0.02%), 811 (2.90%), 812 (22.57%), 821 (0.02%), and 822 (1.95%). In general, the 800, 801, and 810 models are unlikely to facilitate crown fires. Ladder fuels tend to be sparse and discontinuous and are not well developed and/or the canopy is relatively open. Fires are likely to remain on the ground, with occasional torching of individual or groups of trees and short runs. The 802, 811, 812, 821, and 822 models are more problematic. They generally have better developed and/or more continuous fuel ladders (mainly understory trees) and denser overstory canopies, which provide access paths for fire to enter the crowns of individual or groups of trees and for fire to travel between tree crowns. Fires also have more avenues to travel into and between tree crowns, so torching of individual and groups of trees is more likely. But ground fuels are too light to sustain more than short runs of crown fire, so it is unlikely that large scale crown fires would develop, except under most unusual combinations of contributing factors.

There are 35 combination fuel models totaling 2109 acres. Fifteen of these combinations (on 888 acres) are likely to facilitate crown fires in the shrub and overstory tree layer as both the primary and secondary (8, 9, & 11) fuels have moderate to widespread fuel ladders and generally moderately dense to dense canopies.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
800/500	60	40	24.89
800/510	60	40	73.75
800/9900	60	40	25.04
801/201	50	50	14.92
801/201	60	40	4.82
801/501	50	50	49.12
801/501	70	30	55.77
801/511	50	50	212.95
801/511	60	40	10.69
801/521	50	50	71.99
801/9900	60	40	265.27
801/9900	70	30	88.02
802/1002	70	30	6.62
802/202	60	40	30.10
802/502	50	50	8.04
802/512	50	50	57.17
802/512	60	40	168.41
810/510	60	40	7.10
811/1111	70	30	26.65
811/201	50	50	7.33
811/201	60	40	14.43
811/501	50	50	4.42
811/511	50	50	23.93
811/511	60	40	7.28
811/511	70	30	43.30
811/9900	60	40	33.76
811/9900	80	20	12.16
812/202	50	50	8.74
812/212	60	40	6.96
812/512	50	50	367.93
812/512	60	40	44.55
812/512	70	30	199.97
812/522	50	50	56.68
812/522	70	30	29.77
822/522	50	50	45.97
		Total	2108.50

Anderson Fuel Model 9 (3436 acres, 15% of the watershed) is mostly found under the canopies of pole and small sawtimber-size, moderately dense to dense (40-100% crown closure) MHC, SMC, and MRI types, with minor amounts in the MHW, DFR, PPN, and KMC forest types. It is found primarily in the upper Little Grass Valley Creek drainage, Walts Creek drainage and drainages to the north and east of it, upper Phillips Gulch, and north and northwest of the IOOF Camp. There are also scattered polygons of this type throughout the area occupied by Fuel Model 8. It is found as a secondary fuel model on 99 acres in widely scattered locations.

This model is most often associated with forest stands with larger components of ponderosa and/or sugar pine and/or black or white oak. Typically, fuels are in the form of a shallow (1-3 inches) and somewhat compact (deeper and less compact than Model 8) litter of conifer needles and/or hardwood leaves, twigs, and small branches under tree canopies. There are occasional concentrations of heavier fuels where trees have died and are in various stages of decomposition, where tops or limbs have broken and fallen, where there are concentrations of shrubs, and/or where there are groups of seedling, sapling, or pole-size trees. Fires tend to burn faster (7.5 chains/hour) in these fuels than in Model 8 fuels, with higher flame lengths (2.6 feet) and intensities. High winds can blow or roll burning hardwood leaves ahead of flame fronts, thereby increasing rates of spread above those predicted for this model. Flare ups and occasional torching of trees may occur in concentrations of fuel.

Fuel Model 9 has 8 levels of fuel hazard that are likely to result in different fire behaviors, depending upon the spatial arrangement and continuity of ladder fuels and tree or shrub crowns. These are 900 (0.14% of the watershed), 901 (0.78%), 902 (3.28%), 910 (0.04%), 911 (1.48%), 912 (6.76%), 921 (0.01%), and 922 (2.15%). In general, the 900, 901, and 910 models are unlikely to facilitate crown fires. Ladder fuels tend to be sparse and discontinuous and are not well developed and/or the canopy is relatively open. Fires are likely to remain on the ground, with occasional torching of individual or groups of trees. The 902, 911, 912, 921, and 922 models are more problematic. They have better developed and/or more continuous fuel ladders (mainly understory trees) and denser overstory canopies, which provide access paths for fire to enter the crowns of individual or groups of trees and for fire to travel between tree crowns. Fires have more avenues to travel into and between tree crowns, so torching of individual and groups of trees is more likely. But ground fuels are too light to sustain more than short runs of crown fire, so it is unlikely that large scale crown fires would develop, except under most unusual combinations of contributing factors.

Fuel Model 9
(long needle conifer/hardwood)

There are 13 combination fuel models, totaling 251 acres. Ten of these combinations (on 221 acres) are likely to facilitate runs of crown fire in the shrub and overstory tree layer as both the primary and secondary (2 & 5) fuels have moderate to widespread fuel ladders and generally moderately dense to dense canopies.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
901/201	70	30	5.14
901/501	60	40	13.26
910/610	50	50	11.59
911/211	50	50	13.51
911/511	60	40	6.75
911/511	70	30	31.99
912/212	80	20	7.22
912/512	50	50	38.46

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
912/512	60	40	18.55
912/512	70	30	30.47
912/522	50	50	43.11
922/522	50	50	19.96
922/522	70	30	11.41
		Total	251.42

Anderson Fuel Model 10 (18 acres, <1% of the watershed) is mostly found under the canopies of pole and small sawtimber-size, dense (60-100% crown closure) MHC and SMC forests, with minor amounts in MHW and DFR forests. It is found in widely scattered locations and outside the watershed boundary northeast of Hoadley Peaks and of Buckhorn Summit. Model 10 is found as a secondary fuel model on 13 acres in the very southwest corner of the watershed.

This model is most often associated with forest stands with larger components of Douglas-fir, ponderosa pine, and black oak. Typically, fuels are in the form of a moderately deep (3-4 inches) and somewhat compact litter of conifer needles and/or hardwood leaves, twigs, and small branches under tree canopies. There are more concentrations of heavier fuels than in Models 8 and 9, where there is logging slash, where trees have died and are in various stages of decomposition, where tops or limbs have broken and fallen, where there are concentrations of shrubs, and/or where there are groups of seedling, sapling, or pole-size trees. Fires tend to burn faster (7.9 chains/hour) in these fuels than in Model 8 and 9 fuels, with higher flame lengths (4.8 feet) and intensities. Spotting on logs and litter, flareups, crowning, and occasional torching of trees may occur in fuel concentrations.

Fuel Model 10
(mixed conifer/heavy litter)

Fuel Model 10 has 3 levels of fuel hazard, 1011 (0.01% of the watershed), 1012 (0.01%), and 1022 (0.05%). These all have better developed and/or more continuous fuel ladders (mainly understory trees) and denser overstory canopies, which provide access paths for fire to enter the crowns of individual or groups of trees and for fire to travel between tree crowns. Fires have more avenues to travel into and between tree crowns, so torching of individual and groups of trees is more likely. Ground fuels are heavier than in the other timber fuel models and in some areas could sustain crown fire.

The only combination fuel model is a 1012-50%/912-50% on a little over an acre. This combination is likely to facilitate torching of individual and groups of trees and runs of crown fire in the overstory tree layer as both the primary and secondary fuels have moderately widespread fuel ladders and generally dense canopies.

Anderson Fuel Model 11 (4 acres, <1% of the watershed) is found in a poorly stocked (25-39% crown closure), pole-size WFR forest in the very southwest corner of the watershed. It is found as a secondary fuel model on 77 acres of SMC and DFR in Upper Phillips Gulch and just south of Highway 299 to the northwest of the IOOF Camp.

This slash model (light logging slash) is associated with conifer forests with larger components of Douglas-fir, white fire, and ponderosa pine. Typically, fuels are in the form of moderately deep (1 foot), discontinuous twigs, branches, and tops, with a light litter of conifer needles and/or grass, forbs, and shrubs. There are occasional concentrations of heavier fuels where trees have died and are in various stages of decomposition, where tops or limbs have broken and fallen, where there are concentrations of shrubs, and/or where there are groups of seedling, sapling, or pole-size trees. Fires tend to burn through the slash and herbaceous fuels at 6.0 chains/hour and have lower flame lengths (3.5 feet) and intensities than Model 10 fires as fuels are more scattered. Flare ups and occasional torching of trees may occur in concentrations of fuel.

Fuel Model 11 has one level of fuel hazard, 1110. In general, this model is unlikely to facilitate crown fires as ladder fuels tend to be discontinuous and are not well developed and the canopy is relatively open. Fires are likely to remain on the ground, with occasional torching of individual or groups of trees.

Anderson Fuel Model 99 (823 acres, 4% of the watershed) is typically found in all vegetation types, but primarily (60+%) in sparser (10-39% crown closure), pole and small sawtimber-size stands of MHC, especially where there is a large component of canyon live oak. Lesser amounts (20%) are found in sparse, pole size MHW and SMC forests, in the BAR type (10%), and in the DFR, PPN, MCP, CPC, WFR, and WTM types. This model is concentrated in the area delineated by Buckhorn Summit on the northeast to Coggins Park on the southeast to Arts Peak on the southwest to Mikes Peak on the northwest. It is found as a secondary fuel model on 618 acres, primarily between Grass Valley Creek Reservoir and Buckhorn Station and the IOOF Camp and in scattered locations to the south of the reservoir.

This model is most often associated with southeast- to west-facing slopes and ridgetops, especially at higher elevations, and in granitic soils. This model describes areas of mostly bare soil, primarily granitic sand, between trees and shrubs. If present, fuels consist of moss, scattered annual grass or forbs, scattered leaves, and/or occasional shrubs, stunted trees, or fallen tree tops or limbs. Although fire might spot in localized fuels, fuels are so sparse overall that they could not carry a fire across the openings.

There are 15 combination fuel models totaling 2359 acres. None of these combinations are likely to facilitate runs of crown fire in the shrub or overstory tree layer found as the secondary (2, 5, 8, & 9) fuels as ladder fuels are sparse, canopies tend to be open, and litter layers are shallow.

Combination Fuel Models			
Fuel Model (combination)	Primary Fuel Model (%)	Secondary Fuel Model (%)	Acres
9900/200	60	40	118.78
9900/200	80	20	13.46
9900/500	60	40	599.86
9900/500	80	20	214.34
9900/501	60	40	6.48
9900/510	60	40	85.53
9900/510	80	20	12.37
9900/800	60	40	912.56
9900/800	70	30	10.66
9900/800	80	20	278.01
9900/810	60	40	38.91
9900/810	70	30	0.39
9900/900	60	40	45.62
9900/910	60	40	15.93
9900/910	70	30	5.66
		Total	2358.56

Fire Ecology of Significant Plants

In order to create, and/or maintain desired vegetation cover in the GVC watershed it is necessary to understand as much as possible about the individual plants and plant communities found there and the effects of management on those plants and communities. Fuel management treatments can take a variety of forms and influence plants in multiple ways. As one of the fuel treatments recommended in this plan is prescribed fire, it is useful to know the fire ecology of the primary species that will be affected. These species are Douglas-fir, white fir, ponderosa pine, sugar pine, gray pine, black oak, white oak, canyon live oak, greenleaf manzanita, whiteleaf manzanita, buckbrush, and deerbrush. A summary of some fire related characteristics of these species is included below. More complete information on fire ecology, fire effects, and fire management considerations is included in Appendix D. A comprehensive write up for each species, from which the material in Appendix D came, can be downloaded from the USFS Fire Effects Information System website (www.fs.fed.us/database/feis/welcome.htm).

Douglas-fir - Mature Douglas-firs are relatively resistant to damage from fires of all severity, with the exception of their foliage, which is highly flammable. This results in lower resistance in younger trees with thinner bark and crowns closer to the ground. Low- and moderate-severity fires that expose mineral soil without altering its chemical or physical properties and don't damage seeds in cones are likely to be followed by adequate regeneration. But a study of hand planting on granitic soils on the Klamath NF found that seedlings on unburned plots were 7 times more numerous than those on burned plots. And another study found that on dry sites, natural regeneration following broadcast burning is unpredictable and often poor, due to high soil temperatures and moisture stress. Seedling growth is sometimes lower where slash piles have been burned.

Ponderosa pine - Mature ponderosa pines are very resistant to damage from fires of all severity. Crown scorch is the greatest cause of damage. Younger trees with thinner bark and canopies closer to the ground are most susceptible. Low- and moderate-severity fires that expose mineral soil without altering its chemical or physical properties and don't damage seeds in cones are likely to be followed by good regeneration.

Sugar pine - Mature sugar pines are very resistant to damage from fires of all severity. As with ponderosa pine, crown scorch is the greatest cause of damage. Younger trees with thinner, bark and canopies closer to the ground are susceptible to damage from low- and moderate-severity fires. Low- and moderate-severity fires that expose mineral soil without altering its chemical or physical properties and don't damage seeds in cones are likely to be followed by good regeneration.

White fir - Mature white firs are moderately tolerant to damage from fires of all severity. Crown scorch, cambial heating of trunks, and heating of roots cause the greatest damage. Younger trees with thinner, resin blistered bark and drooping branches closer to the ground are highly susceptible to damage from low- and moderate-severity fires. Low- and moderate-severity fires that leave partial shade, expose mineral soil without altering its chemical or physical properties, and don't damage seeds in cones are likely to be followed by good regeneration. If no shade remains, regeneration is likely to be delayed. In mixed conifer forests seedlings are often abundant under montane chaparral shrubs that form brushfields after high severity crown fires.

Incense cedar - Mature incense cedars are resistant to damage from fires of all severity. Foliage killed by crown scorch will generally not be replaced. Younger trees with highly flammable bark and foliage are highly susceptible to damage from low- and moderate-severity. Low- and moderate-severity fires that leave partial shade, expose mineral soil without altering its chemical or physical properties, and don't damage seeds in cones are likely to be followed by good regeneration.

Gray pine - Mature gray pine are resistant to damage from fires of all severity due to thick bark and self-pruning of trunks. But wood, bark, cones, and needle sheaths are all highly flammable due to heavy resin output and foliage contains ether extracts. Younger trees are highly susceptible to damage from low- and moderate-severity fires. Low and moderate severity fires that expose mineral soil without altering its chemical or physical properties and don't damage seeds in cones are likely to be followed by good regeneration.

California black oak - Mature black oaks are subject to trunk and crown damage from fires of all severity. Younger trees are highly susceptible to damage from low and moderate severity fires. Low- and moderate-severity fires that don't kill root crowns, expose mineral soil without altering its chemical or physical properties, and don't damage acorns in the soil or on the trees are likely to be followed by good regeneration. Black oaks sprout vigorously from boles, root crowns, and roots.

Oregon white oak - Mature white oaks are rarely killed by low- and moderate-severity fires. Younger trees are highly susceptible to damage to trunks and crowns from low and moderate severity fires. Low- and moderate-severity fires that don't kill root crowns, expose mineral soil without altering its chemical or physical properties, and don't damage acorns in the soil or on the trees are likely to be followed by good regeneration. White oaks sprout vigorously from boles, root crowns, and roots.

Canyon live oak - The trunks of mature canyon live oaks, which are sensitive to heat damage and have relatively thin, highly flammable bark, are often damaged by even low-severity fires. Younger trees are highly susceptible to damage to trunks and crowns from low- and moderate-severity. Low and moderate severity fires that don't kill root crowns are likely to stimulate prolific sprouting from them. Repeated burning of live oak stands will create dense, shrubby growth.

Pacific madrone - The trunks of mature madrones, which are sensitive to heat damage and have relatively thin bark, are often damaged by even low-severity fires. Younger trees are highly susceptible to damage to trunks and crowns from low and moderate severity fires. Low- and moderate-severity fires that kill the tops of madrones are likely to stimulate vigorous sprouting from underground burls. These sprouts are likely to grow rapidly. Madrones also seed heavily, providing a good seed source for regeneration.

Oregon bigleaf maple - Bigleaf maples generally grow in moist areas where fires are infrequent and generally of low-severity. It is a species well adapted to fire. The trunks of mature bigleaf maples are readily killed by moderate- and high-intensity fires, which sometimes damage the root crowns. Younger trees are highly susceptible to damage to trunks and crowns from low and moderate severity fires. But low- and moderate-severity fires that kill the tops of madrones are likely to stimulate prolific sprouting from root crowns. These sprouts are likely to grow rapidly.

White alder - White alders generally grow in moist areas where fires are infrequent and generally of low-severity. Moderate- and high-intensity fires readily kill tops of young and mature alders. Alders are not vigorous sprouters and rarely regenerate from sprouts. But low- and moderate-severity fires that expose mineral soils, especially in the moist areas in which alders grow, will stimulate regeneration, provided a seed source is close enough.

Tanoak - Tanoak in this watershed grows in a shrub form. It is a fire sensitive species highly susceptible to top kill from even low-severity fires as it has thin bark that provides little insulation from radiant heat. Low and moderate severity fires that don't kill the underground burls are likely to stimulate moderately vigorous sprouting from them. Studies have shown that the sprouting potential of tanoak is strongly correlated to the size and vigor of the parent plant, which determines the size of the burl. As tanoaks age, burls generally increase in size and vigor, but resprouting potential develops slowly. Preharvest underburning will kill at least a portion of understory tanoak if conducted in late spring (June) under conditions that cause high duff consumption. On sites with 60-80 year conifer rotations, one well-timed, effective underburn can eliminate tanoak as a competitor to conifer regeneration for two rotations.

Greenleaf manzanita - Greenleaf manzanita is a fire sensitive species that, because of its habit of growing in dense stands, the persistence of its dead branches and stems, volatile oils and terpenes in its foliage, and its low moisture content during the summer, is highly susceptible to top kill from low- to moderate-severity fires and complete kill by severe fires. Root burls that survive fires generally sprout vigorously. Fire stimulates germination of seeds stored in the soil, which results in abundant regeneration. The density of seedlings appears to be positively related to the area and amount of surface fuels burned.

Fire Ecology of Selected Plants Found in the GVC Watershed

Species		Resistance to Damage by Fire: Young Tree/Shrubs Fire Severity*			Mature Trees Fire Severity			Seeds or Acorns Fire Severity		
		Low	High	Crown	Low	High	Crown	Low	High	Crown
Douglas-fir	foliage highly flammable	low	low	low	high	mod	low	mod on ground	low on ground	mod
gray pine	all parts highly flammable	low	low	low	mod	mod	mod	high	mod	mod
incense cedar	foliage highly flammable	low	low	low	high	mod	mod	high	mod	mod
ponderosa pine	fire resistant	mod	low	low	high	mod	> most	high	high	mod
sugar pine	fire resistant	low	low	low	high	mod	> most	high	high	mod
white fir	fire intolerant; easily killed	low	low	low	mod	low	low	high	low	low
black oak	easily killed; vigorous sprouter	low	low	low	mod	low	low	low	low	low
live oak	easily killed; vigorous sprouter	low	low	low	mod	low	low	low	low	low
bigleaf maple	easily killed; vigorous sprouter	low	low	low	mod	low	low	low		
white oak	easily killed; vigorous sprouter	low	low	low	high	mod	mod	high for buried acorns	mod	mod
madrone	easily killed; vigorous sprouter	low	low	low	low	low	low	high	mod	low
white alder	easily killed; poor sprouter	low	low	low	low	low	low	low	low	low
buckbrush	highly flammable; weak/no sprouter	low	low	low	low	low	low	high for buried seeds	high for buried seeds	high for buried seeds
CA hazel	easily killed but sprouts	low	low	low	low	low	low	low	low	low
deerbrush	vigorous sprouter after spring fire weak sprouter after summer fire weak/no sprouting when decadent	low	low	low	low	low	low	high for buried seeds low in heavy duff	high for buried seeds low in heavy duff	high for buried seeds low in heavy duff
Him blackberry	easily killed; vigorous sprouter	low	low	low	low	low	low	high for buried seeds	high for buried seeds	high for buried seeds
manzanita, greenleaf	flammable; vigorous sprouter	mod	low	low	low	low	low	high for buried seeds	high for buried seeds	high for buried seeds
manzanita, whiteleaf	flammable; weak/no sprouter	mod	low	low	low	low	low	high for buried seeds	high for buried seeds	high for buried seeds
poison oak	easily killed; vigorous sprouter	low	low	low	low	low	low	mod	low	low
snowberry	variable response to fire highly flammable if many dead stems	low	low	low	low	low	low	mod for buried seeds	low	low
tanoak	easily killed; vigorous sprouter	low	low	low	low/mod	low	low	low	low	low

* Low=low severity fire, High=moderate to high severity fire, Crown=crown fire

Fire Ecology of Selected Plants Found in the GVC Watershed (cont.)

Species	Regeneration Success After Rx Fire – Fire Severity: Low Severity		Moderate Severity		High Severity		Considerations for Rx Fire
	Mesic**	Xeric**	Mesic	Xeric	Mesic	Xeric	
Douglas-fir	favored	often poor	favored	often poor	often poor	poor	See 'Fire Management Implications' in Appendix D
gray pine	fair	worst	mod	mod	best	good	See 'Fire Management Implications' in Appendix D
incense cedar	best	good	good	good	mod	mod	Spring, low severity fire for thinning
ponderosa pine	good	good	good	good	best & >others	same	Fall, low severity fire causes the least damage; 20-25 yrs bet. or 2 low-mod severity fires >7 yrs. apart; reduces N
sugar pine	good	good	good	good	best & >others	same	
white fir	good	mod	mod	mod	poor	poor	Don't burn if desire retention of WF; see 'Fire Management Implications' in Appendix D
black oak	good	mod	good	mod	fair	worst	Late fall, low severity fires cause the least damage + consume the most fuel; 4 yrs. between burns
live oak	good	good	good	good	fair	worst	Winter, low severity fires cause the least damage
bigleaf maple	some seeding	poor	some seeding	poor	some seeding	poor	
white oak	mod	mod	better	better	best	good	Late fall, low severity fires to maintain WO
madrone	good	mod	best	good	poor	worst	Don't burn if desire conifer regen & heavy PM is in stand
white alder	poor	poor	mod	poor	good	poor	
buckbrush	good	good	good	good	good	good	Fall burn if want to maintain brush; burn at 20-25 yr intervals to maintain vigor; burn 5-10 acs at a time to enhance regen; frequent burns will eliminate
CA hazel	good	mod	good	mod	good	mod	Burn in spring if want to maintain; frequent (<4 yrs) or severe burns will eliminate
deerbrush	good	good	good	good	good	good	Frequent burns will eliminate Early-late fall burns (flame lngth 12-22")(duff: 9-63% moisture, 70-94% consumption)=abundant regen Early-late spring burns (flame length 20-38")(duff: 18-120% moisture, 83-92% consumption)=no regen
Him blackberry	good	good	good	good	good	good	Regen from underground & seeds in soil
manzanita, greenleaf	good	good	good	good	good	good	More duff consumed=more regen; early spring burns before active gwth=increased foliage palatability; greatest mortality when fuel drier + active aboveground growth; understory burn kills or reduces vigor of shrubs & seeds & depletes seeds in soil
manzanita, whiteleaf	good	good	good	good	good	fair	Parameters for safe late winter/early spring burns: High intensity burn: humidity 26%, temp. 84, wind 10 mph, fuel stick moisture 5% Low intensity burn: humidity 58%, temp. 40, wind 0 mph, fuel stick moisture 15%
poison oak	good	good	good	good	fair	fair	Regen from root crown & rhizomes & some from seeds
snowberry	good	good	good	good	fair	fair	One of 1st recolonizers; burn 4 dys after heavy rain; spring burn min. temp 55, max. humidity 55%, wind speed 2-12 mph
tanoak	good	mod	good	mod	fair	worst	Preharvest burn in late spring (June for high duff consumption & mortality) if manage for conifers & heavy TO stocking in stand

** Mesic=sites with moderate moisture, Xeric=sites with little moisture

Whiteleaf manzanita - Whiteleaf manzanita is a fire sensitive species that, because of its habit of growing in dense stands, the persistence of its dead branches and stems, volatile oils and terpenes in its foliage, and its low moisture content during the summer, is highly susceptible to top kill from low- to moderate-severity fires and complete kill by severe fires. Regeneration following fire is from seeds in the soil that are stimulated to germinate by the heat. Repeated fires before the shrubs have developed to sexual maturity and produced another seedbank will eliminate this species from the ecosystem.

Deerbrush - Deerbrush is a fire sensitive species that is usually killed by fire. It can sprout from live root crowns, but sprouting is usually weak and often nonexistent. Heat stimulates germination of seeds stored in the soil and regeneration is often profuse. Seeds in the soil can retain their viability for many years and surface fires where there are no deerbrush evident can stimulate regeneration of a dense carpet of seedlings. Repeated fires at short intervals (<4 years), before shrubs have developed to sexual maturity and produced another seedbank, will eliminate this species from the ecosystem.

Buckbrush - Buckbrush is a fire sensitive species that is highly flammable even in winter and is usually killed by fire. Heat stimulates germination of seeds stored in the soil and regeneration is often profuse. Seeds in the soil can retain their viability for many years. Repeated fires before shrubs have matured enough to produce another seedbank will eliminate this species from the ecosystem.

California hazel - Hazel is easily killed by even spring fires. If root crowns are not killed by fire they sprout profusely and vigorously. Repeated spring fires when the soil is moist increase sprouts, but repeated summer fires can expose and kill the roots, exhausting stored food.

Snowberry - Snowberry is top killed by fire, but underground rhizomes generally survive even severe fires. Regeneration is primarily from these rhizomes and snowberry is one of the first plants to recolonize after a fire. Low- and moderate-severity fires may spare seeds in the soil, which can also help regenerate this species. Snowberry is highly flammable if there are many dead stems, can produce firebrands, and has the potential for spot fires to start.

Poison oak - Poison oak is easily top killed by fire, with all but low-intensity fires killing rhizomes on the soil surface and moderate- to severe-severity fires killing shallowly buried rhizomes. Poison oak sprouts vigorously from these rhizomes and root crowns following a fire. It is one of the first plants to recolonize after a fire. Some regeneration is from seed, but success is spotty.

Himalayan blackberry - Himalayan blackberries are easily top killed by fire, but it is uncommon for plants to be killed. Following a fire blackberries regenerate vigorously from roots, rhizomes, and rootstocks. Seed buried in the soil, which is viable for many years and is protected from fire, rapidly recolonizes a burned area. Fire appears to actually rejuvenate blackberry patches, to the benefit of wildlife that utilize the fruit, foliage, and cover.

CHAPTER 6. RECOMMENDED WILDLAND DEFENSE PROJECTS

This fire management plan is a product of the goals and objectives of the community in general. This chapter recommends specific treatments, with general project descriptions and map (‘Fire Presuppression Projects), which are consistent with community goals, but no site-specific projects will occur that do not meet an individual landowner’s personal goals. The recommended projects are representative of the types of fuel treatments that would be beneficial for reducing the adverse effects of wildfire in the GVC watershed, but are not inclusive of all such projects in all locations. This document can be used as a source of information for designing other projects.

Land and resource managers have begun incorporating both ecological and economic principles when developing management practices for integrated fire protection strategies. Probably the greatest single advancement in ecosystem management is the recognition of the need to plan projects on a landscape, or ecosystem level. Managing vegetation over a landscape that includes residential areas, industrial and non-industrial forest lands, and public lands can help maintain long-term soil productivity, provide for vegetation and wildlife diversity, maintain aesthetics, and reduce fire, disease and insect risks while providing greater fire safety.

Bureau of Land Management, CDF, USFS, and private resource managers recognize that the expansion of homes into the 'wildland-urban interface' has created a potential for devastating loss of lives, dwellings, and forest resources. Foresters, ecologists, wildlife biologists and fire managers are developing new strategies to allow safer coexistence of people and wild lands. Prescriptions for maintaining healthy, fire resistant forest conditions often call for reduced tree and shrub densities and use of low intensity prescribed fire. Forests with modified fuels will appear more open and park-like than the often crowded forests that presently exist. Less dense forests will often produce more forage for deer and other wildlife and increase the prey base for many predators. These practices will also reduce the intensity of wildfires that often have deleterious effects on soil.

Wildfire presuppression projects involving manipulations of vegetation need to consider possible adverse effects on the protective soil cover (especially on granitic soils), wildlife habitat, water quality, and viewsheds. Most land managers, Grass Valley Creek residents, and members of the public will support some timber harvesting and fuel modification projects when these activities will:

- improve forest health, reduce the potential for stand replacing wildfires, and provide safe travel for residents and fire fighters
- protect and/or enhance soil stability
- maintain and/or enhance water quality
- maintain and/or enhance critical or limited wildlife habitat.
- protect forest views through design of fuel breaks, hazard reduction projects, and other fire defense preparations to high aesthetic standards.

Relevant Factors Affecting Wildland Defense Projects

The Grass Valley Creek watershed is a complex ecosystem in multiple ownerships with multiple goals. Developing a single fire management prescription is not appropriate for such a watershed. Ideally, fire preplanning should be done on a site-specific basis. To aid in this process it is worthwhile to summarize the factors identified during research for this plan that will likely affect the development of useful prescriptions. These are categorized as natural and human, with a brief description of the characteristics of each factor that influences planning.

BLM Lands

Natural

Soils – Most of the area is on highly erosive, droughty, and/or low fertility granitic soils. Due to erosion sensitivity and difficulty in reestablishing vegetation, these conditions increase operational difficulties in pre-suppression and suppression activities and in post fire revegetation and rehabilitation projects.

Soil protective cover – Duff and litter layers tend to be thin (<1” deep), especially on granitic soils. There are many patches or areas of soil that are bare or mostly bare of any cover. These factors increase the erosion susceptibility of soil and subsequent revegetation problems.

Slope steepness – About 50% of the area is on slopes greater than 40%. Experience has shown that as slope gradients increase, fire severity and suppression difficulty tend to increase. Erosion hazards increase directly with slope, as do operational difficulties.

Slope aspect – There are many south- and west-facing slopes on the BLM portion of the watershed. Experience has shown that these slopes are hotter and drier than north and east slopes, experience the greatest fire severity, and are the most difficult to revegetate. These slopes tend to be more sparsely vegetated and thus have a greater hazard of erosion and more existing erosion.

Vegetation types – There is a mosaic of vegetation types, with few types occupying extensive areas. This tends to increase operational difficulties in vegetation management treatments while at the same time enhancing opportunities to tie prefire treatments into control points. It also tends to enhance fire suppression efforts by providing multiple control points.

There is an abundance of hardwood, mixed hardwood-conifer, and chaparral vegetation types. These types tend to have lower commercial values, with less conifer volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest.

There are dense and abundant brushfields, primarily of tanoak and/or manzanita. These brushfields are concentrated at higher elevations in the south and southeastern portion of the watershed. Because brushfields have more fuel close to the ground and tend to be relatively continuous, they have a high fuel hazard and will tend to burn more intensely.

The conifer, hardwood, and mixed hardwood-conifer forest is relatively young in age, with most trees in the range of sapling to small sawlog size. These stands tend to have lower commercial values, with less volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest. They also tend to be more susceptible to damage from fire as there are more fire ladders, crowns are closer to the ground, and bark is thinner.

Fuel types – There is a mosaic of fuel types, ranging from non-flammable to highly flammable. This mosaic increases the opportunities for and effectiveness of prefire vegetation treatments and enhances fire control opportunities.

Fire weather – Weather during fire season can be severe, with any combination of high temperatures, low humidity, long rainless periods, and high winds. The weather is one of the factors that gives this area a “Very High” fire hazard severity rating.

Fire risk - Summer lightning storms occur regularly, though some years have more activity than others do. Dry lightning storms have occurred in the area. Downstrikes increase fire risk, especially on exposed ridges, of which there are many on the BLM lands.

Human

Road system - The area under BLM management, which is primarily in granitic soils, has a sparse road system. There is access along the eastern and southern boundaries of the watershed, from Shingle Shanty to the GVC reservoir and south to the southwest corner of the watershed, and along Phillips Gulch and the watershed boundary to the north. Lack of access limits vegetation management, fuels modification, and fire suppression options.

Major roads – There are several heavily-traveled, paved roads (Hwy 299, Trinity Dam Blvd., Lewiston Rd., Poker Bar Rd.) and two less traveled roads (Hoadley Peaks and County Line Rds.) in proximity to dense forest and other vegetation where treatments are advisable. This creates operational difficulties for helicopter and cable yarding systems used in removing logs. It increases risks of fire starts and of smoke hazards to traffic during prescribed burning. Visual sensitivity to fuel treatments is also greater.

Log landings - There are few and scattered log landings. This creates operational difficulties for traditional treatments requiring handling and removal of logs. Landings along Highway 299 have been used in the past.

Powerlines - There are several powerlines located near dense forest, main roads, and/or residential areas where fuel treatments that include logging would be advisable. This creates operational difficulties for helicopter and cable yarding systems used in removing logs.

Property ownership – BLM administers most of the eastern two-thirds of the GVC watershed, but there are multiple ownerships, with varying objectives, scattered throughout these lands. This may result in obstacles to landscape level, pre-fire and fire restoration projects and/or to fire suppression efforts.

Scattered residential areas increase fire risk and hazard and sensitivity to adjacent fuel management activities.

Values at risk – The values at risk are high, which contributes to the “Very High” fire hazard severity rating. These values are soil stability, fertility, and productivity, water quality, plant and animal diversity, wildlife habitat, recreational opportunities, aesthetics, forest health, forest products, roads, powerlines, and the South Hoadley Peak relay station.

Fire risk – The risk of fire starts is high along well-traveled roads, such as Highway 299, County Line Road, Hoadley Peaks Road, Trinity Dam Boulevard, and Lewiston Road. There are also risks of escapement associated with prescribed fire.

Regulatory constraints - Reducing sediment into the Trinity River is the main BLM management objective. As a result, timber harvesting has been constrained until 2007, except for fuel management, fire hazard reduction, hazard tree removal, insect damage control, or wildlife habitat management. Sensitivity to erosion will limit the type, extent, and/or timing of fuel modification prescriptions. Presuppression projects need to ameliorate adverse effects on the protective soil cover, wildlife habitat, and viewsheds. Riparian areas are required to be protected with wide buffers. In areas of decomposed granite, vehicles are limited to designated roads and trails and prohibited during the rainy season, which may limit wet season management activities. BLM is also limited on use of dozers for fire suppression to existing roads, trails, and fuelbreaks, which limits fire suppression options. To preserve the “natural” character of the area and the visual quality for recreationists, management activities need to be visually subordinate to the natural landscape and “changes in any of the basic elements caused by a management activity should not be evident in the characteristic landscape”. In this watershed, with so much vegetative and landscape diversity, this should not overly constrain management.

Air quality – The GVC watershed is in the North Coast Air Basin, while the valley areas to the east are in the Sacramento Valley Air Basin. Trinity County and the GVC watershed have a high air quality whereas Redding is the 21^{st} worst city in the nation for air quality. Smoke can create severe visibility problems along travel corridors as well as health problems in developed areas. Global warming is aggravated by atmospheric carbon dioxide, one of the by-products of burning. Smoke management requirements will restrict the location, timing, and amount of prescribed fire used as a management tool.

Industrial Forest Lands

Natural

Soils – There are large areas of ultramafic soils on SPI lands and relatively small areas of granitic soils. The other industrial ownerships are either all or mostly on granitic soils. The difficulties with granitic soils are as described in the BLM section. Ultramafic soils tend to have a chemical imbalance that makes them toxic to many plants and sometimes difficult to regenerate after vegetation is removed. These soils also have severe erosion hazards and are susceptible to mass movement, requiring operational sensitivity.

Soil protective cover – Duff and litter layers tend to be thin (<1” deep), especially on granitic soils. There are many patches or areas of soil that are bare or mostly bare of any cover. These factors increase the erosion susceptibility of soil and subsequent revegetation problems.

Slope steepness – About 30% of the area is on slopes greater than 40%. Experience has shown that as slopes increase, fire severity and suppression difficulty tend to increase. Erosion hazards increase directly with slope, as do operational difficulties.

Slope aspect – There are some southeast- to west-facing slopes on SPI lands (and Roseburg and Trans-Wood), with difficulties as described under BLM. But the general aspect of most SPI lands (and Crane Mills) is northerly to easterly. These slopes tend to be cooler and moister, with lower fire severities and more success in revegetation (for exceptions, see Soils).

Vegetation types – There is a mosaic of vegetation types, but primarily DFR, with SMC at higher elevations and scattered MHC and MHW. There are opportunities to tie prefire treatments into vegetation types that will act as control points. These control points may also aid in fire suppression.

There is an abundance of hardwood, mixed hardwood-conifer, and chaparral vegetation types in some areas. These types tend to have lower commercial values, with less conifer volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest.

There are a few dense and abundant brushfields, primarily of manzanita and/or buckbrush. These brushfields are concentrated on southeast- to west-facing slopes in the northwestern portion of the watershed. Because they have abundant fuel close to the ground and tend to be relatively continuous, they have a high fuel hazard and will tend to burn intensely.

The conifer, hardwood, and mixed hardwood-conifer forest is relatively young in age, with most trees in the range of sapling to small sawlog size. These stands tend to have lower commercial values, with less volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest. They also tend to be more susceptible to damage from fire as there are more fire ladders, crowns are closer to the ground, and bark is thinner.

Fuel types – There is a mosaic of fuel types, ranging from non-flammable to highly flammable. This mosaic increases the opportunities for and effectiveness of prefire vegetation treatments and enhances fire control opportunities.

Fire weather – Weather during fire season can be severe, with any combination of high temperatures, low humidity, long rainless periods, and high winds. The weather is one of the factors that gives this area a “Very High” fire hazard severity rating.

Fire risk - Summer lightning storms occur regularly, though some years have more activity than others do. Dry lightning storms have occurred in the area. Downstrikes increase fire risk, especially on exposed ridges, of which there are many on industrial lands.

Human

Road system - The area under SPI management, which is primarily in ultramafic or other soils, has an adequate road system. There is access to SPI lands in the northwestern portion of the watershed from Highway 299, Trinity Dam Blvd., and Indian Creek Road. Access is no limitation to vegetation management, fuel modification, and fire suppression options. Access to most of Trans-Wood lands is also adequate, with a road connecting to Highway 299. Access to Roseburg and Crane Mills lands is presently non-existent.

Major roads – Highway 299 is in proximity to dense forest and other vegetation where treatments are advisable along about two miles of SPI lands and one-half mile of Trans-Wood lands. This creates operational difficulties for helicopter and cable yarding systems used in removing logs in this area. It increases risks of fire starts and of smoke hazards during prescribed burning. Visual sensitivity to fuel treatments is also greater.

Log landings – There are abundant log landings scattered throughout SPI lands. These facilitate operations requiring handling and removal of logs.

Powerlines - Powerlines are found on only one corner of one section of SPI lands. These lines have only minimal effect on helicopter and cable yarding operations as they are in an area of mostly low site, noncommercial vegetation.

Property ownership – SPI owns most of the northwest one-third of the GVC watershed, with the other industrial ownerships southeast and east of it. There are multiple ownerships, with varying objectives, adjacent to these lands. This may result in obstacles to landscape level, pre-fire and fire restoration projects and/or to fire suppression efforts. There are a few residential areas adjacent to SPI and Trans-Wood lands, which increases fire risk and hazard and sensitivity to adjacent fuel management activities.

Values at risk – The values at risk are high, which contributes to the “Very High” fire hazard severity rating. These values are soil stability, fertility, and productivity, water quality, critical wildlife habitat, forest health and productivity, and roads.

Fire risk – The risk of fire starts is high along well-traveled roads, such as Highway 299, County Line Road, Hoadley Peaks Road, Trinity Dam Boulevard, and Lewiston Road. There are also risks of escapement associated with prescribed fire.

Regulatory constraints – Non-commercial operations on private lands, such as creation of fuelbreaks (when there is no commercial component), are not regulated. When commercial forest products are removed, the California Forest Practice Rules (FPRs) regulate their removal. Protections are required for soil (to prevent erosion), watercourses (to prevent sedimentation), habitat for Federal and State listed threatened and endangered species and species of concern (to prevent extirpation), and cultural resources (to prevent damage). A cumulative impacts assessment must be prepared for the affected watershed(s), minimum stocking standards must be met following logging, and standards for roads, tractor roads, landings, and all aspects of logging must be met. Winter operation plans are required for logging between November 15th to April 1st. Hazard reduction (slash treatment) following logging is required along public roads and private roads open to public access and within 200 feet of residences. Before burning slash, CDF must be notified.

Air quality – The GVC watershed is in the North Coast Air Basin, while the valley areas to the east are in the Sacramento Valley Air Basin. Trinity County and the GVC watershed have a high air quality whereas Redding is the 21st worst city in the nation for air quality. Smoke can create severe visibility problems along travel corridors as well as health problems in developed areas. Global warming is aggravated by atmospheric carbon dioxide, one of the by-products of burning. Smoke management requirements may restrict the location, timing, and amount of prescribed fire used as a management tool.

Rural Residential Lands

Natural

Soils – More than half of the residential parcels are on granitic soils and about one-quarter are on ultramafic soils. The difficulties with these soils are as described in the BLM and SPI sections above.

Soil protective cover – Duff and litter layers tend to be thin (<1” deep), especially on granitic soils. There are many patches or areas of soil that are bare or mostly bare of any cover. These factors increase the erosion susceptibility of soil and subsequent revegetation problems.

Slope steepness – Most of the residential structures are on or near the bottoms of drainages on slopes of less than 40%. These are the areas that can be expected to have lower fire severity and less suppression difficulty. Erosion hazards should be less and there should be fewer operational difficulties.

Slope aspect – There are some residential structures and parcels on southeast- to west-facing slopes, with difficulties as described under BLM. But most residential structures are on flats or north to east facing slopes

Vegetation types – There is a mosaic of vegetation types, with few types occupying extensive areas. On a parcel level this probably won’t increase operational difficulties in vegetation management treatments. It will enhance opportunities to tie prefire treatments into control points and tend to enhance fire suppression opportunities by increasing control points.

There is an abundance of hardwood, mixed hardwood-conifer, chaparral, and grass vegetation types in some areas. These types tend to have lower (or no) commercial values, with less conifer volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest.

There are some dense brushfields, primarily of manzanita and/or buckbrush. These brushfields are concentrated on southeast- to west-facing slopes in the northwestern portion of the watershed.

Because they have abundant fuel close to the ground and tend to be relatively continuous, they have a high fuel hazard and will tend to burn intensely.

The conifer, hardwood, and mixed hardwood-conifer forest is relatively young in age, with most trees in the range of sapling to small sawlog size. These stands tend to have lower commercial values, with less volume/acre, which tends to increase operating costs for vegetation management prescriptions that include commercial harvest. They also tend to be more susceptible to damage from fire as there are more fire ladders, crowns are closer to the ground, and bark is thinner.

Fuel types – There is a mosaic of fuel types, ranging from non-flammable to highly flammable. This mosaic increases the opportunities for and effectiveness of prefire vegetation treatments and enhances fire control opportunities.

Fire weather – Weather during fire season can be severe, with any combination of high temperatures, low humidity, long rainless periods, and high winds. The weather is one of the factors that gives this area a "Very High" fire hazard severity rating.

Fire risk - Summer lightning storms occur regularly, though some years have more activity than others do. Dry lightning storms have occurred in the area. Downstrikes increase fire risk, especially on exposed ridges. Few such ridges occur on residential lands, but there are many in the vicinity.

Human

Road system - A road from Highway 299, Trinity Dam Blvd., or Lewiston Road accesses every residential area. Some of these roads are single lane, bordered by sections of dense vegetation. Access is no limitation to vegetation management or fuel modification, but will sometimes limit fire suppression options.

Major roads – There are several heavily-traveled, paved roads (Hwy 299, Trinity Dam Blvd., Lewiston Rd., Poker Bar Rd.) in proximity to residential areas and in some places, dense forest and other vegetation. This creates operational difficulties for helicopter and cable yarding systems used in removing logs. It increases risks of fire starts and of smoke hazards to traffic during prescribed burning. Visual sensitivity to fuel treatments is also greater.

Log landings – There are few log landings in residential areas. This creates operational difficulties for traditional treatments requiring handling and removal of logs.

Powerlines - Powerlines are found on or adjacent to many residential parcels. These lines create operational difficulties for helicopter and cable yarding systems used in removing logs and for suppression activities.

Property ownership – The majority of residential property is within one mile of Highway 299. Most of the residential property is either bordered by or surrounded by BLM and/or SPI lands. Although these large landholders have different objectives than the residential owners, they share in common the desire to prevent catastrophic fires. Good communication will be required for cooperation on landscape level, presuppression projects.

Values at risk – The values at risk are high, which contributes to the "Very High" fire hazard severity rating. These values are homes and outbuildings, personal property, gardens, ornamental trees and shrubs, roads and fences, forest health, soil stability, fertility, and productivity, wildlife habitat, water quality, and aesthetics.

Fire risk – The risk of fire starts is high along well-traveled roads, such as Highway 299, County Line Road, Trinity Dam Boulevard, and Lewiston Road. There are also risks of escapement associated with prescribed fire.

Regulatory constraints – Non-commercial operations on private lands, such as creation of fuelbreaks (when there is no commercial component), are not regulated. When commercial forest products are removed, the California Forest Practice Rules (FPRs) regulate their removal. Protections are required for soil (to prevent erosion), watercourses (to prevent sedimentation), habitat for Federal and State listed threatened and endangered species and species of concern (to prevent extirpation), and cultural resources (to prevent damage). A cumulative impacts assessment must be prepared for the affected watershed(s), minimum stocking standards must be met following logging, and standards for roads, tractor roads, landings, and all aspects of logging must be met. Winter operation plans are required for logging between November 15th to April 1st. Hazard reduction (slash treatment) following logging is required along public roads and private roads open to public access and within 200 feet of residences. Before burning slash, CDF must be notified.

Air quality – The GVC watershed is in the North Coast Air Basin, while the valley areas to the east are in the Sacramento Valley Air Basin. Trinity County and the GVC watershed have a high air quality whereas Redding is the 21st worst city in the nation for air quality. Smoke can create severe visibility problems along travel corridors as well as health problems in developed areas. Global warming is aggravated by atmospheric carbon dioxide, one of the by-products of burning. Smoke management requirements may restrict the location, timing, and amount of prescribed fire used as a management tool.

Watershed-Wide Projects

Watershed-wide projects are those that benefit not only individual landowners, but area residents and even people living well away from the project area. Watershed-wide projects are an opportunity to bring together resource agencies, industrial and non-industrial forestland managers, and area residents for a common purpose. Benefits include reduced fire danger leading to potentially lower suppression costs with less resource loss, improved wildlife habitat, improved community coordination, and public education on the benefits of fire planning. For example, construction of fuelbreaks can result in substantial savings in the event of a fire. The homes that survived the Lowden and Oregon Fires generally had some form of fuelbreak around them. Non-monetary losses in wildland fires include temporary and permanent changes in wildlife habitat, water quality, growing site productivity, view, and recreational opportunities.

Project 1 - Watershed-Wide Ridgetop Shaded Fuelbreaks

A series of shaded fuelbreaks on main ridgetops are recommended to provide control lines for fire suppression, anchor points for suppression backfires and presuppression controlled burns for fuel reduction, and travel routes for firefighters and equipment.

Fuelbreak specifications will vary depending upon landowner objectives, vegetative cover, location, topography, accessibility, soil conditions, and available manpower and funds. Fuelbreaks should be wide enough to stop a crown fire and allow it to drop to the ground, where control efforts would be more effective.

Once watershed-wide fuelbreaks are established, it is expected that periodic prescribed burning, mowing, grazing, or clearing and chipping of underbrush in the fuelbreaks would be quick and inexpensive methods to maintain them. Burning could be done using crews from the BLM, CDF, USFS, Trinity River Conservation Camp, Trinity County Resource Conservation District, Watershed Research and Training Center, and/or contract crews. Fuelbreaks are recommended in the following locations (see 'Fire Presuppression Projects' map):

Public Lands (from north to south)

Watershed Boundary Shaded Fuelbreak

a) The first leg of the proposed shaded fuelbreak on BLM lands runs along the north watershed boundary through the corner of BLM land in the SE ¼, SE ¼, Section 26, T33N, R9W and along the ridge into Sections 30, 29, 28, & 27, T33N, R8W, ending at North Hoadley Peak. A portion of this proposed fuelbreak, in Sections 30, 29, & 28, was completed before the Lowden Fire and further work was done on it during the fire. Portions in those sections need widening and the portion in Section 27 needs more extensive work.

b) The next leg runs along the east watershed boundary. A 100-foot wide fuelbreak has been completed from North Hoadley Peak south through BLM and SPI lands to the private property just north of

Buckhorn Summit. This fuelbreak needs to be widened (see specifications below) to at least the road (where the road is outside the fuelbreak). Existing slash piles on BLM lands need to be burned.


East GVC watershed boundary shaded fuelbreak (lower right to upper middle on 2000 aerial photo) and the same fuelbreak (with unburned piles) and Hoadley Peaks Road (2002 photo).

South of Buckhorn Summit the watershed boundary runs through BLM lands in Sections 13 & 24, T32N, R8W, Section 31, T32N, R7W, and Section 6, T31N, R7W, where it turns west at Shoemaker Bally. In the south one-half of Section 24 the Whiskeytown NRA conducted a prescribed burn in 1997 that burned up to the ridge on the east side. A fuelbreak is proposed for the west side of the ridge and for the rest of the watershed boundary.

Whiskeytown NRA prescribed fire (1997) in the Crystal Creek watershed. The ridge is the watershed boundary between Grass Valley Creek and Crystal Creek.

Starting at the intersection of the road and watershed boundary 3/8-mile northeast of Shoemaker Bally is an existing fuelbreak that runs north for ½-mile along the watershed boundary and then turns northeast and runs for ½-mile along the boundary between Crystal Creek and the North Fork of Cottonwood Creek. The history and purpose of this narrow fuelbreak is unknown. It runs through brushfields and may have been designed as a control line for broadcast burning of the brushfields to the south.

c) The next leg, that runs west from Shoemaker Bally, crosses just the corner of BLM lands in Section 6, T 31N, R7W.

d) The final leg runs northwest from the southwest corner of the watershed to the confluence of Grass Valley Creek and the Trinity River. It runs through BLM lands in Sections 35, 26, 27, 28, & 20, T32N, R8W, in Section 2, T32N, R8W, and in Sections 34 & 27, T33N, R9W.

Internal Shaded Fuelbreaks

a) A proposed shaded fuelbreak runs along the south watershed boundary of Upper Phillips Gulch from Trinity Dam Boulevard through BLM, through State of California land in the S ½, N ½ Section 32, T32N, R8W, to the north Little GVC watershed boundary. No fuelbreak presently exists in this location.

b) A proposed shaded fuelbreak runs from South Hoadley Peak southwest along a ridge to Highway 299 about ¾ mile southeast of Buckhorn Station. No fuelbreak presently exists in this location.

c) A proposed shaded fuelbreak runs from the IOOF camp to the watershed boundary between GVC and Walts Creek and ties in with a fuelbreak that runs from Highway 299 just west of Walts Creek, along the watershed boundary between Walts Creek and GVC, tying in with a fuelbreak along the north watershed boundary of Walts Creek.

d) A proposed shaded fuelbreak runs from Highway 299 just east of Walts Creek, along the east watershed boundary of Walts Creek to the headwaters, along the watershed boundary between GVC and Little GVC to Mainline Road, and down a ridge to the GVC Reservoir.

e) A proposed shaded fuelbreak runs from Highway 299 just northwest of Shingle Shanty up a ridge to the watershed boundary between GVC and Little GVC.

f) A proposed shaded fuelbreak runs from the end of the 18/19 Road northeast along a ridge to the south watershed boundary of Walts Creek.

g) A proposed shaded fuelbreak runs from the end of the 18/19 Road southwest along a ridge to Joes Peak on the west watershed boundary.

h) A proposed shaded fuelbreak runs from the 18/19 Road, about ¼ mile west of the gate, northeast along a ridge to the watershed boundary between GVC and Little GVC.

i) A proposed shaded fuelbreak runs southwest from the GVC Reservoir up a ridge and a road to the watershed boundary between GVC and Corral Creek.

j) A proposed shaded fuelbreak runs northeast up a ridge from Mainline Road on GVC in the NW ¼, NW ¼ Section 26, T32N, R8W, across Green Gate Road, to the switchback in the N ¼ Section 24, and up a ridge to the east watershed boundary in the SE ¼, NE ¼ Section 24, T32N, R8W.

k) A proposed shaded fuelbreak runs southwest up a ridge crisscrossed by Mainline Road, from GVC in the SE ¼, NE ¼ Section 26, T32N, R8W to the watershed boundary between GVC and Corral Creek just south of the junction of Mainline and Corral Creek Roads.

External Shaded Fuelbreak

a) A proposed shaded fuelbreak runs through BLM lands along the west watershed boundary of Tom Lang Gulch from just south of Highway 299, through residential land in the SW ¼, SE ¼ Section 27, T33N, R9W, to the Trinity River.

Industrial Forest Lands

Watershed Boundary Shaded Fuelbreak

a) The first leg of the proposed shaded fuelbreak runs along the north watershed boundary through SPI lands in Section 25, T33N, R9W. A portion of this section was burned in the Lowden Fire and subsequently salvage logged and replanted to conifers.

b) The next leg runs along the east watershed boundary through SPI lands in section 2, T32N, R8W. A 100-foot wide fuelbreak has been completed through this section, but should be widened (see specifications below). A quarter mile north and south of Buckhorn Summit the watershed boundary runs through Trans-Wood Company and other private lands. No fuelbreak exists on these lands.

c) The next leg that runs west from Shoemaker Bally crosses Crane Mills lands in Section 6, T 31N, R7W and in Section 2, T 31N, R8W, and SPI lands in Section 1, T 31N, R8W.

d) The final leg runs northwest from the southwest corner of the watershed to the confluence of Grass Valley Creek and the Trinity River. It crosses Crane Mills lands in the NW ¼ Section 28, T32N, R8W in the vicinity of Arts Peak and SPI lands in Sections 29, 20, 17, 18, & 7, T32N, R8W and Sections 12, 11, 2, & 3, T32N, R9W.

Internal Shaded Fuelbreaks

a) A shaded fuelbreak from Highway 299 from ½ mile west of Fawn Lodge south along a ridge to the N ¼ Section 12, T32N, R9W. No fuelbreak presently exists in this location but this area was logged within the past few decades.

b) A fuelbreak from Highway 299 from 1 mile east of Fawn Lodge southwest along a ridge to the NE ¼ Section 12, T32N, R9W. No fuelbreak presently exists in this location but this area was logged within the past few decades.

Rural Residential & Non-industrial Forest Lands (from north to south)

Watershed Boundary Shaded Fuelbreak

a) The first leg of the proposed shaded fuelbreak runs along the north watershed boundary from the confluence of Grass Valley Creek and the Trinity River south to the junction of Lewiston Road and the road to the Hamilton ponds, south along Lewiston Road to Coffin Road, southeast up the ridge through the corner of BLM land in the SE ¼, SE ¼, Section 26, T33N, R9W to the south boundary of the SPI property in Section 25. The next section runs along the ridge through the NE ¼, SE ¼, Section 30, T33N, R8W east of Trinity Dam Boulevard.

b) The next leg runs along the east watershed boundary. There is non-industrial forestland just north and south of Buckhorn Summit. In the SW ¼, SW ¼ of Section 19 and in Section 30, T32N, R7W, non-industrial forestland is on the west side of the ridge and Whiskeytown NRA lands are on the east side. Prescribed burns have been conducted on most of the NRA lands between 1994 and 1997, but there are sections where more fuel reduction would be beneficial. The private lands have been logged and in some areas have dense forest and brush. It is advisable to establish a wide fuelbreak in this area to protect Coggins Park and the upper Crystal Creek watershed.

c) The next leg that runs west from Shoemaker Bally crosses private non-industrial forestlands in Section 2, T 31N, R8W that have been logged within the past decade.

d) The final leg runs northwest from the southwest corner of the watershed to the confluence of Grass Valley Creek and the Trinity River. It runs through non-industrial forestlands in Section 2, T31N, R8W that were logged within the last decade. It crosses more private forest lands at the headwaters of Joseph and Mule Gulches in the NW ¼ Section 20, T32N, R8W and in the SE ¼, SE ¼ Section 34, T33N, R9W south of Highway 299. It runs through residential property north of Old Highway Road and west of Lewiston Road in the E ¼ Section 27, T33N, R9W. Treatment of this last section is described in 'Project 12, Residential Area Watershed Boundary Shaded Fuelbreak' in the 'Residential Projects' section below.

Internal Shaded Fuelbreak

g) A proposed shaded fuelbreak runs from the end of the 18/19 Road southwest along a ridge through BLM lands, private non-industrial forest lands, and again through BLM lands to Joes Peak on the west watershed boundary.

Many of these proposed fuelbreaks have existing access points that facilitate logging, hauling, precommercial thinning, and slash disposal. But many of them on granitic soils are no longer accessible by road, so treatments will be more difficult and costly. In many of the proposed locations for fuelbreaks, especially on granitic soils, vegetation is already sparse, so little work would need to be done, other than removing fuel ladders and relatively minor thinning and pruning.

Watershed-Wide Shaded Fuelbreak Specifications (Public, Non-Industrial Forest, Rural Residential)

Objectives and guidelines for the fuelbreaks are as follow:

a) Fuelbreaks should be located to take advantage of existing fire barriers, such as roads, Grass Valley Creek Reservoir, natural openings, areas of exposed soil, and meadows. Where needed, timber stand improvements, timber harvests, slash disposal, mowing, and/or prescribed fire should be used to reduce the fuel hazard on lands bordering the fuelbreaks. On granitic soils, the cautions in the 'Soils' and 'Forestry' sections should be adhered to, especially on southeast to west aspects.

b) Ideally, fuelbreaks should be easily accessible by fire crews and equipment at many points.

c) Fuelbreaks should be designed so that they incorporate and imitate the forms of natural openings in the forest.

d) Portions of fuelbreaks visible from residential areas, Highway 299, Trinity Dam Boulevard, Lewiston Road, Old Highway Road, Poker Bar Road, Hoadley Peaks Road, County Line Road, and the Dam Access Road should be visibly pleasing.

e) Fuelbreak corridors should be at least 200 feet wide and ideally centered within a 1320-foot wide area where some level of fuel modification is done.

f) Ground cover (duff, needles and low forbs) should be retained to keep soil erosion to a minimum, especially on granitic soils and on southeast to west aspects. (see 'Soils' section)

g) Low growing vegetation (shrubs and suppressed trees) that act as fuel ladders should be thinned and removed under tree canopies, but more shrub canopy cover should be retained on southeast to west slopes to protect soil from erosion. (see 'Soils' section)

h) Emphasize retention of tree species that are adapted to fire and beneficial to wildlife. Favor Douglas-fir, ponderosa pine, and sugar pine. These conifer species, when mature, have thick bark and can survive low to moderate intensity fires.

California black oak, Oregon white oak, canyon live oak, and Pacific madrone are more resistant to crown fire then conifers. Although relatively low intensity surface fires can kill these hardwoods, they will resprout. Oaks and madrones also provide acorns or berries as well as habitat for a variety of wildlife.

i) Thin trees to encourage open stands. Spacing between residual trees depends on a number of factors, including the size and species of trees, the amount, size, and species of understory vegetation retained, soil type, steepness of slope, position of the fuelbreak in relation to the topography, aspect, and the characteristics of the adjacent forest and landscape. (see 'Forestry' section)

For maximum protection from crown fires, the crowns of mature conifers (single trees or clusters of several trees) should be 20 feet apart, with an average canopy closure of from 30-50%. Where slash and low growing fuels are minimal in and adjacent to the fuelbreak, a spacing of 10-15 feet is adequate and will increase shading, thereby reducing the regrowth of low growing vegetation. In this case, an average canopy closure of from 50-70% should be adequate The higher canopy closure is recommended on granitic soils and southeast to west aspects to provide adequate litter for soil protection.

Intermediate trees should be thinned so that crowns are about 6 feet apart. The spacing between crowns will not be uniform. Many spaces will be larger but few should be smaller than the recommended distances. Favor retaining Douglas-fir, ponderosa pine, sugar pine, oaks, and madrone. Always favor trees, regardless of species, with full, healthy crowns on at least 40% of the bole.

j) Prune residual trees up at least 10 feet, provided that full, healthy crowns are left on at least 40% of the bole. Where vegetation is retained under the canopy of a tree, prune up three times the height of the vegetation. Disposal of limbs will depend upon site conditions. Where there is much exposed soil, especially granitic soil, place limbs in a fashion to protect the soil surface. Where litter or vegetation is abundant, scatter limbs in sparser areas, pile and burn in openings, and/or leave for wildlife cover.

k) Retain a minimum of 2 snags (>20 inches dbh and 20 feet tall) per acre if no safety or fire control conflict exists. But snags on ridges are not recommended due to their tendency to catch fire and spread embers over long distances.

l) Retain a minimum of 5-6 logs (greater than 10 inches in diameter and 10 feet long) per acre, except in fire safety areas (see GVC WA). Logs should be scattered, not concentrated together, and be pulled away from the base of trees.

m) Provide islands of preferred plant species (up to 30% by area) within fuelbreak areas for browsing wildlife. Trees within these islands should be pruned at least three times the height of the browse species that are left.

n) Rather than convert hardwoods to conifers, retain hardwood stands, as they tend to be resistant to crown fires and rapid spread of ground fires, are beneficial for many species of wildlife, and help protect soil from erosion.

o) Fuelbreaks should be designed to allow for the use of prescribed fire, mowing, and/or chipping in order to provide long-term maintenance of the area. Seedlings and brush will rapidly appear in an open forest stand and must be removed periodically. Prescribed fire, mowing, and or/chipping on flatter slopes are perhaps the best ways to control excess reproduction while maintaining ecosystem conditions promoting healthy, large trees and a sustainable open forest stand.

Project 2 - Roadside Shaded Fuelbreaks

State Highway 299 is a heavily traveled highway, especially during the fire season, that traverses the mid to lower watershed. Poker Bar Road, Lewiston Road, and Trinity Dam Boulevard are also heavily traveled County roads at all times of year. Old Highway Road, Hoadley Peaks Road, and County Line Road are less well traveled roads, as are gated and ungated roads on public and private lands. A fire along any of these roads could temporarily block access by fire engines as well as egress into or from the area by residents and tourists.

Roads, in addition to providing travel routes, can act as firebreaks for many types of fire and provide control points for fire suppression. But roads are also a common area for fire ignitions. Fuel modification alongside roads can reduce the availability of fuels for such ignitions as well as the rate of spread and fire intensity once fuels are ignited. This increases the time before fires build up enough energy to become difficult to control and thus increases the effective response time for fire control resources to arrive and control fires. Shaded fuelbreaks are recommended along the following roads (see 'Fire Presuppression Projects' map):

- A shaded fuelbreak has been created along the north side of Highway 299 on BLM lands (see 'Fire Presuppression Projects' map). Fuelbreaks have not been created on private lands and none have been created on public lands on the south side of the highway as that closely borders Little GVC, which acts somewhat as a barrier to fire spread. There are many locations where little to no work needs to be done due to large road cuts and fills and/or lack of flammable vegetation. It is recommended that the fuelbreak on public lands be extended to include all public and private lands from the Crystal Creek Road turnoff to Douglas City. Consider doing some fuel reduction in the outer riparian zones of Little GVC and GVC where it is unlikely that soil disturbance will aggravate erosion. Continue to widen the fuelbreak on the north side of the highway as funds are available.

Highway 299 shaded fuelbreak

- Poker Bar Road is a heavily traveled access road to a large subdivision along Trinity River. Although it is outside the watershed boundary, it is ½-mile west of the residential subdivision near the mouth of GVC, is bordered by heavy concentrations of highly flammable fuels, and is the only paved access road to the subdivision.
- Old Highway Road is a lightly traveled road that connects Poker Bar Road and Lewiston Road and is an alternate route should Highway 299 be closed across Tom Lang Gulch. It is bordered by heavy concentrations of highly flammable fuels.
- Lewiston Road is a heavily traveled access road to the large subdivision near the mouth of GVC and to Lewiston. It is bordered along many sections by heavy concentrations of highly flammable fuels.

- Trinity Dam Boulevard is a heavily traveled access road to Lewiston and Trinity and Lewiston Lakes. It is bordered along some sections by heavy concentrations of highly flammable fuels, but there are many sections where little to no work needs to be done due to large road cuts, fills, and turnouts and/or a lack of flammable vegetation.

Fuels along Old Highway Road.

- Lower Phillips Gulch Road is a gated road that is lightly used by SPI and BLM resource managers. This is a low priority road for fuel treatment as it borders Phillips Gulch, has relatively light fuels (some heavier), is lightly used, and is only used by people highly aware of fire potential.
- Upper Phillips Gulch Road is a gated road that is lightly used by SPI and BLM resource managers. This is a low priority road for fuel treatment as it borders Phillips Gulch, has relatively light fuels, is lightly used, and is only used by people highly aware of fire potential.
- One-quarter mile up Upper Phillips Gulch Road is a road that continues up a draw to a landing. This road is rarely used by BLM resource managers. This is a very low priority road for fuel treatment as it borders a wet draw, has relatively light fuels due to the Lowden Fire, and is only used by people highly aware of fire potential.
- Dam Access Road is a gated road that is lightly used, primarily by BOR, BLM, and TCRCD resource managers, to access GVC Reservoir and beyond. This is a high priority road for fuel treatment as it is bordered along many sections by relatively dense fuels and is in a strategic location to halt fire spread from Highway 299 into the upper watershed. In many sections it has high, steeply sloped cut banks that are slumping and eroding in spots and are on south aspects. It is not advisable to remove vegetation on or close to the tops of these cut banks as it is likely that erosion will be accelerated. Residual canopy closure on south facing slopes should be at least 70%.

Hoadley Peaks Road fuelbreak needs widening and more thinning in spots.

- The 18/19 Road is a gated road that is lightly used by BLM and TCRCD resource managers. This is a low priority road for fuel treatment as it borders GVC, has relatively light fuels (heavier in some sections), is lightly used, and is only used by people highly aware of fire potential. In many sections it has high, steeply sloped cut banks that are slumping and eroding in spots and are on south aspects. It is not advisable to remove vegetation on or close to the tops of these cut banks as it is likely that erosion will be accelerated.
- Mainline Road is a gated road that is lightly used, primarily by BOR, BLM, and TCRCD resource managers, to access the inlet of GVC Reservoir, Corral Creek Road, and the southwest portion of the watershed. This is a medium to high priority road for fuel treatment as it is bordered along some sections by GVC and relatively dense fuels, accesses locations on GVC suitable for filling fire engines, and is the only road in this portion of the watershed. In many sections, especially after crossing GVC, it has high, steeply sloped cut banks that are slumping and eroding in spots. It is not advisable to remove vegetation on or close to the tops of these cut banks as it is likely that erosion will be accelerated. Before it crosses GVC and after it crosses the watershed boundary it is on south and west aspects that tend to have sparse vegetative cover. The cautions on vegetation removal on these aspects apply.
- The unnamed road that accesses the inlet of GVC Reservoir from Mainline Road is lightly used, primarily by BLM and DFG resource managers. This is a low priority road for fuel treatment, although fire engines may be able to fill at the reservoir. Relatively dense brush and small trees border portions of this road.
- Corral Creek Road is lightly used by BLM and TCRCD resource managers. This is a very low priority road for fuel treatment as it borders Corral Creek on the south for much of its length, has relatively light fuels on the north side (heavier in the first ½ mile), is a dead-end road, and is only used by people highly aware of fire potential. The cautions on vegetation removal on cut banks and on south aspects apply.

- County Line Road is a public road moderately used by resource managers, private landowners, hunters, and recreationists to access the south and east portions of the watershed. This is a high priority road for fuel treatment as it is bordered along some sections by dense fuels and is the main access road to this portion of the watershed. Although cut banks tend to be short it is not advisable to remove vegetation on or close to the tops of them as it is likely that erosion will be accelerated. Sections with the densest vegetation are from Buckhorn Summit to the watershed boundary and from Shasta Bally Road to the southwest corner of the watershed.
- Green Gate Road is a gated BLM road very lightly used by BLM and TCRCD resource managers, and private landowners at the south end. This is a low priority road for fuel treatment as it is a midslope road that offers little strategic value for fire suppression and is gated on private property on the south end. But it is an access road for a proposed ridgetop fuelbreak, is bordered along many sections by dense fuels, and is the only road between the east watershed boundary and Mainline Road on GVC. Although cut banks on this road tend to be short, it is not advisable to remove vegetation on or close to the tops of them as it is likely that erosion will be accelerated. Cautions on vegetation removal on south and west aspects, of which there are many along this road, apply.
- The unnamed spur road running south from the switchback just south of the Green Gate Road on County Line Road in Sec 24, T32N, R8W has a good road base but needs brushing. It is a single-lane dirt road about 1/3-mile long. It is a BLM road very lightly used by BLM and TCRCD resource managers. This is a very low priority road for fuel treatment as it is a midslope road that offers little strategic value for fire suppression. But it is an access road below a proposed ridgetop fuelbreak, is bordered along many sections by dense fuels, and it accesses young conifer stands that will soon be ready for commercial thinning and are in a highly flammable condition. Although cut banks on this road are short, it is not advisable to remove vegetation on or close to the tops of them as it is likely that erosion will be accelerated. This road is located on south and west aspects, so cautions on vegetation removal apply.
- The unnamed, gated spur road running north from County Line Road just before the watershed boundary in the NE ¼, NE ¼ Sec 24, T32N, R8W is a single-lane dirt road that accesses private property through BLM lands. It is a BLM road very lightly used by BLM, TCRCD, and private resource managers. This is a low to mid priority road for fuel treatment. It is an access road below and to a proposed ridgetop fuelbreak, is bordered along many sections by dense fuels, can be used as a control point for prescribed burning, and accesses a few young conifer stands that will soon be ready for commercial thinning and are in a highly flammable condition. Although cut banks on this road are short, it is not advisable to remove vegetation on or close to the tops of them as it is likely that erosion will be accelerated. This road is located on south and west aspects, so cautions on vegetation removal apply.
- Hoadley Peaks Road is a public road moderately used by BLM and SPI resource managers, maintenance personnel for the communications relay station on South Hoadley Peak, private landowners, hunters, and recreationists. A 100-foot wide shaded fuelbreak has been created along the ridge paralleling Hoadley Peaks Road on public and SPI lands. Although much of the road is within, or partly within, the ridgetop fuelbreak it is a high priority road for fuel treatment as it is bordered along some sections by dense fuels and is the main access road to the relay station and the northeast portion of the watershed. Where the road is outside this fuelbreak, a shaded fuelbreak should be created on either side of the road. Although cut banks tend to be short it is not advisable to remove vegetation on or close to the tops of them as it is likely that erosion will be accelerated.

Ideally, fuelbreaks should be wide enough to slow fire rate of spread sufficiently to allow fire control resources time to arrive on scene before fires reach denser fuels. For more remote areas this is unlikely. Fuelbreak specifications will vary depending upon landowner objectives, vegetative cover, location, topography, accessibility, soil conditions, and available manpower and funds. See the ‘Watershed-wide Shaded Fuelbreak Specifications’ above for applicable fuelbreak construction specifications.

2.1 Remove trees and brush - Trees along road edges that constrict views, prevent two vehicles from safely passing each other, or act as fire ladders should be removed. Brush and small trees should be removed within 50 feet of the edge of county and ungated public roads and within 10-20 feet of the edge of other roads. See the 'Soils' and 'Forestry' sections for limitations on vegetation removal on granitic soils and south and west aspects. Minimum tree removal should include those marked by a forester or fire professional. Each landowner or right-of-way owner should determine additional tree removal. In some cases commercial tree removal may be done under a THP fuel hazard exemption on private lands.

This and the following work could be done using crews from the BLM, CDF, Crystal Creek or Trinity River Conservation Camps, Trinity County Resource Conservation District, Watershed Research and Training Center, and/or contract crews.

2.2 Prune trees - Dominant and co-dominant trees should be pruned up to 16 feet above the ground, but always leaving at least 40% of the bole in live crown. As canyon live oak limbs tend to droop near to the ground, it is better to prune the ends of the branches up high enough so that surface fires are unable to ignite the foliage. If possible, provide at least 200 feet of sight distance along county and ungated public roads. In places with limited turnouts, longer sight distances are necessary to assure fire vehicle traffic safety and to minimize delays.

2.3 Dispose of vegetation – Vegetation removed from the fuelbreaks should be chipped for biomass or the chips scattered over the ground, piled and burned, removed from the site, or otherwise treated so as to eliminate it as a fuel source.

2.4 Maintain fuelbreaks – As roadsides are well lit, vegetation will likely reoccupy fuelbreaks relatively quickly, requiring periodic maintenance. Prescribed burning, mowing, and/or grazing of young underbrush in the fuelbreaks would be quick and relatively inexpensive methods to maintain them.

2.5 Provide gate access – In the event of a fire, locked gates may hamper access. Emergency response agencies need to obtain keys and combinations to these locks or have their own locks added to the gates.

Project 3 – Timber Sales for Fuel Reduction

Timber sales are recommended in overstocked stands of small to medium-sized sawtimber to 1) increase the growing space for and growth rates of individual residual trees so they will more quickly attain a size that is more fire resistant and 2) prepare the stands for understory thinning and/or prescribed fire to reduce surface and ladder fuels. It is recognized that timber harvesting, even if done by helicopter, will likely cause limited short-term soil erosion. But by creating more fire safe stand conditions and healthier, more fire resistant trees it is expected that devastating crown and high intensity fires will be prevented. Without doubt such fires would cause much more erosion, over a longer time frame, than harvesting.

Most stands that are suitable for this treatment are in the DFR4M&D and SMC4M&D types on northwest to northeast aspects, have existing fuels representative of fuel models 8 or 9, have light surface fuels but moderate to extensive fuel ladders, and have moderately dense to dense canopies. There are also suitable stands in the MHC4M&D type. Priority harvest units are near residential areas (especially to the west of them), around the communications relay station on South Hoadley Peak, within areas bordered by shaded fuelbreaks, around the Grass Valley Creek reservoir, and adjacent to road corridors, especially along Highway 299, Poker Bar Road, Old Highway Road, Lewiston Road, Trinity Dam Boulevard, Hoadley Peaks Road, and County Line Road (see 'Fire Presuppression Projects' map). The fuelbreak along Highway 299 on public lands does not extend to the south side of the highway so fuel treatments, including harvesting, south of Little GVC take on more importance.

The silvicultural options for these sales would be commercial thinning from below, sanitation/salvage, individual tree selection, group selection, and shelterwood with reserves. The harvesting methods would be by helicopter and/or cable yarding, using existing roads and landings. Whole tree yarding is recommended to reduce logging slash, unless it is needed to cover areas of bare soil or add large woody debris.

If whole tree yarding is not done, treatment of logging slash is critical as it can fuel moderate to high intensity fires and crown fires. Most forest stands currently have relatively light surface fuels, including forest litter. In many situations adequate slash treatment may be obtained by lopping and scattering tops and limbs away from tree trunks. If there are bare areas, cable corridors, or skid roads, slash could be scattered over these areas to increase protective cover. Alternatively, slash could be chipped where there is access, piled and burned, burned where there are concentrations, or broadcast burned. In all cases residual trees should be protected from trunk and foliage scorch by piling in openings and pulling fuels away from tree trunks. Broadcast burning should be avoided on granitic soils, as should any slash treatment that removes more than 30% of the litter and duff layers.

Timber sale design and execution should at all times minimize soil disturbance and prevent sedimentation into watercourses, especially in decomposed granitic soils (see ‘Soils’ and ‘Forestry’ sections).

Project 4 – Understory Thinning for Fuel Reduction

Thinning and/or removal of understory sapling and pole-size trees is recommended in forests with excessive stocking or ladder fuels and/or where prescribed fire will be applied under small to medium-size trees to reduce surface and ladder fuels. Whether thinned trees will have market value depends in part upon tree species, size, density, and quality, stand size and location, and markets. Where there is adequate value, thinnings should be utilized for whatever product is most economically feasible. In such cases, harvesting and resource protections should follow the guidelines for timber sales (see ‘Forestry’ section).


Ladder Fuels on Hoadley Peaks Rd

Where there is inadequate value, thinnings can be treated in a variety of ways, 1) by piling and burning, either before or during broadcast understory burning, 2) by piling in openings and leaving unburned for wildlife habitat, 3) by scattering away from the trunks of residual trees (or leaving in place) before broadcast understory burning, 4) by placing over bare soil areas, and/or 5) by lopping and scattering without burning.

Priority understory thinning units are in areas with dense fuel ladders or pole size stands, near residential areas, within areas bordered by shaded fuelbreaks, around the Grass Valley Creek reservoir, and adjacent to road corridors, especially along Highway 299, Poker Bar Road, Old Highway Road, Lewiston Road, Trinity Dam Boulevard, Hoadley Peaks Road, and County Line Road (see ‘Fire Presuppression Projects’ map). Understory thinning project design and execution will at all times minimize soil disturbance and prevent sedimentation into watercourses, especially in decomposed granitic soils (see ‘Soils’ and ‘Forestry’ sections).

Project 5 – South Hoadley Peak Timber Sale for Fuel Reduction

On the southeast to west sides of the communication relay station on top of South Hoadley Peak is a MHC stand of small sawtimber that has moderate density fuel ladders that tend to be clumpy and are generally not close to the facility. The surface fuel model is a combination of 2 and 8, with light surface fuels broken up by bare patches.


South Hoadley Peak propane tanks for the communications facility.

On the northeast to north sides is a dense, pole-size DFR stand that has moderate density fuel ladders and light model 9 surface fuels that are continuous. This stand closely borders the facility and is within twenty feet of a bank of large propane tanks that fuel the facility.

Just north of this stand is a dense, small to medium sawtimber-size DFR stand with continuous model 10 surface fuels. To the northeast and west is a dense, small to medium sawtimber-size SMC stand with continuous model 8 surface fuels. Both of these stands have moderate density ladder fuels and a component of white fir.

The facility is currently vulnerable to damage from crown fires coming from the west to northeast. It is recommended that a combination of commercial thinning, individual tree selection harvesting, and understory thinning of ladder fuels be done to open the canopy and lower the chance of crown fires reaching the facility. Leave trees should primarily be dominant and codominant ponderosa and sugar pine, Douglas-fir, and black oak, with occasional white fir. It might be best to open the stand in two stages to allow residual trees to develop greater wind firmness. An area of denser canopy could be left near the facility to act as a windbreak, provided the canopy is opened enough downslope to stop a crown fire. Canopy density could also be feathered into adjacent stands, especially to the southwest to northwest, to reduce the chance of windthrow. Timber sale design and execution should at all times minimize soil disturbance and prevent sedimentation into watercourses, especially in decomposed granitic soils (see 'Soils' and 'Forestry' sections).

South Hoadley Peak communications relay facility.

Logging could be done by tractor or cable as the access road circles the peak. Yarding of tops is recommended to reduce logging slash, unless slash is needed to cover areas of bare soil or add large woody debris. If whole tree yarding is not done, treatment of logging slash is critical as it can fuel moderate to high intensity fires and crown fires. Except for scattered fuel concentrations, these stands currently have relatively light surface fuels. In many situations, adequate slash treatment may be obtained by lopping and scattering tops and limbs away from tree trunks. If there are bare areas, cable corridors, or skid roads slash could be scattered over these areas to increase protective cover. Alternatively, slash could be chipped where there is access, piled and burned, burned where there are concentrations, or broadcast burned. In all cases, residual trees should be protected from trunk and foliage scorch by piling in openings and pulling fuels away from tree trunks. Broadcast burning should be avoided on these granitic soils, as should any slash treatment that removes more than 30% of the litter and duff layers.

Project 6 – Prescribed Fire for Fuel Reduction

Prescribed fire is one recommended method to reduce logging and thinning slash and/or naturally occurring fine fuels that could increase fire intensity and rate of spread. Prescribed fire typically takes the form of 1) burning individual piles of slash, 2) burning non-piled concentrations of slash, 3) broadcast burning slash and litter, or 4) broadcast burning brushfields. It is used to burn slash created by human activity, naturally occurring forest litter, and brushfields. Fuels to be burned can be burned as they are, manipulated prior to burning and/or be burned at different times of the year to achieve different levels of fuel consumption.

In general, it is recommended that late fall, 'cool' prescription fires be done on a 10 to 20 year cycle and after thinnings or timber harvests. 'Cool' fires are desirable to prevent complete burning of duff and litter, but on granitic soils even this type of burn can cause loss of protective duff and litter and subsequent soil erosion (see 'Soils' & 'Forestry' sections). Broadcast burning on granitic soils should be limited to northwest to east aspects, less than 40% slopes, non-riparian areas, and probably just to burning of fuel concentrations or patches or strips. If it is likely that burning will expose extensive areas of soil that will be exposed to winter rainfall, it is probably better to treat slash in some other manner.

Thinning or removal of understory sapling to pole-sized trees is recommended where prescribed fire will be applied. Priority burning units correspond to priority harvest and thinning units, in areas with dense fuel ladders, near residential areas, adjacent to road corridors, and within areas bordered by shaded fuelbreaks, especially along Highway 299, Poker Bar Road, Old Highway Road, Lewiston Road, Trinity Dam Boulevard, Hoadley Peaks Road, and County Line Road. (see 'Fire Presuppression Projects' map) Understory thinning project design and execution should at all times minimize soil disturbance and prevent sedimentation into watercourses, especially in decomposed granitic soils (see 'Soils' & 'Forestry' sections).

Project 7 – Prescribed Fire for Fuel Reduction and Acceleration of Forest Succession

There are some relatively dense concentrations of brush at higher elevations, particularly south of Highway 299 on granitic soils (see ‘Primary’ & ‘Secondary WHR Habitat’ maps). These brushfields are generally composed of either pure tanoak or manzanita or a variable mix of these two species. Shrubs are of variable height, but generally less than four to five feet tall. Most brushfields appear to be fairly old (most are evident in 1957 aerial photos, had young trees in them that are still there, and were estimated to be 90 years old in the GVC WA), but do not have an abundance of dead limbs as would be expected in decadent stands.

Successional brushfields northwest of Buckhorn Bally.

Most of these brushfields had larger trees in them before logging began in the late ‘40s. Many of them now have variable densities of conifers, primarily sapling and pole-sized white fir, Douglas-fir, and sugar pine, growing through and above the brush canopy. If the classical successional process continues uninterrupted by wildfire, logging, insect or disease outbreak, or other calamity, the emerging forest will eventually shade out these brushfields. This process is evident in a number of forest stands near the watershed boundary along County Line Road. While this process is occurring, there will remain a high fuel hazard in these areas.

Depending upon the objectives for these brushfields, there are various alternative treatments that could be applied. If the desired future condition is to return them to a forested condition, which is recommended, then wherever tree regeneration is found it should be protected from fire. Tree growth should be enhanced by manipulating or removing brush in its vicinity and by thinning dense pockets of trees. Brush patches between pockets of trees should be treated to reduce fuel loads and flammability, but not to eliminate brush, which is protecting the soil from erosion. Several prescriptions, or combinations of same, as follow, could reasonably be expected to lower fuel hazards, enhance tree growth while protecting the trees from wildfires, protect the soil from erosion, and improve forage and travel corridors for browsers.

1) Create firebreaks, mechanically or by hand, around pockets of regeneration and larger individual trees. Connect these firebreaks to enclose brush patches. Leave a 20 foot untreated buffer above road cutbanks, on fill slopes, and along draws to catch potential sediment, protect the soil from surface erosion, and provide root anchoring. Broadcast burn the brush patches in the early spring. This would create a mosaic of relatively clear areas between pockets of trees. Brush would be consumed to different degrees and would eventually reoccupy the areas, at which time it could be treated in a similar manner. Areas where brush was treated could be planted with appropriate tree species and/or seeded with native grasses and forbs. If a serious commitment was made to reestablishing trees, a VH mulcher could be used to prepare planting spots that are free from roots of competing shrubs.

2) Where slopes permit (<40%), create firebreaks with a tracked vehicle equipped with a brushcutter or hydroaxe (Brontosaurus, ASV Posi-Track, or equivalent). Leave a 20-foot untreated buffer above the cutbanks of roads, on fill slopes, and along draws to catch potential sediment and provide root anchoring of the soil. Either broadcast burn treated areas in the early spring to reduce fuel loads or leave masticated brush in place to act as mulch. Areas where brush was treated could be planted with appropriate tree species and/or seeded with native grasses and forbs.

This treatment would create a mosaic of relatively clear areas between pockets of trees. The response of both manzanita and tankoak to burning would depend upon its timing and intensity. If done before active aboveground growth and when fuels are moister, there should be vigorous sprouting of foliage that is more palatable to browsers. If done after aboveground growth has started and when fuels are drier, there would likely be greater mortality but also more germination of seeds. The response of tanoak would depend upon the intensity of burn, which would likely be greater, with greater mortality of brush and acorns, as the season progressed and fuels dried.

If no burning is done, there would be considerably more dead fuel on the ground than before mastication, but it would tend to be compact so would be less of a fuel hazard than standing brush. Manzanita seeds would not be stimulated to germinate so there would be little regeneration from that source. Both manzanita and tanoak would sprout vigorously. If the areas were planted with conifers and seeded to grass and forbs, a mix of these and brush sprouts would eventually occupy the treated areas. These areas could be treated in a similar manner at a future time, but would probably have more trees in them at that time.

Project 8 – Sign Roads to Facilitate Fire Suppression Access

The ability to drive quickly to a fire without getting lost can mean the difference between saving or losing homes, lives, or forest resources. While local fire personnel may know access routes (but sometimes not), out of area firefighters often do not. Adequate signing of access roads and current maps that include road names are critical to suppression efforts and firefighter safety. This fire plan has a map with the current names of all the major roads, but some of these roads are not signed at either the point of origin or at critical junctions. Some short roads to individual houses or to residential areas that are signed [see 'Transportation System (Fire Access)', pp. 11-18] are not included on this map due to space limitations. It is suggested that these be added to maps used by local fire stations. At a minimum, signs should be placed at the following locations:

1) Road to Hamilton Ponds
2) Junction of Lewiston Turnpike and Trinity Dam Boulevard
3) Junction of Lewiston Turnpike and Hoadley Peaks Road
4) Both ends of Lower Phillips Gulch Road
5) West end of Upper Phillips Gulch Road
6) Junction of Highway 299 and Dam Access Road
7) Junction of Dam Access Road and Mainline Road
8) Junction of Dam Access Road and 18/19 Road
9) Junction of Mainline Road and Corral Creek Road
10) Junction of Mainline Road and SPI road at gate in the SW ¼, SW ¼, Section 35, T32N, R8W
11) Junction of Highway 299 and County Line Road
12) Both junctions of County Line Road and Green Gate Road
13) Junction of County Line Road and Crystal Creek Road
14) Junction of County Line Road and Shasta Bally Road
15) Junction of County Line Road and SPI/private road in SW ¼, NE ¼, Section 2, T31N, R8W
16) Junction of County Line Road and Indian Creek Road

Project 9 – Provide Access to and Protection for Water Sources

The ability to refill fire engines and water tenders quickly and efficiently can mean the difference between losing or saving homes, lives, or forest resources. Roads that are adequate for fire engines and water trucks to access pools in creeks, ponds, or other water sources may need to be constructed, reconstructed, or maintained. Water sources need to be protected from drying up or filling in with sediment. Signing of water sources is critical to aid in their location by firefighters.

9.1 **Provide a map and list of water sources to fire fighting agencies -** Maps and lists of the types, capacities, refill rates, and locations of water sources, including ponds, watercourses, tanks, hydrant locations, pumps, and power supplies, would be helpful should fire engines need to refill their tanks. A copy of these maps and lists should be provided to the Lewiston VFD, the CDF fire station at Fawn Lodge, Weaverville, and Shasta, the USFS fire stations at Mule Creek, Junction City, and Hayfork, the Whiskeytown NRA fire station, and to one or more permanent residents in each community who are actively involved in community fire protection.

9.2 **Assess the suitability of the lower Hamilton Pond as a helicopter fill -** A preattack assessment of the lower Hamilton Pond as a water source suitable for helicopter fills should be made by a person qualified to assess for safety hazards to helicopters (see pg 10).

9.3 **Sign readily accessible water sources (ponds, watercourses, pools, fire hydrants, water tanks) -** A simple sign can be posted on roads and driveways indicating that a water source, including type and capacity, is available for emergency fire fighting and refilling of engines. Signs should be metal, painted with reflective paint, and be clearly visible from the road. Sign the tanker fills at the junction of County Line Road and Grass Valley Creek in Section 31, T32N, R7W, at the Mainline Road crossing of GVC in the SW ¼, NE ¼, Section 26, T32N, R8W, at the GVC Reservoir, south of the 18/19 Road in the SE ¼, SW ¼, Section 16, T32N, R8W, and at Hamilton Ponds.

9.4 Repair the water tank and inlets at the County Line Road crossing of GVC in Section 31, T32N, R7W – The concrete tank at this location needs minor repair on the inside and under one corner of the foundation. The two inlet lines need to be repositioned in the creek. Minor work could be done on the short access road to the tank outlet.

9.5 Protect the water pump house and electrical supply at the IOOF camp from potential damage by fire – The water pump that supplies water for domestic and fire fighting use is housed in a wooden pump house with a metal roof and supplied with electricity through above ground lines. These should be protected by clearing flammable vegetation in proximity to them and siding the pump house with a suitable fire retarding material as appropriate.

9.6 Protect the water supplies at individual homes and in residential areas – Any exposed water pipes, pumps, powerlines, or propane tanks should be protected by clearing flammable vegetation in proximity to them and burying them and/or covering them with reflective metal or other suitable fire retarding cover as appropriate.

Project 10 – Improve and Sign Safety Areas

There is limited road access within the GVC watershed, with many dead end roads. Topography is steep and dissected, making foot travel difficult and increasing the likelihood of firefighters getting lost. Situations could arise during fire suppression efforts where escape routes for firefighters were blocked. For these reasons, potential safety areas have been identified and shown on the 'Fire Control Access and Infrastructure' map.

These areas were identified based on their proximity to large bodies of water and the sparseness of flammable fuels in their vicinity. Helicopter pads shown on the map are other areas that would provide a measure of safety in the event of a fire blowup. It should be stressed that these areas are for firefighters who are equipped for fire emergencies. Residents in the watershed should exit the area via Highway 299 or one of the county roads. The safety areas should be improved so as to meet the following conditions:

10.1 Maintain safety areas shown on map – The spoil area to the northeast of the Hamilton Ponds near the mouth of GVC, the meadow to the east, and the ponds themselves are safety areas. The GVC Reservoir is a mid-watershed safety area. These safety areas should be checked annually to insure they meet the following conditions:

a) Have a way for vehicles to enter and exit the areas

b) Within 100 feet of the safety areas have all snags, dead top trees, and trees with heart rot or heavy mistletoe that could fall into the safety areas removed (ex. a 40 foot snag within 40 feet of a safety area would be removed, but retained if it occurred 60 feet from the safety area perimeter.

10.2 Sign safety areas with 'Safety Area' signs - Signs provide fire fighters unfamiliar with the area with landmarks. They should clearly designate the routes to and the locations of safety areas. Signs should be metal and should be painted with reflective paint.

10.3 Provide maps to fire fighting agencies – Maps showing the location and size of safety areas and the type of route marking should be provided to all agencies responsible for fire suppression in the plan area, including local fire stations.

Project 11 - Wildlife Enhancement

Based on limited forest sampling, most of the forested area is understocked with snags and large woody debris. Enhancement of these features as part of fuel modification projects may be appropriate, especially if snags and woody debris are reduced in fuelbreak areas.

11.1 Create and/or retain large woody debris - Large logs on the forest floor play an important role in re-establishing forest biota after intense fires have passed. Large logs are sometimes too wet to fully burn when a fire passes through an area. In addition to being a reservoir for important soil fungi, these logs provide shelter, cover and even food for numerous wildlife species such as insects, amphibians, chipmunks, squirrels, voles, and moles. Without the cover provided by logs following an intense fire they would become easier prey for predators such as hawks, foxes and snakes. Opportunities may exist to import large cull logs from annual spring clearing of trees that have fallen across roads.

11.2 Create snags or tree platforms - Standing and fallen dead trees have different ecological roles. Snags are particularly important to birds and bats. Hawks and owls use them for perches during hunting and as plucking platforms after hunting. Many birds use them for courtship, display, nesting, feeding, roosting and cover during wet or cold storms. Cavities in the base of snags serve as dens for numerous mammals. Within the Grass Valley Creek residential areas there are few snags, so retention of snags on public and industrial forest lands becomes more important. Their value for wildlife habitat should be weighed against concerns for safety. Where snags are removed, consider placing cavity nesting boxes and platforms in green trees.

Residential Projects

Four immediate concerns face fire fighters if a rapidly moving fire starts in, or around, the residential areas in the Grass Valley Creek watershed. First, fire fighters would need to concentrate on accessing the fire scene while allowing residents to evacuate. Second, protection of homes and evacuation of residents would be a priority over containing a rapidly building fire. Third, the relatively dense home site development in some areas would limit the fire fighters' ability to burn out, or 'back fire', the area between the on-coming fire and natural fuel breaks without risking homes and other property. Fourth, the limited safety zones and escape routes could put residents and fire fighters at risk, if they are over run by fire. In the worst case scenario, fire fighters would concentrate on evacuation and not try to protect structures, and thus be unable to take effective action against the fire.

Although many residents have already done some fuel/fire hazard reduction on their properties, there remains some potential for fuel/fire hazard reduction, sanitation-salvage harvesting, and/or commercial thinning treatments in portions of the residential areas. Some of these treatments may produce commercial quality logs while others may produce no marketable products. Timber harvesting, even for safety reasons, will be constrained on some parcels because of visual, soil, wildlife, tree felling hazard, and/or philosophical concerns of the owners. Objectives for and definitions of a healthy forest, value, and fire risk will invariably differ between owners. The following recommended projects are consistent with community goals, but no site-specific projects will occur that do not meet an individual landowner's personal goals.

Project 12 - Residential Area Watershed Boundary Shaded Fuelbreak

There is a zone of gray pine with heavy brush (primarily buckbrush, manzanita, and scrub canyon live oak) and litter (pitchy pine limbs and tops) fuels bordering the watershed boundary to the west of the subdivision on Lewiston Road (between Old Highway Road and Ponderosa Pines Road). This represents an extreme fuel and fire hazard to the subdivision. The probability of a wildfire entering this area from the west is high as the risk of fire starts is high along Highway 299 and Poker Bar Road, both well-traveled roads to the west, there are many homes to the west, and high winds blow from that direction during the fire season. Within the subdivision moderate, and in some cases heavy, overstocking of small diameter hardwood and conifer trees occurs on some parcels. Some fuel reduction work has been done on some of these parcels.

Gray pine and brush just west of GVC watershed boundary. Brush clearing evident on private lands.

It is recommended that a shaded fuelbreak be created on the top of the ridge on private lands within the subdivision and on public lands south to Highway 299 and to the west of the ridge and south to Old Highway Road. Ideally this fuelbreak would go from the ridge to a buffer on Tom Lang Gulch, continue up the west side of the gulch, across Old Highway and Poker Bar Roads, and over the next ridge. It would extend from Highway 299 (or Old Highway Road) to the Trinity River. This would create an area fuelbreak that would provide better protection to the subdivision. It could be created in stages, with timber sales in some stands, roadside shaded fuelbreaks along Poker Bar, Old Highway, and Lewiston Roads and Highway 299, and various fuel treatments in brushfields, hardwood stands, and precommercial conifer stands.

There are various ways to treat the fuels in this area. Broadcast burning is not recommended unless the fuels are crushed or mowed first, as they are highly flammable and will produce long flame lengths. Most of the area could be mowed with a tractor equipped with a brushcutter or hydroaxe. Concentrations of fuel should be removed from the bases of trees that are to be retained. This is especially important for gray pine, which has abundant resin on the trunk and can easily ignite. Concentrations of fuel could be burned prior to broadcast burning to reduce fire intensity and potential control problems. These modified fuels could then be broadcast burned in strips, back burning downhill from east to west in stages.

Burning in the fall after the fine fuels are wet will enhance germination of buckbrush the next spring (it is a weak resprouter). This will provide ground cover and high quality browse for deer, which will keep shrub growth under control for some years. If buckbrush is burned in the spring, there is likely to be less germination. If it is desired to maintain buckbrush over time, repeat burns should occur 20-25 years apart so that the shrubs can mature and build up a seedbank in the soil.

Both manzanita and canyon live oaks are easily killed by burning but both resprout vigorously, and germination of manzanita seeds is enhanced by fire. These species will be harder to eradicate with repeat burning, but eradication should not be the goal as they help protect the soil surface, provide browse, and provide habitat for many species of wildlife. Temporarily reducing these fuels should be the goal of fuel treatments.

Another way to treat the fuels is to pile them by hand or with equipment and then burn the piles in the fall, winter, or spring. Abundant germination of buckbrush and manzanita can be expected where the piles were burned, especially at larger piles. Creative piling could be done to enhance shrub reestablishment at predetermined sites. It should be noted that if only small areas revegetate with buckbrush, heavy browsing might cause it to die out.

Project 13 - Residential Area Defensible Space Fuelbreaks

Within the residential areas moderate, and in some cases heavy, overstocking of small diameter hardwood and conifer trees occurs on some parcels. Over-stocked stands favor shade tolerant species and reduce tree growth, often resulting in trees taking 7-15 years to gain one inch in diameter. Stress in overstocked stands increases the likelihood of disease or tree mortality, which can lead to an increase in dead fuels. In addition, fuel ladders occur that can rapidly carry a fire into tree crowns, hampering control.


Defensible Space

13.1 Defensible space - Defensible landscape designs should be built into areas around homes. Clear flammable vegetation and dead fuels within 30 feet of homes and other buildings. Use irrigation, fire resistant plants and other techniques shown in Appendix F to reduce the susceptibility of homes to fire damage.

13.2 Fuel modification - Fuel modification within 100-150 feet of homes should be considered by landowners. Treatments should be similar to those done in fuelbreak areas, except that irrigated areas and the use of fire resistant landscaping can allow greater vegetative cover (refer to Appendix F).

Defensible Space Fuel Modification Distances			
Percent Slope	Distance From House		
	Uphill	Sidehill	Downhill
Level to 20%	100 feet	100 feet	100 feet
21% to 40%	150 feet	150 feet	200 feet
41% to 60%	200 feet	200 feet	400 feet

Reduce fire hazard and improve forest health around homes by breaking up the vertical and horizontal continuity of fuels. The residential area, in general, has one or more of the following general stand treatment needs:

a) **Understory thinning/fuel reduction -** Tree crowns in some yards are overlapping and there are numerous small trees in the understory. This fuel condition presents a risk of rapid movement of fire into the crowns of overstory trees as well as rapid horizontal fire spread through the crowns. These stands should be thinned to remove ladder fuels, to favor the larger trees with better crowns, and to create breaks between individual trees or clumps of trees.

Recommended Distances Between Tree Crowns by Percent Slope	
Percent Slope	Distance Between Tree Crowns
Level to 20%	10 feet
21% to 40%	20 feet
41% to 60%	30 feet

b) **Overstory thinning -** In some areas stand basal area is 200 ft^2 or more, which indicates a dense to moderately dense forest. Thinning should be done in these stands to remove suppressed or intermediate trees in order to favor the healthy dominant and co-dominant trees. This treatment would improve growth on the residual trees and reduce fire danger by breaking up the continuity of crowns while removing potential ladder fuels in the form of intermediate and suppressed trees. Commercial timber harvesting, however, would have to meet landowner objectives for visual quality, wildlife and other values. Clean up of logging slash would be necessary to achieve improved fire protection. Any sale of wood products from a timber harvest will require filing of a timber harvest plan with CDF. If trees are harvested within 150 feet of structures approved and legally permitted by the County Building Department, a simple timber harvest plan exemption can be filed. An exemption can also be filed to remove dead, dying, and diseased trees anywhere on the property in amounts of less than 10% of the average volume per acre.

Project 14 - Residential Area Emergency Fire Vehicle Access

If access to homes is unsafe for fire engines, firefighters may have to leave them unprotected. In some cases driveways will need to be signed and upgraded to expedite access by emergency fire engines. In other cases heavy brush or dense trees along access roads will need to be cleared or thinned to provide visibility and protection from intense heat if a fire should approach the roads.

14.1 Sign driveways with resident's 911 addresses and name(s) - Signs provide fire fighters unfamiliar with the area with landmarks. In addition, they allow for improved response, not only for fire fighters, but also for all emergency responses. County Ordinance #1124-2 requires 911 addresses to be placed at all residences so that they are legible and easily visible from the road upon which the premises front. Numbers are required to be at least three inches in height and preferably made from reflective material for ease of night viewing. Although not required, signs could also include the resident(s) last name.

14.2 Provide gate access – In the event of a fire, locked gates may hamper access. Emergency response agencies need to obtain keys and combinations to these locks or have their own locks added to the gates.

14.3 Sign culverts, septic tanks, or other sensitive areas to indicate weight capacity - Engine operators can more quickly and safely drive to homes when bridges, culverts and other crossings are clearly marked as being capable of supporting the weight of the engines. Fire engines weigh between 17½ to 20 tons, water tenders more. Consult the Department of Transportation, Highway Design Manual, "Minimum Thickness of Cover for Culverts" table to determine adequacy for engine crossing. Any soft ground, septic tanks, buried water lines or other hazards to equipment should be marked to protect facilities and equipment.

14.4 Construct turn-arounds in driveways - Most modern fire engines require a minimum 27-35 foot radius to be able to turn around, although a smaller distance can be provided if there is a turning space to back into. If an engine cannot safely enter and exit a driveway it may have to leave a home unprotected or set up a hose lay from the road. Residents can check with the local CDF fire department at Fawn Lodge or the Lewiston Volunteer Fire Department on Texas Avenue in Lewiston to determine if their driveways are adequate.

14.5 Construct turnouts - In residential areas, construct 10x30 foot turnouts approximately every 400 feet along access roads where visibility or terrain act as bottlenecks to safe travel. Some turnouts already exist and minor tree removal and grading will allow other locations to be quickly developed into turnouts. Use existing flats and natural turnouts whenever possible rather than constructing new turnouts that require excavation into slopes. Obtain landowner permission for all turnouts.

14.6 Clear brush and small trees along driveways – Some sections of access road are lined with heavy brush or dense trees that limit visibility and/or will support intense fire with long flame lengths. This vegetation should be cleared, thinned, and/or pruned within 10-50 feet of the roads, as specified below.

a) Remove trees and brush - Trees along road edges that constrict views, prevent two vehicles from safely passing each other, or act, as fire ladders should be removed. Brush and small trees should be removed within 30-50 feet of the edge of main roads and within 10-20 feet of the edge of other roads. But see the 'Soils' and 'Forestry' sections for limitations on vegetation removal on granitic soils and south and west aspects. Minimum tree removal should include those marked by a forester or fire professional. Additional tree removal should be determined by each landowner. Commercial tree removal may be done under a THP fuel hazard exemption under specified conditions on private land.

Strips of dense brush and/or trees can be left at strategic locations to provide privacy screening for homes and yards, provided there is sufficient cleared area around them to prevent rapid fire spread. But it should be recognized that these strips, because they have denser fuels, might catch fire from flying embers (spotting fires) during wildfires.

b) Prune trees - Dominant and co-dominant trees should be pruned up to 16 feet above the ground, but always leaving at least 40% of the bole in live crown. Smaller trees should be pruned at least three times the height of any vegetation under them. As canyon live oak limbs tend to droop near to the ground, it is better to prune the ends of the branches up high enough so that surface fires are unable to ignite the foliage. Provide at least 200 feet of sight distance along roads. In places with limited turnouts, longer sight distances are necessary to assure fire vehicle traffic safety and to minimize delays.

Project 15 - Community Education

The Grass Valley Creek Watershed Fire Management Plan is a synthesis of information from community meetings, individual landowner consultations, on-site reviews, recommendations from fire experts from the Lewiston VFD, BLM, USFS, CDF, and the TCRCD, and literature reviews. Annual or semi-annual community fire planning meetings with resource managers and fire professionals from these agencies and organizations may be beneficial for residents to establish and update a phone list of neighbors to warn in the event of a fire, to remind landowners of the danger of fuel build up around homes, to encourage maintenance of fuelbreaks along roads, to plan the periodic maintenance of community fuel breaks, and to inform new residents about this fire management plan.

15.1 Develop a phone list - An 'early warning system' between neighbors can be useful to inform other residents of potential danger in the event of a fire in, or potentially affecting, residential areas. Residents at widespread locations may not be aware of a fire in other portions of the watershed. Early warning can facilitate orderly actions by residents at more remote locations. This system can also be used to determine if a fire, or other event, even requires action by landowners well away from the incident.

15.2 Establish an annual fire meeting - Annually or semi-annually meet as a community with fire and resource professionals from LVFD, CDF, BLM, TCRCD, and/or SPI to update a phone list of neighbors to warn in the event of a fire, to remind landowners of the danger of fuel build up around homes, to encourage maintenance of fuelbreaks along roads, to plan the periodic maintenance of community fuelbreaks, and to inform new residents about this fire management plan.

Funding Sources

There are two programs available to forest landowners that share costs for stewardship and forest improvement projects. These are cooperative programs that assist eligible landowners through technical and financial assistance for planning, reforestation, thinning, wildlife habitat improvement and other investments that enhance forest resources such as soils, water quality, recreation and timber growth and quality. The Environmental Quality Incentives Program (EQIP) is a federal program and the California Forest Improvement Program (CFIP) is a state program.

These programs can assist in development of shaded fuel breaks, fuel modification, and defensible zones around homes and other buildings, improving water quality, and other projects as determined on a site specific basis.

EQIP - This is a program administered by the Natural Resources Conservation Service (NRCS). This program has two parts to it, one that funds geographic priority areas (GPA) and one which funds natural resource concerns (NRC). The South Fork of the Trinity River and the Eel River are currently the only targeted GPA's in Trinity County, but landowners in the Grass Valley Creek drainage are eligible for Forestry/Range and Salmon/Steelhead NRC 50% cost share funding of up to $10,000 per year and $50,000 per five-year contract. Eligibility for EQIP requires the landowner to be a producer of agricultural products and to own at least 10 acres that are zoned for that use. Forest practices funded by this program are firebreaks, fuelbreaks, thinning, slash disposal, tree/shrub pruning, site preparation, prescribed burning, and tree/shrub planting. The signup period for this program is ongoing, with awards made every Spring. As of the writing of this document, EQIP has been funded for over $39 million for fiscal year 2001-2002.

CFIP - To qualify for CFIP, administered by the California Department of Forestry and Fire Protection (CDF), requires a minimum of 20 acres of forested land zoned to allow forest resource management, although two or more contiguous landowners can cooperate to meet the 20 acre minimum size requirement. The minimum project size is 5 acres, with no minimum acreage requirements for land and resource conservation projects. A landowner may apply for a practice at any time of year. The CFIP requires a management plan and a 10-year land use agreement. Project boundaries, cost estimates, prescriptions for proposed practices and a work schedule are included in the plans. The program will cost share the management plan and projects for up to 75% of costs, up to a maximum allowable cap rate. As of the writing of this document, CFIP has been funded for $1 million, with additional funds to be added from the federal Forest Land Enhancement Program.

APPENDIX A

RECOMMENDED PROJECT MITIGATION MEASURES

Mitigation Measure	Fuelbreak Areas	Watercourse Zones	Homes & Roads	Other Treatment Areas
FB#1	All areas of disturbance			
FB#2				
FB#3	All areas of disturbance			
FB#4				
FB#5	All areas of disturbance			
T&E#1, 2, & 3	All areas of disturbance			
S#1		No Tractor Operations		
S#2				
S#3				
S#4				
S#5		No Tractor Operations		
S#6				
S#7	All areas of disturbance			
WLPZ#1				
WLPZ#2				
WLPZ#3				
WLPZ#4				
WLPZ#5				
WLPZ#6				
CR#1, 2 & 3	All areas of disturbance			
FH#1 & 2	All areas of disturbance			
FH#3				
FH#4				
FH #5	Locations as appropriate			

Fuelbreak Mitigation Measures

FB# 1 - Maintain stand diversity by retaining a minimum of 5-10 ft^2 basal area per acre of hardwoods in addition to the conifers.

FB# 2 - Protect large diameter snags (20" dbh & 20' tall) and large downed logs (10" diameter and 8' long), consistent with landowner and safety objectives, by clearing away light fuels within 10' of such snags/logs.

FB# 3 - If snag and cavity nesting trees must be removed, consider placement of wildlife structures, such as roost poles, platforms, artificial cavities and nest boxes, and placement of large logs within treated areas.

FB# 4 - Emphasize retaining canopy closure and concentrate treatments on pruning ladder fuels and ground fuels.

FB# 5 - Trees should not be pruned to less than 40% live crown.

Threatened and Endangered Species

T&E # 1 - Consult the California Department of Fish and Game Natural Diversity Database for known occurrences of rare, endangered or sensitive species habitat in, and adjacent to, areas where site disturbing activities are to occur.

T&E # 2 - If an occurrence of rare, endangered or sensitive species is likely, survey prior to ground disturbing operations. If present, designate Special Treatment Areas, projects, and timing of operations to benefit, or at least not adversely affect, the protected species.

T&E # 3 - Inspect the area for live trees and snags with visual evidence of use as nesting and roosting sites for rare, endangered, or threatened species. Such snags must be retained, unless they are a safety or fire hazard. Snags that are safety or fire hazards must be felled. Retain other snags, especially where found within watercourse and lake protection zones.

Soils

Soil # 1 - Limit tractor operations to less than 40 percent slopes, with contour windrowing of slash on slopes over 25 percent. Leave effective berms of residual soil to impede surface water flow.

Soil # 2 - Tractor piling of slash should only be done by equipment with a brush rake.

Soil # 3 - Tractor operations should only be done when the soil is dry or on snow.

Soil # 4 - Flag an equipment exclusion zone (using the CA Forest Practice Rules setbacks) to prohibit equipment operations near perennial and ephemeral streams or the bottoms of drainages.

Soil # 5 - Water breaks (waterbars) should be constructed in treated areas using the spacing guidelines in the CA Forest Practice Rules to minimize surface runoff. Spacing should be less on granitic soils as per CDF's "Recommended Mitigation Measures for Timber Operations in Decomposed Granite Soils with Particular Reference to Grass Valley Creek and Nearby Drainages" as revised in March of 1991 (available from CDF, Weaverville office).

Soil # 6 - Flag or otherwise delineate potential landslide prone and other unstable areas and prohibit heavy equipment operations on these areas.

Soil # 7 - Evaluate and describe any unusual circumstances or project site conditions (e.g. soil type, slope % or aspect, size of project, soil moisture) that could result in surface erosion effects not adequately mitigated by the above mitigation measures. Provide for additional environmental evaluation of these areas as needed.

Water Resources, Wetlands and Riparian Areas

WLPZ # 1 - Flag or otherwise designate watercourse and lake protection zones where ground-disturbing equipment will be precluded.

WLPZ # 2 - Prevent slash and debris deposition within watercourse and lake protection zones. Accidental depositions should be cleaned up immediately.

WLPZ # 3 - No machinery should be serviced adjacent to streams, lakes, within wet meadows, marshes and other wet areas, or in other areas where such servicing will permit grease, oil, or fuel, or other toxic substances to enter lakes, streams or wet areas.

WLPZ # 4 - Flag any domestic water supply sources within operation areas to protect water quality.

WLPZ # 5 - Discuss with equipment operators and woods bosses how activities in the vicinity of the protection area will be carried out to prevent water quality degradation.

WLPZ # 6 - Flag, or otherwise delineate equipment exclusion zones around wet meadows, marshes, and other wet or sensitive areas.

Prehistoric & Historic Cultural Resource Values

CR # 1 - An archeological records search and project review should be made by the Northeast Information Center at Chico State University for projects on private lands that have not been previously reviewed.

CR # 2 - Survey project areas for prehistoric and/or historic resources and if sites are located, flag equipment exclusion zones and prepare other appropriate mitigation measures necessary to protect the site.

CR # 3 - If any archeological or historical resources are inadvertently encountered during or after operations, contact CDF immediately to arrange for an evaluation by a professional archaeologist, if necessary. Cease all project activities near the discovered site until appropriate protection measures are developed.

Forest Health Recommended Actions

FH # 1 - Treat all slash and other fine fuels generated from project activities. To prevent the infestation of residual stands of three-needle pines with Ips and Dendroctonus beetles, slash created between November 1-May 15 should be immediately treated by chipping, burning, lopping, or hauling off-site.

FH # 2 - To prevent the infestation of pine stands with root rot pathogens after precommercial thinning, apply borax to thinned stumps.

FH # 3 - Encourage residential landowners to plant understocked areas, thin overstocked areas, and prune trees to improve form, aesthetics and reduce fire hazard.

FH # 4 - Encourage residential landowners to salvage dead, damaged, dying and diseased trees where it is a hazard to residents.

FH # 5 - Enhance wildlife habitat through the use of habitat modification and construction of nesting boxes, platforms, wildlife piles, guzzlers etc.

APPENDIX B

ASSESSOR'S SECURED PROPERTY LIST

APN	PARCEL	G OWN	GOV SPI	NAME_L_1ST	NAME_1ST_L	NAME2
015-210-1200	0152101200	CA	CA	ELLEN PICKET STATE FOREST	ELLEN PICKET STATE FOREST	%DIR. CA. DEPT. OF FOR
025-190-0100	0251900100	PRV	PRV	HUDSON DAVID O. & PEGGY A.	DAVID O. & PEGGY A. HUDSON	
025-180-1100	0251801100	PRV	PRV	BELL JR. ERNEST L. & KRISTEL	JR. ERNEST L. & KRISTEL BELL	
025-030-1300	0250301300	PRV	PRV	NYBORG LARRY A.	LARRY A. NYBORG	
025-060-2500	0250602500	PRV	PRV	HARTIN SYLVIA A.	SYLVIA A. HARTIN	
025-060-2600	0250602600	PRV	PRV	ORTIZ ANTHONY R.	ANTHONY R. ORTIZ	
015-200-0200	0152000200	PRV	PRV	ROSEBURG RESOURCES CO.	RESOURCES CO. ROSEBURG	
025-090-3600	0250903600	PRV	PRV	CAIRES J.A. & Z.A. TSTRES	J.A. & Z.A. TSTRES CAIRES	
015-210-3600	0152103600	PRV	PRV	REDDING LODGE #271 I.O.O.F.	LODGE #271 I.O.O.F. REDDING	
015-210-1000	0152101000	PRV	PRV	RICH WILLIAM ALLEN	WILLIAM ALLEN RICH	
015-210-0500	0152100500	PRV	PRV	REDDING LODGE I.O.O.F.#271	LODGE I.O.O.F.#271 REDDING	
015-230-2300	0152302300	PRV	PRV	WILSON W.L. & G.I. REV. LVG.	W.L. & G.I. REV. LVG. WILSON	
015-230-4100	0152304100	PRV	PRV	SALMON CREEK RESOURCES INC.	CREEK RESOURCES INC. SALMON	%JOE & JILL RICE
015-230-2400	0152302400	PRV	PRV	GRIBBLE GARNETT	GARNETT GRIBBLE	
015-220-0900	0152200900	PRV	PRV	BURGESS ANDREW ETAL	ANDREW BURGESS	
015-260-0100	0152600100	PRV	PRV	SMITH THOMAS W.	THOMAS W. SMITH	
015-260-0900	0152600900	PRV	PRV	LANDLES JANET C.	JANET C. LANDLES	
015-250-0800	0152500800	PRV	PRV	CRANE MILLS	MILLS CRANE	
015-230-4300	0152304300	PRV	PRV	SALMON CREEK RESOURCES INC.	CREEK RESOURCES INC. SALMON	%JOE & JILL RICE
015-480-0300	0154800300	PRV	PRV	CAMPILLO FRANK JAMES	FRANK JAMES CAMPILLO	
017-200-1900	0172001900	PRV	PRV	WHITELEY T.J. & B.A. TRUSTES	T.J. & B.A. TRUSTES WHITELEY	
017-200-0900	0172000900	PRV	PRV	ASHER G.E. & B.A. FAM. TRST.	G.E. & B.A. FAM. TRST. ASHER	
017-200-1100	0172001100	PRV	PRV	ASHER G.E. & B.A. FAM. TRST.	G.E. & B.A. FAM. TRST. ASHER	
015-210-4100	0152104101	PRV	PRV	TEISSEIRE E. REV. LVG. TRST.	E. REV. LVG. TRST. TEISSEIRE	
025-190-1200	0251901200	PRV	PRV	LARKINS GERALD L. EATATE OF	LARKINS GERALD L. EATATE OF	
017-200-2100	0172002100	PRV	PRV	BURTCHETT M.W. TRST. ETALS	M.W. TRST. ETALS BURTCHETT	
017-200-2200	0172002200	PRV	PRV	ASHER GE&BA F.TRST 2/5/91 ETAL	GE & BA F.TRST 2/5 /. 91 ASHER	%ASHER, GERAL
017-200-1200	0172001200	PRV	PRV	CRANE MILLS INC.	MILLS INC. CRANE	
015-230-1700	0152301700	PRV	PRV	TRANS-WOOD CO.	CO. TRANS-WOOD	
015-230-1700	0152301700	PRV	PRV	TRANS-WOOD CO.	CO. TRANS-WOOD	
017-200-2400	0172002400	PRV	PRV	CRANE MILLS	MILLS CRANE	
015-260-1000	0152601000	PRV	PRV	LANDLES JANET C.	JANET C. LANDLES	
015-260-1100	0152601100	PRV	PRV	SMITH GEORGE ETAL	GEORGE SMITH	
015-260-1200	0152601200	PRV	PRV	DENNIS KENNETH & RITA ETAL	KENNETH & RITA DENNIS	
015-480-0200	0154800200	PRV	PRV	HENSON J.F. & J.C. TRUSTEES	J.F. & J.C. TRUSTEES HENSON	
015-480-0400	0154800400	PRV	PRV	CARTER JAMES & DOLORES ETAL	JAMES & DOLORES CARTER	
017-200-0800	0172000800	PRV	PRV	ASHER G.E. & B.A. FAM. TRST.	G.E. & B.A. FAM. TRST. ASHER	
015-200-0600	0152000600	PRV	PRV	LUDDEN THOMAS J. & JOANNE	THOMAS J. & JOANNE LUDDEN	

ADDRESS	CITY	STATE	ZIP CODE	ZIP_4	CITY_STATE	ST NO	STREET_BOX	ACRES
P.O. BOX 944246	SACRAMENTO	CA	94244	2460	SACRAMENTO CA		P.O. BOX 944246	160
3429 ELIZABETH ST	EUREKA	CA	95503	5003	EUREKA CA	3429	ELIZABETH	40
PO BOX 636	LEWISTON	CA	96052	636	LEWISTON CA		PO BOX 636	30.81
PO BOX 3171	EUREKA	CA	95502	0	EUREKA CA		PO BOX 3171	37.79
4727 ALLENDALE STREET	OAKLAND	CA	94619	0	OAKLAND CA	4727	ALLENDALE STREET	44.13
3802 CAPE COD DR	STOCKTON	CA	95209	0	STOCKTON CA	3802	CAPE COD	172.13
P.O. BOX 680	WEED	CA	96094	680	WEED CA		P.O. BOX 680	160
780 BAIN PLACE	REDWOOD CITY	CA	94062	0	REDWOOD CITY CA	780	BAIN PLACE	9.08
HC01 BOX 1102	LEWISTON	CA	96052	0	LEWISTON CA		HC01 BOX 1102	196.97
P.O. BOX 403	IGO	CA	96047	0	IGO CA		P.O. BOX 403	26.28
HC01 BOX 1102	LEWISTON	CA	96052	0	LEWISTON CA		HC01 BOX 1102	239.7
2806 FREEBRIDGE	REDDING	CA	96001	0	REDDING CA	2806	FREEBRIDGE	13.46
3333 TOMKINS HILL RD	LOLETA	CA	95551	0	LOLETA CA	3333	TOMKINS HILL	489
7021 CHURN CREEK RD	REDDING	CA	96002	0	REDDING CA	7021	CHURN CREEK	189.17
PO BOX 200	REDWOOD VALLEY	CA	95470	0	REDWOOD VALLEY CA		PO BOX 200	280
21 CAMINO POSADA COURT	WALNUT CREEK	CA	94595	0	WALNUT CREEK CA	21	CAMINO POSADA COURT	8
P.O. BOX 2490	SHASTA	CA	96087	0	SHASTA CA		P.O. BOX 2490	24.67
BOX 318	CORNING	CA	96021	0	CORNING CA		BOX 318	160
3333 TOMKINS HILL RD	LOLETA	CA	95551	0	LOLETA CA	3333	TOMKINS HILL	77
P.O. BOX 491	CLOVERDALE	CA	95425	0	CLOVERDALE CA		P.O. BOX 491	17.59
PO BOX 129	EUREKA	CA	95501	0	EUREKA CA		PO BOX 129	51.43
C/O D. SCOTT/ 900 MARKET ST	REDDING	CA	96001	0	REDDING CA		C/O D. SCOTT/ 900 MARKET	52.56
C/O D. SCOTT/ 900 MARKET ST	REDDING	CA	96001	0	REDDING CA		C/O D. SCOTT/ 900 MARKET	68
150 LASSEN VIEW LN	RED BLUFF	CA	96080	2314	RED BLUFF CA	150	LASSEN VIEW	120
C/O 17 BRINDLE POND RD	CENTER BARNSTEAD	NH	32250	0	CENTER BARNSTEAD NH		C/O 17 BRINDLE POND RD	58.55
555 H STREET	EUREKA	CA	95501	0	EUREKA CA	555	H STREET	17
C/O D. SCOTT/ 900 MARKET ST	REDDING	CA	96001	0	REDDING CA		C/O D. SCOTT/ 900 MARKET	40
BOX 318	CORNING	CA	96021	0	CORNING CA		BOX 318	5
P.O.BOX 250	REDDING	CA	96001	0	REDDING CA		P.O.BOX 250	49.07
P.O.BOX 250	REDDING	CA	96001	0	REDDING CA		P.O.BOX 250	49.07
P.O.BOX 318	CORNING	CA	96021	0	CORNING CA		P.O.BOX 318	35
P.O. BOX 2490	SHASTA	CA	96087	0	SHASTA CA		P.O. BOX 2490	27.1
PO BOX 248	WHITMORE	CA	96096	0	WHITMORE CA		PO BOX 248	32.5
24840 FAIRBANKS LN	COVELO	CA	95428	0	COVELO CA	24840	FAIRBANKS	33.44
26 FOREST SIDE	SAN FRANCISCO	CA	94127	0	SAN FRANCISCO CA	26	FOREST SIDE	21.13
3932 BECHELLI LANE	REDDING	CA	96002	0	REDDING CA	3932	BECHELLI LANE	19.2
C/O D. SCOTT/ 900 MARKET ST	REDDING	CA	96001	0	REDDING CA		C/O D. SCOTT/ 900 MARKET	40
HC01 BOX 900	LEWISTON	CA	96052	9700	LEWISTON CA		HC01 BOX 900	174

SQ_FEET	USE CODE	LAND VALUE	IMPROV VALUE	PERS VALUE	TOTAL EXEMP	NET VALUE	BOOK PAGE
6969600	3XXX	14607	0	0	0	14607	015-210
1742400	CXX1	45117	39478	0	7000	77595	025-190
1342083	CXX1	156726	107661	0	7000	257387	025-180
1646131	AXXX	49537	0	0	0	49537	025-030
1922303	AXXX	50771	0	0	0	50771	025-060
7497983	AXXX	126559	0	0	0	126559	025-060
6969600	3XXX	14649	0	0	0	14649	015-200
395525	AXXX	4874	0	0	0	4874	025-090
8580013	AXXX	48803	0	0	0	48803	015-210
1144757	AXXX	28980	0	0	0	28980	015-210
10441331	TXXX	90408	82860	0	0	173268	015-210
586319	CXX1	37119	28285	0	0	65404	015-230
21300840	AXXX	62622	0	0	0	62622	015-230
8240245	BXXX	61585	847	0	0	62432	015-230
12196800	AXXX	29282	0	0	0	29282	015-220
348480	AXXX	16493	0	0	0	16493	015-260
1074625	BXXX	26955	2689	0	0	29644	015-260
6969600	3XXX	14649	0	0	0	14649	015-250
3354120	AXXX	11527	0	0	0	11527	015-230
766220	AXXX	26299	0	0	0	26299	015-480
2240291	AXXX	13794	0	0	0	13794	017-200
2289513	3XXX	4812	0	0	0	4812	017-200
2962080	3XXX	6226	0	0	0	6226	017-200
5227200	CXXX	0	0	0	0	0	015-210
2550439	EFX1	71749	43458	0	0	115207	025-190
740520	AXXX	9095	0	0	0	9095	017-200
1742400	3XXX	3662	0	0	0	3662	017-200
217800	3XXX	458	0	0	0	458	017-200
2137489	AXXX	72206	0	0	0	72206	015-230
2137489	AXXX	72206	0	0	0	72206	015-230
1524600	3XXX	3205	0	0	0	3205	017-200
1180477	AXXX	23652	0	0	0	23652	015-260
1415700	AXXX	29472	0	0	0	29472	015-260
1456647	AXXX	32515	0	0	0	32515	015-260
920423	AXXX	22543	0	0	0	22543	015-480
836351	AXXX	12393	0	0	0	12393	015-480
1742400	3XXX	3662	0	0	0	3662	017-200
7579440	4XC2	26700	59027	0	7000	78727	015-200

APN	PARCEL	G OWN	GOV SPI	NAME_L_1ST	NAME_1ST_L	NAME2
015-230-2600	0152302600	PRV	PRV	CRIFFIELD JERRY	JERRY CRIFFIELD	
015-210-4600	0152104600	PRV	PRV	CASTRO GEORGENE C. & CARL B.	GEORGENE C. & CARL B. CASTRO	
015-210-4400	0152104400	PRV	PRV	CASTRO GEORGENE C. & CARL B.	GEORGENE C. & CARL B. CASTRO	
015-210-4500	0152104500	PRV	PRV	CASTRO GEORGENE C. & CARL B.	GEORGENE C. & CARL B. CASTRO	
015-210-4000	0152104001	PRV	PRV	PARSONS D.F. & J.K TRUSTEES	D.F. & J.K TRUSTEES PARSONS	
015-210-3000	0152103000	PRV	PRV	POTTER SHARON A. & KIM F.	SHARON A. & KIM F. POTTER	
015-210-3600	0152103600	PRV	PRV	REDDING LODGE #271 I.O.O.F.	LODGE #271 I.O.O.F. REDDING	
015-210-3600	0152103600	PRV	PRV	REDDING LODGE #271 I.O.O.F.	LODGE #271 I.O.O.F. REDDING	
015-210-4300	0152104300	PRV	PRV	REDDING LODGE #271 I.O.O.F.	LODGE #271 I.O.O.F. REDDING	
015-210-2000	0152102000	PRV	PRV	CASTRO GEORGENE C. & CARL B.	GEORGENE C. & CARL B. CASTRO	
025-090-4900	0250904900	PRV	PRV	TYLER WALTER C. & TERRY ANN	WALTER C. & TERRY ANN TYLER	
015-230-3600	0152303600	PRV	PRV	TRANS-WOOD CO.	CO. TRANS-WOOD	
015-230-4600	0152304600	PRV	PRV	ELLEFSON WAYNE K. & ARLENE T	WAYNE K. & ARLENE T. ELLEFSON	
015-230-3900	0152303900	PRV	PRV	LARKIN JOHN D. & EVA L.	JOHN D. & EVA L. LARKIN	
015-230-3000	0152303000	PRV	PRV	BARR SINCLAIR & HILL TRST.	SINCLAIR & HILL TRST. BARR	
015-230-3300	0152303300	PRV	PRV	BLANCHARD MICHAEL & PAMELA	MICHAEL & PAMELA BLANCHARD	
015-230-3400	0152303400	PRV	PRV	BLANCHARD NORMAN & MARY E.	NORMAN & MARY E. BLANCHARD	
015-230-3800	0152303800	PRV	PRV	SHELTON JESSE	JESSE SHELTON	
015-230-1900	0152301900	PRV	PRV	BARR SINCLAIR & HILL TRST.	SINCLAIR & HILL TRST. BARR	
015-480-0100	0154800100	PRV	PRV	KING COLIN M.	COLIN M. KING	
025-660-3400	0256603400	PRV	PRV	KREICK DAWN	DAWN KREICK	
025-6603800	0256603800	PRV	PRV	BURTON HERBERT & PATRICIA	HERBERT & PATRICIA BURTON	
025-660-3900	0256603900	PRV	PRV	LEE TERRY D. & MARJORIE J.	TERRY D. & MARJORIE J. LEE	
025-660-3300	0256603300	PRV	PRV	KEAVY TIM & JANET	TIM & JANET KEAVY	
025-660-3200	0256603200	PRV	PRV	LARSON DONALD W. & JOY E.	DONALD W. & JOY E. LARSON	
025-660-2900	0256602900	PRV	PRV	LANE JR. BERTRAM A. & TINA M	JR. BERTRAM A. & TINA M. LANE	
025-660-2400	0256602400	PRV	PRV	SIMON ROBERT D.	ROBERT D. SIMON	
025-660-2600	0256602600	PRV	PRV	HERRON BILLY Y. & SANDRA K.	BILLY Y. & SANDRA K. HERRON	
025-660-3100	0256603100	PRV	PRV	VALENTINO CAROL I.	CAROL I. VALENTINO	
025-660-3000	0256603000	PRV	PRV	STOCKHOFF WARREN H. & JOAN M	WARREN H. & JOAN M. STOCKHOFF	
025-660-3000	0256603000	PRV	PRV	STOCKHOFF WARREN H. & JOAN M	WARREN H. & JOAN M. STOCKHOFF	
025-660-3500	0256603500	PRV	PRV	LANGER KENNETH B. & KARIN	KENNETH B. & KARIN LANGER	
025-660-3700	0256603700	PRV	PRV	ROSS LEWIS D.	LEWIS D. ROSS	
025-660-3600	0256603600	PRV	PRV	WILCOX DAVID L.	DAVID L. WILCOX	
025-660-2800	0256602800	PRV	PRV	MERIDETH FLOYD & SHARON	FLOYD & SHARON MERIDETH	
025-650-0200	0256500200	PRV	PRV	RILEY JOSEPH & BARBARA	JOSEPH & BARBARA RILEY	
025-650-0100	0256500100	PRV	PRV	JARMIN ROBERT A.	ROBERT A. JARMIN	
025-650-0700	0256500700	PRV	PRV	MONTGOMERY R.A. & I.B.TSTEES	R.A. & I.B.TSTEES MONTGOMERY	

ADDRESS	CITY	STATE	ZIP CODE	ZIP_4	CITY_STATE	ST NO	STREET_BOX	ACRES
P.O. BOX 674	WEAVERVILLE	CA	96093	674	WEAVERVILLE CA		P.O. BOX 674	3.45
3490 NICOLET LN	REDDING	CA	96001	4721	REDDING CA	3490	NICOLET	40
3490 NICOLET LN	REDDING	CA	96001	4721	REDDING CA	3490	NICOLET	15.03
3490 NICOLET LN	REDDING	CA	96001	4721	REDDING CA	3490	NICOLET	80
122 LOMA VISTA DRIVE	SONOMA	CA	95476	0	SONOMA CA	122	LOMA VISTA DRIVE	40
PO BOX 100	SHASTA	CA	96087	0	SHASTA CA		PO BOX 100	30.45
HC01 BOX 1102	LEWISTON	CA	96052	0	LEWISTON CA		HC01 BOX 1102	196.97
HC01 BOX 1102	LEWISTON	CA	96052	0	LEWISTON CA		HC01 BOX 1102	196.97
HC01 BOX 1102	LEWISTON	CA	96052	0	LEWISTON CA		HC01 BOX 1102	5.37
1524 HOMINY WAY	REDDING	CA	96003	0	REDDING CA	1524	HOMINY	3.34
BOX 347	LEWISTON	CA	96052	0	LEWISTON CA		BOX 347	9.5
P.O.BOX 250	REDDING	CA	96001	0	REDDING CA		P.O.BOX 250	60
PO BOX 519	SHASTA	CA	96087	519	SHASTA CA		PO BOX 519	22.22
PO BOX 2358	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2358	17.08
100 E CYPRESS AVE #200	REDDING	CA	96002	113	REDDING CA	100	CYPRESS	3.8
P.O. BOX 232	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		P.O. BOX 232	2.21
P.O.BOX 269	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		P.O.BOX 269	2.46
PO BOX 277	CARPINTERIA	CA	93014	277	CARPINTERIA CA		PO BOX 277	5
1824 COURT STREET	REDDING	CA	96001	0	REDDING CA	1824	COURT STREET	1.85
2434 30TH AVE	SAN FRANCISCO	CA	94166	0	SAN FRANCISCO CA	2434	30TH	16.01
PO BOX 2614	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2614	1.01
P.O. BOX 176	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 176	2.12
P.O. BOX 45	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		P.O. BOX 45	2.2
P.O. BOX 265	LEWISTON	CA	96052	265	LEWISTON CA		P.O. BOX 265	1.02
2211 OLD PIEDMONT ROAD	SAN JOSE	CA	95132	0	SAN JOSE CA	2211	OLD PIEDMONT ROAD	1.14
ST. RT. BOX 41	LEWISTON	CA	96052	0	LEWISTON CA		ST. RT. BOX 41	3.88
PO BOX 207	LEWISTON	CA	96052	207	LEWISTON CA		PO BOX 207	2.13
P.O. BOX 747	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 747	2.5
10108 LA PLACITA DR	RANCHO CORDOVA	CA	95670	0	RANCHO CORDOVA CA	10108	LA PLACITA	2
4120 MITCHELL ROAD	EUREKA	CA	95501	0	EUREKA CA	4120	MITCHELL ROAD	2.11
4120 MITCHELL ROAD	EUREKA	CA	95501	0	EUREKA CA	4120	MITCHELL ROAD	2.11
2615 WORTHINGTON DR	EUREKA	CA	95501	0	EUREKA CA	2615	WORTHINGTON	2.8
12652 ESTHER STREET	BORON	CA	93516	0	BORON CA	12652	ESTHER STREET	1.75
P.O. BOX 136	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 136	1.34
PO BOX 108	LEWISTON	CA	96052	108	LEWISTON CA		PO BOX 108	2.47
22140 EARL DRIVE	CASTRO VALLEY	CA	94546	0	CASTRO VALLEY CA	22140	EARL DRIVE	2.24
8678 THELEN CT	ORANGEVALE	CA	95662	0	ORANGEVALE CA	8678	THELEN	3.15
PO BOX 2807	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2807	2.61

SQ_FEET	USE CODE	LAND VALUE	IMPROV VALUE	PERS VALUE	TOTAL EXEMP	NET VALUE	BOOK PAGE
150281	CXX2	54706	26505	0	0	81211	015-230
1742400	AXXX	11382	0	0	0	11382	015-210
654707	AXXX	11382	0	0	0	11382	015-210
3484800	CXX3	24396	17077	0	0	41473	015-210
1742400	AXXX	0	0	0	0	0	015-210
1326401	CXX1	110248	88198	0	7000	191446	015-210
8580013	AXXX	48803	0	0	0	48803	015-210
8580013	AXXX	48803	0	0	0	48803	015-210
233917	AXXX	4874	0	0	0	4874	015-210
145490	AXXX	2041	0	0	2041	0	015-210
413820	EEX1	26642	44898	0	7000	64540	025-090
2613600	AXXX	43338	0	0	0	43338	015-230
967903	CXX2	59321	178797	0	7000	231118	015-230
744005	CXX1	18315	134346	0	7000	145661	015-230
165529	AXXX	29890	0	0	0	29890	015-230
96269	CXX1	16169	51442	0	7000	60611	015-230
107159	CXX1	9752	64078	0	7000	66830	015-230
217800	CXX1	68806	42861	0	0	111667	015-230
80587	AXXX	19173	0	0	0	19173	015-230
697397	AXXX	22543	0	0	0	22543	015-480
43997	CXX1	21542	40696	0	5600	56638	025-660
92347	EFX1	29845	31000	0	7000	53845	025-660
95831	AXXX	32834	0	0	0	32834	025-660
44431	EFV1	49612	11024	0	7000	53636	025-660
49659	EFX1	19685	23494	0	0	43179	025-660
169013	CXX1	42154	84848	0	0	127002	025-660
92783	BXXX	37454	10404	0	0	47858	025-660
108900	EFV1	36226	8914	0	7000	38140	025-660
87120	AXXX	13008	0	0	0	13008	025-660
91911	CXX1	21035	47760	0	0	68795	025-660
91911	CXX1	21035	47760	0	0	68795	025-660
121969	EEX1	32416	41291	0	0	73707	025-660
76230	CXX1	41616	72828	0	0	114444	025-660
58370	EFX1	45565	10597	0	0	56162	025-660
107593	CXX1	43235	37830	0	0	81065	025-660
97573	EEX1	79444	21618	0	0	101062	025-650
137213	CXX1	16198	62478	0	0	78676	025-650
113691	CXX1	47004	96451	0	7000	136455	025-650

APN	PARCEL	G OWN	GOV SPI	NAME_L_1ST	NAME_1ST_L	NAME2
025-540-0300	0255400300	PRV	PRV	TINGSTAD-DORAN LILLIAN	LILLIAN TINGSTAD-DORAN	
025-290-0500	0252900500	PRV	PRV	THOMSON GREG	GREG THOMSON	
025-290-0600	0252900600	PRV	PRV	STRATTON STEVE & TAUNA	STEVE & TAUNA STRATTON	
025-290-0700	0252900700	PRV	PRV	TEUSCHER ROGER & DONNA	ROGER & DONNA TEUSCHER	
025-290-0800	0252900800	PRV	PRV	BEAVER JOHN T.	JOHN T. BEAVER	
025-290-1100	0252901100	PRV	PRV	MEISSNER WM. E. FAM. 1989 & WILLIAM & MYRTLE TRSTEES	WM. E. FAM. 1989 & WILLIAM & MYRTLE MEISSNER	
025-290-2800	0252902800	PRV	PRV	MEISSNER WM. E. FAM. 1989 & WILLIAM & MYRTLE TRSTEES	WM. E. FAM. 1989 & WILLIAM & F111 MYRTLE MEISSNER	
025-290-0400	0252900400	PRV	PRV	HOWARD HARVEY A. & JANET J.	HARVEY A. & JANET J. HOWARD	
025-290-4100	0252904100	PRV	PRV	LEE TERRY D. & MARJORIE J.	TERRY D. & MARJORIE J. LEE	
025-290-3300	0252903300	PRV	PRV	BOCSKAY CAROL & AGOTA	CAROL & AGOTA BOCSKAY	
025-290-0300	0252900300	PRV	PRV	RICE P.E. & M.D. TRUSTEES	P.E. & M.D. TRUSTEES RICE	
025-290-2400	0252902400	PRV	PRV	BERGESCH JOSEPH C.	JOSEPH C. BERGESCH	
025-290-2300	0252902300	PRV	PRV	MORRIS CLARENCE J.	CLARENCE J. MORRIS	
025-290-2500	0252902500	PRV	PRV	MOONEY JOHN W.	JOHN W. MOONEY	
025-290-1200	0252901200	PRV	PRV	MEISSNER W.H. & M. TRSTEES	W.H. & M. MEISSNER	
025-290-1700	0252901700	PRV	PRV	MEISSNER ERNEST R. & ROSEMAR	ERNEST R. & ROSEMAR MEISSNER	
025-290-1800	0252901800	PRV	PRV	TOMASINI JOHN R. & NICOLA	JOHN R. & NICOLA TOMASINI	
025-290-3800	0252903800	PRV	PRV	BONOMINI CARL A.	CARL A. BONOMINI	
025-290-2000	0252902000	PRV	PRV	KAUFFMAN DAN	DAN KAUFFMAN	
025-290-3900	0252903900	PRV	PRV	THOMPSON MICHAEL W.	MICHAEL W. THOMPSON	
025-290-1000	0252901000	PRV	PRV	OWYANG GUY & SUE TRSTEES	GUY & SUE OWYANG	
025-290-1300	0252901300	PRV	PRV	HENSIC DONALD I. & CYNTHIA S	DONALD I. & CYNTHIA S. HENSIC	
025-290-1600	0252901600	PRV	PRV	SCRIBNER PAUL E. & LINDA L.	PAUL E. & LINDA L. SCRIBNER	
025-290-3000	0252903000	PRV	PRV	ALLEN KENNETH W. & DELIGHT	KENNETH W. & DELIGHT ALLEN	
025-290-2900	0252902900	PRV	PRV	HENSIC DONALD I.	DONALD I. HENSIC	
025-290-1400	0252901400	PRV	PRV	FLITTER E.H. FAM. LVG. TRST.	E.H. FAM. LVG. TRST. FLITTER	
025-290-0900	0252900900	PRV	PRV	WILLS ROBERT J. & LAURIE A.	ROBERT J. & LAURIE A. WILLS	
025-290-1500	0252901500	PRV	PRV	CARR JOAN E.	JOAN E. CARR	
025-290-2600	0252902600	PRV	PRV	SMITH THERESA ENID	THERESA ENID SMITH	
025-290-4000	0252904000	PRV	PRV	TONEY KATHERINE JORDAN	KATHERINE JORDAN TONEY	
025-290-2100	0252902100	PRV	PRV	NIES CLARENCE F. & LORENA A.	CLARENCE F. & LORENA A. NIES	
025-290-3600	0252903600	PRV	PRV	PERINI BONNIE DEAN	BONNIE DEAN PERINI	
025-290-2700	0252902700	PRV	PRV	JAMES JACQUELINE REV.TRUST	JACQUELINE REV.TRUST JAMES	
025-060-0700	0250600700	PRV	PRV	MCCALL HOWARD L. & BETTY J.	HOWARD L. & BETTY J. MCCALL	
025-060-2500	0250602500	PRV	PRV	HARTIN SYLVIA A.	SYLVIA A. HARTIN	
025-060-2600	0250602600	PRV	PRV	ORTIZ ANTHONY R.	ANTHONY R. ORTIZ	

ADDRESS	CITY	STATE	ZIP CODE	ZIP_4	CITY_STATE	ST NO	STREET_BOX	ACRES
PO BOX 603	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		PO BOX 603	4.9
18916 CREST AVE	CASTRO VALLEY	CA	94546	0	CASTRO VALLEY CA	18916	CREST	2.8
7463 LA PAZ COURT	PALO CEDRO	CA	96073	0	PALO CEDRO CA	7463	LA PAZ COURT	1.8
3788 HOWE COURT	FREMONT	CA	94538	0	FREMONT CA	3788	HOWE COURT	2.5
1522 ESTELLE AVE	SAN JOSE	CA	95118	0	SAN JOSE CA	1522	ESTELLE	2.5
15636 TRINITY MOUNTAIN RD	FRENCH GULCH	CA	96033	0	FRENCH GULCH CA	15636	TRINITY MOUNTAIN ROAD	2.5
15636 TRINITY MOUNTAIN R+H23D	FRENCH GULCH	CA	96033	0	FRENCH GULCH CA	15636	TRINITY MOUNTAIN ROAD	2.5
PO BOX 329	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		PO BOX 329	2.5
BOX 45	DOUGLAS CITY	CA	96024	0	DOUGLAS CITY CA		BOX 45	3.1
P.O. BOX 592	LEWISTON	CA	96052	592	LEWISTON CA		P.O. BOX 592	1.25
6691 STARKES GRADE RD	POLLOCK PINES	CA	95726	9536	POLLOCK PINES CA	6691	STARKES GRADE	2.5
P.O. BOX 1384	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P.O. BOX 1384	2.56
5722 DRAKES DRIVE	BYRON	CA	94514	0	BYRON CA	5722	DRAKES DRIVE	2.5
PO BOX 288	WINDSOR	CA	95492	0	WINDSOR CA		PO BOX 288	2.56
15636 TRINITY MT RD	FRENCH GULCH	CA	96033	0	FRENCH GULCH CA	15636	TRINITY MT	2.5
5141 MAYWOOD AVE	LOS ANGELES	CA	90041	0	LOS ANGELES CA	5141	MAYWOOD	2.5
2070 ATHENS AVE	REDDING	CA	96001	0	REDDING CA	2070	ATHENS	2.5
P.O.BOX 1077	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P.O.BOX 1077	3.14
805 N 14TH ST	ROGERS	AR	72756	0	ROGERS AR	805	14TH	2.5
PO BOX 1917	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 1917	2.28
550 E 20 STREET	OAKLAND	CA	94606	0	OAKLAND CA	550	20 STREET	2.5
424 EASTWOOD DR	PETALUMA	CA	94954	0	PETALUMA CA	424	EASTWOOD	2.5
P.O. BOX 478	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 478	2.5
P.O. BOX 231386	SACRAMENTO	CA	95823	1386	SACRAMENTO CA		P.O. BOX 231386	2.5
424 EASTWOOD DR	PETALUMA	CA	94954	0	PETALUMA CA	424	EASTWOOD	2.5
5825 MARK TWAIN AVE	SACRAMENTO	CA	95820	0	SACRAMENTO CA	5825	MARK TWAIN	2.5
HCO1 BOX 47	LEWISTON	CA	96052	0	LEWISTON CA		HCO1 BOX 47	2.5
PO BOX 248	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 248	2.5
3928 LAVERNE WAY	SACRAMENTO	CA	95864	741	SACRAMENTO CA	3928	LAVERNE	2.5
P.O. BOX 140	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 140	2.01
HC01 BOX 9	LEWISTON	CA	96052	9701	LEWISTON CA		HC01 BOX 9	3.11
1932 GWIN RD	MC KINLEYVILLE	CA	95519	3907	MC KINLEYVILLE CA	1932	GWIN	1.36
3601 DOTHAN DR	MODESTO	CA	95357	1429	MODESTO CA	3601	DOTHAN	2.5
HC 02 BOX 1200	LEWISTON	CA	96052	9704	LEWISTON CA		HC 02 BOX 1200	168.47
4727 ALLENDALE STREET	OAKLAND	CA	94619	0	OAKLAND CA	4727	ALLENDALE STREET	44.13
3802 CAPE COD DR	STOCKTON	CA	95209	0	STOCKTON CA	3802	CAPE COD	172.13

SQ_FEET	USE CODE	LAND VALUE	IMPROV VALUE	PERS VALUE	TOTAL EXEMP	NET VALUE	BOOK PAGE
213443	CXX1	37359	176840	0	7000	207199	025-540
121969	AXXX	32966	0	0	0	32966	025-290
78409	AXXX	21618	0	0	0	21618	025-290
108900	BXXX	25908	0	0	0	25908	025-290
108900	BXXX	25637	0	0	0	25637	025-290
108900	AXXX	4874	0	0	0	4874	025-290
108900	AXXX	4874	0	0	0	4874	025-290
108900	AXXX	21193	0	0	0	21193	025-290
135037	CXX1	31156	113315	0	7000	137471	025-290
54450	EFX1	17834	20096	0	0	37930	025-290
108900	EFX1	18776	71371	0	7000	83147	025-290
111513	CXX1	11264	43559	0	0	54823	025-290
108900	AXXX	2315	0	0	2315	0	025-290
111513	AXXX	6448	0	0	0	6448	025-290
108900	AXXX	8647	0	0	0	8647	025-290
108900	AXXX	5379	0	0	0	5379	025-290
108900	AXXX	12319	0	0	0	12319	025-290
136779	CXX1	13794	114970	0	7000	121764	025-290
108900	AXXX	1542	0	0	1542	0	025-290
99317	AXXX	6506	0	0	0	6506	025-290
108900	AXXX	6448	0	0	0	6448	025-290
108900	CXX1	33293	166464	0	0	199757	025-290
108900	CXX1	17353	104532	0	7000	114885	025-290
108900	AXXX	5687	0	0	0	5687	025-290
108900	BXXX	31212	2601	0	0	33813	025-290
108900	AXXX	3247	0	0	0	3247	025-290
108900	CXX1	25638	174787	0	7000	193425	025-290
108900	CXX1	25941	75661	0	0	101602	025-290
108900	EFX1	32858	13007	22588	0	68453	025-290
87557	CXX1	26805	100279	0	7000	120084	025-290
135471	CXX1	29337	137302	0	7000	159639	025-290
59241	EFX1	28080	5670	0	0	33750	025-290
108900	AXXX	1234	0	0	1234	0	025-290
7338553	DEX3	219772	195351	0	7000	408123	025-060
1922303	AXXX	50771	0	0	0	50771	025-060
7497983	AXXX	126559	0	0	0	126559	025-060

APN	PARCEL	G OWN	GOV SPI	NAME_L_1ST	NAME_1ST_L	NAME2
025-060-2600	0250602600	PRV	PRV	ORTIZ ANTHONY R.	ANTHONY R. ORTIZ	
025-190-1200	0251901200	PRV	PRV	LARKINS GERALD L. EATATE OF	LARKINS GERALD L. EATATE OF	
025-190-0200	0251900200	PRV	PRV	HEILMAN J.H. & M.A. TRSTEES	J.H. & M.A. HEILMAN	
025-190-0500	0251900500	PRV	PRV	HEILMAN J.H. FAMILY TRUST & M.A. TRST'	HEILMAN J.H. FAMILY TRUST & F89 M.A. TRST'	
025-190-1200	0251901200	PRV	PRV	LARKINS GERALD L. EATATE OF	LARKINS GERALD L. EATATE OF	
025-190-0800	0251900800	PRV	PRV	WELCH D. & S.L. REV. TRST. & DALE & SHIRLEY TRST	D. & S.L. REV. TRST. & F77 DALE & SHIRLEY TRST	
025-200-0500	0252000500	PRV	PRV	ADAMS ERIKA W.	ERIKA W. ADAMS	%ROBERT L. REH
025-180-2500	0251802500	PRV	PRV	SIMPSON R.M. & N.E. TRUSTEES	R.M. & N.E. TRUSTEES SIMPSON	
025-180-2600	0251802600	PRV	PRV	SIMPSON SCOTT R. & KELLY	SCOTT R. & KELLY SIMPSON	
025-180-2200	0251802200	PRV	PRV	SEARCY WILLIAM & NONA ETALS	WILLIAM & NONA ETALS SEARCY	
025-180-3000	0251803000	PRV	PRV	HOWE RONALD & MELINDA J.	RONALD & MELINDA J. HOWE	
025-180-2900	0251802900	PRV	PRV	HOWE RONALD & MELINDA J.	RONALD & MELINDA J. HOWE	
025-180-2800	0251802800	PRV	PRV	HOWE RONALD D'ALTON & MELINDA	RONALD D'ALTON & MELINDA HOWE	
025-650-1200	0256501200	PRV	PRV	MAXWELL G.S. & E.B. TRSTEES	G.S. & E.B. MAXWELL	
025-650-1100	0256501100	PRV	PRV	HINKLE ROBERT SHANNON	ROBERT SHANNON HINKLE	
025-180-1200	0251801200	PRV	PRV	COFFIN DONALD L. & MONICA L.	DONALD L. & MONICA L. COFFIN	
025-180-1000	0251801000	PRV	PRV	SUMNER MICHAEL W. & POLLY A.	MICHAEL W. & POLLY A. SUMNER	
025-180-1900	0251801900	PRV	PRV	WELLOCK DAVID R.	DAVID R. WELLOCK	
025-180-2100	0251802100	PRV	PRV	SEARCY NONA E. ETALS	NONA E. ETALS SEARCY	
025-650-1000	0256501000	PRV	PRV	GONZALES JOSE M. & SOCORRO M.	JOSE M. & SOCORRO M. GONZALES	
025-650-0900	0256500900	PRV	PRV	WARD ROY D. & GAYL L.	ROY D. & GAYL L. WARD	
025-650-0500	0256500500	PRV	PRV	BRAXTON BILLY W. & SHARON M.	BILLY W. & SHARON M. BRAXTON	
025-650-0600	0256500600	PRV	PRV	DAVENPORT EDWARD C.	EDWARD C. DAVENPORT	
025-650-0300	0256500300	PRV	PRV	BONNER FREDRICK S.	FREDRICK S. BONNER	
025-650-0400	0256500400	PRV	PRV	THOMPSON JOHN	JOHN THOMPSON	
025-650-0800	0256500800	PRV	PRV	MONTGOMERY R.A. & I.B.TSTEES	R.A. & I.B.TSTEES MONTGOMERY	
025-180-0200	0251800200	PRV	PRV	PERRY DOUGLAS	DOUGLAS PERRY	
025-220-1400	0252201400	PRV	PRV	PETERSON BARBARA J.	BARBARA J. PETERSON	
025-090-3900	0250903900	PRV	PRV	YOUNG WAYNE P. & JANICE	WAYNE P. & JANICE YOUNG	
025-090-3400	0250903400	PRV	PRV	FRISBIE ROBERT N.	ROBERT N. FRISBIE	
025-090-4400	0250904400	PRV	PRV	YOUNG WAYNE PAUL	WAYNE PAUL YOUNG	
025-090-3500	0250903500	PRV	PRV	REIMANN ANITA	ANITA REIMANN	
025-090-4800	0250904800	PRV	PRV	TYLER BOBBY & WENDY	BOBBY & WENDY TYLER	
025-090-3700	0250903700	PRV	PRV	YOUNG WAYNE P. & JANICE	WAYNE P. & JANICE YOUNG	
025-090-2700	0250902700	PRV	PRV	HAGEN STEPHEN J.	STEPHEN J. HAGEN	
025-090-4700	0250904700	PRV	PRV	OCAMPO J.A. & M.H. TRUSTEES	J.A. & M.H. TRUSTEES OCAMPO	

ADDRESS	CITY	STATE	ZIP CODE	ZIP_4	CITY_STATE	ST NO	STREET_BOX	ACRES
3802 CAPE COD DR	STOCKTON	CA	95209	0	STOCKTON CA	3802	CAPE COD	172.13
C/O 17 BRINDLE POND RD	CENTER BARNSTEAD	NH	32250	0	CENTER BARNSTEAD NH		C/O 17 BRINDLE POND RD	58.55
P.O. BOX 786	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 786	40
FAWNLODGE RD PO BOX 786	LEWISTON	CA	96052	0	LEWISTON CA		FAWNLODGE RD PO BOX 786	25
C/O 17 BRINDLE POND RD	CENTER BARNSTEAD	NH	32250	0	CENTER BARNSTEAD NH		C/O 17 BRINDLE POND RD	58.55
2485 HOWARD ST	REDDING	CA	96001	0	REDDING CA	2485	HOWARD	0.38
133 SEQUOIA CIRCLE	SANTA ROSA	CA	95401	0	SANTA ROSA CA	133	SEQUOIA CIRCLE	56.6
PO BOX 816	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 816	39.29
PO BOX 608	LEWISTON	CA	96052	608	LEWISTON CA		PO BOX 608	39.95
536 W 12TH AVE	CHICO	CA	95926	0	CHICO CA	536	12TH	20
P.O. BOX 2060	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P.O. BOX 2060	10
P.O. BOX 2060	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P.O. BOX 2060	9.79
P.O. BOX 2060	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P.O. BOX 2060	10
HCR 1 BOX 85	LEWISTON	CA	96052	0	LEWISTON CA		HCR 1 BOX 85	2.33
PO BOX 867	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 867	2.16
STAR RT., BOX 87	LEWISTON	CA	96052	0	LEWISTON CA		STAR RT., BOX 87	17.73
149 MADERA AVE	SAN CARLOS	CA	94070	0	SAN CARLOS CA	149	MADERA	20.5
PO BOX 126	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 126	15
536 W 12TH AVE	CHICO	CA	95926	2135	CHICO CA	536	12TH	0.37
313 ALGEN AVE	MODESTO	CA	95351	0	MODESTO CA	313	ALGEN	2.2
PO BOX 1331	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 1331	2.3
BOX 1555	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		BOX 1555	2.4
HC 1 BOX 84	LEWISTON	CA	96052	0	LEWISTON CA		HC 1 BOX 84	2.07
11433 MAGNOLIA AVE	RIVERSIDE	CA	92505	0	RIVERSIDE CA	11433	MAGNOLIA	2.02
HCR 79	LEWISTON	CA	96052	0	LEWISTON CA		HCR 79	2.1
PO BOX 2807	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2807	2.24
3345 COFFEY LANE	SANTA ROSA	CA	95403	0	SANTA ROSA CA	3345	COFFEY LANE	5
PO BOX 818	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 818	18.6
PO BOX 370	LEWISTON	CA	96052	370	LEWISTON CA		PO BOX 370	9.84
P.O. BOX 346	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 346	12
PO BOX 370	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 370	9.8
PO BOX 672	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 672	16
P0 BOX 2812	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		P0 BOX 2812	23.73
PO BOX 370	LEWISTON	CA	96052	370	LEWISTON CA		PO BOX 370	23.24
PO BOX 2001	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2001	37
1721 HILLSIDE BLVD	S SAN FRANCISCO	CA	94080	0	S SAN FRANCISCO CA	1721	HILLSIDE BLVD	28.8

SQ_FEET	USE CODE	LAND VALUE	IMPROV VALUE	PERS VALUE	TOTAL EXEMP	NET VALUE	BOOK PAGE
7497983	AXXX	126559	0	0	0	126559	025-060
2550439	EFX1	71749	43458	0	0	115207	025-190
1742400	AXXX	28082	0	0	0	28082	025-190
1089000	CXX1	55684	168946	0	7000	217630	025-190
2550439	EFX1	71749	43458	0	0	115207	025-190
16553	CXX2	4059	15450	0	0	19509	025-190
2465497	AXXX	11479	0	0	0	11479	025-200
1711471	CXX1	45937	160222	0	7000	199159	025-180
1740221	CXX1	45937	0	0	0	45937	025-180
871200	AXXX	11781	0	0	0	11781	025-180
435600	AXXX	37702	0	0	0	37702	025-180
426451	CXX1	47174	113735	0	7000	153909	025-180
435600	AXXX	33075	0	0	0	33075	025-180
101495	CXX1	22543	69083	0	7000	84626	025-650
94090	BXXX	38496	24743	0	0	63239	025-650
772319	CXX2	99461	240035	0	7000	332496	025-180
892980	CXX1	158887	131082	0	0	289969	025-180
653400	CXX1	34517	104624	0	7000	132141	025-180
16117	CXX1	2944	15743	0	0	18687	025-180
95831	AXXX	18650	0	0	0	18650	025-650
100189	CXX2	52984	135108	0	0	188092	025-650
104543	CXX1	19696	59137	0	7000	71833	025-650
90169	CXX1	27443	70789	0	7000	91232	025-650
87991	CHX1	27469	71889	0	7000	92358	025-650
91477	CXX1	33697	74136	0	7000	100833	025-650
97573	BXXX	29907	6101	0	0	36008	025-650
217800	CXX2	15407	80441	0	0	95848	025-180
810217	CXX2	27096	46216	0	0	73312	025-220
428630	EEX1	12407	6171	0	7000	11578	025-090
522720	CXX1	17890	57482	0	7000	68372	025-090
426889	AXXX	13524	0	0	0	13524	025-090
696960	EFX1	26922	9317	0	0	36239	025-090
1033679	DHE2	13769	78778	0	7000	85547	025-090
1012333	AXXX	25815	0	0	0	25815	025-090
1611720	CXX1	46244	91363	0	0	137607	025-090
1254529	BXXX	45506	2487	0	0	47993	025-090

APN	PARCEL	G OWN	GOV SPI	NAME_L_1ST	NAME_1ST_L	NAME2
025-090-4600	0250904600	PRV	PRV	CARR WAYNE D.	WAYNE D. CARR	
025-090-4600	0250904600	PRV	PRV	CARR WAYNE D.	WAYNE D. CARR	
025-090-4000	0250904000	PRV	PRV	FERGUSON DYLAN	DYLAN FERGUSON	
025-090-2200	0250902200	PRV	PRV	ALLEN E.R. REV. FAM. TRST. &	E.R. REV. FAM. TRST. &	
				EARL RAY & MARYLE T	EARL RAY & MARYLE T. ALLEN	
025-090-2400	0250902400	PRV	PRV	JONES SHIRLEYNE	SHIRLEYNE JONES	
025-220-1500	0252201500	PRV	PRV	BOOTH R.G. & D.M.E. TRSTEES	R.G. & D.M.E. BOOTH	
025-220-1100	0252201100	PRV	PRV	NICHOLS CAROL	CAROL NICHOLS	%CAROL ELI
025-060-0100	0250600100	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
025-090-1500	0250901500	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
025-190-0700	0251900700	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-140-0700	0151400700	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
025-060-2400	0250602400	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-210-4900	0152104900	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-140-2800	0151402800	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
015-140-1200	0151401200	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-140-1700	0151401700	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-210-1100	0152101100	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-210-1400	0152101400	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-220-1600	0152201600	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-250-0600	0152500600	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
017-200-0300	0172000300	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
015-200-0400	0152000400	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-140-0200	0151400200	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
015-210-4800	0152104800	PRV	SPI	SIERRA PACIFIC HOLDING CO.	SIERRA PACIFIC HOLDING CO.	
015-220-1200	0152201200	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	
025-060-0600	0250600600	PRV	SPI	SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC INDUSTRIES	

ADDRESS	CITY	STATE	ZIP CODE	ZIP_4	CITY_STATE	ST NO	STREET_BOX	ACRES
P.O. BOX 458	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 458	32.95
P.O. BOX 458	LEWISTON	CA	96052	0	LEWISTON CA		P.O. BOX 458	32.95
PO BOX 2751	WEAVERVILLE	CA	96093	0	WEAVERVILLE CA		PO BOX 2751	29.25
16958 ROAD #400	MADERA	CA	93638	8101	MADERA CA	16958	ROAD	14
PO BOX 831	LEWISTON	CA	96052	0	LEWISTON CA		PO BOX 831	40
HCO1 BOX 940	LEWISTON	CA	96052	0	LEWISTON CA		HCO1 BOX 940	11
HCO-1 BOX 940	LEWISTON	CA	96052	0	LEWISTON CA		HCO-1 BOX 940	1
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	640
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	80
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	302
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	643
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	146.81
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	442.36
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	480.82
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	640
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	560
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	639
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	160
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	820.87
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	542
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	210
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	77.3
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	292.4
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	40.94
PO BOX 496014	REDDING	CA	96049	6014	REDDING CA		PO BOX 496014	150.2
P.O. BOX 496014	REDDING	CA	96049	6014	REDDING CA		P.O. BOX 496014	56

SQ_FEET	USE CODE	LAND VALUE	IMPROV VALUE	PERS VALUE	TOTAL EXEMP	NET VALUE	BOOK PAGE
1435301	CXX1	68057	54991	0	7000	116048	025-090
1435301	CXX1	68057	54991	0	7000	116048	025-090
1274130	EFV1	37981	18906	0	7000	49887	025-090
609840	DEX2	36068	40953	0	0	77021	025-090
1742400	CXX1	59550	67419	0	7000	119969	025-090
479160	EEX1	22250	15934	0	7000	31184	025-220
43560	EEX1	7509	2812	0	0	10321	025-220
27878400	3XXX	48857	0	0	0	48857	025-060
3484800	4XBX	25890	2785	0	0	28675	025-090
13155120	3XXX	27650	0	0	0	27650	025-190
28009080	3XXX	58870	0	0	0	58870	015-140
6395043	3XXX	17553	0	0	0	17553	025-060
19269201	3XXX	40500	0	0	0	40500	015-210
20944519	3XXX	44021	0	0	0	44021	015-140
27878400	3XXX	58429	0	0	0	58429	015-140
24393600	3XXX	51167	0	0	0	51167	015-140
27834840	3XXX	58395	0	0	0	58395	015-210
6969600	3XXX	12485	0	0	0	12485	015-210
35757097	3XXX	71885	0	0	0	71885	015-220
23609520	3XXX	52608	0	0	0	52608	015-250
9147600	3XXX	22407	0	0	0	22407	017-200
3367189	AXXX	31212	0	0	0	31212	015-200
12736943	3XXX	33507	0	0	0	33507	015-140
1783347	3XXX	3659	0	0	0	3659	015-210
6542711	3XXX	42504	0	0	0	42504	015-220
2439360	3XXX	4532	0	0	0	4532	025-060

APPENDIX C

WILDLIFE HABITAT RELATIONSHIPS

(From A Guide to Wildlife Habitats of California, CA Department of Fish & Game, 1988)

GVC WHR HABITAT TYPES

Sierran Mixed Conifer (SMC)
Barbara H. Allen

Vegetation
Structure. The Sierran mixed conifer habitat is an assemblage of conifer and hardwood species that forms a multilayered forest. Historically, burning and logging have caused wide variability in stand structure, resulting in both even-aged and uneven-aged stands (Rundel et al. 1977). Virgin old-growth stands where fire has been excluded are often two-storied, with the overstory comprised of mixed conifer and the understory white fir and incense-cedar (Tappeiner 1980).

Forested stands form closed, multilayered canopies with nearly 100 percent overlapping cover (Rundel et al. 1977). When openings occur, shrubs are common in the understory (Kosco 1980). Closed canopy stand distribution is both extensive and patchy depending on scale, site, slope, soils, microclimate, and history.

At maturity, the dominant conifers range from 30 to 60 m (100 to 200 ft) tall with highly variable basal areas of about 17 to 26 sq m (180 - 280 sq ft). Diameter breast height at maturity for pines and Douglas-fir is commonly greater than 1 m (40 in); white fir greater than 0.9 m (35 in) is common (Laake and Fiske 1983b). Fuel loading in stands heavy with pine may reach 27,000 kg/ha (70 to 80 t/ac) in natural stands; whereas fuel loading in stands heavy with fir may reach 16,000 kg/ha (40 to 50 t/ac).

Composition. Five conifers and one hardwood typify the mixed conifer forest white fir, Douglas-fir, ponderosa pine, sugar pine, incense-cedar, and California black oak. White fir tends to be the most ubiquitous species (though most often a minor overstory component) because it tolerates shade and has the ability to survive long periods of suppression in brush fields. Douglas-fir dominates the species mix in the north, but is absent south of the Merced River (Tappeiner 1980). Ponderosa pine dominates at lower elevations and on south slopes. Jeffrey pine commonly replaces ponderosa pine at high elevations, on cold sites, or on ultramafic soils (Rundel et al. 1977). Red fir is a minor associate at the highest elevations. Sugar pine is found throughout the mixed conifer type. Black oak is a minor, but widespread, component in mixed conifer stands. Though black oak does best on open sites, it is maintained under adverse conditions such as shade, ridge tops, and south slopes where conifers may regenerate in its shade (Tappeiner 1980). In the central and particularly southern Sierra Nevada, giant sequoia is a striking associate of the mixed conifer type (Rundel et al. 1977). White fir, incense-cedar and sugar pine are associated with the mesic giant sequoia sites (Tappeiner 1980).

Deerbrush, manzanita, chinquapin, tan oak, bitter cherry, squawcarpet, mountain whitethorn, gooseberry, rose, and mountain misery are common shrub species in the mixed conifer understory (Kosco and Bartolome 1983). Grasses and forbs associated with this type include mountain brome, Carex, bull thistle, iris, Juncus, and needlegrass. In all, over 100 species of grasses, forbs and shrubs contribute to the flora of the mixed conifer habitat (Tappeiner 1980).

Other Classifications.- Other names for the Sierran mixed conifer habitat include yellow pine forest (Munz 1973). Parker and Matyas (1981) divide Sierran mixed conifer into five series: mixed conifer-fir, mixed conifer-pine, ponderosa pine, white fir and Jeffrey pine. Rundel et al. (1977) describes the mixed conifer as part of a White fir-mixed conifer forest and Cheatham and Haller (1975) call this habitat Sierran coniferous forest (8.42), a major subdivision of the lower montane coniferous forest habitat (8.4). Sierran mixed conifer is SAF type 243 (Tappeiner 1980). Where ponderosa pine or Douglas-fir predominates without significant amounts of white fir or incense-cedar, the forest is typed as Pacific ponderosa pine or Pacific ponderosa pine-Douglas-fir (SAF types 245 and 244, respectively) (McDonald 1980).

Habitat Stages
Vegetation Changes t;2-5:S-D;6. After logging or burning, succession proceeds from an ephemeral herb to perennial grass-herb, through a shrub-perennial grass stage, to conifers (Burcham 1964). In many areas, however, shrubs appear in the first year after disturbance (Kosco 1980). The habitat stages are stage 1, grass-forb, with bedstraw, plantain, mountain brome, and needlegrass as common early succession species; stage 2, shrub-seedling-sapling, characterized by manzanita, Ceanothus, cherry, gooseberry, and mountain misery. In the seedling tree stage through the sapling tree, pole tree, small tree, and medium/large tree stages, the five conifers gain dominance of the site.

Duration of Stages. Stage duration has been described by Verner (1980). The grass-forb stage, generally is short-lived (less than 2 years). The shrub-seedling-sapling stage is usually evident by yr 2 and lasts 10 to 40 yr; this stage is a mixture of shrubs and saplings up to 6 m (20 ft) tall depending on the site, degree, and type of disturbance. If tall shrubs capture the site, it may take 10 to 15 plus years for trees to dominate the site. The pole-medium tree stage supports trees up to 15 m (50 ft) tall and may last from 15 to 90 yr on poor sites. The mature and overmature stages include stands greater than about 30 m (100 ft) in height.

Biological Setting

Habitat. The type adjoins the Pacific ponderosa pine-Douglas-fir type (SAF 244) in the Klamath Mountains and Cascade Range, the Pacific ponderosa pine (SAF 245) and interior ponderosa pine (SAF 237),(PPN) at lower elevations and drier slopes, and the white fir (SAF 211), (WFR) and red fir (SAF 207), (RFR) types at higher elevations. Montane meadows and riparian deciduous woodlands are found within the Sierran mixed conifer type. Digger-pine oak, blue oak savannah and chaparral types may adjoin this type at drier, and lower elevations.

Wildlife Considerations. The mixed conifer forest supports some 355 species of animals (Verner and Boss 1980). Sensitive species inhabiting mixed conifer include spotted owl, fisher and pine marten. Endangered species include bald eagle and peregrine falcon (Verner and Boss 1980). Variety in plant species composition provides diversity in food and cover. Black oak acorns, berries from a variety of shrubs (e.g., deerbrush), and a great number of grasses and forbs provide the forage resource essential for wildlife (Kosco and Bartolome 1983).

Physical Setting

Soils supporting the Sierran mixed conifer habitat are varied, derived primarily from Mesozoic granitic, Paleozoic sedimentary and volcanic rocks, and Cenozoic volcanic rocks. Serpentine soils, found primarily in the northern mixed conifer zone, support a number of endemic plants. Soils are deep to shallow. Fissures and cracks in granitic parent material often support forest growth, even where soil development is shallow. Temperatures range from 24 to 58 C (40 to 96 F) in summer and 4 to 36 C (10 to 60 F) in winter and decrease with elevation (Major 1977). The growing season ranges between 90 and 330 days in the north with 40 to 200 frost-free days, and 180 to 365 days in the south with 180 frost-free days. Precipitation ranges from 76 to 229 cm (30 to 90 in) per year, from October to May, with increasing snowfall as elevation increases.

Distribution

The Sierran mixed conifer habitat generally forms a vegetation band ranging 770 to 1230 m (2500 to 4000 ft) in the north to 1230 to 3076 m (4000 to 10,000 ft) in the southern Sierra Nevada (Griffin and Critchfield 1972). The Sierra Nevada mixed conifer forest occupies between 1.8 to 3.2 million ha (4.5 to 7.8 million ac) in southern Oregon and California, dominating western middle elevation slopes of the Sierra Nevada. Disjunct populations of mixed conifer are found in the Peninsular, Transverse, and Coast ranges of California.

Klamath Mixed Conifer (KMC)

Gary L. Benson

Vegetation

Structure. Klamath-enriched mixed conifer (KMC) habitats typically are tall, dense to moderately open, needle-leaved evergreen forests with patches of broad-leaved evergreen and deciduous low trees and shrubs (Kochler 1977). On favorable mesic sites with little disturbance, the habitat is dominated by tall evergreen conifers up to 60 m (200 ft) in height with a rich shrub layer and well-developed herbaceous layer (Sawyer and Thornburgh 1977). On more xeric sites, the habitat is generally open, but very diverse forest land (Sawyer and Thornburgh 1977) having a well developed shrub layer.

Composition. The overstory layer is characterized by a mixture of conifers. Dominant conifers in the western portion of this habitat are white fir and Douglas-fir. In the east, dominant conifers are white fir, Douglas-fir, ponderosa pine, incense cedar and sugar pine. Other conifers in the overstory layer include Shasta red fir, Sierra lodgepole pine, mountain hemlock, western white pine, knobcone pine, Jeffrey pine and Brewer spruce. In a few isolated stands, other relic conifers include Pacific silver fir, subalpine fir, Port-Orford-cedar, Alaska-cedar, and Engelmann spruce. Occasional broad leaved trees include Sierra chinquapin, canyon live oak and California black oak. Pacific yew occurs as a small tree in the understory (D. A. Thornburgh, Dept. of Forestry, Humboldt State University, Arcata, Calif., pers. comm.; Parker and Matyas 1981) .

At higher elevations, red fir and mountain hemlock are more prevalent with occasional whitebark pine and foxtail pine (D. A. Thornburgh, pers. comm.). At lower elevations or on more xeric sites, ponderosa pine becomes more prevalent and white fir and Douglas-fir are reduced. Jeffrey pine is the principal overstory species found on ultramafic soils and serpentine outcrops (Kochler 1977, Sawyer and Thornburgh 1977).

Dense forests have a very rich shrub layer which can include Sierra laurel, Sadler oak, dwarf rose or western thimbleberry. In open-to-moderately dense forests, shrub-size plants in the subcanopy include small individuals of overstory species, especially Shasta red fir and white fir, as well as bitter cherry, Sierra chinquapin, pinemat manzanita, squawcarpet, huckleberry oak, Oregon-grape, greenleaf manzanita, dwarf rose, snowberry, and juneberry (Kochler 1977, Parker and Matyas 1981). The herbaceous layer is well developed and includes twinflower, American trailplant, queencup beadlily, western rattlesnake plantain, sweet-scented bedstraw, chimaphila spp., Idaho fescue, and tufted pinegrass (Sawyer and Thornburgh 1974).

Additional detailed information about the species composition in this habitat is contained in Sawyer and Thornburgh (1974).

Other Classifications. Other names for Klamath-enriched mixed conifer habitat include Mixed Conifer-Klamath Enriched Series (Parker and Matyas 1981), Klamath Montane Forest with Yellow Pine and Klamath Montane Forest with Douglas Fir (Kochler 1977), and Enriched Conifer Forest (Thorne 1976). It is included in the Red Fir Forest by Munz and Keck (1973) and in the Mixed Evergreen Zone by Proctor (1980). Cheatham and Haller (1975) further divide Klamath-enriched Conifer Forest into Siskiyou Enriched Conifer (8.541) and Salmon-Scott Enriched Conifer Forest (8.542). Sawyer and Thornburgh (1977) include Klamath-enriched Mixed Conifer habitat in the category of Abies magnifica Zone and in the upper elevations of the Abies concolor Zone of the "Klamath Montane Forests".

Habitat Stages

Vegetation Changes 1;2-5:S-D;6. Sawyer and Thornburgh (1977) indicate that the early successional stage is usually dense montane chaparral which originates from buried seed. This chaparral is dominated by manzanita, huckleberry oak, golden chinquapin, tobaccobrush and bitter cherry. This shrub stage is followed by a dense young growth conifer forest. According to Proctor (1980), the Klamath-enriched mixed conifer habitat goes through different successional stages following disturbance or manipulation. In general, these types presented by Proctor are early seral grassland, early seral shrub, young or second growth (conifer) forest and mature or old growth (conifer) forest. Sawyer and Thornburgh (1974, 1979)(No 1979 Lit Cite.) have identified several plant communities within the Klamath-enriched mixed conifer habitat that are considered to be potential or climax plant communities. They indicate that in some of these potential communities successful reproduction of most of the overstory species occurs in the understory indicating that the communities are perpetuating themselves.

Duration of Stages. Whittaker (1960) indicates that some forest trees in the Siskiyou Mountains are several centuries old. His studies also indicate that frequent fires were common, with older trees surviving intensive burns and continuing to dominate the upper levels of the tree strata. He concludes that portions of this habitat are stable for several centuries before natural disturbance restarts the process of succession. He further concludes that many vegetative units exhibited stability in spite of frequent fires and should be regarded as fire-adapted vegetation of a summer-dry climate. Commonly the plant communities in this habitat are 200 years old or younger. Often these communities have old growth conifers with deep fire scars, indicating the ability to persist in spite of fires. The mixed conifer communities of the eastern Klamath region are stable, with frequent light fires. The mixed conifer communities of the western Klamath region are usually burned enough to revert to the montane chaparral type (D. A. Thornburgh, pers. comm.).

Biological Setting

Habitat. The Klamath-enriched mixed conifer habitat is bounded by many other wildlife habitats. At the lower westernmost elevations, the demarcation between the Klamath-enriched mixed conifer habitat and the coastal mixed conifer habitat is not very clear. Klamath-enriched mixed conifer habitat has a larger number of conifer species, whereas the coastal mixed conifer habitat is dominated by white fir and Douglas-fir as well as hardwood species including Pacific madrone and tanoak. Numerous but small meadows and seeps occur throughout this habitat, contributing greatly to wildlife diversity. At lower elevations on its eastern border, the Klamath-enriched mixed conifer habitat interfaces with several habitats including Sierran mixed conifer, ponderosa pine, montane hardwood-conifer and mixed chaparral. On drier or very rocky sites or on rock outcrops, montane chaparral habitat occurs at the same elevation as Klamath-enriched mixed conifer habitat. At the upper elevation of this habitat, it interfaces with the subalpine conifer habitat.

Wildlife Considerations. The Klamath-enriched mixed conifer habitat covers a moderately large area in northwestern California. Extensive glaciation combined with complex geology has led to highly diverse vegetation, soils and wildlife habitats. A wide array of nesting and feeding opportunities and thermal cover for wildlife has resulted. Proctor (1980) lists the wildlife species that use this habitat at various successional stages. Rare, threatened or endangered wildlife in this habitat include spotted owl, peregrine falcon, wolverine, and Siskiyou Mountain salamander.

Physical Setting

The Klamath-enriched mixed conifer habitat occupies a complex of mountain ranges in northern California which are characterized by rugged, deeply dissected terrain with steep slopes due to extensive glaciation. This area has a considerable amount of ultramafic parent material and soils with scattered areas of serpentinitic soils; it also overlays a very old and complex geological structure. Average slopes are 60 percent or more and valleys are narrow. Soils found at higher elevations are predominantly Xerochrepts and Xerumbrepts and are generally very gravelly or cobbly. There are scattered areas of shallow unproductive soils such as Xerochrepts, or Xeralfs overlying peridotite and serpentine rock formations (Proctor 1980). There are also extensive areas of more productive Alfisols (B. Adamson, Shasta-Trinity National Forest, Redding, Calif., pers. comm.).

Climatic conditions include warm, wet winters and hot dry summers Mean monthly temperatures during the hottest month of the year range from 14 to 22 C (57 to 72 F). During the coldest month of the year temperatures range from 10 to 8 C (15 to 46 F). Mean annual temperature is approximately 11 C (52 'F) (Proctor 1980). Precipitation varies from 177 cm (69 in) on the western (maritime) side to 60 cm (24 in) on the eastern (continental) side. Most of the precipitation occurs during winter with generally less than 15 percent of precipitation falling during summer. Snowfall is moderate, ranging from 3 to 150 cm (2 to 60 in), with large amounts of snowfall occurring at the middle and high elevations where this habitat occurs. In years of heavy snowpack, the snow field may remain through the summer on north- and east-facing slopes above 1850 m (6160 ft) (Sawyer and Thornburgh 1974, Proctor 1980).

Distribution

The Klamath-enriched mixed conifer habitat is located within the Klamath Region, a geologically defined area in northwestern California comprised of a complex of mountain ranges including the Scott, Salmon, Marble, and southern Siskiyou Mountains, and the Trinity Alps. This habitat is normally found between 1350 2100 m (4500 - 6900 ft) and is restricted to the Klamath Region of northern California and southwestern Oregon.

Douglas-Fir (DFR)

Martin G. Raphael

Vegetation

Structure. This habitat forms a complex mosaic of forest expression due to the geologic, topographic, and successional variation typical within its range (Sawyer 1980). Typical aggregations include a lower overstory of dense, sclerophyllous, broad-leaved evergreen trees (tanoak, Pacific madrone) up to 35 m (114 ft) tall, with an irregular, often open, higher overstory of tall needle-leaved evergreen trees (Douglas-fir) up to 90 m (295 ft) (Marcot 1979, Sawyer 1980, Franklin et al. 1981, Thornburgh 1982). A small number of pole and sapling trees occur throughout stands (Thornburg 1982). On wet sites, shrub layers are well developed, often with 100 percent cover. Cover of the herbaceous layer under the shrubs can be up to 10 percent. At higher elevations, the shrubs disappear and the herb layer is often 100 percent. Typical mesic habitats have a poorly developed or non-existent shrub and herb layer. Dry habitats have greater cover of shrubs and especially grasses (Franklin and Dyrness 1973, D. A.Thornburgh, pers. comm.). On steeper (> 75%), drier slopes with shallow soils, the shrub and herb layer is poorly developed, represented mainly by moss-covered rocks (Sawyer et al. 1977). Diameter of overstory Douglas-fir ranges up to 450 cm (1140 in) and averages 150 to 220 cm (360 to 560 in) on better sites (Franklin and Waring 1980). Density of Douglas-fir decreases with stand age from about 400 stems >2 m tall/ha (160/ac) in 100-year old stands to 290 stems/ha (116/ac) in 250-year-old stands; density of other species increases from 765 to 1212 stems/ha (306 to 490/ac) M. G. Raphael, unpublished data). In a study of similar forests in Oregon, overstory foliage biomass was similar in young (37-year-old) stands, but understory biomass was nine times greater in the older stand (Grier et al. 1974). Mature overstory Douglas-fir trees have a typically cylindrical crown beginning at 20 to 40 m (66 to 131 ft), composed of irregularly scattered branches (Franklin et al. 1981). Diversity of tree size typically increases with stand age, as does tree spacing

(Franklin et al. 1981). Young stands have closely spaced and uniformly distributed trees, whereas older stands show a more patchy stem distribution. Snags and downed logs, an important structural component of this habitat, increase in density or volume with stand age (Franklin and Waring 1980, Raphael and Barrett 1984).

Composition. Overstory composition varies with soil parent material, moisture, topography, and disturbance history. Dry steep slopes on metamorphic and granitic parent materials are dominated by canyon live oak. Less rocky, dry soils support Douglas-fir, tanoak, and Pacific madrone in association with sugar pine, ponderosa pine, black oak, and canyon live oak. Deep mesic soils support an overstory of Douglas-fir with a tanoak-dominated understory. Wettest sites include Pacific yew and, less consistently, Port-Orford cedar. On ultrabasic derived soils, Douglas-fir attains less dominance and is replaced by Port-Orford cedar on mesic sites to the extreme northwest (Stein 1980a) and open stands of Jeffrey pine, incense cedar, sugar pine, knobcone pine, and western white pine on more xeric sites (Whittaker 1960, Whittaker 1961, Rockey et al. 1966, Mize 1973, Sawyer et al. 1977). In the southern and eastern extent if the type, ponderosa pine becomes a major codominant with Douglas-fir, and cover of black oak increases(Waring and Major 1964, Sawyer et al. 1977). In the absence of fire or other disturbance, western hemlock may occur as a codominant with Douglas-fir and tanoak at the western extent of the type in areas transitional to redwood forest (Sawyer et al. 1977). The shrub layer is typically composed of canyon live oak, Oregon-grape, California blackberry, dwarf rose, and poison-oak (Franklin and Dyrness 1973). Mesic sites support vine maple, California hazel, salal, and Pacific rhododendron (Sawyer et al. 1977). On sedimentary soils, the principal understory shrubs are California huckleberry, snowbrush ceanothus, salal, and Oregon-grape. Ultrabasic soils support a shrub layer of huckleberry oak, shrub tanoak, California-laurel, California buckthorn, and Brewer oak (Whittaker 1960). Forbs and grasses include Pacific trillium, western swordfern, insideout flower, broad-leaf starflower, deervetch vanillaleaf, American deervetch, princes pine, common Whipplea, California honeysuckle, American trailplant, whitevein shinleaf, western rattlesnake plantain, Sierra fairy bells, bracken fern, western fescue, common beargrass, and Hartford oniongrass (Franklin and Dyrness 1973, Sawyer et al. 1977). Mize (1973), Simpson (1980), and Laidlaw-Holmes (1981) discuss understory composition in relation to parent material and soil moisture.

Other Classifications. Other names for Douglas-fir habitat include Douglas-fir-Tanoak-Madrone, Douglas-fir-Pine-Madrone, Douglas-fir Series (Parker and Matyas 1981), Port-Orford-Cedar-231 (Stein 1980a), Douglas-fir-Tanoak-Pacific Madrone -234(Sawyer 1980), Western Hemlock Forest -8.22, and Douglas-fir Forest -8.24 (Cheatham and Haller 1975), Douglas-fir Forest -13(Munz and Keck 1959), Evergreen Forest Land -42 (Anderson et al. 1976), Mixed-Evergreen Zone (Franklin and Dyrness 1973), Pseudotsuga-Hardwood Forest (Sawyer et al. 1977), Mixed Evergreen Forest with Chinquapin, and Mixed Evergreen Forest with Rhododendron (Kochler 1977), and Mixed Evergreen Forest(Marcot 1979).

Habitat Stages

Vegetation Changes 1; 2-5:S-D;6. After a major disturbance, Douglas-fir habitats can proceed through structural classes 1-5, although the sequence is often truncated on poorer sites. Stage 6 stands occur when periodic disturbance leads to a multi-aged stand or a shade tolerant understory develops. This habitat can exist as any of the canopy closure classes S-D, although class D is most frequent. After logging or intense fire, tanoak regenerates by sprouting and Douglas-fir by seeding. Good seed years are irregular, with peaks at about seven-year intervals (Thornburg 1982). Tanoak sprouts grow faster than Douglas-fir seedlings and initially dominate along with various shrubs and herbs. Tanoak can form a nearly solid canopy for 60 to 100 years until natural mortality allows Douglas-fir to become dominant. In mixed stands of tanoak and Douglas-fir, the latter overtops tanoak in 15 to 30 years on mesic sites (Thornburgh 1982). On xeric sites, hardwoods dominate longer. Thus, abundance and growth of tanoak sprouts depends on the structure of the previous stand and on available soil moisture. Over the course of succession, grasses, herbs, and shrubs are most abundant in the seedling tree class, least abundant in pole and small tree classes, and moderately abundant in the medium/large tree class. Snag and log volume also increase with stand age.

Duration of Stages. Because of frequent fires, typical climax Douglas-fir habitat is rare (Thornburgh 1982). In the absence of disturbance, such stands develop in 80 to over 250 years, depending on site quality (McArdle 1961, Lang 1980). Individual Douglas-fir trees can live to 1250 years; ages in excess of 750 years are common (Franklin and Waring 1980). Following disturbance, the seedling tree class persists for 5 to 20 years, depending on site quality. The sapling tree class can be 5 to 60 years old the pole-tree, small tree, and medium large tree classes can be 20 to 130, 35 to over 130, and 80 to over 250 years, respectively (McArdle 1961, Lang 1980, Franklin et al. 1981). Multilayered (class 6) stands probably develop over the same time period as medium/large tree stands.

Biological Setting

Habitat. Douglas-fir occurs at low to moderate elevations in juxtaposition with a number of other habitats. Redwood (RDW) occurs at lower elevations to the west, and Mixed Conifer (MCN) occurs to the east and at higher elevations within the range of Douglas-fir. To the north, especially in more mesic sites, this habitat is bounded by hemlock and sitka spruce zones of Franklin Dyrness (1973)(No 1973 cite. Only a 1969 Cite. Not placed in Lit Cite at enc.). More xeric sites to the south are bounded by and interspersed with Valley-Foothill Hardwood (VFH) and Valley-Foothill Hardwood-Conifer (VHC). Their habitats, such as Montane Hardwood (MHW), Montane Hardwood Conifer (MHC), Montane Riparian (MRI) and Montane Chaparral (MCP) form a complex mosaic with Douglas-fir at similar elevations (Sawyer et al. 1977).

Wildlife Considerations. This habitat supports a high abundance of wildlife species. Weins (1975)(Not in Habitat Lit Cite.) reported that northwest coastal coniferous forests supported a higher average bird density than any other forest type in North America. Bird species typical of this habitat include spotted owl, western flycatcher, chestnut-backed chickadee, golden-crowned kinglet, Hutton's vireo, solitary vireo, hermit warbler, and varied thrush. Among amphibians and reptiles, the distributions of northwestern salamander, Pacific giant salamander, Olympic salamander, Del Norte salamander, black salamander, clouded salamander, tailed frog, and northwestern garter snake are largely coincident with the distribution of Douglas-fir habitat. Although not restricted to this habitat, the ensatina is its most abundant amphibian. Typical mammals include fisher, deer mouse, dusky-footed woodrat western redbacked vole, creeping vole, Douglas' squirrel, Trowbridge's shrew, and shrew-mole.

Physical Setting

Climatically, this habitat experiences hot, dry summers and cool, mild, wet winters. Mean July temperatures range from 14 to 22 C (57-72 F). Average January temperatures range from 0 to 8 C (32-46 F) (Proctor et al. 1980). Annual precipitation varies from 60 to 170 cm (24-27 in), generally less than 15 percent falling during summer. Precipitation increases inland and at higher elevations. Snowfall ranges from 3 to 80 cm (2 to 31 in) and rarely persists later than June (Proctor et al. 1980). Topography is characterized by rugged, deeply dissected terrain and steep slopes (Franklin and Dyrness 1973), especially toward the south. Major soil types are based on sedimentary granitic, and ultramafic parent materials of gabbro, peridotite, and serpentine (Whittaker 1960).

Distribution

Douglas-fir habitat occurs in the north Coast Range from Sonoma County north to the Oregon border and in the Klamath Mountains of California and Oregon. This habitat usually occurs at elevations from 150 to 600 m (500 to 2000 ft) in the Coast Range and from 300 to 1200 m (1000 to 4000 ft) in the Klamath Mountains. It can occur at higher elevations if plentiful precipitation is present (Sawyer 1980).

White Fir (WFR)

Karen Shimamoto

Vegetation

Structure. The White Fir (WFR) habitat is characterized by nearly monotypic even-aged overstory (Cheatham and Haller 1975, Paysen et al, 1980, Riegel 1982, Rundel et al. 1977). Overlapping crowns that cast deep shade are characteristic, although open stands are common (Cheatham and Haller 1975, Eyre 1980, Riegel 1982). Northern California specimens grow to about 70 m (230 ft) in height. Southern California specimens grow to about 30 m (100 ft) (Cheatham and Haller 1975). The understory may consist of sparsely scattered grasses, forbs, and shrubs, or white fir seedlings and saplings (Cheatham and Haller 1975, Eyre 1980, Paysen et al. 1980). However, on moist swales or drainage bottoms, herbaceous cover may approach 100 percent (Rundel et al. 1977). Downed material usually consists of logs, branches and needle litter (Cheatham and Haller 1975). Fire influences the white fir habitat by causing a mosaic of even-aged stands in different successional stages.

Composition. Mature white fir stands, normally monotypic, with more than 80 percent occurring as white fir, are found throughout California; from the Klamath Mountains along the north coast to the south coast mountain ranges, and in interior ranges from the Warner Mountains in the Great Basin to the Clark, Kingston, and New York mountain ranges in interior southern California (Rundel et al. 1977, Parker and Matyas 1981).

Shade and downed woody material tend to inhibit understory species (Parker and Matyas 1981). In the Klamath Mountains, for example, canyon live oak and chinquapin are the predominant understory species and open stands usually include squawcarpet and barberry. Dense stands, however, have herbaceous species such as wake robin, vetch, and pipsissewa. Jeffrey pine is an associate in the Cascades and Warner mountain ranges, with greenleaf manzanita and currant as understory shrubs. Tree associates change in the southern Sierra Nevada, where sugar pine, incense-cedar, and red fir are found. Pipsissewa, wintergreen, current, and snowplant are in the understory (Cheatham and Haller 1975). In the south coast range and south interior range, sugar pine and single-leaf pinyon occur as associates of white fir, most commonly on cool, north- and east-facing slopes, respectively. Rundel et al. (1977) describes white fir vegetative composition over elevational and moisture differences in the Sierra Nevada.

Other Classifications. Historically, the white fir habitat has been described as part of the mixed conifer habitat (white fir phase) (Griffin 1967) or as ecotonal between mixed conifer and red fir. Munz and Keck (1959) simply included it in yellow pine forest. White fir habitat is now named White Fir (Parker and Matyas 1981); White Fir (211) (Eyre 1980); White Fir Series (Paysen et al. 1980); White Fir Zone (Franklin and Dyrness 1973); Sierran White Fir (8.424) and Southern California White Fir (8.532) (Cheatham and Haller 1975); White Fir-Sugar Pine Forest (Thorne 1977).

Habitat Stages

Vegetation Changes 1;2-5:S-D;6. Following disturbance, white fir proceeds through the seral stages (Gordon 1970,1973b, Eyre 1980, Conard 1980, Conard and Radosevich 1982, Hopkins 1982, Laacke and Fiske 1983).

In the grass/forb stage, bare mineral soil provides the best seedbed for white fir. If the site has been burned, brush seedlings such as manzanita, snowbrush ceanothus, mountain whitethorn, deerbrush, willow, bittercherry, huckleberry oak, currant, gooseberry and chinquapin also become established.

In the shrub/sapling stage, large brush fields comprise 75 percent of the vegetative cover and persist for 30-50 years. Varying density of white fir seedlings (1000-10,000 stems per ha) establish within 10 to 20 years, growing under and eventually overtopping the brush. In managed situations, brush is removed and white fir growth increases by as much as 200 percent in height.

In the pole/medium tree stage, white fir overtops the shrubs which for the most part are shaded out and die. Sometimes an understory of white fir establishes by the time the overstory reaches pole height. This multilayered condition persists into later stages. In the large tree stage, a characteristic understory develops including whitevein shinleaf, little prince's pine, bracken fern, striped coralroot, and milk kelloggia primarily root parasites and semiparasitic species.

Duration of Stages. The duration of the grass/forb stage is dependent on the availability of a white fir seed source and a good seed crop every 3-9 years (Schopmeyer 1974, Gordon 1978). Reforestation activities would limit the duration of this seral stage to less than 5 years. In the shrub/sapling stage, white fir seedlings and saplings can persist for 30 to 50 years under a brush overstory. The average age in the large tree stage is 250 to 300 years with 70 to 90 cm (28-35 in) dbh (Hopkins 1979a, 1979b).

Biological Setting

Habitat. In the Klamath Mountains, the Cascades, and the Sierra Nevada, white fir habitat occurs between mixed conifer and red fir habitats (Eyre 1980, Parker and Matyas 1981). In the south coast Transverse and Peninsular ranges, and in the mountain ranges of interior southern California, white fir intergrades at lower elevations with mixed conifer and is replaced at higher elevations by lodgepole pine (Cheatham and Haller 1975, Parker and Matyas 1981).

Wildlife Considerations. White fir habitat is probably the coolest, moistest, nonriparian habitat within the lower to mid-elevation forests in northern California. In southern California this habitat is colder and drier, probably equivalent to the red fir habitat elsewhere, but with drier conditions (Cheatham and Haller 1975).

As stands mature, a high percentage of defective trees are found, the result of windthrow and heart rot fungus (Gordon 1973, Hopkins 1982). Excellent habitat is provided for snag and cavity dependent wildlife species, particularly when breaks occur between 15-30 m (50-100 ft). The additional benefit of heart rot is the cylindrically stable snag created as a result of the rot moving from the inside of the tree to the outer diameter.

White fir is the preferred tree species for insect-gleaning yellow-rumped warblers and western tanagers, and is also commonly used by other insect-gleaning birds, such as mountain chickadee, chestnut-backed chickadee, golden-crowned kinglet, and black-headed grosbeak (Airola and Barrett 1985).

Physical Setting

White fir habitats are found on a variety of soils developed from different parent material, including volcanic and igneous rocks, granitics, various metamorphics, and sedimentary material (Franklin and Dyrness 1973, Fowells 1965, Hopkins 1982). Soils are coarse textured, well-drained, have poorly developed profiles, are often rocky, and are cold, with mean annual temperatures from 0 to 10 C (32 -50 F) (Cheatham and Haller 1975, Riegel 1982, Laacke and Fiske 1983a). Cooler north- and east-facing slopes are the most common sites throughout the state, however, Riegel (1982) noted the presence of unusually xeric white fir stands in the Warner Mountains. Precipitation is between 76-178 cm (30-70 in) mostly in the form of snow. Almost all precipitation falls between October and May (Laacke and Fiske 1983).

Distribution

Elevation of white fir habitat varies with latitude. In the Klamath Mountains of Trinity and Siskiyou Counties, white fir is found from 1370 to 1680 m (4500-5500 fl); from 1520 to 1830 m (5000-6000 ft) in the Cascade and Warner Mountains; at about 1675 m (5500 ft) in the Southern Sierra Nevada; above 1800 m (6000 ft) throughout the Transverse and Peninsular Ranges; and between 1800 to 2135 m (6000-7000 ft) in the southern interior ranges (Cheatham and Haller 1975, Parker and Matyas 1981). Small relict stands are also found at 2300 to 2880 m (7500-9500 ft) in the Clark, Kingston, and New York Mountains in the Mojave Desert (Thorne 1977, Paysen et al. 1980).

Ponderosa Pine (PPN)

E. Lee Fitzhugh

Vegetation

Structure. Tree spacing in ponderosa pine stands varies from open patchy to extremely close. On high quality sites, virgin stands may be 46-55 m (150-180 ft) high, with diameters from 0.91.2 m (3-4 ft) (Harlow and Harrar 1950). Typical overstory coverage of all layers may exceed 100% (Vankat 1970). Other conifers, when present, provide denser crowns than do the pine, thus creating habitat diversity. Grasses, shrubs, and deciduous trees may be present or absent. Typical coverage of shrubs is 10-30% and of grasses and forbs is 5-10% (Barbour 1986).

Composition. The ponderosa pine habitat includes pure stands of ponderosa pine as well as stands of mixed species in which at least 50% of the canopy area is ponderosa pine. Associated species vary depending on location in the state and site conditions. Typical tree associates include white fir, incense-cedar, Coulter pine, Jeffrey pine, sugar pine, Douglas-fir, bigcone Douglas-fir, canyon live oak, California black oak, Oregon white oak, Pacific madrone and tanoak.

Associated shrubs include manzanita, ceanothus, mountain-misery, Pacific dogwood, hairy yerba-santa, yellowleaf silktassel, bitter cherry, California buckthorn, poison-oak, Sierra gooseberry.

Grasses and forbs include slimleaf brome, Orcutt brome, carex, smallflower melicgrass, bluegrass, bottlebrush squirreltail, bedstraw, bracken fern, bush morning-glory, rhomboid clarkia, Child's blue-eyed mary, shrubby eriastrum, splendid gilia, Sierra iris, whisker-brush, Inyo bush lupine, summer lupine, purple nightshade, streptanthus, gooseroot violet, and wild iris.

Other Classifications. The ponderosa pine habitat, as defined here, forms a part of the yellow pine forest of Munz and Keck (1959) and Thorne (1977), the montane forest of Griffin and Critchfield (1976)(No 1976 Lit Cite. There is a 1972 Lit Cite. 1972 Cite not placed in Lit cite at end.), the ponderosa/Jeffrey pine series of Pays More restrictive types which include only a part of the ponderosa pine habitat are Pacific ponderosa pine (245) (Eyre 1980), ponderosa pine (Parker and Matyas 1979 and Barbour and Major 1977), western Sierra ponderosa pine forest (Barry unpublished, cited in Cheatham and Haller 1975), ponderosa pine series of the Sierra montane conifer forest (Pase 1982a), Coast Range ponderosa pine forest and "westside" ponderosa pine forest (Cheatham and Haller 1975), and Sierran yellow pine forest (Kochler 1977). en, et al. (1980) and the mid-montane conifer forest of Barbour (1986). In addition, on those sites where ponderosa pine is dominant, portions of other montane forests (Kochler 1977), and Pacific ponderosa pine-Douglas-fir (Barbour 1986), and mixed conifer (244, 243), (Eyre 1980) are included in ponderosa pine habitat.

Habitat Stages

Vegetation Changes 1; 2-5:SD. Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic ground fires. In many of these stands, crown fires result in dense montane chaparral communities (Cheatham and Haller, 1975). Young, dense stands, as in plantations, exclude most undergrowth once trees attain a closed canopy. Prior to that, dense brush is typical, but an herbaceous layer may develop on some sites.

Duration of Stages. On sites or areas that are dry or of low quality, significant pine regeneration may depend on concurrent disturbance of chaparral and a good pine seed crop with favorable weather. Thus, it may require 50-100 years for significant pine regeneration in the absence of intervention. Clear cuts with minimal brush control develop a dense stand of pole-size trees in 20-30 years, twice the time required when brush is completely removed. Dense brush is typical in young stands and an herbaceous layer may develop on some sites. On drier sites, there is fewer tendencies for succession toward shade-adapted species. Sites disturbed by fire or logging sometimes are converted to dense montane chaparral or mixed chaparral. Moist chaparral areas of higher site quality tend to develop directly into mixed conifer stands. As young, dense stands age and attain a closed canopy, they exclude most undergrowth. When other adapted conifers occur in moist ponderosa pine stands of medium to high site quality, they may form a significant understory in about 20 years in the absence of fire. If allowed to continue, such succession may change the structure and composition of the stand within 40 years sufficiently to favor wildlife adapted to mixed conifer habitats. Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic ground fires (Cheatham and Haller 1975).

Biological Setting

Habitat. In Northern California, ponderosa pine stands occur above coastal oak woodland, valley oak woodland, blue oak woodland, blue oak-digger pine and below mixed conifer. Montane hardwood stands may be below or interspersed with ponderosa pine. Jeffrey pine stands often occur above ponderosa pine, but may be found on serpentine soils or on harsh sites at lower elevations in the ponderosa pine zone. Farther south, coastal scrub, chamise-redshank, mixed chaparral, or woodland oaks are typical at the lower boundary of the ponderosa pine habitat, with bigcone Douglas-fir or true firs at the upper edge. Dry, rocky sites within the habitat may support montane chaparral, mixed hard wood-conifer or closed-cone pine-cypress. Isolated, small patches of bigcone Douglas-fir may occur in mesic canyons or on north-facing slopes within ponderosa pine stands.

Wildlife Considerations. Ponderosa pine sometimes is a transitional or migratory habitat for deer and can be extremely important to deer nutrition in migration holding areas. A mixture of early and late successional stages closely interspersed probably will provide good general wildlife habitat but riparian zones, deer migratory routes and holding areas require special consideration during management planning. The California condor uses the ponderosa pine habitat from Madera and Santa Clara Counties southward. Moreover, the Sierra Nevada red fox, Siskiyou mountain salamander and Shasta salamander also are found in the habitat.

Physical Setting

The lower elevational limit of the habitat may correspond to a mean annual temperature less than 13 C (55 F) and precipitation greater than 350 mm (33 in) except in southern California (Barbour 1986). Brown (1982) reported a minimum precipitation level of 635 mm (25 in) annually in the Peninsular Ranges. Ponderosa pine is found on all aspects, depending on soils and location within the local elevational range. Less than one-third of the precipitation is snowfall (Barbour 1986).

Distribution

Ponderosa pine habitat is found on suitable mountain and foothill sites throughout California except in the immediate area of San Francisco Bay, in the north coast area, south of Kern County in the Sierra Nevada and east of the Sierra Nevada Crest. Elevational ranges include 240-180 m (800-5000 ft) in the northern Sierra Nevada and Cascades, 1200-2100 m (3937-6890 ft) in the central and southern Sierra Nevada and 1300-2140 m (4265-7021 ft) in the Transverse and Peninsular Ranges, although it may be found as low as 105 m (3445 ft) in moist south-coastal sites (Rundel et al. 1977, Thorne 1977, Brown 1982 and Cheatham and l Haller 1975). The ponderosa pine habitat is replaced by Jeffrey pine on the Mojave Desert slopes of the Transverse Range and often on the eastern side of the Peninsular and Coast Ranges.

Closed-Cone Pine-Cypress (CPC)

Deborah B. Jensen

Vegetation

Structure._ This habitat includes a number of different series of evergreen, needle-leaved trees. The height and canopy closure of these series are variable and depend upon site characteristics, soil type, the age of the stand and the floristic composition (Cheatham and Haller 1975, Kochler 1977, Parker and Matyas 1981). The closed-cone pine habitats are similar to each other and will be described separately from the cypress habitats, although some of the series within this habitat contain both pine and cypress.

Cypress habitats may reach a height of 10 to 20 m (33 to 66 ft). The understory is a well-developed shrub layer of chaparral species (chamise and manzanita) on open, well-drained sites and a low, dense cover of shrubs and herbs on the poorly drained soils. On low nutrient or serpentinic soils the shrub layer cover is often less than 50 percent. Pine habitats typically reach heights of 30 m (66 ft). Most pine series have a shrub layer of chaparral species with high relative cover (up to 100% and a sparse herbaceous layer.

After fire, particularly on good sites, both cypress and pine habitats form dense, even-aged stands. As the stand matures, the stocking density decreases, but single species site dominance is common. Closed-cone Pine-Cypress habitats found along the extreme coast or on very shallow infertile soils contain stunted, wind-pruned individuals.

Composition._ This habitat is typically dominated by a single species of one of the closed-cone pines or cypress; few stands contain both pines and cypress. In general, associated species change as the dominant species changes. In southern California, cypress habitats are dominated by Tecate, Cuyamaca, or Piute cypress and contain species common to the surrounding chaparral such as chamise, manzanita, ceanothus and California buckwheat (Armstrong 1978).

MacNab and Sargent cypress, both northern California species, are frequently associated with digger pine, leather oak, scrub oak, sticky whiteleaf manzanita and/or wedgeleaf ceanothus (Cheatham and Haller 1975, Vogl et al. 1977); the herbaceous layer may support a number of grasses and forbs. Sargent cypress stands are on moister slopes than the surrounding (No Hardham 1982 Lit Cite. There is a Hardham 1962 cite.) ding chaparral stands (Koenig et al. 1982, Hardham 1982). Modoc cypress groves contain species from the adjacent yellow pine, juniper woodland or sage scrub habitats.

Along the immediate coast in Central California, Monterey cypress occurs in nearly pure stands with some salal and rhododendron in the understory. Gowen cypress associates with a number of north coastal shrub species, including rhododendron, Pacific bayberry and salal. Santa Cruz cypress stands, also found in Central California, include knobcone pine, ponderosa pine and silverleaf manzanita (Cheatham and Haller 1975, Vogl 1977, Kochler 1977). Mendocino pygmy cypress, the northern-most coastal cypress, may be codominant with pygmy pine. The understory in these stands has a number of northern shrub species associates including California huckleberry, Labrador tea, glossyleaf manzanita and salal (Sholars 1983(No Sholars 1983 Lit Cite. I used Sholars 1982 for Lit Cite at end.), Westman and Whittaker 1975).

The pines which dominate Closed-cone habitats are knobcone pine, Monterey pine, Bishop pine, Torrey pine and beach pine. Knobcone pine frequently grows in small dense patches with chamise, ceanothus, leather oak and manzanita occurring between patches or in openings in the pine stands (Colwell 1980). Monterey pine stands include coast live oak and occasionally knobcone pine and madrone in the overstory. The shrubby understory includes California buckthorn, poison oak, California huckleberry and woolyleaf manzanita (Roy 1966). Shrubs associated with Bishop pine stands are typically those of the surrounding vegetation: California huckleberry, salal, rhododendron and Labrador tea in the north, (Westman and Whittaker 1975) and chamise, manzanita, toyon and poison oak in the southern stands (Cole 1980). Torrey pine stands are very rare, two stands occur on the mainland and two on the Channel Islands. Associated woody vegetation includes manzanita, ceanothus and California sage. Beach pine habitats, found on stabilized dunes of the north coast, include bearberry manzanita, salal, Pacific bayberry and wavyleaf silktassel (Thorne 1976).

Other Classifications.- Other names of Closed-cone Pine-Cypress habitat include: MacNab Cypress, Sargent Cypress, Pygmy Cypress, Modoc Cypress, Piute Cypress, Knobcone Pine, Bishop Pine, Monterey Pine, Santa Cruz Cypress, Gowen Cypress, Monterey Cypress, Cuyamaca Cypress, Tecate Cypress, and Torrey Pine Series (Parker and Matyas 1981); Knobcone Pine - 248 (Colwell 1980), Closed-cone Coniferous Pine, Monterey Pine, and Torrey Pine Series, (Paysen et al. 1980), Closed-cone Pine Forest (Munz and Keck 1973), Coastal Cypress and Pine Forests (Kochler 1977), 42 Evergreen Forest Land (Anderson et al. 1980)(No Anderson et al. 1980 Lit Cite. Only Anderson et al. 1976.) and Closed-cone coniferous woodland, Shore pine woodland and Torrey pine woodland (Thorne 1976).

Habitat Stages

Vegetation Changes 1;2-5:S-D. Closed-cone pines and cypress retain their seeds in serotinous cones which remain on the branches. These habitats are true fire-climax or fire-dependent vegetation types, but fire may occur at any phase of the community. The heat of the fire causes the cones to release seeds which fall on the bare mineral soils. The full sunlight provided in early successional stages is excellent for seedling establishment and promotes the dense even-aged stands typical of all types of closed-cone pine and cypress habitats. Numerous "fire following" herbaceous species are abundant in the early successional stages following fire.

Duration of Stages._ Stand longevity varies greatly among types. For some, the fire frequency and life span are not known; other types are known to be short-lived. For example, knobcone has a short life span, with fire frequencies between 35-50 years. Individual knobcones which escape fire rarely live to 100 years of age (Vogl 1963)(No Vogl 1963 Lit Cite.). Tecate cypress do not produce cones until the trees are 10 years old and they reach maximum cone production at about 50 years (Zedler 1977). In contrast to these, small individuals of pygmy pine may be over 200 years old.

Biological Setting

Vegetation._ The cypress habitats usually occur as "arboreal islands" (Bowers 1961) within a matrix of chaparral or forest types. Similarly the pine habitats are patches in the surrounding chaparral, Montane Hardwood-Conifer or Mixed Conifer habitats.

Wildlife Considerations._ Numerous game species, including tree squirrels and band-tailed pigeons, and nongame species make use of this type for feeding and cover. Few species make substantial use of this type as a breeding habitat, although the great horned owl and red-tailed hawk will nest in closed-cone pine forests.

Physical Setting

Closed-cone Pine-Cypress habitats are typically found on sites that are more rocky and infertile than the surrounding soils. Many stands (especially of knobcone pine, and Sargent and MacNab cypress) are found on serpentine soils. Although, typically found at low elevations, due to the coastal distribution of much of this habitat type, interior stands may be found at elevations up to 2000 m (6550 ft). Landforms are gentle to steep slopes where stands occur in interior California and coastal terraces or bluffs where distributed along coastal California.

Distribution

Closed-cone pine-cypress occurs in patches as an interrupted forest along coastal California from southern San Diego county north to Oregon. Inland, the distribution is a few widely scattered locations in the Peninsular and Coast Ranges and in the North and Central Sierra Nevada. Monterey Cypress occurs naturally in two locations on the Monterey peninsula. Elevations range from nearly sea level to approximately 2000 m (6550 ft) (Griffin and Critchfield 1972, Cheatham and Haller 1975).

Montane Hardwood-Conifer (MHC)

Richard Anderson

Vegetation

Structure. Montane Hardwood-Conifer (MHC) habitat includes both conifers and hardwoods (Anderson et al. 1976), often as a closed forest. To be considered MHC, at least one-third of the trees must be conifer and at least one-third must be broad-leaved (Anderson et al. 1976). The habitat often occurs in a mosaic-like pattern with small pure stands of conifers interspersed with small stands of broad-leaved trees (Sawyer 1980). This diverse habitat consists of a broad spectrum of mixed, vigorously growing conifer and hardwood species. Typically, conifers to 65 m (200 ft) in height form the upper canopy and broad-leaved trees 10 to 30 m (30 to 100 ft) in height comprise the lower canopy (Proctor et al. 1980, Sawyer 1980). Most of the broad-leaved trees are sclerophyllous evergreen, but winter-deciduous species also occur (Cheatham and Haller 1975).

Relatively little understory occurs under the dense, bilayered canopy of MHC. However, considerable ground and shrub cover can occur in ecotones or following disturbance such as fire or logging. Steeper slopes are normally devoid of litter; however, gentle slopes often contain considerable accumulations of leaf and branch litter (Cheatham and Haller 1975).

Composition. Common associates in MHC are ponderosa pine, Douglas-fir, incense-cedar, California black oak, tanoak, Pacific madrone, Oregon white oak, and other localized species. Species composition varies substantially among different geographic areas.

In the north coast, California black oak, Oregon white oak, golden chinquapin, and canyon live oak are commonly found with white fir, Douglas-fir, and ponderosa pine (Parker and Matyas 1981). In the Klamath Mountains and north coast from the Oregon border to Marin County, Oregon white oak, tanoak, Pacific madrone, red alder, Douglas-fir, western red cedar, western hemlock, ponderosa pine, sugar pine, and knobcone pine are common (Kochler 1977, McDonald 1980(Is it a or b Lit Cite), Parker and Matyas 1981). In the northern interior, California black oak, bigleaf maple, Pacific madrone, and tanoak are common with ponderosa pine, white fir, incense-cedar, Douglas-fir, and sugar pine forming the overstory. In the northern Sierra Nevada, common associates include California black oak, bigleaf maple, white alder, dogwood, Douglas-fir, incense-cedar and ponderosa pine. In the southern Sierra Nevada, common associates include California black oak, black cottonwood, canyon live oak, Jeffrey pine, Douglas-fir, ponderosa pine, sugar pine, incense-cedar, and localized areas of giant sequoia (Kochler 1977, Parker and Matyas 1981). In the central coast, common associates include coast live oak, big leaf maple, Pacific madrone, tanoak, canyon live oak, Coulter pine, coastal redwood and, to a lesser extent, California black oak and ponderosa pine. In the northern central coast, Douglas-fir is found; while in the southern areas, bigcone Douglas-fir occurs. In the Tehachapi, transverse and peninsular ranges of Southern California, common associates include canyon live oak, Pacific madrone, coast live oak and, to a lesser extent, California black oak, ponderosa pine, sugar pine, and incense-cedar (Thorne 1976, Kochler 1977, Parker and Matyas 1981).

Other Classifications. Montane Hardwood-Conifer is very diverse and has been given a variety of names in the literature including: Mixed Evergreen Forest (Munz and Keck 1973); Mixed Evergreen Zone - Second Growth Forest (Broadleaf 1.1.1H) (Mixed 1.2.31) (Proctor et al. 1980); Mixed Evergreen Forest with Chinquapin, Mixed Hardwood Forest, Mixed Hardwood and Redwood Forest, Oregon Oak Forest, Coulter Pine Forest (Kochler 1977); Mixed Evergreen Forest, Coast Range Mixed Conifer Forest, Santa Lucia Fir Forest, Coast Range Ponderosa Pine Forest, Coulter Pine Forest (Cheatham and Haller 1975); Santa Lucia Fir Series, Bigcone Douglas-fir Series, Madrone Series and Black Oak Series (Paysen 1980)(No Paysen 1980 Lit Cite. There is a Paysen et al. Cite.); Oregon White Oak (Stein 1980); California Black Oak (McDonald 1980); Douglas-fir-Tanoak-Pacific Madrone (Sawyer, 1980); Black Oak Series, Maple-Alder-Dogwood Series, Mixed Conifer-Pine Series, Madrone-Tanoak Series (Parker and Matyas 1981).

Habitat Stages

Vegetation Changes 1; 2-5:S-D; 6. This habitat is climax in most cases; however, it can occur as a seral stage of mixed conifer forests. Vegetation response following disturbance, such as fire or logging, begins with a dense shrubby stage dominated by taller broad-leaved species. The stand gradually increases in height, simultaneously developing into two canopy strata with faster growing conifers above and broad-leaved species below. On mesic sites the conifer component overtakes the hardwood component more rapidly than on xeric sites, where the hardwood component is dominant longer (McDonald 1980).

Duration of Stages. Secondary succession following disturbance is vigorous, with shrubs and trees regenerating together. The conifer component develops into relatively large, mature trees within 30 to 50 years. The broad-leaved component normally requires 60-90 years. Eventually the conifer component overtakes the broad-leaved component. Successional sequence and timing varies geographically and differs depending on species and environmental factors such as climate, water, and soil.

Biological Setting

Habitat. Geographically and biologically, Montane Hardwood-Conifer is transitional between dense coniferous forests and montane hardwood, mixed chaparral, or open woodlands and savannahs. MHC merges with many other habitats at its upper and lower ecotones. These habitats include Valley-Foothill Hardwood (VFH), Valley-Foothill Hardwood-Conifer (VHC), Valley-Foothill Riparian (VRI), Closed-Cone Pine-Cypress (CPC), Montane Hardwood (MHW), Mixed Conifer (MCN), Douglas-fir (DFR), Redwood (RDW), Montane Riparian (MRI), Montane Chaparral (MCP), and Mixed Chaparral (MCH). The habitat is an area of vegetational and floristic diversity with large numbers of endemic species (Proctor et al. 1980).

Wildlife Considerations. Montane Hardwood-Conifer provides habitat for a variety of wildlife species. Mature forests are valuable to cavity nesting birds. Moreover, mast crops are an important food source for many birds as well as mammals. Canopy cover and understory vegetation are variable which makes the habitat suitable for numerous species. In mesic areas, many amphibians are found in the detrital layer. Due to geographic variation in components of Montane Hardwood-Conifer, caution must be exercised when predicting wildlife species use.

Physical Setting

Montane Hardwood-Conifer generally occurs on coarse, well drained mesic soils, in mountainous terrain with narrow valleys. Slopes average approximately 57 percent with all aspects encountered. Winters are cool and wet;

summers are hot and dry. Northern California Montane Hardwood-Conifer sites have less rainfall and fog than Redwood (RDW) or Mixed Conifer (MCN) habitats. In southern California, this habitat is found at higher elevations, and in moist canyons. Average rainfall is 60 to 170 mm (25 to 65 in), with some fog. The growing season is 7 to 11 months, with 200 to 300 frost-free days. Mean summer maximum temperatures are 25 to 36 C (75 to 95 F). Mean winter minima are 2 to 4 C (29 to 30 F) (Munz and Keck 1970)(No Munz and Keck 1970 Lit Cite).

Distribution

Montane Hardwood-Conifer occurs throughout California and is somewhat continuous from Santa Cruz County northward through outer coast range into Oregon, usually some distance inland m the coast (Cheatham and Haller 1975). The habitat typically lows the upper and/or inland margins of the coastal redwood RDW) or Douglas fir (DFR) habitats. It can also be found on north facing slopes of the inner north coast ranges, the Santa Lucia Mountains, as well as small patches extending to Santa Barbara County (Cheatham and Haller 1975). Montane Hardwood-Conifer also occurs somewhat continuously down the Sierra Nevada to the transverse ranges. Elevations range from 300 to 10 m (1000 to 4000 ft) in the north to 605 to 1760 m (2000 to 00 ft) in the south. Isolated patches of MHC can be found throughout the transverse and peninsular ranges of southern California.

Montane Hardwood (MHW)

Philip M. McDonald

Vegetation

Structure A typical montane hardwood habitat is composed of a pronounced hardwood tree layer, with an infrequent and poorly developed shrub stratum, and a sparse herbaceous layer. On better sites, individual trees or clumps of trees may be only 3 to 4 m (10 to 13 ft) apart. On poorer sites, spacing increases to 8 to 10 m (26 to 33 ft). Where trees are closely spaced, crowns may close but seldom overlap. Living crowns on mature canyon live oaks occupy about 60 percent of the bole on typical sites and up to 80 percent on poor sites. Tree heights tend to be uniform at most ages in mature stands where hardwoods occur, but subordinate to conifers. Mature oaks on better sites and in canyons range between 17 and 30 m (56 and 98 fl) tall and up to 150 cm (59) in) dbh. On poorer sites, mature trees typically are 10 to 15 m (33 to 49 ft) tall with boles up to 65 cm (26 in) in dbh, with dome-shaped crowns almost as wide as the trees are tall. On rocky summits, canyon live oak is a shrub of small diameter, usually less than 4 m (13 ft) in height. Snags and downed woody material generally are sparse throughout the montane hardwood habitat.

Composition In the Coast Range and Klamath Mountains, canyon live oak often forms pure stands on steep canyon slopes and rocky ridge tops. It is replaced at higher elevations by huckleberry oak (Parker and Matyas 1980)(No 1980 Lit Cite only 1979 and 1981.). At higher elevations, it is scattered in the overstory among ponderosa pine, Coulter pine, California white fir, and Jeffrey pine, the latter on serpentine and peridotite outcrops. Middle elevation associates are Douglas-fir, tanoak, Pacific madrone, California-laurel, California black oak, and bristlecone fir. Knobcone pine, Digger pine, Oregon white oak, and coast live oak are abundant at lower elevations. Understory vegetation is mostly scattered woody shrubs (manzanita, mountain-mahogany, poison-oak) and a few forbs.

In the Transverse and Peninsular ranges of southern California, overstory associates at middle and higher elevations are Jeffrey pine, ponderosa pine, sugar pine, incense-cedar, California white fir, bigcone Douglas-fir, California black oak, and Coulter pine. At lower elevations, associates are white alder, coast live oak, bigleaf maple, California-laurel, bigcone Douglas-fir, and occasionally valley oak, Digger pine, and blue oak (Cheatham and Haller 1975, McDonald and Littrell 1976). Understory shrub species are manzanita, poison-oak, coffeeberry, currant, and ceanothus.

In the southern Cascade and Sierra Nevada ranges, steep, rocky south slopes of major river canyons often are clothed extensively by canyon live oak and scattered old-growth Douglas-fir. Elsewhere, higher elevation overstory associates are typical mixed conifer and California black oak; lower elevation associates are Digger pine, knobcone pine, tanoak, Pacific madrone, and scrubby California-laurel. Associated understory vegetation includes Oregon-grape, currant, wood rose, snowberry, manzanita, poison-oak, and a few forbs and grasses.

Other Classifications In southwest Oregon, the species is part of the mixed evergreen (Pseudotsuga-sclerophyll) zone and to a lesser extent the conifer forest zone on drier areas (Franklin and Dryness 1969). These classifications are pertinent to California as well. In California, canyon live oak occurs in 12 of the 17 forest communities described by Munz and Keck (1968)(No Munz and Keck 1968 in Hab Lit Cite.), in 8 dominance types in the Sierra Nevada (Myatt 1980), and in 6 ecological provinces (Parker and Matyas 1980). Cheatham and Haller (1975) place canyon live oak in

8 minor subdivisions of 2 habitat types. Canyon live oak is recognized as a forest cover type by the Society of American Foresters and is an associate species in eight other types (Eyre 1980).

Habitat Stages

Vegetation Changes 1; 2-5:S-D. Initial establishment of canyon live oak is by acorns, most of which do not move far from beneath tree crowns. Wider dissemination of acorns and seeds of associate species is by birds and mammals. After establishment, canyon live oak sprouts vigorously from the root crown. Most hardwood associates also sprout prolifically. Rapid sprout growth enables the hardwoods to capture most of the favorable micro sites, forcing the conifers to invade harsher sites, or those made harsh by hardwood roots below ground and hardwood shade above. Delayed establishment, slow growth, and sparse or clumpy distribution of conifers often results. In most instances, succession is slow. Seldom is canyon live oak a pioneer species, but occasionally it invades and becomes established on alluvial soils (Heady and Zinke 1978). Canyon live oak has loose, dead, flaky bark that catches fire readily and burns intensely (Plumb 1980). Occasional fire often changes a stand of canyon live oak to live oak chaparral, but without fire for sufficient time, trees again develop. Where fire is frequent, this oak becomes scarce or even drops out of the montane hardwood community.

Duration of Stages A type more stable than Montane Hard wood is difficult to envision. The large number of species in the type, both conifer and hardwood, allow it to occupy and persist in a wide range of environments. Good soils and poor, steep slopes and slight, frequently disturbed and pristine all are at least adequate habitats for one or more species. Longevity (at least 300 years for some species), and large size help to ensure dominance. Seed and sprout reproductive modes assure both wide spread and stationary reproduction, and consequently several age and size classes usually are present in most areas. Growth of most hardwoods, especially canyon live oak, generally is slow and depends on depth and rockiness of soil, slope, and possibly length of time for roots to reach groundwater (Myatt 1980)

Biological Setting

Habitat At lower elevations, neighboring habitats are Valley foothill Hardwood-conifer (VHC) and, to a lesser extent, Closed cone Pine Cypress (CPC). At low and middle elevations, Mixed Chaparral (MCH) interfaces with Montane Hardwood. Wildlife habitats at middle elevations, often overlapping above and below, are Montane Hardwood-conifer (MHC), Mixed Conifer (MCN), Douglas-fir (DFR) and, to a lesser degree, Pine-juniper (PJN). At higher elevations, Montane Hardwood is neighbor to Eastside Pine (EPN), Jeffrey Pine (JPN), and Montane Chaparral (MCP).

Wildlife Considerations Bird and animal species characteristic of the Montane Hardwood habitat include disseminators of acorns (scrub and Steller's jays, acorn woodpecker, and western gray squirrel) plus those that utilize acorns as a major food source wild turkey, mountain quail, band-tailed pigeon, California ground squirrel, dusky-footed woodrat, black bear, and mule deer. Deer also use the foliage of several hardwoods to a moderate extent. Many amphibians and reptiles are found on the forest floor in the Montane Hardwood habitat. Among them are Mount Lyell salamander, ensatina, relictual slender salamander, western fence lizard, and sagebrush lizard. Snakes include rubber boa, western rattlesnake, California mountain kingsnake, and sharp tailed snake.

Physical Setting

Canyon live oak and associates are found on a wide range of slopes, especially those that are moderate to steep. Soils are for the most part rocky, alluvial, coarse textured, poorly developed, and well drained. Soil depth classes range from shallow to deep. L Canyon live oak, incense-cedar, and a few other associates are also found on ultrabasic soils. Mean summer temperatures in the Montane Hardwood habitat vary between 20 and 25 C (68 and 77 F) and mean winter temperatures between 3 and 7 C (37 and 45 F). Frost-free days range from 160 to 230 (Thornburgh 1986)(No Thornburgh 1986 in Habitat Lit Cite.). Annual precipitation varies from 2794 mm (110 in) in the northern Coast Range to 914 mm (36 in) in the mountains of southern California.

Distribution

The Montane Hardwood habitat ranges throughout California mostly west of the Cascade-Sierra Nevada crest. East of the crest, it is found in localized areas of Placer, El Dorado, Alpine and San Bernardino Counties. Elevations range from 100 m (300 fl) near the Pacific Ocean to 2745 m (9000 ft) in southern California.

Montane Riparian (MRI)

William E. Grenfell Jr.

Vegetation

Structure. The vegetation of montane riparian (MRI) zones is quite variable and often structurally diverse (Marcot 1979). Usually, the montane riparian zone occurs as a narrow, often dense grove of broad-leaved, winter deciduous trees up to 30 m (98 ft) tall with a sparse understory. At high mountain elevations, MRI is usually less than 15 m (49 ft) high with more shrubs in the understory. At high elevations, MRI may not be well developed or may occur in the shrub stage only.

Composition. In northwest California along streams west of the Klamath Mountains, black cottonwood is a dominant hardwood. In some areas, it is codominant with bigleaf maple. In either case, black cottonwood can occur in association with dogwood and boxelder. At high elevations black cottonwood occurs with quaking aspen and white alder (Parker and Matyas 1979).

In northeastern California, black cottonwood, white alder and thinleaf alder dominate the montane riparian zone. Oregon ash, willow and a high diversity of forbs are common associates.

In the Sierra Nevada, characteristic species include thinleaf alder, aspen, black cottonwood, dogwood, wild azalea, willow and water birch (southern Sierra east of the crest), white alder and dogwood (north Sierra) .

In the southern Coast Range as well as Transverse and Peninsular ranges, bigleaf maple and California bay are typical dominants of montane riparian habitat. Fremont cottonwood is the most important cottonwood in the Sierra below 1524 m (5000 ft), much of the Coast Ranges and the Transverse and Peninsular ranges.

MRI habitats can occur as alder or willow stringers along streams of seeps. In other situations an overstory of Fremont cottonwood, black cottonwood and/or white alder may be present.

Other Classifications. Montane riparian habitats are also described as riparian (Laudenslayer 1982), riparian deciduous (Verner and Boss 1980, Marcot 1979), bigleaf maple, alder, maple-alder-dogwood, white alder, willow and alder-willow series (Parker and Matyas 1979), mixed riparian woodland -6.21, willow thickets - 6.24 and red alder groves - 6.22 (Cheatham and Haller 1975).

Habitat Stages

Vegetation Changes 1;2-5:S-D;6. Definite successional stages are not described in the literature. Many montane riparian stages may prevail indefinitely, climax or subclimax. Shrub-type stages should be evaluated as size/age class 1 or 2. Overstory trees such as cottonwood, maple and alder may range up to size/age class 6.

Duration of Stages. Montane riparian habitats within given watersheds tend to maintain the same mosaic of stages. However, the location of these stages may vary as a result of periodic torrential flows. Riparian Systems can be damaged by debris, sedimentation, or uprooting of entire plants which are redeposited further downstream (Campbell and Green 1968).

Biological Setting

Habitat. The transition between MRI and adjacent non-riparian vegetation is often abrupt, especially where the topography is steep. This habitat intergrades with montane chaparral, montane hardwood, montane hardwood/conifer, lodgepole pine, red fir and wet meadow habitats.

Wildlife Considerations. All riparian habitats have an exceptionally high value for many wildlife species (Thomas 1979, Marcot 1979, Sands 1977). Such areas provide water, thermal cover, migration corridors and diverse nesting and feeding opportunities. The shape of many riparian zones, particularly the linear nature of streams, maximizes the development of edge which is so highly productive for wildlife (Thomas 1979).

The range of wildlife that uses the MRI habitat for food, cover and reproduction include amphibians, reptiles, birds and mammals. The southern rubber boa and Sierra Nevada red fox are among the rare, threatened or endangered wildlife that use MRI habitats during their life cycles.

Physical Setting

Riparian areas are found associated with montane lakes, ponds, seeps, bogs and meadows as well as rivers, streams and springs. Water may be permanent or ephemeral (Marcot 1979). The growing season extends from spring until late fall, becoming shorter at higher elevations. Most tree species flower in early spring before leafing out.

Distribution

Montane riparian habitats are found in the Klamath, Coast and Cascade ranges and in the Sierra Nevada south to about Kern and northern Santa Barbara Counties, usually below 2440 m (8000 ft). The Peninsular and transverse ranges of southern California from about southern Santa Barbara to San Diego Counties also include MRI habitat. MRI subtype, consisting mostly of red alder, is found from northern San Luis Obispo to Del Norte Counties along the immediate coast (Cheatham and Haller 1975).

Montane Chaparral (MCP)

Roland J. Risser and Michael E. Fry

Vegetation

Structure. The growth form of montane chaparral species can vary from treelike (up to 3 meters) to prostrate. When mature, it is often impenetrable to large mammals. Its structure is affected by site quality, history of disturbance (e.g., fire, erosion, logging) and the influence of browsing animals. For example, on shallow granitic soils in the Sierra Nevada, low dense growths of pinemat manzanita and huckleberry oak characterize an edaphic climax community, associated with scattered conifers and much exposed granite. Following fire in the mixed conifer forest habitat type, whitethorn ceanothus-dominated chaparral may persist as a subclimax community for many years. Montane chaparral is characterized by evergreen species; however, deciduous or partially deciduous species may also be present. Understory vegetation in the mature chaparral is largely absent. Conifer and oak trees may occur in sparse stands or as scattered individuals within the chaparral type.

Composition. Montane chaparral varies markedly throughout California. Species composition changes with elevational and geographical range, soil type, and aspect. One or more of the following species usually characterize montane chaparral communities: whitethorn ceanothus, snowbrush ceanothus, greenleaf manzanita, pinemat manzanita, hoary manzanita, bitter cherry, huckleberry oak, sierra chinquapin, juneberry, Fremont silktassel, Greene goldenweed, mountain mahogany, toyon, sumac and California buckthorn. As one or more of these species become dominant under various environmental regimes, further subclassification of the montane chaparral series is possible (Krebs 1972, McNaughton 1968).

Other Classifications. Montane chaparral has been broadly described as chaparral (Munz and Keck 1973, (Kochler 1977) or mountain shrub (USDA 1977). Subclassifications based upon predominant species composition have also been described as montane mixed shrub series, huckleberry oak/pinemat manzanita series, bush chinquapin series, greenleaf manzanita series, tobacco brush series, mountain whitethorn series (Parker and Matyas 1981); upper montane chaparral, lower montane chaparral (Cheatham and Haller 1975).

Habitat Stages

Vegetation Changes 1;2-4:S-D. Montane chaparral in California occurs in gradations between two characteristic successional sequences: The first sequence is associated with poorer, typically shallow soils (in early stages of development), often overlying fractured bedrock. Here, chaparral species may predominate to form an edaphic climax community

In the second sequence, chaparral is a secondary succession following disturbance on deeper forest soils. After disturbance (logging, fire, erosion) chaparral proliferates and may exclude conifers and other vegetation for many years. However, chaparral may facilitate the germination of red fir seedlings (Barbour 1984) and other shade tolerant conifers by providing a protective cover, moderating microclimate, and improving soil conditions. Chaparral shrubs may be an essential link in forest succession by building up soil nutrient levels, especially nitrogen, to the point where trees can survive (Zavitovski and Newton 1968). In mature timber stands, chaparral species may senesce due to insufficient light through the canopy and are only present as a sparse understory. Thus, silvicultural practices have a strong influence on the structure of montane chaparral.

Most montane chaparral species are fire adapted. Mature plants sprout back from the root crown. Some species require scarification of the seed for germination and may produce numerous seedlings after a fire (Gratkowski 1961). However, if fires are too frequent, these species may be eliminated (Biswell 1969) changing the subsequent structure of the community. Deer and livestock foraging on sprouting chaparral may also have a significant effect on its rate of development, structure, and ultimate species composition (Biswell and Gilman 1961, Davis 1967). The forage yields of most sprouting shrubs are reduced for the first few years after a fire, but rapidly regain their original status. Burned areas commonly produce new shrub growth high in protein and are a preferred food source for herbivores (Einarsen 1946, Swank 1956).

Duration of Stages. Following fire, herbaceous plants may dominate for up to 5 years. Usually within 7 to 9 years the brush overstory is fully developed (Sweeney 1956, Sampson 1944). Chaparral may persist for up to 50 years or longer before conifer development begins to significantly reduce the shrub growth through shading (Lyon 1969, Sweeney 1968). Where chaparral types occur as an edaphic climax (i.e., on poor, rocky soils, fractured bedrock or lava caps), growth rates may be rather slow, growth form is usually small and stunted, and individuals may be quite old. Development of montane chaparral at high elevations is often slowed by cold temperatures, snow cover and a short growing season (Barbour and Major 1977). However, at lower elevations, burned or logged areas may sprout new growth by the next growing season.

Biological Setting

Habitat. Montane chaparral adjoins a variety of other wildlife habitats, including montane riparian (MRI), mixed chaparral (MCH), and perennial grassland (PGS). It becomes established in disturbed coniferous habits such as ponderosa pine (PPN), mixed conifer (SMC), Jeffrey pine (JPN), red fir (RFR) and lodgepole pine (LPN). At high elevations in the southern Sierra, it may occur with a sparse juniper overstory. At the lower extent of its elevational range, montane chaparral may intergrade with mixed chaparral, a very similar habitat type.

Wildlife Considerations. Montane chaparral provides habitat for a wide variety of wildlife. Numerous rodents inhabit chaparral (Wirtz 1974). Deer and other herbivores often make extensive use of chaparral. Throughout the west slope of the Sierra and south through the Transverse Range, deer are strongly associated with chaparral communities. Montane chaparral provides critical summer range foraging areas, escape cover and fawning habitat. In the Sierra, fawning areas are frequently found where the chaparral lies adjacent to or contains an interspersion of perennial grass or meadow-riparian habitat (Ashcraft 1975, Dasmann, 1971, Ashcraft 1976, Pacific Gas and Electric 1981). Some small herbivores use chaparral species in fall and winter when grasses are not in abundance. Rabbits and hares eat twigs, evergreen leaves and bark from chaparral. Shrubs are important to many mammals as shade during hot weather, and moderate temperature and wind velocity in the winter (Loveless 1967). Many birds find a variety of habitat needs in the montane chaparral. It provides seeds, fruits, insects, protection from predators and climate, as well as singing, roosting and nesting sites (Verner and Boss 1980), Storer and Usinger 1970).

Physical Setting

Montane chaparral can be found on shallow to deep soils, on all exposures, and from gentle to relatively steep slopes. It may dominate on more xeric sites, but occurs locally throughout the coniferous forest zone. Generally, climate is like that associated with the coniferous forest zone, cold winter temperatures with substantial precipitation. Summers are typically hot and dry (Barbour and Major 1977). In the northern portion of the state, montane chaparral is found between 914 to 2743 m (3000-9000 ft). In southern California this type occurs above 2134 m (7000 ft).

Distribution

Montane chaparral is associated with mountainous terrain from mid to high elevation at 914 to 3047 m (3000-10,000 ft). It occurs in southern California above 2134 m (7000 ft) in the Transverse Range of Los Angeles, and in San Bernardino, Riverside and San Diego counties; from Siskiyou to Kern counties in the Cascade and Sierra Nevada mountains; as a minor type from Tehama to Lake counties; and in Del Norte, Siskiyou, Trinity, and Shasta counties in the North Coast Ranges and Klamath mountains (Barbour and Major 1977). As a successional stage following disturbance, its distribution coincides with the ponderosa pine and mixed coniferous forest habitat types (Barbour and Major 1977).

Annual Grassland (AGS)

John G. Kie

Vegetation

Structure. Annual Grassland habitats are open grasslands composed primarily of annual plant species. Many of these species also occur as understory plants in Valley Oak Woodland (VOW) and other habitats. Structure in Annual Grassland depends largely on weather patterns and livestock grazing. Dramatic differences in physiognomy, both between seasons and between years, are characteristic of this habitat. Fall rains cause germination of annual plant seeds. Plants grow slowly during the cool winter months, remaining low in stature until spring, when temperatures increase and stimulate more rapid growth. Large amounts of standing dead plant material can be found during summer in years of abundant rainfall and light to moderate grazing pressure. Heavy spring grazing favors the growth of summer-annual forbs, such as tarweed and turkey mullein, and reduces the amount of standing dead material. On good sites, herbage yield may be as high as 4900 kg/ha (4400 lb/ac) (Garrison et al. 1977).

Composition. Introduced annual grasses are the dominant plant species in this habitat. These include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include broadleaf filaree, redstem filaree, turkey mullein, true clovers, bur clover, popcorn flower, and many others. California poppy, the State flower, is found in this habitat. Perennial grasses, found in moist, lightly grazed, or relic prairie areas, include purple needlegrass and Idaho fescue. Vernal pools, found in small depressions with a hardpan soil layer, support downingia, meadowfoam, and other species (Parker and Matyas 1981). Species composition is also related to precipitation (Bartolome et al. 1980). Perennial grasses are more common on northern sites with mean annual rainfall greater than 150 cm (60 in). Soft chess and broadleaf filaree are common in areas with 65-100 cm (25-40 in) of rainfall, and red brome and redstem filaree are common on southern sites with less than 25 cm (10 in) of precipitation (Bartolome et al. 1980).

Other Classifications. Annual Grassland habitat has been described as Valley Grassland (Munz and Keck 1959, Heady 1977), Valley and Foothill Grassland (Cheatham and Haller 1975), California Prairie (Kochler 1977), Annual Grasslands Ecosystem (Garrison et al. 1977), Brome grass, Fescue, Needlegrass, and Wild Oats series (Paysen et al. 1980), and Annual Grass-Forb series (Parker and Matyas 1981).

Habitat Stages

Vegetation Changes i-2:5-D. Annual Grassland habitats occupy what was once a pristine native grassland. The native grassland likely consisted of climax stands of perennial bunchgrasses, such as purple needlegrass, on wetter sites (Bartolome 1981, Bartolome and Gemmill 1981), with annual species existing as climax communities on drier alluvial plains (Webster 1981). Today, plant succession in the classical sense does not occur in Annual Grassland habitats. However, species composition is greatly influenced by seasonal and annual fluctuations in weather patterns. Annual plants germinate with the first fall rains that exceed about 15 mm (0.6 in), growing slowly during winter and more rapidly in spring (Heady 1977). Botanical composition changes throughout the growing season because of differences in plant phenology (Heady 1958). Most annuals mature between April and June (Heady 1977), although some species, such as tarweed and turkey mullein, continue to grow into summer. Fall rains that encourage germination, followed by an extended dry period, favor the growth of deep-rooted forbs (Duncan and Woodmansee 1975), but continuing rainfall favors rapidly growing grasses (Pitt and Heady 1978). Livestock grazing favors the growth of low-stature, spring-maturing forbs, such as filaree (Freckman et al. 1979), and summer annuals, such as turkey mullein (Duncan 1976). Because these are important food plants for many wildlife species, proper levels of livestock grazing are generally beneficial in this habitat. In the absence of livestock, Annual Grassland habitats are often dominated by tall, dense stands of grasses such as ripgut brome (Freckman et al. 1979) and wild oats.

Duration of Stages. Although Annual Grassland habitats consist largely of non-native annuals, these effectively prevent the reestablishment of native perennials over large areas and now comprise climax communities (Heady 1977). Introduced annuals should be considered naturalized plant species and so managed, rather than as invading species characteristic of poor range sites.

Biological Setting

Habitat. Annual Grassland habitat is found just above or surrounding Valley Foothill Riparian (VRI), Alkali Scrub (ASC), Fresh Emergent Wetland (FEW), Cropland (CRP), Orchard-Vineyard (OVN), and Pasture (PAS) habitat types, and below Valley Oak Woodland (VOW), Blue Oak Woodland (BOW), Blue Oak-Digger Pine (BOP), Chamise-Redshank (CRC), and Mixed Chaparral (MCH) habitats. Annual Grassland habitat also borders Coast Oak Woodland (COW), Closed Cone-Pine-Cypress (CPC), Coastal Scrub (CSC), and Eucalyptus (EUC) habitats.

Wildlife Considerations. Many wildlife species use Annual Grasslands for foraging, but some require special habitat features such as cliffs, caves, ponds, or habitats with woody plants for breeding, resting, and escape cover. Characteristic reptiles that breed in Annual Grassland habitats include the western fence lizard, common garter snake, and western rattlesnake (Basey and Sinclear 1980). Mammals typically found in this habitat include the black-tailed jackrabbit, California ground squirrel, Botta's pocket gopher, western harvest mouse, California vole, badger, and coyote (White et al. 1980). The endangered San Joaquin kit fox is also found in and adjacent to this habitat (U.S. Fish and Wildlife Service 1983). Common birds known to breed in Annual Grasslands include the burrowing owl, shorteared owl, horned lark, and western meadowlark (Verner et al. 1980). This habitat also provides important foraging habitat for the turkey vulture, northern harrier, American kestrel, black-shouldered kite, and prairie falcon.

Physical Setting

Annual Grassland habitat occurs mostly on flat plains to gently rolling foothills. Common soil orders include Entisols and Alfisols (Garrison et al. 1977). Entisols are often found at lower elevations on flood plains and swales that receive periodic deposits of alluvium (U.S. Soil Conservation Service 1975), and are characterized by little or no pedogenic horizon development. Alfisols occur at higher elevations above the valley floor (Garrison et al. 1977). Some Annual Grassland habitats can be found in the drier portion of the southern San Joaquin Valley on Aridisols (Garrison et al. 1977). Climatic conditions are typically Mediterranean, with cool, wet winters and dry, hot summers. The length of the frost free season averages 250 to 300 days (18 to 21 fortnights) (Garrison et al. 1977). Annual precipitation is highest in the north (Redding, 960 mm (38 in)) and north coast (Ukiah, 909 mm (36 in)), decreasing to the south (Sacramento, 430 mm (17 in); Stockton, 339 mm (13 in); Fresno, 259 mm (10 in)), and reaching a minimum in the southern San Joaquin Valley (Bakersfield, 150 mm (6 in)) (Major 1977).

Distribution

Annual Grassland habitat occurs throughout the central valley of California, in the coastal mountain ranges as far north as Mendocino County, and in scattered locations in southern California. It occurs from sea level to about 1200 m (3900 ft) in elevation (Heady 1977). Relics of the pristine California prairie can be found throughout this habitat, including sites at Jepson Prairie (Solano County), and at the University of California's Hopland Field Station (Mendocino County) and Hastings Natural History Reservation (Monterey County). However, these relics are limited in size and may not constitute a separate habitat.

Wet Meadow (WTM)

Raymond D. Ratliff

Vegetation

Structure. Wet Meadows at all elevations generally have a simple structure consisting of a layer of herbaceous plants. Shrub or tree layers are usually absent or very sparse; they may, however, be an important feature of the meadow edge. Within the herbaceous plant community a microstructure is frequently present. Some species reach heights of only a few centimeters while others may grow a meter or more tall (> 3 ft). Except where broken by boulders, canopy cover is dense (60-100%). At the substrate surface, distances between individual shoots may vary from 1 or 2 mm (0.04-0.08 in) to as much as 2 or 3 cm (0.81.2 in) depending upon the species present.

Composition. Wet Meadows occur with a great variety of plant species; therefore, it is not possible to generalize species composition. Species may differ, but several genera are common to Wet Meadows throughout the State. They include Agrostis, Carex, Danthonia, Juncus, Salix, and Scirpus. Important grass and grasslike species include thingrass, abruptbeak sedge, beaked sedge, Nebraska sedge, tufted hairgrass, needle spikerush, fewflowered spikerush, common spikerush, baltic rush, Nevada rush, iris-leaf rush, pullup muhly, and panicled bulrush. Important forbs include Anderson aster, Jeffrey shootingstar, trailing Saint-Johnswort, hairy pepperwort, primrose monkeyflower, western cowbane, American bistort, cows clover, and small white violet. Willow and bilberry are the only shrubs found in much abundance. Fewer species occur as surface water depth increases during spring runoff.

Other Classifications. Poorly drained, closed-basin and moderately drained, closed-basin Wet Meadows were defined by Hormay (1943b). Bennett (1965) divided Wet Meadows into the Sphagnum, Coarse-leaved Sedge, Fine-leaved Sedge, and Grass subtypes. Subalpine or Alpine Moist-to-wet, Tule, and Wet meadow subformations were described by Hall (1979). Several series similar to this Wet Meadow classification occur within his subformations: Wet Meadow-Tall Sedge, Nebraska Sedge, Wet Meadow-Short Sedge, Wet Meadow-rush, and Wet Meadow-Spikesedge. Sedge and Wiregrass series were included in the graminoid subformation of the herbaceous formation in southern California (Paysen et al. 1980). Ratliff (1982) described five montane Wet Meadow series: Beaked Sedge, Ephemeral-lake, Hillside Bog, Nebraska Sedge, and Fewflowered Spikerush. Some of those series occurred in the subalpine as well. The most important subalpine Wet Meadow series was, however, the Shorthair Reedgrass.

Habitat Stages

Vegetation Changes 1;2:S-D. Generally, Wet Meadow communities succeed bog communities. In turn, Wet Meadows are succeeded by mesic meadows and by dry meadows or forest. Mesic and dry meadows may have a sparse cover of shrubs. Succession to coniferous forest is frequent at montane and subalpine elevations. At lower elevations, succession to broad leaved trees or shrubs, particularly sagebrush, may occur. Wood (1975) showed that succession of open meadow to forest and succession of forest to open meadow has occurred at the same location over geologic time. Therefore, Wet Meadows need not necessarily succeed to forest. Most Wet Meadow plant species are perennial, and a substantial change in the plant community may develop slowly. Differences in species composition between observations of Wet Meadow communities may therefore represent temporal fluctuations rather than successional trends. Perturbations that alter the Wet Meadow environment are usually necessary to set successional changes in motion. Overgrazed Wet Meadows have more forbs and fewer grasses and grasslike species than properly grazed or ungrazed (by livestock) meadows, and taller species are replaced by lower growing types. Channel erosion lowers the water table, causing succession to species of dryer habitats.

Duration of Stages. The single most important characteristic of a Wet Meadow is its hydrology. Seasonality and reliability of yearly water inflows and outflows largely determine the vegetational stability of Wet Meadows. Therefore, Wet Meadow habitats exist indefinitely unless the hydrologic regimes are altered. Some meadows in the Sierra Nevada are at least 1200 years old (Wood 1975).

Biological Setting

Habitat. Wet Meadows usually occur as ecotones between Fresh Emergent Wetlands (FEW) and Perennial Grassland (PGS) or mesic meadow types. Mesic meadows contain some species in common with Wet Meadows, and the distinction between wet and mesic meadows is not always clear. Where Wet Meadows merge with Fresh Emergent Wetlands, slight differences in water depth control the species present.

Wildlife Considerations. In late summer, small mammals may visit Wet Meadows that have dried. However, the meadows are generally too wet to provide suitable habitat for small mammals. Mule deer and elk may feed in Wet Meadows, seeking especially forbs and palatable grasses. Waterfowl, especially mallard ducks, frequent streams flowing through Wet Meadows. Yellow-headed and red-winged blackbirds occasionally nest in Wet Meadows with tail vegetation and with adequate water to discourage predators (Storer and Usinger 1963). The striped racer is the common snake of Wet Meadows in the Sierra Nevada and Cascade Range. Various frog species are abundant in Wet Meadows throughout California. Six species of trout (Brown, cutthroat, golden, rainbow, eastern brook, and Mackinaw) inhabit streams of the Sierra Nevada (Storer and Usinger 1963), and presumably may occur in perennial streams of wet meadows. In the southern Sierra Nevada, the golden trout is the important fish of meadow habitats at high elevations.

Physical Setting

Wet Meadows occur where water is at or near the surface most of the growing season, following spring runoff. Hydrologically, they occupy lotic, sunken concave, and hanging sites (Ratliff 1985). Lotic sites (Gosselink and Turner 1978) are those with main input flow (other than precipitation) from upstream sources; at least early in the growing season, water flows across them at depths of 10 to 20 cm (4-8 in). Downstream runoff is the principal output flow. Lotic sites are topographic basins but have a slight slope, which permits drainage of surface water. Percolation is nil due to the saturated or slowly permeable nature of underlying materials. Sunken concave sites also receive water input from upstream sources, but evapotranspiration is the main output flow. Percolation is slowed by heavy-textured soils and/or shallow bedrock; however, in contrast to lotic and hanging sites, soil of sunken concave sites may dry to considerable depth by fall. Hanging sites are watered by hydrostatic flows as springs or seeps. They frequently occur on rather steep slopes, and downstream runoff is the main output flow. Surface flows, although constant, are usually no more than 1 cm (0.4 in) deep.

Distribution

Wet Meadows occur throughout virtually every forest type of the Sierra and Pacific Northwest floristic provinces and as inclusions in the northern coastal prairie and sagebrush steppe (Barbour and Major 1977). Where conditions are favorable, Wet Meadows occur in the Transverse and Peninsular ranges of Southern California. In the Sierra Nevada and Cascade ranges, Wet Meadows usually occur above 1200 m (3940 ft) in the north and above 1800 m (5900 ft) in the south. In the Klamath Mountains, Wet Meadows occur in the California red fir zone at 1400 m (4600 ft) to 1950 m (6400 ft) elevation. Swales in the valley and foothill grasslands occasionally provide conditions suitable for Wet

Meadow species. However, because the vegetation is composed mostly of annual grasses and forbs and because the sites dry rapidly, these swales are not considered true Wet Meadows.

Lacustrine (LAC)

William E. Grenfell Jr.

General Description

Structure. Lacustrine habitats are inland depressions or dammed riverine channels containing standing water (Cowardin 1979). They may vary from small ponds less than one hectare to large areas covering several square kilometers. Depth can vary from a few centimeters to hundreds of meters. Typical lacustrine habitats include permanently flooded lakes and reservoirs (e.g., Lake Tahoe and Shasta Lake), intermittent lakes (e.g., playa lakes) and ponds (including vernal pools) so shallow that rooted plants can grow over the bottom. Most permanent lacustrine systems support fish life; intermittent types usually do not.

Aquatic Environment

Suspended organisms such as plankton are found in the open water of lacustrine habitats. Dominant are the phytoplankton, including diatoms, desmids and filamentous green algae. Because these tiny plants alone carry on photosynthesis in open water, they are the base upon which the rest of limnetic life depends. Suspended with the phytoplankton are animal or zooplankton organisms which graze upon the minute plants. Most characteristic are rotifers, copepods and cladocerans (Smith 1974).

The plants and animals found in the littoral zone vary with water depth, and a distant zonation of life exists from deeper water to shore. A blanket of duckweed may cover the surface of shallow water. Desmids and diatoms, protozoans and minute crustaceans, hydras and snails live on the under-surface of the blanket; mosquitoes and collembolans live on top. Submerged plants such as algae and pondweeds serve as supports for smaller algae and as cover for swarms of minute aquatic animals. As sedimentation and accumulation of organic matter increases toward the shore, floating rooted aquatics such as water lilies and smartweeds often appear. Floating plants offer food and support for numerous herbivorous animals that feed both on phytoplankton and the floating plants (Smith 1974).

Other Classifications.- Other names of lacustrine habitats include Lacustrine (Cowardin et al. 1979), Lakes - 10.41, Manmade Reservoirs - 10.42 and Ponds -10.43 (Cheatham and Haller 1975). The U.S. Fish and Wildlife Service summarizes several lacustrine habitats according to their occurrence in certain terrestrial habitats (Proctor et at. 1980).

Aquatic Zones and Substrates

The lacustrine habitat may exist in any of the structural classes 1:2 4:O~B. The limnetic or open water zone extends from the deepest part to the depth of effective light penetration. The submerged (littoral) zone is shallow enough to permit light penetration and occurs at the edges of lakes and throughout most ponds. Periodically flooded lacustrine habitats should be evaluated only when water is present. This stage usually cannot support fish populations, and therefore will not attract fish predators. To qualify as shoreline, there must be a water border and less than 2 percent vegetation. Shoreline vegetation exceeding 2 percent would fall into the riparian category.

Lakes and ponds are more or less temporary features of the landscape because of a slow siltation process. The time it takes depends on size, rate of sedimentation and the increase of organic matter.

Biological Setting

Habitat. Lacustrine habitats may occur in association with any terrestrial habitats, Riverine (RIV) and Fresh Emergent Wetlands (FEW).

Wildlife Considerations. Lacustrine habitats are used by 18 mammals, 101 birds, 9 reptiles and 22 amphibians for reproduction, food, water and cover. This represents about 23 percent of the species in the Wildlife Habitat Relationships data base. The endangered Santa Cruz long-toed salamander and rare black toad require ponds for breeding. The endangered bald eagle feeds on fish and some birds taken from lakes.

Physical Setting

The relatively calm waters of lakes and ponds offer environmental conditions that contrast sharply with those of running water. Light penetration is dependent on turbidity. Temperatures vary seasonally and with depth. Because only a small proportion of the water is in direct contact with the air and because decomposition is taking place on the bottom, the oxygen content of lake water is relatively low compared to that of running water. In some lakes, oxygen may decrease with depth, but there are many exceptions. These gradations of oxygen, light and temperature along with the currents and seiches, profoundly influence the vertical distribution of lake organisms (Smith 1974).

Distribution

Lacustrine habitats are found throughout California at virtually all elevations, but are less abundant in arid regions.

Barren (BAR)

Monica D. Parisi

Vegetation

Structure and Composition. -- Barren habitat is defined by the absence of vegetation. Any habitat with <2% total vegetation cover by herbaceous, desert, or non-wildland species and <10% cover by tree or shrub species is defined this way. Structure and composition of the substrate is largely determined by the region of the state and surrounding environment. In the marine and estuarine environment, barren habitat includes rocky outcroppings in the intertidal and subtidal zones, open sandy beaches and mudflats. Along rivers, it includes vertical river banks and canyon walls. Desert habitats may be defined as barren when vegetation is widely spaced. Alpine barren habitat includes exposed parent rock, glacial moraines, talus slopes and any surface permanently covered with snow or ice. Urban settings covered in pavement and buildings may classified as barren as long as vegetation, including non-native landscaping, does not reach the % cover thresholds for vegetated habitats.

Other Classifications. -- Most vegetation classification systems do not include a barren category. Sparsely vegetated substrate is assumed to be a component of the surrounding vegetation type. CALVEG (1981) defines a Barren and a Snow/Ice type. UNESCO (1996) includes a Barren type.

Habitat Stages

No stages are defined for this type. Many barren types will remain so during the time frame of consideration for management actions. An example is exposed rock in alpine settings, where the combined actions of freezing and thawing, wind and water erosion, and chemical breakdown caused by colonizing lichens eventually creates enough organic material to support higher plants. However, the time period for primary succession to a vegetated habitat type may be thousands of years.

Seasonal changes and management regimes may render some habitats barren for short periods of time. Alpine meadows may be seasonally covered with snow or ice. Disked or plowed agricultural fields will be barren for a few months until resowed. In an urban setting, newly-graded suburban sites converted from other habitat types may be barren for up to two years -- usually until trees, shrubs, lawns or other ground covers have been planted.

Biological Setting

Habitat. Barren habitat may be found in juxtaposition with many different habitats, depending on the region of the state. Along the coast, barren mudflats are found with marine and estuarine habitats and fresh and saline emergent wetlands. Sandy beaches and sand dunes with less than 2% vegetative cover are themselves classified as barren. In the Central Valley, bluffs above river corridors covered with valley oak woodland, valley foothill-riparian or annual grassland habitat may drop sharply into steep barren riverbanks of loose soils. In an alpine setting, exposed parent rock is associated with subalpine conifer, red fir, lodgepole pine, pinyon-juniper, aspen, montane riparian, and montane chaparral habitats and, above timberline, with alpine dwarf shrub and wet meadow habitats. In the desert regions, palm oasis, Joshua tree, desert wash, desert succulent shrub, desert scrub and alkali desert scrub may all give way to a barren classification if conditions become extreme enough.

Wildlife Considerations. Where there is little or no vegetation, structure of the non-vegetated substrate becomes a critical component of the habitat. Cormorants and many hawks and falcons nest on rock ledges. Plovers, stilts, avocets, several gulls and terns, including the state and federally-endangered California least tern, nighthawks and poorwills rely on open ground covered with sand or gravel for constructing small scrape nests. The state-threatened bank swallow uses barren vertical cliffs of friable soils along river corridors to dig holes for nesting and cover. Rocky river canyon walls above open water are preferred foraging habitat for many bats. In the desert, open sandy soil is critical as burrowing and egg-laying substrate for horned lizards and fringe-toed lizards, including the state-endangered and federally-threatened Coachella Valley fringe-toed lizard. Among alpine habitats, ground-dwelling mammals such as pika and marmots rely on talus slopes for cover.

Physical Setting

The physical settings for permanently barren habitat represent extreme environments for vegetation. An extremely hot or cold climate, a near-vertical slope, an impermeable substrate, constant disturbance by either human or natural forces, or a soil either lacking in organic matter or excessively saline can each contribute to a habitat being inhospitable to plants.

Distribution

Barren habitat occurs throughout the state at every elevation.

APPENDIX D

FIRE ECOLOGY, EFFECTS, & MANAGEMENT IMPLICATIONS FOR PLANTS COMMONLY FOUND IN THE GVC WATERSHED

FIRE ECOLOGY

CONIFERS

Douglas-fir (Pseudotsuga menziesii var. menziesii)

FIRE ECOLOGY OR ADAPTATIONS :
Plant adaptations to fire: Coast Douglas-fir is more fire resistant than many of its associates and can survive moderately intense fires. Thick, corky bark on the lower bole and roots protects the cambium from heat damage. In addition, the tall trees have their foliage concentrated on the upper bole, which makes it difficult for fire to reach the crown [58]; however, it should be noted that trees are typically not free of lower branches up to a height of 33 feet (10 m) until they are more than 100 years old [31]. Moderately severe understory burns in 50- to 60-year-old mixed and pure stands near Mount Rainier caused little cambial injury to Douglas-fir but killed most of the thin-barked western redcedar [68]. Following the Hoh Fire in Olympic National Park, Douglas-fir's survival rate was considerably higher than Sitka spruce (Picea sitchensis), western redcedar, western hemlock, and bigleaf maple (Acer macrophyllum) [3].

When trees are killed, Douglas-fir relies on wind-dispersed seed off-site trees to colonize the burned area. If catastrophic fires are extensive, a seed source may be limited due to the lack of seed trees. Under these circumstances, seeds come from mature trees that survive fire, survivors in small unburned pockets, or from trees adjacent to the burned area. Where seed trees are scarce, it may take 100 years or more for Douglas-fir to restock the burned area [65]. On the other extreme, when fires do not kill all the trees in a stand, seedling establishment may begin within a year or two after burning [34]. Mineral soils exposed by fire are generally considered favorable seedbeds [17].

Fire regime: Widely distributed as a canopy dominant in lower and middle elevation forests throughout the Pacific Northwest, Douglas-fir occupies forests with varied fire regimes. In general, the size and severity of natural fires tend to decrease, while fire frequency increases southward from western Washington to northern California [58]. In western Washington, Douglas-fir is a primary component of moist forests experiencing infrequent, widespread, stand-replacing fires that occur at perhaps 400- to 500-year intervals [27,45]. Dry areas of the western hemlock zone in the central Oregon Cascades experience both frequent, low- to moderate-severity fires and stand-replacing fires [58]. The mean fire interval in these forests is between 50 and 150 years [45,51]. Frequent, low- to moderate-severity fires occasionally crown and create patches of even-aged stands. Underburning is more common and allows Douglas-fir to survive repeated fires. Thus uneven-aged old-growth Douglas-fir stands are more common in the central Oregon Cascades [58,66]. In mixed evergreen forests of southern Oregon and northern California, fires occurred at frequencies of 5 to 25 years [45]. Where Douglas-fir is seral, its great longevity allows it to maintain itself as a canopy dominant until the next catastrophic fire [34].

POSTFIRE REGENERATION STRATEGY :
off-site colonizer; seed carried by wind; postfire years 1 and 2
secondary colonizer; off-site seed carried to site after year 2

Gray Pine (Pinus sabiniana)

FIRE ECOLOGY OR ADAPTATIONS :
Fire is a natural component of the blue oak-gray pine community [1]. Historically, these woodlands burned at 15- to 30-year intervals [1]. Fires were typically intense but of light or moderate severity, with vegetation and fuels extremely dry in summer [9,28]. Researchers at the San Joaquin Experimental Range in O'Neals, California, noted fire surface temperatures near woody vegetation of 1,200 degrees Fahrenheit (650 deg C) in a blue oak-gray pine community with a mixed-grass and sparse brush understory [28]. A prescribed fire in a blue oak-gray pine community in Glenville, Kern County, generated subsurface temperatures of 156 degrees Fahrenheit (69 deg C) at a depth of 2 inches (0.8 cm) below ground [35].

Gray pine is highly flammable. The needles contain ether extracts [5]. It is a heavy resin producer, with the wood, bark, cones, and needle sheaths all containing pitch [35,40]. Congealed flows of resin that have dripped from wounds are common on gray pine. Consequently, it is susceptible to fire damage [40].

Gray pine has two adaptations that enable it to survive fire. First, some large trees will withstand moderate-severity fire. Mature trees with thick bark and self-pruned trunks are best able to avoid fatal scorching [35]. Secondly, seed regeneration is favored following fire. Fire creates a favorable bare mineral soil seedbed, and heat scarification of the woody seedcoat increases germination rates [40].

POSTFIRE REGENERATION STRATEGY :

Tree without adventitious-bud root crown
Ground residual colonizer (on-site, initial community)
Secondary colonizer - on-site seed
Secondary colonizer - off-site seed

Incense Cedar (Calocedrus decurrens)

FIRE ECOLOGY OR ADAPTATIONS :

Incense-cedar is highly susceptible to fire [20,24]. Incense-cedar seedlings have very flammable bark and foliage, and are usually totally consumed by fire. More mature trees have a thicker basal bark (up to 6 inches [15 cm]) that adequately protects them from ground fires [1]. Incense-cedar shows best seedling germination on fresh mineral soil or very light litter [13]. Incense-cedar sheds its needles in late August and produces about 2,000 pounds of litter per acre (4,940/ha) per year. This deep litter layer provides sufficient fuel for moderate- to high-severity fires [5].

A study of incense-cedar dry rot furnished the most complete record of the fire history in the mixed conifer ecosystem. The shortest period between fires was 3 years, the longest was 11, with high-severity fires occurring every 8 years on average [13]. In Lava Beds National Monument, California, historical records show presettlement fire intervals to have been every 7.3 to 17 years [18].

POSTFIRE REGENERATION STRATEGY :

Tree without adventitious-bud root crown
Initial-offsite colonizer (off-site, initial community)

Ponderosa Pine (Pinus ponderosa var. ponderosa)

FIRE ECOLOGY OR ADAPTATIONS :

Fire is an integral part of the ecology of Pacific ponderosa pine. Studies have shown that prior to 1900, most stands experienced low-severity surface fires at intervals ranging from 1 to 30 years. Fire scars and pollen analysis trace this phenomena back to at least A.D. 1500. Fire has allowed Pacific ponderosa pine to dominate sites where it is the potential climax as well as sites where it is seral to more shade-tolerant tree species [2,22,26,39].

Pacific ponderosa pine has evolved with a thick bark and open crown structure that allows it to survive most fires. Mature trees will self-prune, leaving a smooth bole which reduces aerial fire spread. Other fire adaptations include deep roots, high foliar moisture content, insulated bud scales, and medium to light lichen growth [16,17,54]. Seedlings prefer the mineral-soil seedbeds created by fire [42].

Fire also shapes the composition of Pacific ponderosa pine stands. In the late 1800's stands exhibited open parklike appearances with well-stocked overstories and relatively few understory trees. Fire suppression, however, has allowed the unnatural buildup of forest fuels which has increased the occurrence of stand-replacing fires. Over the last 100 years of fire suppression, seral Pacific ponderosa pine stands have been replaced by shade-tolerant climax stands [2,22,26].

POSTFIRE REGENERATION STRATEGY :

Crown-stored residual colonizer; short-viability seed in on-site cones
Off-site colonizer; seed carried by wind; postfire years 1 and 2
Off-site colonizer; seed carried by animals or water; postfire yr 1&2

Sugar Pine (Pinus lambertiana)

FIRE ECOLOGY OR ADAPTATIONS :

Sugar pine is very resistant to low- to moderate-severity fires. It has adapted a thick, fire-resistant bark and open canopy that retards aerial fire spread. Young sugar pine seedlings prefer bare mineral seedbeds [2,3].

POSTFIRE REGENERATION STRATEGY :

off-site colonizer; seed carried by wind; postfire years 1 and 2
off-site colonizer; seed carried by animals or water; postfire yr 1&2

White Fir (Abies concolor)

FIRE ECOLOGY OR ADAPTATIONS:
White fir occurs in a variety of forest and habitat types that evolved with a variety of fire regimes. Thin-barked and resin blistered, with drooping lower branches, young white fir is highly susceptible to fire, and mature trees are only moderately fire tolerant. White fir is an aggressive, shade-tolerant species that will seed into the understory of low-elevation ponderosa or Jeffrey pine stands or into mixtures of ponderosa pine, Douglas-fir, quaking aspen, and southwestern white pine [185]. On these sites, its numbers were previously controlled by frequent surface fires. With fewer fires in the last century, it is becoming a major stand component at elevations and on sites where historically it was minor [178]. At mid-elevations in the mixed conifer and white fir zones, fires may have burned in a pattern of different severities, including patches where most of the moderately susceptible trees such as white fir, survived [25], and patches where white fir stands were completely destroyed [201]. This type of fire regime creates a forest mosaic of stands with varied structures, species compositions, and seral stages. White fir is also a component of forest communities that evolved with less frequent, stand-replacing fires. The following discussion provides examples from white fir communities that evolved with mixed, understory, and stand-replacement fire regimes.

The primary range of white fir is in the mid-elevation, mixed conifer and white fir zones in California and the central and southern Rocky Mountains. These forest types may be characterized by a mixed fire regime, with fires of variable frequency and severity [25], with some sites experiencing frequent surface fires [7], and others experiencing infrequent crown fires. Mean fire intervals are generally intermediate to intervals in understory and stand replacement regimes, ranging between 30 and 100 years [25]. Mean fire intervals in Sierra Nevada mixed conifer forests are estimated to range between 5 and 30 years, and varied in response to ignition source, fuel accumulations, fuel moisture and burning conditions [332]. Any given location within a mixed fire regime could experience some stand-replacement fires and some nonlethal fires along with a number of fires that burned at mixed severities, creating mosaic patterns of stand structure and fuels [25,215,304]. Low severity fires thin understory regenerating trees, while more severe crown fires may knock succession back to herbs and shrubs. Thus, past burn mosaics tended to increase the probability that subsequent fires would also burn in a mixed pattern. Complex mountain topography also contributed to variable fuels and burning conditions that favored nonuniform fire behavior [25]. After decades of fire exclusion, much of the landscape mosaic has aged and advanced successionally, and patches of late successional forests with large accumulations of dead and living fuels have coalesced, increasing likelihood of fires of unusual size and severity [25,54,169,209,285,286,287,315]. This shift toward landscape homogeneity may adversely affect biodiversity, and may also be perpetuated as the probability of large, high-severity fires increases with continued fire suppression [338]. Much of the living fuels in these forests are small white firs and other shade tolerant species, filling in the understories with dense thickets and increasing fuel continuity and fire ladders of resinous foliage, often in cylindrical crowns that may lead to crown fires when they do burn [178,186,223,287]. Fuel loadings in this type may vary widely due to stand history and site productivity [25,330].

There is evidence that a mixed regime may have been important for perpetuation of giant sequoia groves in the Sierra Nevada [25,295]. Giant sequoia groves burned every 2-10 years for the last 3000 years and have not burned in 100-130 years [288,289,295]. The more mesic, mid-elevation, mixed conifer forests of California formerly experienced low to moderate severity wildfires every 15 to 30 years [287,332]. Other areas that may have had mixed fire regimes include the Marble Mountains of northern California [304]; the mixed conifer zone in the montane forests of the Madrean borderlands; the Animas Mountains of southwest New Mexico [296]; mixed conifer forests in the Jemez Mountains, New Mexico [307]; the white fir/Rocky Mountain maple habitat type in Arizona and New Mexico [232,294]; the high elevation, white fir/forest fleabane habitat type [294]; the lowest elevations of the subalpine forest in New Mexico [86,157,223]; the mixed conifer zone of the Sandia Mountains, New Mexico [36]; and the white fir zone in the central Siskiyou Mountains, Oregon [3].

White fir is also a component of drier ponderosa and Jeffrey pine habitat types that evolved with an understory fire regime. An understory fire regime is characterized by relatively frequent, low severity fires that result in open, uneven-aged stands consisting primarily of the more fire tolerant species. White fir was not a major component of these stands under this regime, and existed as scattered individuals or small groups that managed to survive to a fire resistant age. Open ponderosa pine, larch and Douglas-fir forests at lower elevations in the west have been extensively harvested and protected from fire resulting in a compositional shift to an unnaturally dense understory of Douglas-fir, grand fir white fir, or incense-cedar [27,185,234]. Areas where this fire regime was important include the ponderosa pine and mixed conifer forests of southern Arizona and New Mexico [33,35,68,115,296]; the Sacramento and White mountains of New Mexico [224]; and ponderosa pine stands in central Oregon [252,297]. Because of changes in fuels during the last century, these areas may now experience crown fires when they do burn, with high tree mortality [5].

White fir may also be a component in ecosystems with a stand-replacement fire regime such as western subalpine forests and Douglas-fir/western hemlock forests [25]. The more arid Jeffrey pine forests on the Mojave Desert side of the mountains in southern California may also have a stand-replacement fire regime due to the slow build up of fuels in the arid environment [287]. Evidence of a stand-replacement fire regime in a white fir-Jeffrey pine forest type in the Lake Tahoe Basin is presented by Russell and others [263]. Similarly, the subalpine forests are limited by cold and are also slow growing so fires are naturally infrequent and when they do burn it is usually a stand replacing fire in severe weather [5,287].

The following table provides some fire regime intervals for ecosystems in which white fir occurs:

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
silver fir-Douglas-fir	*Abies amabilis-Pseudotsuga menziesii* var. *menziesii*	> 200
California montane chaparral	*Ceanothus* and/or *Arctostaphylos* spp.	50-100 [59]
curlleaf mountain-mahogany*	*Cercocarpus ledifolius*	13-1000 [28,271]
mountain-mahogany-Gambel oak scrub	*C. l.-Quercus gambelii*	< 35 to < 100
western juniper	*Juniperus occidentalis*	20-70
Rocky Mountain juniper	*J. scopulorum*	< 35
Engelmann spruce-subalpine fir	*Picea engelmannii-Abies lasiocarpa*	35 to > 200
blue spruce*	*P. pungens*	35-200
pinyon-juniper	*Pinus-Juniperus* spp.	< 35 [59]
Rocky Mountain lodgepole pine*	*P. contorta* var. *latifolia*	25-300+ [24,259]
Sierra lodgepole pine*	*P. c.* var. *murrayana*	35-200
Colorado pinyon	*P. edulis*	10-49
Jeffrey pine	*P. jeffreyi*	5-30
western white pine*	*P. monticola*	50-200
Pacific ponderosa pine*	*P. ponderosa* var. *ponderosa*	1-47
Rocky Mountain ponderosa pine*	*P. p.* var. *scopulorum*	2-10
Arizona pine	*P. p.* var. *arizonica*	2-10 [59]
quaking aspen (west of the Great Plains)	*Populus tremuloides*	7-120 [59,125,213]
mountain grasslands	*Pseudoroegneria spicata*	3-40 (10**) [24]
Rocky Mountain Douglas-fir*	*Pseudotsuga menziesii* var. *glauca*	25-100 [59]
coastal Douglas-fir*	*P. m.* var. *menziesii*	40-240 [59,229,258]
California mixed evergreen	*P. m.* var. *m.-Lithocarpus densiflorus-Arbutus m.*	< 35
California oak woodlands	*Quercus* spp.	< 35
oak-juniper woodland (Southwest)	*Quercus-Juniperus* spp.	< 35 to < 200
canyon live oak	*Q. chrysolepis*	<35 to 200
California black oak	*Q. kelloggii*	5-30
western redcedar-western hemlock	*Thuja plicata-Tsuga heterophylla*	> 200
mountain hemlock*	*T. mertensiana*	35 to > 200
elm-ash-cottonwood	*Ulmus-Fraxinus-Populus* spp.	< 35 to 200 [59]

* fire return interval varies widely; trends in variation are noted in the species summary ** (mean)

POSTFIRE REGENERATION STRATEGY [290]:
Tree without adventitious bud/root crown
Crown residual colonizer (on-site, initial community)
Initial off-site colonizer (off-site, initial community)
Secondary colonizer (on-site or off-site seed sources)

HARDWOODS

California Black Oak (Quercus kelloggii)

FIRE ECOLOGY OR ADAPTATIONS :
Fire ecology: California black oak's large leaves produce large amounts of forest litter. Under a 75-year-old stand in the Sierra National Forest of California, the average annual litter accumulation by weight was 0.6 ton per acre (1.3 t/ha), and total litter accumulation was 6.2 tons per acre (13.9 t/ha) [24].

Plant adaptations: California black oak has adapted to fire by sprouting from the root crown. Further fire adaptations include an extensive root system capable of supporting vigorous sprouting, and seedbed requirements (mineral soil or light duff) matching those produced by light- or moderate-severity fire [7,34].

POSTFIRE REGENERATION STRATEGY :
Tree with adventitious-bud root crown/root sucker
Initial-offsite colonizer (off-site, initial community)
Secondary colonizer - off-site seed

Canyon Live Oak (Quercus chrysolepis)

FIRE ECOLOGY OR ADAPTATIONS :
Canyon live oak typically sprouts prolifically from the stump or rootcrown after the trunk or crown is marginally damaged by fire [70]. Because of its proclivity for resprouting, stand turnover is generally minimal [59]. Frequent fires tend to promote multistemmed shrublike growth forms. Open woodlands dominated by canyon live oak are
transformed into live oak chaparral by repeated fires, but once protected from fire, chaparral reverts to woodlands as the oaks grow tall enough during fire-free intervals to shade-out competing vegetation and intra-clump stem density declines [49, P. McDonald pers. comm. 1990]. Where canyon live oak occurs in fireprone chaparral, its growth form is typically shrublike [59]. Stems of canyon live oak are sensitive to fire, and larger treelike individuals are generally found only in areas that have not burned within 50 years or more [57]. Many sites dominated by this oak are xeric and rocky, with little understory vegetation, and probably carry fire only under unusual circumstances [57,73]. Disjunct mesic areas in canyon bottoms or open higher elevation stands which burn at locally reduced fire intensity are generally somewhat protected from fire [59].

The presence of evergreen leaves, the ability to sprout prolifically, and the ability to assume a shrublike growth form enhance the postfire survival of canyon live oak. The shrublike growth forms of other live oaks reach maturity sooner than treelike growth forms of the same species [54]. Evergreen leaves permit greater allocation of energy to regeneration than to vegetative growth and also help to conserve potentially scarce nutrients [49]. Canyon live oak can readily reestablish a site through prolific sprouting, but establishment through seed can also supplement sprout production during years with adequate precipitation [49]. The ability to sprout generally reduces the importance of a seed reservoir in chaparral plants and minimizes the necessity of long-lived seed for postfire regeneration [62]. It should be noted that fire plays no role in stimulating the germination of the heat-sensitive canyon live oak acorns [40,42]. The long-lived canyon live oak can persist with or without fire.

POSTFIRE REGENERATION STRATEGY :
Tree with adventitious-bud root crown/soboliferous species root sucker
Initial-offsite colonizer (off-site, initial community)

Oregon Bigleaf Maple (Acer macrophyllum)

FIRE ECOLOGY OR ADAPTATIONS :
Bigleaf maple is well adapted to fire. It sprouts prolifically from its root crown following crown destruction by fire [30,50]. On moist upland sites in the Cascades, sprouting allows bigleaf maple to become a part of the immediate postfire community when the conifer overstory is removed or killed. Its abundance on upland sites following fire seems to change little, and it remains scattered [31]. Seedling establishment on recently burned areas has not been reported, although it could potentially invade burned sites via seed transported from off-site by wind or birds and small mammals. Fowells [20] reported that "In the Oregon coast range and on the western slopes of the Cascades, [bigleaf maple] frequently invades logged and burned areas, particularly in moist locations."

Bigleaf maple often grows along streams and rivers where soils are moist [20]. Trees in these habitats may escape fire or be subjected to fires of lower intensity than those in adjacent uplands [1]. Stands of bigleaf maple and red alder bordering streams of the Tillamook Burn of Oregon were untouched by a severe fire in 1933 and survived light fires in 1939 and 1945 [6].

POSTFIRE REGENERATION STRATEGY :
survivor species; on-site surviving root crown or caudex

Oregon White Oak (Quercus garryana)

FIRE ECOLOGY OR ADAPTATIONS :
Fire ecology: Historically, Oregon white oak was subjected to a fire regime of low-severity surface fires occurring every few years. A study in the Oregon white oak woodlands of Humboldt Redwoods State Park, California, revealed a history of fire every 7.5 to 13.3 years during the presettlement era [47]. Frequent fire resulted in the open savannas typical of presettlement times in the Willamette Valley, Oregon, and the Bald Hills of California [49]. Dead woody fuels were scant, but flashy fuels (grasses) were abundant and dry early in summer. The fire spread rate was moderated by the gentle topography typical of this cover type. Fire seldom spread into adjacent coniferous forests [5].

Plant adaptations: Oregon white oak has adapted to low- to moderate-severity fire by sprouting from the bole, root crown, and roots [25,36,48]. Sprouts of this species grow far more rapidly than do seedlings. Young trees not subjected to periodic top-kill by fire followed by sprouting often do not attain sexual maturity before they succumb to herbivory [48]. Initial establishment of seedlings is somewhat dependent on fire also. Although this species does not require a bare mineral seedbed, seedling recruitment is greatly enhanced when the litter layer has been removed by fire [4].

Pacific Madrone (Arbutus menziesii)

FIRE ECOLOGY OR ADAPTATIONS :
Pacific madrone depends on periodic fire to eliminate or greatly reduce the conifer overstory [4,62]. Postburn regenerative modes include both the production of prolific sprouts and abundant seed [4]. Following fires that kill aerial stems, madrone sprouts vigorously via dormant buds located on an underground regenerative organ known as a burl [16,26,61]. Burls serve as a source of stored carbohydrates and aggregations of adventitious buds, enabling madrone to rapidly occupy the initial postburn environment [31,39]. Burl development also enhances survival after repeated burning [4,33]. On favorable growth sites within redwood and mixed-evergreen forests, trees attain diameters and bark thicknesses capable of surviving light groundfires [4]. Exposed mineral soil seedbeds and light canopy densities associated with recent burns are conducive to madrone seedling establishment [4,46,59].

POSTFIRE REGENERATION STRATEGY :
survivor species; on-site surviving root crown or caudex
off-site colonizer; seed carried by animals or water; postfire yr 1&2
crown stored residual colonizer; short-viability seed in on-site cones

White Alder (Alnus rhombifolia)

FIRE ECOLOGY OR ADAPTATIONS :
White alder plants are not fire resistant. However, since they are restricted to streamside habitats that burn infrequently, plants may escape fire. Along the San Gabriel River in California, Brothers [6] observed no evidence of fire on large white alder that which were older than the last major fire in the area.

POSTFIRE REGENERATION STRATEGY :
Tree with adventitious-bud root crown/soboliferous species root sucker
Initial-offsite colonizer (off-site, initial community)

SHRUBS

Buckbrush (Ceanothus cuneatus)

FIRE ECOLOGY OR ADAPTATIONS :
Wedgeleaf ceanothus exhibits numerous specialized adaptations to fire [35]. An abundance of long-lived seed accumulates in the soil, litter, or duff during fire-free intervals [17,52,55]. Significant amounts of seed are protected from the harmful effects of fire by overlying soil. Heat generated by fire subsequently stimulates widespread germination.

Wedgeleaf ceanothus often occurs in chaparral communities characterized by dense shrub growth with interlocking crowns and an abundance of deadwood [21,39]. These fire-prone communities are subject to large-scale conflagrations at periodic intervals. Historic fire frequencies have been estimated at 25 to 40 years for chaparral in southern California [38] and 30 to 60 years for chaparral in the central part of the state [20]. Broadleaf sclerophylls such as wedgeleaf ceanothus are characterized by a relatively large amount of fine fuels, low moisture content, much dead material, and a high proportion of resin, oil, wax, and volatile products, and thus contribute to the overall flammability of these communities [40]. Traits such as seedbanking and lack of a widespread seed dispersal mechanism suggest that ceanothus may be particularly well adapted to large fires so typical of chaparral [34].

POSTFIRE REGENERATION STRATEGY :
Ground residual colonizer (on-site, initial community)

California Hazel (Corylus cornuta var. californica)

FIRE ECOLOGY OR ADAPTATIONS :
California hazel sprouts from the root crown after the aboveground portion of the plant has been destroyed [26].

POSTFIRE REGENERATION STRATEGY :
Tall shrub, adventitious-bud root crown
Initial-offsite colonizer (off-site, initial community)

Deerbrush (Ceanothus integerrimus)

FIRE ECOLOGY OR ADAPTATIONS :
Deer brush recovers from fire by establishing from seed and by sprouting from the root crown [12,22,36,37,30,41,44,55]. Seedling establishment is the most common method of postfire regeneration. Heat scarification of seed and increased light after fire favor deer brush seedling establishment, and seedlings are often dense in the first few years after fire [14,30]. Deer brush is apparently a weak sprouter after fire.

Fire regimes: Chaparral - Historic fire return interval in chaparral has been estimated at 20 to 30 years [59]. Fires perpetuated a mosaic of age classes on chaparral landscapes, which decreased the chances for widespread fires. The intense, fast-moving chaparral fires tended to be confined by natural fuel breaks formed from age-class boundaries and topographic features [18].

Mixed conifer - These forests were characterized by frequent, low-intensity surface fires that favored ponderosa and sugar pines, oaks, and sprouting shrubs over shade-tolerant, fire-sensitive species such as incense-cedar and white fir (Abies concolor) [18]. Based upon fire scar data, fire return intervals averaged 8 years [67,83] and ranged from 4 to 20 years [43].

Deer brush appears to be important in early postfire succession but only a minor species in mature mixed-conifer forest. Deer brush in the understory of mixed coniferous forest is usually decadent, and decadent plants show poor sprouting response after top-kill. Seedling establishment, however, is usually good, even if deer brush plants are no longer present in the understory [22,36,37].

POSTFIRE REGENERATION STRATEGY :
Tall shrub, adventitious-bud root crown
Ground residual colonizer (on-site, initial community)

Himalayan Blackberry (Rubus discolor)

FIRE ECOLOGY OR ADAPTATIONS :
Blackberries are typically observed in greatest abundance following fire or other types of disturbance. The Himalayan blackberry is well adapted to invade recently burned sites. Most blackberries sprout vigorously after fire [9]. Various regenerative structures located at or below the ground surface enable this shrub to sprout, even when aboveground foliage is totally consumed by fire. Sprouting through rooting stem nodes [32] is also likely if even portions of the aboveground stem remain undamaged.

Most blackberries store seed in seedbanks. Plants can readily reoccupy recently burned sites through seed protected from the direct effects of fire by overlying soil or duff. Seed generally remains viable for long periods of time [2] and germinates in abundance after disturbance. The relatively large, sweet, succulent fruits of blackberries amply reward animal dispersers [16], and some postfire reestablishment through seed transported from off-site is also probable.

POSTFIRE REGENERATION STRATEGY :
Tall shrub, adventitious-bud root crown
Rhizomatous shrub, rhizome in soil
Geophyte, growing points deep in soil
Initial-offsite colonizer (off-site, initial community)
Ground residual colonizer (on-site, initial community)

Manzanita, Greenleaf (Arctostaphylos patula)

FIRE ECOLOGY OR ADAPTATIONS :
Greenleaf manzanita has a dynamic relationship with fire [18]. This shrub has adapted specialized reproductive processes that enhance its ability to survive fires [36]. It can reestablish by sprouting from dormant buds in the root burl or from fire-stimulated germination of dormant residual seeds in the soil [36,59,66].

Greenleaf manzanita is very susceptible to fire due to its stand density, presence of volatile materials in its leaves, low moisture content of foliage during summer, and the persistence of its dead branches and stems [10,18,51]. This shrub forms stands that are conducive to very rapid and extensive fire spread due to its physical and chemical characteristics [33].

POSTFIRE REGENERATION STRATEGY :
Small shrub, adventitious-bud root crown
Ground residual colonizer (on-site, initial community)

Manzanita, Whiteleaf (Arctostaphylos viscida)

FIRE ECOLOGY OR ADAPTATIONS :
Plant adaptations: Whiteleaf manzanita establishes after fire by fire-stimulated germination of dormant seeds stored in the soil [13,22,23].

Fire ecology: Whiteleaf manzanita has various morphological adaptations that encourage fire. During drought, the plant undergoes branch die-back, which contributes to fuel loading. Continuous shedding of bark adds additional fuel [36]. The surface-to-volume ratio of leaves and twigs are perfectly scaled for maximum air circulation, resulting in more complete burning of the plant and adding to fire intensity [20]. Additionally, leaves and twigs contain flammable oils and terpenes [40]. Philpot [40] has reported the heat value of whiteleaf manzanita leaves and twigs at 8,942 Btu per pound (4,973 cal/kg).

POSTFIRE REGENERATION STRATEGY :
Ground residual colonizer (on-site, initial community)

Poison Oak (Toxicodendron diversilobum)

FIRE ECOLOGY OR ADAPTATIONS :
Poison-oak's primary postfire regeneration strategy is vigorous sprouting from the root crown and/or rhizomes [16,46,68].

Fire is not required for poison-oak seed germination. Keeley [37], however, reported a significant ($p<0.001$) increase in germination when seeds were exposed to charate. Postfire seedlings probably originate from both soil-stored seed and fresh seed dispersed by birds.

POSTFIRE REGENERATION STRATEGY :

Tall shrub, adventitious-bud root crown
Rhizomatous shrub, rhizome in soil
Ground residual colonizer (on-site, initial community)
Secondary colonizer - off-site seed

Snowberry (Symphoricarpos albus)

FIRE ECOLOGY OR ADAPTATIONS:

Common snowberry is classified as a "survivor" [71,103] and has high resistance to fire [26,73,84]. It is a rhizomatous species with rhizomes buried 2 to 5 inches (5-12.5 cm) deep in mineral soil [50,70,104]. After fire has killed the top of the plant, new growth sprouts from these rhizomes [77,83,118]. This rhizomatous growth response is highly variable and depends on conditions at specific sites [23,77,84]. Regeneration from buried seed is favored by fires of low severity and short duration that remove little of the soil organic level [23,55].

Common snowberry occurs in a wide variety of community/habitat types and plant associations (see DISTRIBUTION AND OCCURENCE frame). There are many fire regimes included within these plant communities [15,31,41,42]. To learn more about fire regimes and fire ecology of communities where common snowberry occurs, refer to the FEIS summary for the dominant species under "FIRE ECOLOGY OR ADAPTATIONS."

Community or Ecosystem
Scientific name of dominant species
Fire return interval in years

Pacific ponderosa pine*
Pinus ponderosa var. ponderosa
1-47 [19]

Rocky Mountain ponderosa pine*
P. ponderosa var. scopulorum
2-10 [19]

Rocky Mountain lodgepole pine*
P. contorta var. latifolia
25-300+ [6,92]

Rocky Mountain Douglas-fir*
Pseudotsuga menziesii var. glauca
40-140 [79,107]
Pseudotsuga menziesii var. menziesii
coastal Douglas-fir*
95-242 [82,91]

* fire return interval varies widely; trends in variation are noted in the species summary

POSTFIRE REGENERATION STRATEGY:
Rhizomatous shrub, rhizome in soil

Tanoak (Lithocarpus densiflorus)

FIRE ECOLOGY OR ADAPTATIONS :
Tanoak resprouts following fire via dormant buds located on an underground regenerative organ known as a burl or lignotuber [36,53]. Stored carbohydrates in the burl and an extensive taproot system aid in a rapid and aggressive postburn recovery [31,53].

Resistance to low intensity burning is increased in older individuals where the bark may be from 1 to 3 inches (2.5-7.6 cm) thick [36,42].

POSTFIRE REGENERATION STRATEGY :
survivor species; on-site surviving root crown or caudex

FIRE EFFECTS

CONIFERS

Douglas-fir (Pseudotsuga menziesii var. menziesii)

IMMEDIATE FIRE EFFECT ON PLANT :
Trees: Crown fires commonly kill all trees over extensive areas. Hot ground fires that scorch tree crowns and char tree boles kill variable proportions of coast Douglas-fir [3]. Rapidly spreading ground fires tend to inflict more damage to Douglas-fir crowns, while slow spreading ground fires are damaging to the bole and can kill trees through cambial heating [60]. Crown scorching from summer fires is more damaging than late summer or fall fires because more buds are killed. During late summer the buds are set and subsequent-year needles are well protected [75]. Seedlings and saplings are susceptible to and may be killed by even low-intensity ground fires [74].

Seed: Temperatures in excess of 140 degrees F (60 C) are lethal to Douglas-fir seeds. Thus most seeds on the forest floor will be destroyed by fire [35]. Crown fires will kill seeds in green cones; however, green cones are relatively good insulators and are not highly flammable, and fires that not excessively hot often only scorch the cones. Seeds can mature in scorched cones on fire-killed trees, and later disperse onto the burned area [35].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
The Hoh Fire in June 1978 burned 1,230 acres (500 ha) of montane and subalpine coniferous forests. The montane forest was composed primarily of 400- to 500-year-old western hemlock and Douglas-fir. About 10 percent of this forest type was consumed by a crown fire, while most of the remaining forest experienced a hot ground fire with considerable crown scorching. All trees less than 10 feet (3 m) tall were killed. Mortality of overstory trees was high, but Douglas-fir suffered the least. The fire reduced the basal area of all species as follows:

bigleaf maple 100%
western hemlock 80%
western redcedar 50%
sitka spruce 50%
coast Douglas-fir 33%

Ninety-one percent of western hemlock overstory trees were killed, compared with 62 percent of Douglas-fir [3].

PLANT RESPONSE TO FIRE :
Seedling establishment following fire is dependent on the spacing and number of surviving seed trees. Seedling establishment following large stand-destroying fires is slow because seed trees are killed over extensive areas. After the Tillamook Fire in northwestern Oregon, seedlings were restricted to areas around scattered survivors and near the burn edge [77]. Conversely, Douglas-fir can quickly establish a new cohort of seedlings if there are numerous, well-spaced surviving seed trees within the burned area. Conifer seedlings were abundant after the Hoh Fire in Olympic National Park, where 38 percent of mature Douglas-fir survived. Three years after this fire, there were about 3,400 conifer seedlings per acre (8,400/ha), about half of which were Douglas-fir [34]. In the northern Cascades, Douglas-fir seedling frequency was between 80 and 100 percent on three different 4-year-old burns ranging in size from 55 to 410 acres (22-166 ha) [52].

Gray Pine (Pinus sabiniana)

IMMEDIATE FIRE EFFECT ON PLANT :
Moderate-severity fire kills a substantial number of gray pines. The prescribed fire in Glenville (see Fire Ecology or Adaptations) killed 83 percent of gray pine present. All surviving gray pine were large trees [35].

PLANT RESPONSE TO FIRE :
Information regarding postfire recovery of gray pine is sparse. Keeley [30] reported a gray pine seedling density of 133 per acre (54/ha) following a wildfire of unreported severity at Bartlett Springs, Lake County. Percentage cover provided by gray pine in a blue oak-gray pine community often decreases when fires are frequent. Many blue oak ecotypes sprout following fire, and under a regime of frequent fire, rapidly growing blue oak sprouts interfere with gray pine seedling growth [16,26].

Incense Cedar (Calocedrus decurrens)

IMMEDIATE FIRE EFFECT ON PLANT :
Incense-cedar seedlings and saplings are more readily killed by fire than most of their associates. Heat-kill is responsible for much of the mortality. In northern California, a study found nearly all individual seedlings and saplings were killed by a low-severity fire [23]. These results are consistent with those from Lava Beds National Monument, where incense-cedar is considered a decreaser following fire [18]. Incense-cedar has unprotected buds and finely divided foliage that is damaged by fire [24].

Mature incense-cedar's thick bark offers sufficient protection from excessive heat. Most studies find that only an occasional mature incense-cedar will succumb to surface fire. Moderate- to high-severity surface fires that damage trunks, however, make the trees susceptible to dry rot infection [12,19,24].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
Crown damage: Generally, incense-cedar does not replace foliage, buds, or twigs killed by fire. Thus, the amount of green foliage present in scorched crowns following fire is reasonably close to the amount of foliage that will be present in the future [27].

PLANT RESPONSE TO FIRE :
Enhanced incense-cedar seed germination occurs on the exposed mineral soil seedbed created by low-severity fire [19,24].

Ponderosa Pine (Pinus ponderosa var. ponderosa)

IMMEDIATE FIRE EFFECT ON PLANT :
Fire has a wide variety of potential effects on Pacific ponderosa pine. These effects vary according to size, configuration, and density of the stand, in addition to fire severity. Generally, well-spaced seedlings and saplings are able to withstand low-severity fires, as are pole-sized and mature trees. Moderate- to high-severity fires, however, will kill trees pole-sized and smaller. Mature Pacific ponderosa pines have a higher survival rate than younger trees due to their enhanced adaptations to fire [16,39,77].

The principal cause of mortality following fire is crown scorch rather than damage to the cambium or roots. The size of tree determines its ability to withstand scorch. A model has been developed to predict mortality using tree d.b.h. and scorch heights as independent variables. Fire effects are also dependent upon other factors such as season, site condition, tree age and vigor, available moisture, and occurrences of insect and disease attack [39,56].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
If fire consumes any part of tree canopy, the total leaf area is reduced, thus decreasing photosynthesis. If burning results in damage to the bole or roots, nutrient and water transport is impaired. Heat from fire may kill living tissue and result in a certain amount of stress [26,39,55].

Crown damage: Crown scorch appears to be the leading factor in the majority of damage to Pacific ponderosa pine. Estimation of percent crown volume scorch has been proven to be the best predictor of tree mortality following fire. Crown damage is most severe in spring and early summer due to low foliar moisture content and the succulent nature of the buds and twigs [39,55]. Survival of buds is also crucial to postburn survival of Pacific ponderosa pine. Buds can tolerate temperatures 68 degrees F (20 deg C) higher than the needles can due to their protective outer scales. Therefore, large trees can sometimes survive a 100 percent crown scorch provided not all the buds are heat killed [26,39,44,55].

Root damage: Following prescribed burning of old-growth Pacific ponderosa stands in Crater Lake National Park, Oregon, mortality was higher in burned areas (19.5 percent) than in unburned areas (6.6 percent). A major factor contributing to postfire mortality was the reduction of fine roots. Burning reduced fine-root dry weight 50 to 75 percent from 1 to 5 months after burning [64].

Bole damage: This pine is fire tolerant because it has a fire-resistant bark containing a 1/8- to 1/4-inch (0.3-0.6 cm) thick layer at 2 inches (5 cm) diameter [77]. It also has a very moist core of high density wood that dissipates the heat energy it receives, thus protecting the bole from lethal heat levels [55]. Ryan and Frandsen [53], however, found that mature Pacific ponderosa pine trees suffered more basal injuries from smoldering fires than did immature trees because of the greater quantities of accumulated duff surrounding their boles. Cambium damage most often occurs after the passing of high-severity fires. Young trees are most susceptible to cambium damage as a result of thinner bark and a higher occurrence of girdling [26,78]. Partially girdled trees may survive up to 25 percent basal loss if root and crown damage is minimal [71].

Season of burn: Pacific ponderosa pine can withstand low-severity fires, which generally occur during the wet months of early spring or late fall. A dry spring fire may occur when trees are in stress during leaf and bud burst, resulting in higher mortality rates. Trees become dormant toward fall and thus are more fire resistant. In fall, Pacific ponderosa pine can withstand up to 50 percent crown scorch, while in
spring only 30 percent [26,45].

PLANT RESPONSE TO FIRE :
Pacific ponderosa pine's response to fire will vary according to fire severity, tree age, and season. High-severity fires that occur during periods of high stress will generally result in death. Low- to medium-severity fires will generally restrict the growth and regeneration of the tree, but recovery is usually evident the following year [39]. Immediately following fire, Pacific ponderosa pine may experience a large needle drop as a reaction to hot convectional air movement through the canopy [55].

Postfire seedling establishment: Fire creates favorable seedbeds for seedling establishment. The soil is often rich in available inorganic nitrogen that benefits tree growth [52]. Postfire stocking rates depend upon site characteristics, fire severity, and weather. The potential for regeneration after fire is generally considered good [39]. On the Eldorado National Forest, California, a low-severity burn resulted in 20,000 seedlings per acre (49,400/ha) on burned sites and no seedling establishment on unburned sites [39]. In a western Montana study, Pacific ponderosa pine produced 12 percent of the total number of sound seeds found on a burned clear-cut site over a 5-year period [64]. A postburn study in the Plumas National Forest, California, found that Pacific ponderosa pine had the highest postburn percent increase of all other associated species [39]. Postfire stocking rates depend upon site characteristics, fire severity, and weather. The potential for regeneration after fire is generally considered good [39]. In a western Montana study, Pacific ponderosa pine produced 12 percent of the total number of sound seeds found on a burned clear-cut site over a 5-year period [64]. A postburn study in the Plumas National Forest, California, found that Pacific ponderosa pine had the highest postburn percent increase of all other associated species [39].

Postfire growth and recovery: Information concerning Pacific ponderosa pine's response after fire is variable. This may be attributable to the beneficial effects of reduced competition and increased nutrient availability, along with the detrimental effects of damage to the crown, cambium, and roots. Some studies found reductions in diameter and height growth [46,76], while others reported increases in postfire growth [8,46,69,73].

Sugar Pine (Pinus lambertiana)

IMMEDIATE FIRE EFFECT ON PLANT :
Sugar pine is rated as intermediate in fire tolerance. Young sugar pines are susceptible to low- to high-severity fires. Mature trees can survive most fires, suffering only bole scorch. Sugar pine susceptibility to secondary attack by insects and disease following fire is rated as low [3].

PLANT RESPONSE TO FIRE :
Sugar pine reaction to a low-severity fire is by seeding on the exposed mineral soil, thus enhancing germination. High-severity fires that occur during periods of high stress will generally result in death [3,16].

White Fir (Abies concolor)

IMMEDIATE FIRE EFFECT ON PLANT:
White fir seedlings, saplings and poles are thin-barked and resin blistered and are highly susceptible to fire damage and kill [178]. Additionally, young trees have low-growing branches that can easily ignite from burning undergrowth, providing a fuel ladder into the crown. Consequently, young white fir are usually killed by even low-intensity, surface fires [29,168,302]. As trees mature and bark thickens, and some self-pruning of lower branches occurs, they become more resistant to fire [344]. However, the tendency to retain some low branches, the moderately shallow roots, and heavy lichen growth on the branches of white fir make it only moderately fire resistant [55]. In larger trees, mortality results from crown scorch, girdled stems from cambial heating, or damage to moderately shallow roots from soil heating [302,327].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:
The effects of fire on white fir vary with size and age of tree, stand density, fuel loading and fire conditions.

Prescribed low-intensity summer surface fires in mixed conifer forests of Crater Lake National Park, Oregon, resulted in high mortality of small white firs [302]. Similarly, prescribed, low-intensity fall surface fires in a giant sequoia-mixed conifer forest in

Kings Canyon National Park, California, resulted in mortality of 91% of trees less than 6 inches (15 cm) dbh, 39% of trees 6-12 inches (15-30 cm) dbh, and 5% of trees larger than 12 inches dbh [168].

Greater reduction in density is obtained in stands with higher prefire densities. In white fir stands with dense vegetation, consisting of both young stands of pure white fir and open stands of white fir with a shrub understory, fires burned at high intensity and killed most trees in the area studied in the Marble Mountains of California. In lower density forest stands of white fir with old-growth characteristics, fires were of low intensity and burned down rotten logs and standing snags with very little damage to the canopy trees [304]. Prescribed fires resulted in an increase in the density of giant sequoia at the expense of white fir [164,165,169].

Greater mortality of mature trees could be expected in stands with a deep litter layer, since smoldering of the duff for long periods after the fire has passed kills the moderately shallow roots of white fir [4].

PLANT RESPONSE TO FIRE:
Following stand-replacing fires, white fir reestablishes via wind-dispersed seed. Exposed mineral soil seedbeds created by fire favor initial seedling establishment in white fir [159], but seedling survival is better in partial shade [39]. Therefore, seedlings establish soon after fire if a canopy remains [170], but may take several years to establish if the canopy has been removed.

Fire may encourage growth in white fir by eliminating competition. Evidence from a fire-scarred white fir stump in Oregon shows that after being scarred as a sapling-sized tree, it had growth release [3]. However, trees damaged or weakened by fire are also more susceptible to attack by insects and disease. Fire scars may allow a point of entry for a variety of disease and decay organisms [178,336], and fire-weakened trees that are attacked by insects can be killed within a few years [302].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:
The response of white fir to fire is inconsistent and may vary with fire frequency and severity, associated vegetation in the postfire community, location of seed trees, postfire insect and disease effects, and postfire browsing by animals. Mean annual post-fire mortality of 17.8% in white fir was related primarily to fire-caused crown scorch and possibly fine root mortality in Sequoia National Park [233]. White fir is considered more fire resistant than its associated species at high elevations, but less resistant than associated species at low elevations [178,219]. Tree associates Douglas-fir and ponderosa pine are favored by more frequent fires [344]. If the time between fires is long enough, white fir seedlings can germinate and establish under brush cover and thus establish crown dominance over time [65,178,211].

In the mixed conifer zone of the Sierra Nevada, white fir seedlings are often abundant under montane chaparral shrubs that form brushfields after high severity crown fires. Conard and Radosevich [65] found white fir reproducing abundantly on shrub-dominated sites, with a combined seedling and sapling density ranging from 445 to 4,453 per acre (1100-11,000/ha) where crown fires had occurred 38 to 62 years earlier. Densities of both snowbrush ceanothus and manzanita were higher on burned than on unburned and on logged than on unlogged plots [328]. Fire severity can be an important determinant of shrub response in white fir stands. Preharvest burning in a 70-year-old white fir stand in northeastern California resulted in 410,000 snowbrush ceanothus seedlings/ha in moderate-consumption burns, and 94% seed mortality in more severe burns - killing seeds to a depth of 10 cm in the soil [329,330].

Minnich [218] studied conifer reproduction on burned areas in mixed conifer forests in the San Gabriel and San Bernardino mountains of southern California. He found that seeds originating from outside the burned area were responsible for abundant white fir production on burns older than 10 years, but that reproduction was scant on burns less than 5 years old. Similarly, no white fir seedlings established within 5 years of a crown fire in the Sierra Nevada, even though several mature trees survived the fire and thus provided a seed source [65]. Another Sierra Nevada study found negligible white fir reproduction 17 years following a stand-replacing fire, even though a seed source was readily available [51]. Less than 1 year following underburning in a giant sequoia grove, white fir seedling establishment in June was abundant, with 39% survival in October [6].

Most mortality in white fir after the 1st year postfire in mixed conifer in southern Oregon was associated with bark beetles [302].

HARDWOODS

California Black Oak (Quercus kelloggii)

IMMEDIATE FIRE EFFECT ON PLANT :
California black oak is fire sensitive. The outer bark chars readily, and the cambium suffers heat damage even where bark is thick (over 0.5 inch [1.3 cm]). All trees in a stand are usually top-killed following crown fire regardless of size [33], and complete kill is common after such fire in pole-sized or smaller trees [22]. Complete kill is also common when individual trees or clumps of trees are surrounded by or adjoining brush [33].

The amount of damage sustained by surface fire depends upon fire severity. A large percentage of California black oak are completely killed following severe surface fire, especially when trees are shrubby [22]. Moderate-severity fire typically produces localized charring and cambium death in an older trunk, while other trunk portions remain undamaged [34]. Approximately half of all young trees in a stand will be killed by moderate-severity fire [22]; most of the others will be top-killed. Low-severity fire causes some cambium damage to trees pole-sized and under [2,22]. Spring fire corresponding to the active growing season results in greater tissue damage than fire in other seasons [21].

PLANT RESPONSE TO FIRE :
Within a few weeks following fire, most surviving trees sprout from the root crown and undamaged portions of the trunk. This response is independent of the rainy season; new shoots draw upon water reserves in the root system and appear following spring, summer, or fall fire. Sprouting is vigorous in saplings and young trees. Very old trees may fail to sprout or produce only coppice sprouts [30]. Fire prepares an ideal seedbed, and seedlings establish in the first postfire growing season. California black oak seedling populations were significantly increased ($p>0.05$) following a light-intensity prescribed burn of a Jeffrey pine (Pinus jeffreyi)-California black oak forest in Cuyamaca Rancho State Park, California [27]. Long-term recovery of this species is favorable; fire creates the open canopy required for optimum seedling and sprout growth [22].

Canyon Live Oak (Quercus chrysolepis)

IMMEDIATE FIRE EFFECT ON PLANT :
Aboveground foliage of canyon live oak is sensitive to fire, and this plant is generally top-killed by fires of even relatively low intensity [26]. Light ground fires can seriously damage or girdle this oak or produce fatal cambium injuries to the crown and trunk [58,59,73]. The dead flaky outer bark is extremely flammable and can carry fire several feet up the trunk [73]. The bark is relatively thin and offers little protection when compared with other species of oak [58]. The trunk appears to be sensitive to heat damage [70], which often extends up the trunk, far above any obvious signs of charring [72].

The total effect of fire on oaks varies according to fire intensity and severity, fire behavior, season of burn, and the size of the plants [70,72]. Younger plants and those with smaller stems and lower crown heights tend to be most vulnerable [70,72]. Trees with crown-to-ground distances of 15 to 30 feet (5-10 m) or more tend to be most resistant to damage [60]. Larger trees have relatively little dead fuel in the crown since leaf fall occurs in early summer prior to the fire season. The thicker bark of larger oaks provides some additional protection as does the greater living biomass, which decreases overall flammability [60]. Trunks of oaks are, in general, more seriously damaged by slower moving, lower intensity fires than those of higher intensity, but shorter duration. However, because of the presence of heat-sensitive leaves, crowns tend to be more severely injured by fires of higher intensity, but shorter duration. Fires are generally more damaging as the growing season proceeds, with winter fires the least damaging. The bark is typically less severely damaged when burned at lower ambient air temperatures. Oaks less than 6 inches (15.2 cm) d.b.h. are generally top-killed by even low intensity fires [72].

Stem and bark: Young oak stems that have been damaged by heat generally change from gray to reddish-gray in color. The subsurface layer of the bark changes from green to tan or brown, and the inner bark appears yellow instead of the normal white or pink. Damaged inner bark often has a characteristic fermented aroma. The cambium can be considered dead if the bark has been consumed, or if it appears to be cracked and separated from the wood. Trunk char may be categorized as follows [72]:

1) light - spotty char or scorch, scattered pitting of the bark
2) medium - continuous charring, pronounced reductions areas of minor bark reduction
3) heavy - pronounced reductions in bark thickness, in some areas the bark is burned through exposing the wood beneath

Basal scars produced by scorching can admit rot and disease and frequently serve as a point of ignition in subsequent fires [70].

Crown: Crown damage is variable in oaks and the degree of damage can differ even within an individual crown]. Damage may range from essentially none to total removal of the foliage. Crown survival of larger trees is somewhat variable. Trees of 12 inches (30.5 cm) d.b.h. have survived with wounds up to 20 feet (6.1m) in height [70].

Damage within a stand may be serious and widespread. Up to 78 percent of the stands in a given area may be defoliated by char or scorch in bigcone Douglas-fir-canyon live oak forests of California [59]. Fire-related injuries can increase oak's susceptibility to attack by insects, fungus, or windthrow [70]. Belowground portions of canyon live oak generally survive even when the plant is top-killed by fire [58,59,67,68]. However, plants may be killed if burned at too frequent intervals [73]. Acorns of canyon live oak are sensitive to heat and are generally destroyed by fire [24].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :

The full effect of fire on oaks may not become obvious for some time. It may be necessary to wait for at least one growing season, and preferably three, before survival can be accurately determined. Undamaged leaf crowns of seemingly girdled canyon live oaks may appear alive for as long as 8 years after fire [72]. Plumb [70] noted that when dense pure stands of canyon live oak 6 to 12 inches (15-31 cm) d.b.h. were burned, initial damage appeared to be restricted to the bottom 1 to 5 feet (0.3-1.5 m) of the trunk. All trees 3 inches (7.6 cm) d.b.h. or smaller were top-killed within 18 months, but at least 55 percent of the larger trees appeared to be alive, although presumably girdled at the base. However, crowns of 50 percent of the remaining trees turned brown and died by the 36th month after fire, and most of the rest were expected to die within the next few years [70].

Various methods have been developed for assessing damage to oaks including chemical, electrical, and visual techniques [70,72].

PLANT RESPONSE TO FIRE :

Canyon live oak generally sprouts prolifically after fire [59,88,89]. Even seedlings are often capable of sprouting after disturbance [49], and moderate to dense regrowth of sprouts is typical after fire [72]. Canyon live oak sprouts vigorously from the subsurface root crown even when the upper canopy is only partially defoliated by burning or scorching [60,70]. The root crown itself has been described as a "basal woody mass" but does not appear to be lignotuberous [40,60]. Postfire stump-sprouting occurs where portions of the stump remain intact [37,49,67]. Under certain circumstances, some larger trees crown sprout if only "marginally singed" [59]. However, this appears to be somewhat unusual, with resprouting typically occurring from the base and not the crown [57,58,68]. On occasion, plants may sprout from both the base and the crown [P. McDonald pers. comm. 1990].

Postfire recovery: Where sprouting occurs, recovery of canyon live oak is generally rapid. In some areas, sprouts are capable of reaching 3 to 6 feet (1-2 m) in height within only four 4 after fire. On many sites following lighter fires, canyon live oak frequently forms dense, virtually impenetrable stands 3 to 10 feet (1-3 m) in height within 15 to 30 years after fire [59,60]. After 30 years, canyon live oak generally grows in multistemmed clumps which form a closed canopy 15 to 30 feet (5-10 m) high [60]. Frequent fires favor shrublike growth forms of canyon live oak, which often dominates other species following several fires at fairly close intervals [11]. Open woodlands of canyon live oak are temporarily replaced by live oak chaparral after repeated burning [57]. However, protection from fire favors the reestablishment of oak woodlands as oak sprouts ultimately grow tall enough to outcompete other associated plants [49].

Acorns: In certain areas, some postfire establishment can occur through the germination of canyon live oak acorns [88]. However, in most locations, regeneration through seed is probably important only in years of favorable precipitation [77]. Conditions created by fire are not generally conducive to the germination of acorns, and most oaks seldom establish through seed after fire [40,42]. The current year's acorns are generally killed by fire and even acorns stored in the soil are vulnerable to heat [41]. Animals may carry some viable seeds to the site from adjacent unburned stands, and some on-site seeds, more deeply buried in rodent caches, can germinate and contribute to postfire reestablishment.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :

Canyon live oak sprouts most prolifically on sites with deeper soils and with higher soil moisture [38,69]. Sprouting varies according to elevation as follows [69]:

elevation	% sprouting
2,100 ft	73
4,100 ft	60
average	66

Oregon Bigleaf Maple (Acer macrophyllum)

IMMEDIATE FIRE EFFECT ON PLANT :
Most fires top-kill bigleaf maple [30,50]. Severe fires, which transfer heat below the mineral soil surface, damage maple root crowns and thus prevent some plants from sprouting [55]. Following prescribed burning in the western Cascades of Oregon, bigleaf maple was nearly eliminated on severely burned plots but remained abundant in lightly burned areas [15].

PLANT RESPONSE TO FIRE :
Bigleaf maple survives fire by producing numerous root crown sprouts [30,50]. Reported annual sprout growth varies from 3.2 to 6.5 feet (1-2 m) [50] and 9.8 to 13.1 feet (3-4 m) [30]. Sprout development following top-kill of bigleaf maple trees by fire in northern California is summarized below [50]:

time since fire	height of tallest sprout in clump (feet)		crown diameter of sprout clump (feet)		sprouts/clump	
	Ave	Range	Ave	Range	Ave	Range
Second year	9.8	6.8-13.1	11.5	6.8-15.5	78	14-143
Third year	12.8	7.5-17.1	14.7	10.4-21.5	37	8-67

In this study, the number of living sprouts was reduced drastically between the second and third growing season as weak sprouts died and growth was concentrated on fewer stems. Parent tree diameter was found to be related to the number of sprouts per tree, with large diameter trees producing the greatest number of sprouts per tree.

Oregon White Oak (Quercus garryana)

IMMEDIATE FIRE EFFECT ON PLANT :
Crown fire generally kills this species. Moderate-severity surface fire rarely kills large trees, but smaller oaks may be killed or suffer severe cambium damage [13]. Low-severity surface fire rarely harms mature trees, but seedlings and saplings are commonly top-killed. Animal-buried acorns are usually not affected by fire [41,49].

PLANT RESPONSE TO FIRE :
Most researchers report vigorous sprouting of top-killed Oregon white oak [17,36,41,43,53], although at least one researcher [25] has classified this species as a weak sprouter. Sugihara and Reed [48] report more vigorous sprouting in 40-year-old than in 70-year-old oaks. Studies conducted on young, even-aged stands show good postfire recovery of these trees. Oregon white oak top-killed by fall prescribed burning in Shasta and Tehama Counties, California, exhibited vigorous sprouting during the first postfire growing season [53]. In Humboldt and Trinity Counties, California, three-year-old sprouts had grown above the browse line [36].

In the absence of further fire, these sprout clumps form dense, even-aged stands. Most Oregon white oak woodlands of today are of this type due to fire suppression. When subjected to further fire, however, weaker meristematic tissue is killed, and individual root crowns produce fewer sprouts per clump with each fire. Continued periodic fire ultimately results in an open savanna with widely scattered, large oaks [27].

Fire research on Brewer oak is extremely limited. One study followed the postfire recovery of this variety for 3 years after the Three Creeks Burn in Humboldt County, California. This "intense" wildfire top-killed most oak shrubs. At the end of postfire year 1, sprouts varied in height from 4.4 to 11.2 feet (1.3-3.4 m), with an average of 18 sprouts per clump. At postfire year 3, many of the weaker sprouts had died, and sprouts were reduced to an average of 10 sprouts per clump. Sprout height at postfire year 3 was not recorded [43].

Pacific Madrone (Arbutus menziesii)

IMMEDIATE FIRE EFFECT ON PLANT :
Madrone is a fire-sensitive species; aboveground portions are very susceptible to fire mortality [4,10,63]. Low-intensity ground fires usually top-kill madrone seedlings and sapling-sized stems [4]. Thin bark provides little insulation from radiant heat, which usually kills the cambium around the base of the stem [40]. Larger trees with thicker bark frequently survive light underburning on favorable growth sites within redwood and mixed-evergreen forests. Although young, vigorous trees usually exhibit bole

injuries following burning, fire scars tend to heal over rapidly. Older madrones may initially survive light ground fires; however, bole wounds facilitate the entry of insects and disease and many fire-damaged trees eventually die [4].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
Vegetative regeneration: Following fires which kill aerial stems, Pacific madrone initiates a rapid postburn recovery by sprouting from adventitious buds located on an underground, globelike structure known as a burl [31,58]. Burls may reach diameters of 8 inches (20 cm) or more [26]. Since burls contain aggregations of buds, newly sprouted madrones occur as "sprout clumps" [40]. Sprouts are quite tolerant of direct sunlight and develop well in the initial postburn environment [16]. After 10 years of growth on a good site in the northern Sierra Nevada, Pacific madrone sprout clumps averaged 22 feet (6.7 m) in height and 10.2 feet (3.1 m) in crown width with an average of 15 sprouts per clump [39].

The initial postburn recovery is aggressive. Pacific madrone sprouts sometimes grow more than 5 feet (1.5 m) during the first postburn growing season [39]. Although prolific spouting usually occurs during the first 2 years following burning, sprout numbers are drastically reduced between postburn years 2 and 3 as growth is concentrated into multiple dominant stems. Initial trends in postburn recovery of Pacific madrone in northwestern California are presented below [66]:

	Years postburn		
	1	2	3
Average ht of tallest sprout in clump (feet)	4.7	7.7	10.1
Average crown diameter of sprout clump (feet)	4.5	6.8	7.6
Average sprouts per clump	17	16	13

Seedling regeneration: Pacific madrone seedling establishment is favored following fire. Mineral soil seedbeds and light canopy densities of the initial postburn environment are extremely conducive to the successful establishment and growth of madrone seedlings [46,59]. On sites where fires are not too severe, abundant seed is available from residual trees. Off-site seed is also dispersed by mammals and birds. Initial postburn seed production of sprouted madrones has not been reported. Minimum seed-bearing age of seedling-derived plants is 3 to 5 years [16].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
Since sprout production is initially fueled by the residual root system, postburn sprouting potential of madrone is strongly related to the size and vigor of the parent tree. Sprout clumps produced by larger diameter parent trees are generally taller and wider in diameter than those of smaller diameter parent trees; they also produce greater numbers of resprouts [26,58,66]. Site quality apparently has almost no influence on sprout clump development for at least 6 years after fire [58]. Limited observations on sites in southwestern Oregon indicate that previous fires and the subsequent entry of pathogens can substantially reduce the sprouting potential of parent trees greater than 17.2 inches (43 cm) d.b.h. [58].

White Alder (Alnus rhombifolia)

IMMEDIATE FIRE EFFECT ON PLANT :
A study of riparian vegetation following a July high intensity fire in southern California found that about 97 percent of white alder trees were killed, while associated oaks, sycamores, and cottonwoods were top-killed only and resprouted vigorously (Barro 1989, pers. comm.)

PLANT RESPONSE TO FIRE :
A California riparian study found that 60 to 70 percent of mature, white alder trees had either root or trunk sprouts [35]. With this high degree of vegetative regeneration one would expect this plant to sprout following the removal of aboveground vegetation by fire. However, Barro (1989 pers. comm.) found that about 97 percent of white alder died from a high intensity July wildfire. These plants did not resprout.

White alder has light wind-dispersed seed that normally establishes on moist alluvium left bare from receding flood waters. Fires that remove organic soil layers and expose mineral soils, may possibly provide favorable seedbeds for the establishment of white alder seed, providing the soil remains moist.

SHRUBS

Buckbrush (Ceanothus cuneatus)

IMMEDIATE FIRE EFFECT ON PLANT :
Wedgeleaf ceanothus is typically killed by fire. However, seeds stored in soil beneath the parent plants are generally unharmed by most fires. Seed retains viability even when exposed to temperatures up to 176 degrees F (80 degrees C) [62].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
Wedgeleaf ceanothus regenerates through seed after fire [8,35,45,52]. Seed is noted for its long viability [34], and great numbers accumulate in the soil, litter, or duff beneath the parent plants [9,17]. Seed is extremely resistant to heat and remains undamaged even when exposed to temperatures up to 176 degrees F (80 degrees C) [62].

Seedling establishment: Heat generated by fire stimulates the germination of numerous seedlings by breaking down dormancy mechanisms [52]. Concentrations of seedlings are frequently observed in areas that burned particularly hot, such as under brush piles or shrubs [21]. These high temperatures may have reduced competing vegetation as well as enhanced germination through mechanical changes in the seed itself [21]. Establishment is generally rapid. Seedlings are common during the first postfire year, but few emerge during the second year [25,62]. Emergence after the second postfire year is rare.

Germination and subsequent seedling establishment appears to be highest following fall burns, and lowest after fires which occur from March 15 through April 1 [8,25]. This is presumably due to the ameliorating affective of moisture on heat transfer [4]. Following fall burns, seeds are also naturally stratified over the winter months, which promotes germination. Seedlings that emerge after early spring burns are not stratified and, in addition, must compete with a thick growth of herbaceous vegetation [25]. Seedling emergence is generally deferred until the following year when chaparral is burned after early April [8].

Seedling mortality: Seedling mortality is great during the first few years after fire [55]. Declines in seedling numbers of up to 90 percent have been observed during the first 3 years, with first year mortality of 84 percent or more [5]. Much of this mortality is attributable to the effects of drought, competition with grasses and other herbaceous vegetation [56], or intense browsing by herbivores.

Growth: Postfire growth of seedlings has been correlated with the amount of available nitrogen [46]. Maximum seedling height growth during the first summer after fire was 10 inches (25 cm) [9]. On unbrowsed burned plots, plants reached maximum heights of 16 inches (41 cm) after 4 growing seasons [25].

California Hazel (Corylus cornuta var. californica)

IMMEDIATE FIRE EFFECT ON PLANT :
The aboveground parts of California hazel are easily killed by fire, even by light spring fires [7,12].

Because of their moisture requirements, seeds probably do not survive the high temperatures and drying associated with fire.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
California hazel responds to spring fires by vigorous and abundant sprouting; sprouting after summer fires is less vigorous [7]. Prefire stature and density are regained in only a few years [12].

Deerbrush (Ceanothus integerrimus)

IMMEDIATE FIRE EFFECT ON PLANT :
Mature deer brush is usually killed by fire [35]. A few plants may be only top-killed [7,41].

Most soil-stored deer brush seed survives fire [14]. Seed in heavy duff may be killed by moderate to intense fire.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
After soil-stored seed is scarified by fire, deer brush seedlings establish in great numbers. Most seedlings establish in the first postfire growing season [14,22]. Natural thinning reduces seedling density as the stand ages. After a July 1942 wildfire consumed a deer brush stand on the El Dorado National Forest, deer brush density was about 300,000 seedlings per acre at postfire year 1; 10,000 per acre at postfire year 10; 2,500 at postfire year 20; and less than a few hundred seedlings at postfire year 30 [22]. A similar pattern occurred after a "fairly intense" prescribed fire in a giant sequoia grove in Kings Canyon National Park. Burning was conducted in fall 1969. No deerbrush seedlings occurred on the unburned control plot. Deerbrush seedling establishment on burned plots follows [44].

Plot no.	Size (hectares)	Deerbrush seedlings (no. per hectare)		
		1970	1971	1972
1	1.52	9,284	5,248	403
2	2.47	13,993	6,459	808
3	2.53	539	672	269
means		7,939	4,127	494

Arizona chaparral: A dense stand of Pringle manzanita on the Tonto National Forest was burned to reduce fire hazard, increase browse, and increase water yield. Shrubs were sprayed with 2,4-D prior to the fire to increase their flammability. Deer brush was apparently absent from the area prior to burning. At postfire year 1, deer brush seedling density was [60]:

severe fire*	light-severity fire**	herbicide only	no treatment
190	0	0	0

*leaves and twigs mostly consumed
**leaves and small twigs mostly intact

Deer brush sprouts from the root crown after fire, but sprouting response may be weak [21,41]. Sprouts on older plants have been observed to die in their first year even when watered in summer [87]. Park records from Sequoia-Kings Canyon National Park note numerous sites where deer brush seedlings occurred after fire, but only two sites where sprouts were found after fire. In sequoia-mixed conifer forest in Sequoia National Park, deer brush sprouts occurred on 2 of 30 plots that were prescribe burned in November. After October wildland fire on the same watershed, sprouts occurred on 2 of 6 plots [41]. If they survive, deer brush sprouts may grow rapidly. On a site on the Stanislaus National Forest, deer brush sprouts grew 30 inches (75 cm) in the first postfire year [22]. Data on long-term survival of deer brush sprouts are lacking.

Frequent top-kill by fire or other disturbance (approximate fire return interval of less than 4 years) can eliminate deer brush [21,22].

Himalayan Blackberry (Rubus discolor)

IMMEDIATE FIRE EFFECT ON PLANT :
Although Himalayan blackberry plants may be top-killed, actual mortality appears to be uncommon because of the prolific sprouting ability of this shrub.

Most Himalayan blackberry seed stored on-site in the soil or duff is probably unharmed by fire.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
Vegetative response: The Himalayan blackberry is capable of rapid, extensive spread through trailing aboveground stems, which root at the nodes [32]. Plants are presumably able to regenerate vegetatively and resume growth when portions of the aboveground stems remain undamaged. Most blackberries readily regenerate vegetatively from underground structures such as roots, rhizomes, or rootstocks when aboveground
foliage is removed [11]. Regeneration through various underground structures, which are well protected from the direct effects of fire by overlying soil, is probable even when the aboveground vegetation is totally consumed by fire.

Seedling establishment: Exposed mineral soil can provide a favorable seedbed, and extensive postfire establishment of on-site seed is commonly observed in many blackberries. Birds and mammals may also transport some viable seed to the site.

Rate of postfire recovery: The weedy Himalayan blackberry is described as a "serious pest" which is well represented on many types of disturbed sites [7,14]. Its role as a vigorous invader on waste ground suggests the potential for rapid postfire recovery in many areas.

Manzanita, Greenleaf (Arctostaphylos patula)

IMMEDIATE FIRE EFFECT ON PLANT :
Fire generally top-kills greenleaf manzanita, but severe fire may kill it completely. Fire generally scarifies the seed, which promotes later germination [32,33,35].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
The seeds of greenleaf manzanita can survive temperatures in excess of 200 degrees Fahrenheit (93 deg C) for 40 minutes and still germinate [66].

PLANT RESPONSE TO FIRE :
Fire stimulates greenleaf manzanita seeds stored in the soil to germinate [15,28,36,59,68]. Germination of these seeds occurs in the 1st postfire year [36]. It may take 10 or more years before these seedlings mature and produce a significant seed crop [33].

Unless the entire periphery of the lignotuber is deeply charred, which seldom occurs, vigorous sprouting occurs following fire [48]. Shrubs produce new sprouts from dormant buds in the lignotuber in as little as 10 days to 3 weeks [23,24,43]. These new sprouts are capable of heavy seed production by the 2nd postfire year [33].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
Weatherspoon [68] reported on the effects of preharvest burning for shrub control in a white fir (Abies concolor var. lowiana) stand in California. The density of greenleaf manzanita seedlings after postharvest burning was considerably higher for spring burns than for fall burns. This seasonal difference was attributable to consistently higher percent burned area in spring than in fall; in the fall burning period the available fuels were wet due to rains.

The density of greenleaf manzanita seedlings was not significantly reduced by preharvest burning. This may have been due to the relatively low fuel-consumption levels in these burns [68].

Manzanita, Whiteleaf (Arctostaphylos viscida)

IMMEDIATE FIRE EFFECT ON PLANT :
Intense fire kills whiteleaf manzanita [13].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
Fire-activated seeds germinate during the first postfire growing season [13,22,23]. Seedling success rates are good. Whiteleaf manzanita stands are dense by postfire years 3 or 4 [24], and generally remain so. Nine years following a fire in Yuba County, California, the combined density of whiteleaf manzanita and its codominant, deerbrush (Ceanothus integerrimus), was 6,523 plants per acre (16,118/ha) [33]. By postfire year 10, these dense stands of whiteleaf manzanita have reached sexually maturity [12].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
NO-ENTRY

Poison Oak (Toxicodendron diversilobum)

IMMEDIATE FIRE EFFECT ON PLANT :
Fire top-kills poison-oak [13,16]. Wirtz [68] reported that an October, 1953, wildfire in a coastal sage scrub/grassland community near Berkeley, California, top-killed all poison-oak present, leaving only large branches and stumps.

Rhizomes on the soil surface are probably killed by all but light-severity fire, and shallowly buried rhizomes are probably killed by moderate to severe fire. More deeply buried rhizomes are probably not killed.

PLANT RESPONSE TO FIRE :
Poison-oak sprouts vigorously from the root crown and/or rhizomes after fire [13,15,43,46,52]. It sprouts in the first postfire growing season, and for several years thereafter [13,16,52]. Poison-oak sprouts were noted the September following the July, 1985, Wheeler Fire on the Los Padres National Forest, California. The wildfire had spread into a riparian zone containing poison-oak; prefire poison-oak density was unknown. By postfire year 3, poison-oak sprouts dominated most burn plots in the riparian zone [18].

Westman and others [67] estimated that poison-oak fails to sprout when fire reaction intensity exceeds 200 kcal/sec/sq m. Their estimate was derived by modeling fire behavior of a backfire set in coastal sage scrub in the Santa Monica Mountains of California, and observing sprouting the following year. The coastal sage scrub had not burned for 20 to 22 years.

Poison-oak also establishes from seed after fire, although this response is not well documented in the literature. Poison-oak seedlings were observed following site preparation and prescribed burning of an interior live oak-blue oak woodland in Madera County, California. Prefire poison-oak seedling density was 0 percent; seedling density at postfire year 1 was 42 per 8,712 square feet [20].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
Fire response is probably related to Poison oak's successional role in the plant community. Dense poison-oak thickets may develop in chaparral that is control burned several times [12]. Poison-oak may become locally extinct in Douglas-fir forest, however, that is burned every 4 years for 20 years or more [53].

Snowberry (Symphoricarpos albus)

IMMEDIATE FIRE EFFECT ON PLANT:

Common snowberry is top-killed by fire, but belowground parts are very resistant to fire [71,77,83,103,118]. Variable response to fire has been reported [23,77,84] but in general, light- to moderate-severity fires increase stem density [15,23,36], and common snowberry survives even severe fires [15,26,84]. To eliminate rhizomatous sprouting, fire intensity must be severe enough to kill the roots and rhizome system [1].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:

No entry

PLANT RESPONSE TO FIRE:

Common snowberry, as a rhizomatous sprouter, is among the first to recolonize a site after fire [77]. Growth in the 1st postfire year varies, but is generally considered to be good. With light to moderate soil disturbance, resprouting will return common snowberry coverage in a year [36] and common snowberry may produce fruit the 1st year [16]. Sprout height can reach one-half to three-fourths of preburn stem height in the 1st year and equal preburn height in 4 years [84]. Another source [36] states common snowberry will grow 1 foot (0.3 m) the 1st year. Cover and volume measurements consistently exceed preburn values the 2nd year [84] and canopy cover of common snowberry increases rapidly to a maximum in 3 to 5 years after a fire and may maintain this increased coverage [23,80]. Fire severity and soil moisture content at time of burning may determine damage to the rhizome and root system of common snowberry and be responsible for variation in recovery response [52].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:

No entry

Tanoak (Lithocarpus densiflorus)

IMMEDIATE FIRE EFFECT ON PLANT :
Tanoak is a fire-sensitive species. Aboveground portions are extremely susceptible to fire mortality [53,54]. The thin bark provides little insulation from radiant heat, which usually kills the cambium around the base of the stem [30]. As a result, low-intensity ground fires readily top-kill tanoak seedlings and sapling-sized stems [1,48,49]. Larger, thicker barked trees occasionally survive light underburning [42]. Bark thickness of mature trees may range from 1 to 3 inches (2.5-7.5 cm), sometimes reaching 4 to 5 inches (1-12.5 cm). Bole injuries usually result following ground fires, however, and vertical wounds 4 to 10 feet (1.2-3 m) long are common [31,42]. Many older tanoak trees may initially survive light burns, but bole wounds facilitate the entry of insects, and disease and most injured trees eventually die [42].

Long-term survival is most likely in young, vigorous trees where bole wounds tend to heal over rapidly [42]. In virgin redwood stands in Redwood National Park, Veirs [54] found the oldest tanoak trees occupying sites where frequent underburning by indigenous peoples reduced fuel loadings to the point where only light-intensity ground fires occurred. Crown fires kill the aerial portions of all tanoak, regardless of age or size [36,42].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
Tanoak is more susceptible to fire mortality when it occurs beneath a mature conifer overstory. Plants under these conditions are subject to increased stress and are less able to survive fires than when growing in a more open environment. Understory tanoak exhibited significantly lower predawn water potentials than those growing in adjacent open areas [18]. Late spring (June), high duff consumption underburns significantly ($P<.05$) reduced tanoak plant densities in the understory of mixed conifer stands on sites in the Sierra Nevada [18]. (See fire case study for more details.)

PLANT RESPONSE TO FIRE :
After fire or cutting, tanoak resprouts from adventitious buds located on a burl or lignotuber [16,31,42,48]. Most buds are located at or beneath the ground surface [42]. Unless fires are particularly severe, nearly all tanoak resprout to some extent during the first postburn growing season [31].

Tanoak initiates a rapid postburn recovery and is an aggressive competitor during the early stages of postburn succession [1]. Compared to the slow growth of suppressed tanoak understories, tanoak sprout development is dynamic in the postburn environment. Sprout clumps (aggregation of sprouts originating from a single tanoak individual) are characterized by large numbers of resprouts and resprouts grow rapidly, increasing greatly in both height and crown width [14]. If abundant in the preburn community, tanoak often dominates the initial postburn vegetation within 3 to 6 years, forming a dense cover which may exceed 49,400 stems/acre (20,000 stems/ha) [49]. Tanoak sprout development on logged and burned sites in northern California is presented below [42].

# of years after disturbance	Average sprout height (tallest in clump) ft (m)	Average # of sprouts per clump
2	5.2 (1.6)	27
3	6.8 (2.1)	12
4	7.9 (2.4)	10
5	9.3 (2.8)	10
6	10.3 (3.1)	9

The essentially pure, dense, even-aged sprout stands that frequently result following fire provide the mutual shading necessary for optimal tanoak development. Where crowns maintain codominance with one another, height growth is most rapid and tanoak avoids overtopping by associated species. Within approximately 20 years of burning, 60 to 90 percent of the resprouts per sprout clump die as growth is concentrated into multiple, dominant stems [31]. As succession progresses, preburn stand density becomes a significant factor influencing both the growth and continued dominance of tanoak [31].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
Postburn sprouting potential of tanoak is strongly correlated with size and vigor of the parent tree [42,48,49]. Site quality apparently has almost no influence on sprout-clump development for at least 6 years after disturbance [31,48].

Since burl size increases as tanoaks grow, larger stemmed tanoak (> 0.8 inches [2 cm] d.b.h.) usually possess larger burls with increased numbers of dormant buds [49]. Trees greater than 12 inches (30 cm) d.b.h. typically support abundant resprouts. Sprout production by vigorous, large diameter trees is impressive, with as many as 100 resprouts observed on some tanoak individuals. Sprout growth is initially fueled by portions of the residual root system. Sprout growth is related to parent tree diameter [31]. On sites in southwestern Oregon, tanoaks 1 to 4 inches (2 to 10 cm) d.b.h. produced sprout clumps measuring 4.9 feet (1.5 m) tall and 3.6 feet (1.1 m) wide within 6 years of logging [48,49]. Trees 8.3 to 11.8 inches (21-30 cm) d.b.h. produced clumps 7.2 feet (2.2 m) tall with crown widths equaling 8.5 feet (2.6 m). Previous fires and the subsequent entry of pathogens can substantially reduce the sprouting potential of parent trees greater than 16 inches (40 cm) d.b.h. [14]. Sprout numbers also tend to be reduced in older trees where dormant buds are covered by thick bark and where logging debris is piled against tanoak stumps following clearcutting [31].

Although tanoak is able to sprout at a very young age, sprouting potential develops slowly. Younger, smaller stemmed tanoak (< 0.8 inches [2 cm] d.b.h.) sprout much less vigorously than older individuals. Whereas stems in this smaller size class are usually destroyed during fire, sprouting potential is related to burl diameter [49]. Sprouting potential is enhanced as small tanoak age. Older individuals with larger burls generally produce the most vigorous sprouts [31]. On sites in southwestern Oregon, small tanoak produced the following pattern of development within 5 to 6 years after fire or cutting [48]:

age	average burl diameter (mm)	average sprout height inches (cm)	average number of sprouts	average clump diameter inches (cm)
14 - 20	5 - 25	11.2 (28)	4	6.2 (15.6)
28 - 36	26 - 50	25.6 (64)	5	13.9 (34.8)
40 - 52	51 - 75	28.4 (71)	7	14.6 (36.5)

FIRE MANAGEMENT IMPLICATIONS

CONIFERS

Douglas-fir (Pseudotsuga menziesii var. menziesii)

FIRE MANAGEMENT CONSIDERATIONS :
Natural regeneration following slash burning: The effects of slash burning on coast Douglas-fir seedling establishment are contradictory. Some researchers report greater stocking on burned areas, while others report greater stocking on unburned areas [57]. It appears that Douglas-fir is favored by slash burning on mesic and wetter sites in the western hemlock zone. On dry sites, natural regeneration following broadcast burning is unpredictable, and often poor, due to high soil temperatures and moisture stress [17].

Following broadcast slash burning in clearcuts in the Coast and Cascade Ranges in Oregon and Washington, 90 percent of the area is typically moderately or lightly burned, which provides good seedbeds [53,57]. Severe burning, which retards Douglas-fir regeneration because of altered physical and chemical soil properties, occurs on less than 10 percent of the area. This is typically where burning stumps produce intense heat [17]. Minore [55] found that 5-year-old coast Douglas-fir seedling height was lower on sites where slash was piled and burned than on broadcast burned sites.

On erodible granitic soils of the Klamath National Forest, hand planted Douglas-fir seedlings were 7 times more numerous on unburned than on burned plots, 6 years after planting [67].

Models: Peterson and Arbaugh [60] present a model for predicting postfire survival of coast Douglas-fir in the Cascades. The model uses crown and bole damage variables to predict survival.

Salvage logging: Typically less than 3 percent of all merchantable timber in coast Douglas-fir stands is consumed by forest fires. Deterioration rates vary with tree size and wood type. Very little sapwood can be salvaged 3 years after fire, but heartwood deteriorates more slowly. Salvage has been carried out for 1 to 2 years in young-growth stands, 4 to 7 years in intermediate stands, and for 5 to 10 years in old-growth stands [37].

Duff reduction: Duff consumption by prescribed burning can be predicted using weather and fuel variables on cut-over Douglas-fir sites. Generally, most duff is burned when the moisture content of the upper duff is below 30 percent. When the upper duff layer exceeds 120 percent moisture content no combustion takes place. Between these values, the percentage of duff consumed depends on the amount and moisture content of fine woody fuels [44,62].

Gray Pine (Pinus sabiniana)

FIRE MANAGEMENT CONSIDERATIONS :
Gray pine is increasing in blue oak-gray pine communities due to fire suppression and lack of blue oak regeneration [14]. Rangeland managers are reporting an increase of chaparral brush invading grassy understories of blue oak-gray pine woodlands, also because of fire suppression [8]. Timber species are invading the woodlands as well [26]. Prescribed burning would help restore the blue oak-Digger pine community to a more desirable species balance. Managers, however, should be alerted to the regeneration capacity of blue oak ecotypes within their area. See the blue oak FEIS write-up for further information.

Fire managers recommend broadcast burning of blue oak-gray pine woodlands in spring after grasses have dried, usually late May, or in fall after the first rains. Fires are set with drip torches and permitted to burn downslope. There should be little or no wind. Recommended relative humidity range during spring is 30 to 35 percent. Recommended ambient air temperature is between 70 to 80 degrees Fahrenheit (21-27 deg C). In fall, recommended relative humidity is 25 to 30 percent. Fall temperatures of 70 to 75 degrees Fahrenheit (21-24 deg C) are suggested [1].

If the woodlands contain a chaparral understory, upslope strip burning during winter and early spring is recommended. At this time, chaparral brush is fully green and grass shoots are from 2 to 3 inches (0.8-1.2 cm) high. Acceptable ranges of humidity are from 25 to 30 percent; acceptable temperature ranges are from 70 to 75 degrees Fahrenheit (21-24 deg C) [1].

Dwarf-mistletoe is eliminated from an infected area following a stand-replacing fire [31].
Bark beetles (Arhopalus asperatus) have been observed attacking severely scorched gray pine within hours following fire [45].

Incense Cedar (Calocedrus decurrens)

FIRE MANAGEMENT CONSIDERATIONS :
In the central Sierra Nevada, spring is the most satisfactory season for low-severity burning to thin stands of incense cedar. Insects, however, may attack young trees weakened by the treatment [23]. Incense cedar showed an 8 to 12 times greater chance of mortality by insect attack after fire than before fire. Heavy losses from insects will continue for about 2 years after burning [24].

Ponderosa Pine (Pinus ponderosa var. ponderosa)

FIRE MANAGEMENT CONSIDERATIONS :
The last 100 years has produced unplanned, radical changes in stand structure, fuel loadings, and role of fire in Pacific ponderosa pine ecosystems [2]. Postsettlement fire suppression has resulted in dense stockings of shade-tolerant species and the increase of insects and disease. These results have led to other concerns such as loss of timber productivity, loss of natural diversity and aesthetic values, and the increased risk of severe fire damage to homes and harvestable timber [26].

Prescribed fire: Reduction of fuel loads beneath existing stands of Pacific ponderosa pine by the use of prescribed fire has proven useful in reducing the potential threat of wildfires, while also favoring natural regeneration of seral species through site preparation. In western Montana, prescribed burning on an interval of 20 to 25 years is suggested to maintain seral species and open stocking. This would also prune lower branches thus increasing timber values, while also lowering the risk of wildfire [2,22,26,39].

Nutrient depletion: Prescribed fire often leads to the loss of volatile nutrients from the site, especially nitrogen (N). Following a prescribed fire on a Pacific ponderosa pine site in Oregon, all periodic annual growth increments were reduced in surviving trees four growing seasons later. Foliar N concentration was not affected by the fire; however, total foliar N content was reduced immediately after burning. Foliar N content was significantly correlated with the observed reductions in periodic annual increments [39,40].

FIRE CASE STUDIES

CASE NAME :
Impact of prescribed burning on a sequoia-mixed conifer forest

REFERENCE :
Kilgore, B. M. 1072 [80]

SEASON/SEVERITY CLASSIFICATION :
Fall burn / Low- to Moderate-severity

STUDY LOCATION :
The study site was located on the ridge of Redwood Mountain which runs north and south within the 3,100-acre Redwood Mountain Grove of giant sequoia (Sequoiadendron giganteum) in Kings Canyon National Park, Three Rivers, California.

PREFIRE VEGETATIVE COMMUNITY :
Giant sequoia, white fir (Abies concolor), and sugar pine (Pinus lambertiana) dominate the forest, with incense-cedar (Libocedrus decurrens), Pacific ponderosa pine, and California black oak (Quercus kelloggii) represented except in the extreme southern plots. Shrubs and herbs are present but rare, and grasses are almost absent. Major shrub species include Sierra mountain misery (Chamaebatia foliolosa) and Sierra gooseberry (Ribes roezlii). Graminoids include sedges (Carex spp.).

TARGET SPECIES PHENOLOGICAL STATE :
The target phenological states were not recorded.

SITE DESCRIPTION :
The elevation along the ridge ranges from 6,400 feet (1,950 m) at the saddle to nearly 7,000 feet (2,134 m). Hygrothermograph records show a yearly low of 17 degrees F (-8.4 deg C) and a high of 82 degrees F (28 deg C). Temperatures in November just before the burn ranged from 32 to 58 degrees F (0-15 deg C). Relative humidity fluctuated between 30 and 80 percent. Winds in and near the study plots were moderate when present, varying from 0 to 5 mph (0.3 kmh). Average slope was 35 percent. Large portions of this study area are found on soils derived from metamorphic schists.

Burn day conditions were as follows:

Temperature: 59 degrees F (15 deg C)
Humidity: 20 percent
10-hour fuel sticks: 10 grams
Wind speed: 0 mph

FIRE DESCRIPTION :
Twelve 60- by 100-foot (18x30 m) study plots were laid out about 600 feet (183 m) east of the ridge of Redwood Mountain at an elevation of 6,300 feet (1,920 m). Two additional plots were established just below the saddle parking area as demonstration plots. These were selected as being representative of the range of vegetative and fuel conditions found on this east-facing slope of the mountain. Seven of the 12 plots and one demonstration plot were burned, while the remaining plots were retained as controls. For each plot, the following information was measured before and after ignition:

1. Species, diameter, height class > 6 inches d.b.h. (15 cm) or 4.5 feet (1.4 m) tall.
2. Number of white fir and sugar pine saplings per acre in four heights classes.
3. Extent and approximate height of white fir sapling thickets.
4. Coverage and frequency values.
5. Litter and duff weights.
6. Length and diameter of down trees.
7. Chemical light meter indices for light reaching the forest floor.
8. Vegetation appearance recorded by black and white/color photographs from 102 permanent photo points.

After all preburn measurements were made, a 2-foot (0.6 m) wide fire-line was built along the two sides and the bottom of the proposed 5-acre (2 ha) burn area. The burning indices for the burn day were as follows:

	Forecast	Actual	Prescription (range)
Fine Fuel Moisture	6	5	7-10
Spread Index	8	8	5-12
Intensity Index	59	56	37-49
Timber Burning Index	5	5	3-5
Ignition Index	45	55	15-49

All test plots were ignited at 0900 by drip torch along the upper boundary of the burn area. A strip-head fire method of ignition was used and it burned briskly from 0900 to 1200.

FIRE EFFECTS ON TARGET SPECIES :
Ninety-four percent of the 210 2- by 3-foot (0.6x0.9 m) sample plots showed evidence of fire impact. Eighty percent burned almost completely, while 14 percent burned partially or lightly. Only 6 percent of the sample plots remained unburned. Pacific ponderosa pine trees greater than 12 inches (0.3 m) d.b.h. showed an increase in relative density from 7.9 percent to 8.2 percent. This increase may be attributable to the reduction in white fir density. Overall, Pacific ponderosa pine cover percent increased 0.9 percent for all size classes. This suggests that it is relatively resistant to low- to moderate-severity fires under these burn conditions.

Preburn measurement of litter and duff was 50 tons/acre (124 tons/ha). Following burning, litter fuels were reduced by more than 75 percent and duff fuels by more than 85 percent, resulting in a postburn measurement of 7.7 tons/acre (19 tons/ha).

FIRE MANAGEMENT IMPLICATIONS :
This study investigated methods by which the impacts of prescribed fire on certain biotic and abiotic elements of the sequoia-mixed conifer forest ecosystem could be measured. Pacific ponderosa pine was present as a codominant species with an estimated 3.1 trees per acre (7.6/ha). Different fire severities were found to produce different results. In an earlier study, a high-severity fire created more canopy openings, prepared better seedbeds, dispersed smoke more effectively, and consumed surface fuels more completely than this low- to moderate-severity fire. Options for fire management in this type of stand include a high-severity fire followed by another moderate-severity fire 7 to 10 years later; or, alternatively implement two low-severity fires in closer

sequence in order to gradually kill young seedlings and cleanup heavy fuels. Both strategies would allow for more natural regeneration of seral species, while reducing the potential threat of hazardous wildfires.

Sugar Pine (Pinus lambertiana)

FIRE MANAGEMENT CONSIDERATIONS :
Prescribed burning has been found to be an effective management treatment that will destroy infected stands of sugar pine where dwarf mistletoe and other diseases have rendered stands unmerchantable [1]. Dead sugar pine is susceptible to blue stain fungus in the sapwood; however, the heartwood is very durable. Salvageable trees may be found up to 17 years after being killed by fire [15].

White Fir (Abies concolor)

FIRE MANAGEMENT CONSIDERATIONS:
The possible uses of fire in white fir communities include the maintenance of more desirable seral species by thinning small white fir, fuel reduction, seedbed preparation, sanitation against insects and diseases, improvement of visual resources in national parks, creating openings for wildlife habitat, and the establishment of semi-natural processes [74,154,157,300,308,349], including nutrient cycling [226,337].

Thinning: Prescribed burning in areas where white fir is not desired may be useful to control its abundance and promote the growth of more desirable seral species. Burning in some areas may create conditions favorable for suckering of aspen or Rocky Mountain maple [294]. Replacing conifer cover with aspen, shrub, or herbaceous vegetation can improve water yield [55]. Prescribed fire has been used to effectively eliminate fire-intolerant species such as white fir and Douglas-fir and to favor more fire-tolerant species such as ponderosa pine [27,98,115,227] and giant sequoia [163,168]. A dramatic decline in white fir basal area was observed following prescribed burning in the Sierra Nevada [233]. This may be useful in areas experiencing high levels of mortality due to stress from competition for water and resources in overcrowded stands and subsequent vulnerability to insects and disease [267]. Stephenson and Calcarone [287] developed a model to predict areas of montane conifer forest with overcrowded stand conditions. Areas predicted to be experiencing high stand densification meet all of the following criteria: vegetation type is a conifer forest, elevation is below 7,500 feet (2300 m), mean annual precipitation is greater than 25.6 inches (650 mm), canopy cover is greater than 60%, and slope is less that 60%. Fuel loads may be too hazardous to secure desired mortality of white fir while maintaining relatively low mortality of mature trees. Spring burning in old-growth ponderosa pine at Crater Lake National Park resulted in 30% mortality of ponderosa pine greater than 9 inches (22 cm) in diameter [297]. When fire prescriptions cannot ensure that young white fir will not ignite the crown of overstory trees, cutting all trees under a specified size before burning reduces this fire hazard [27]. In three different studies, white fir less than 9 inches (23 cm) dbh [170], 6 inches (15 cm) dbh [222], and 11 feet tall [48] were felled before burning. This method can help to reduce fire damage from future wildfires, as well [5]. Cutting without subsequent burning is less effective [27]. A method of prescribed burning that decreases the probability of damage to mature white fir is given by Weatherspoon and others [331]. However, prescribed burning is not recommended as a thinning tool where true fir is the desired crop tree. In underburned white fir stands in southern Oregon, 36% of the residual white fir trees had sufficient scorch to cause partial cambial death that was associated with stained and decayed wood even 2 years after the burn [98].

Fuel reduction: Heavy fuel loadings and well-developed understories of shade tolerant conifers like white fir set the stage for stand-replacing crown fires [5,349]. By leaving the largest trees and treating fuels, fire tolerant forest conditions can be created, so that fire severity can be reduced. These treatments are sensible where low-severity fire regimes are now supporting high severity fires due to fuel build ups, but not in areas with stand-replacement fire regimes, where weather is the driving factor in fire severity [5]. Prescribed, low-intensity fires will kill large numbers of small white fir and reduce fuel loading, helping to reduce this threat [4,159,164,171,286,302]. Not all forest floor fuel is consumed in an initial prescribed burn [265], and much of the initial volume reduction may be replaced by material killed but not consumed in the initial fire [4,55,86,164,168,302]. The fuel ladder is generally broken by the 1st fire, so that a 2nd fire is generally easier to control, 5-10 years after the 1st [4,171]. Fire effects monitoring in Sequoia and Kings Canyon national parks reveal an average initial reduction in fuel load by 71% (93% duff and 56% woody), 1 year after prescribed burning, an increase in total fuel load from the 1-year postfire to the 5-year postfire inventory and a total fuel load exceeding prefire levels after 10 years, with woody fuels nearly double their prefire levels and duff at 28% prefire levels [163,164]. Tree density was reduced from 498 prefire to 295 post; white fir was 60% pre and 56% 1 year post; 10 years post was at 51% and giant sequoia had increased from 7% to 23% [163,254]. Between 80 and 90% of shrubs on a site will be top-killed by fire. Those capable of sprouting will do so based on season of burn and degree of duff consumption or fire severity. Sprouting shrubs are most susceptible to fire kill under dry conditions in late spring and early fall when fuel consumption is highest [4,159,160]. Summer and fall burning more effectively reduce white fir and giant sequoia fuels than does spring burning [7,167]. Fire used for fuel reduction must be handled carefully to avoid escape and stand damage [349]. Fuel accumulations are site specific but can be estimated using prediction equations based on stand basal area, tree height or diameter or with depth of forest floor and stand overstory age. Info on production and estimation of fuels and fuel characteristics are available for Sierra Nevada mixed conifer [312,313,314], giant sequoia [265,334], ponderosa pine and mixed conifer in the Southwest [264], and for mixed conifer in Arizona [122]. Fire behavior models may be used to predict how silvicultural and fuels treatments will affect fire behavior [286]. In areas with high fuel loadings, dense multistoried stands, and smoke restrictions, it may be necessary to use silvicultural tools that include prescribed fire [123,221,246].

Preharvest underburning/site preparation: Underburning before timber harvesting with the shelterwood method in mixed conifer forests can be used to aid natural regeneration, and reduce shrub seed reserves in the soil [55]. Prescriptions developed in the Blue Mountains of northeastern Oregon recommend felling all understory trees less than 6 inches (15 cm) in diameter before burning. The combination of cutting and burning removes all advanced regeneration, thus sanitizing the site of heart rot which is present in many 5- to 6-inch diameter (12.5 -15 cm) white fir (these trees are white fir x grand fir hybrids). Following harvest, seedling establishment of all conifers was abundant [222]. In some locations preharvest underburning is not recommended because it stimulates dormant shrub seeds to germinate [328]. In the Siskiyou Mountains, soil erosion can be a problem following fires that remove duff layers on granitic soils [30]. Severe fires can eliminate dwarf mistletoe by destroying infected stands [69]. In the Blue Mountains of Oregon, prescribed burning was initiated to sanitize the sites of heart rot and stagnated understory, prepare the site, and encourage natural regeneration [221,246].

Fire can enhance range and wildlife habitats by rejuvenating forage and browse species [55,221,237,246]. Use of prescribed fire for fuel management in California spotted owl habitat is suggested to reduce the threat of stand replacement fires [273,332]. Prescriptions may include leaving snags and larger size fuels for wildlife habitat [221,246]. Additionally, moisture stored in these logs may expedite forest recovery by providing important refuges for roots and associated mycorrhizal fungi of pioneering vegetation [23].

Restoring fire to its natural role in Sierra Nevada forests by prescribed burning at lower and middle elevation types and by allowing lightning fires to burn in higher elevation forests is suggested [169]. Returning fire and natural process to areas that evolved with mixed fire regimes requires a deliberate approach based on descriptions of the mosaic of aggregations that constituted the presettlement forest communities, a determination of the kinds of vegetation changes that it is feasible to make, and the degree of success to be expected from different vegetation management techniques, keeping in mind that that the initial restoration program will determine the character of the vegetation mosaic for centuries to come [52]. Structural maintenance objectives may be biologically infeasible, thereby restricting management to the pursuit of process maintenance objectives [53]. This is complicated by the need to return the forest community to prefire exclusion structure before reintroducing fire to the ecosystem. Managers need region specific fire regime data to develop process-based management schemes [301], and/or determine reference conditions for key ecosystem functional and structural components that may be used in an ecosystem management context [115]. Characteristics for mixed conifer forest reference stands at Sequoia are given by Riegel and others [256]. Tools available to fire managers for prescribed burning planning include PREFEX, a small expert system for managing fire effect information [99], and the Fire Monitoring Handbook [254]. Smoke production and air quality must be considered [58]. Water quality was not adversely affected by prescribed burning in a ponderosa pine-mixed conifer watershed in east central Arizona [121].

FIRE CASE STUDIES

SPECIES: Abies concolor

CASE NAME:
Tharp's Creek prescribed burn, Sequoia National Park

REFERENCE:
Mutch, L. S.; Parsons, J. D. 1998 [233]

FIRE CASE STUDY AUTHORSHIP:
Zouhar, Kris. 2001.

SEASON/SEVERITY CLASSIFICATION:
fall/mixed

STUDY LOCATION:
The Tharp's Creek (burned) and Log Creek (unburned) watersheds are located in the Giant Forest area of Sequoia National Park, California. Two reference stands (upper and lower) are located in each watershed.

PREFIRE VEGETATIVE COMMUNITY:
White fir dominates in all stands, with an inverse J-shaped size distribution. Sugar pine is most common in Lower Tharp's and upper Log stands. Red fir (*Abies magnifica*) is present in significant numbers only in the Lower Log stand. Giant sequoia (*Sequoiadendron giganteum*), incense cedar (*Calocedrus decurrens*), Jeffrey pine (*Pinus jeffreyi*) and California black oak (*Quercus kelloggii*) are only minor components of these stands. Shrub cover ranges form 2% to 20% in the four stands and is comprised mainly of greenleaf manzanita (*Arctostaphylos patula*), mountain whitethorn (*Ceanothus cordulatus*), bush chinquapin (*Chrysolepsis sempervirens*), and gooseberry (*Ribes* spp.). Litter and duff are the predominant ground cover, with scattered herbaceous vegetation.

TARGET SPECIES PHENOLOGICAL STATE:
The phenological state of white fir on the site at the time of burning is not given, however, judging from the timing of the fire, it is likely that white fir seeds had been dispersed and the trees were dormant.

SITE DESCRIPTION:
The study sites comprise the headwater drainages of Tharp's Creek and Log Creek. Soils of both watersheds are predominantly pachic xerumbrepts, derived from granodiorite. Slopes are moderate to steep. The aspect of Tharp's watershed ranges from south to southeast, and Log watershed aspect is primarily west to southwest and northwest. Elevations are 6875 to 7150 feet (2097-2180 m) in the Tharp's watershed and 7080 to 7775 feet (2158-2371 m) in the Log watershed. Mean annual precipitation in the area is 50 inches (1255 mm), with about half falling as snow. Mean January and July temperatures are 32 degrees Fahrenheit (0°C) and 64 degrees Fahrenheit (18°C), respectively.

FIRE DESCRIPTION:
The Tharp's prescribed burn was a 35 acre (14 ha) fire ignited October 23-26, 1990. Ignition occurred primarily in early evening and into the night when relative humidity was 30-40%. Average fuel moistures for litter ad duff were 28%, for 100 hr fuels 14%, and for 1000 hr fuels 64%. Air temperatures during ignition ranged from 50 to 60 degrees Fahrenheit (10-16 °C) and winds were calm. Fire behavior ranged from a backing fire with flame lengths of 0.2 to 0.5 feet (0.05-0.15 m) and rates of spread up to 0.3 feet (0.1 m)/minute, to a strip headfire with flame lengths of 2 to 8 feet (0.6-2.4 m). Areas with heavy fuel concentrations and standing snags burned with the greatest severity. Total preburn fuel load was 94 tons/acre (210 Mg/ha) and total reduction was 85%, with the highest reduction in litter/duff (97%) and 1-hr fuels.

FIRE EFFECTS ON TARGET SPECIES:
The prescribed burn in the Tharp's Creek watershed resulted in a dramatic rise in mortality rates for 5 years following the fire when compared both with the prefire mortality rates and with the unburned Log Creek watershed. Average annual mortality for all trees greater than 4.6 feet (1.4 m) tall in the Lower and Upper Tharp's Creek plots during the 5 year preburn period was 0.8% and 0.6%, respectively. Annual mortality rates in the 1st postburn year increased to 35.2% and 49.4%, and declined to 2.6% and 5.0% by the fifth postfire year. While these rates are well above prefire mortality rates, the 2.6% is within the range of annual mortality rates recorded for the Log Creek watershed for the same period. The greatest reduction in white fir numbers was in the intermediate and subcanopy classes.

Populations and mortality of white fir trees ≥4.6 feet (1.4 m) tall in the Lower Tharp's stand:

	Live trees/ha			**Mean annual % mortality**	
Canopy class	**1985**	**1990**	**1995**	**1986-1990**	**1991-1995**
Dominant	8	8	5	0.0	7.0
Codominant	87	83	61	1.2	5.5
Intermediate	125	121	57	0.7	13.7
Subcanopy	155	149	17	0.7	30.7
All classes	375	361	140	0.8	16.4

Populations and mortality of white fir trees ≥4.6 feet (1.4 m) tall in the Upper Tharp's stand:

	Live trees/ha			Mean annual % mortality	
Canopy class	**1985**	**1990**	**1995**	**1986-1990**	**1991-1995**
Dominant	34	34	20	0.0	9.8
Codominant	76	75	49	0.3	8.1
Intermediate	108	105	31	0.6	19.5
Subcanopy	120	114	8	1.0	28.0
All classes	338	328	108	0.6	17.8

Primary factors associated with mortality in both watersheds during the prefire period and on the Log Creek watershed in general, were dwarf mistletoe, fir canker, fir engravers and stem/root failure that caused crushing by another tree. The postfire mortality in the Tharp's Creek watershed was most directly related to fire-caused crown scorch. There is no indication of a relationship between pre-existing disease or insect conditions and fire-induced mortality, since similar percentages of trees that survived the fire had dwarf mistletoe, and fire engravers associated with them. Fine root mortality may have also played a role in the death of trees several years after the fire, since the 97% reduction of litter and duff indicates a particularly severe fire that would have likely caused substantial fine root mortality. During the prefire period, the Lower Tharp's stand had a slight decline in total basal area due primarily to the death of numerous codominant and intermediate white fir trees, while the Upper Tharp's stand had an increase in basal area during this period. Both stands had a large decline in basal area after the burning due primarily to fire-related mortality. The most important change in size structure in the Log Creek watershed was in the smallest size classes. In the Tharp's Creek stands, there was a dramatic change in the size structure during the postfire period with a decline in mean number of trees/ha in most sized classes, including 75% of the trees ≤ 50 cm dbh killed, and 25% of trees larger than 50 cm dbh killed. The different tree species present died in proportion to their frequency in the watershed. A large number of seedlings had established after the burn on Tharp's Creek and had more rapid height growth relative to seedlings in the Log watershed.

FIRE MANAGEMENT IMPLICATIONS:
Suppression and higher incidence of insects and disease in higher density stands are cited as primary reasons for mortality in unburned stands. In this study, a drought during the 1987-1992 time period is thought to have contributed to the stress that led to mortality in the larger size classes in the Log Creek watershed. In white fir, the probability of mortality increased with percentage of crown scorch, and decreased with dbh. This type of information can help improve the ability of mangers to predict tree morality from prescribed burning and to plan burning conditions to meet specific mortality objectives. Differences in mortality between the Upper Tharp's stand and the Lower Tharp's stand are thought to be due to differences in fire severity between the two stands, with the more severe fire causing higher rates of initial mortality in the larger size classes. The large reductions in tree densities and basal areas in the Tharp's watershed will provide more opportunities for successful establishment of less shade-tolerant species and will help reduce fuel inputs, presumably reducing the hazard of uncontrollable wildfire in the future. However, future burns will likely be necessary to maintain reduced tree densities and low fuel accumulation rates. Mortality is expected to continue to decline over the next several years until they reach near pre-burn levels. It is also expected that the large number of seedlings that established after the burn will result in substantial amounts of ingrowth within the next 10 years.

HARDWOODS

California Black Oak (Quercus kelloggii)

FIRE MANAGEMENT CONSIDERATIONS :
The decline in California black oak populations is due to many factors, and past policies of fire suppression is one of them. This species has evolved under a fire regime of low- to moderate-severity surface fires [22,23] at average intervals of 3.5 years [47]. Fire suppression has resulted in major structural changes in coniferous forests and woodlands of California and southern Oregon. Populations of shade-tolerant white fir (Abies concolor) and Douglas-fir have greatly increased. There has been a greater than 300 percent increase in aggregations of pole-sized conifers. The understory, once an open mixture of shrubs, saplings, grasses and forbs, is now often dominated by dense stands of coniferous saplings or dense, mixed stands of coniferous saplings and brush. Fuel loading in these forests represents an unnatural buildup of downed woody materials. When these forests burn, the dense understory produces a ladder effect, resulting in crown fire [23]. This results in a high-consumption, severe fire that is frequently fatal to California black oak [22]. When the management objective is to increase California black oak recruitment in these dense forests, understories are usually cleared prior to prescribed burning. Kauffman and Martin [22] have recommended low- to moderate-consumption prescribed fire. Forest floor reductions to less than 8 to 16 tons per acre (18-36 t/ha) have been suggested. This may require several fires. Burning favors seedling establishment in several ways. It prepares a favorable seedbed not only by removing litter, but also by killing damaging molds and insects present in the litter layer. Sapling mortality due to root rot decreases following fire [2].

Following a prescribed March burn on the Shasta-Trinity National Forest of California, surviving California black oaks produced a bumper crop of sound acorns, while acorns on nearby unburned ground were mostly unviable. Researchers attributed the difference to insect predation of acorns on the unburned forest floor [7].

FIRE CASE STUDIES

CASE NAME :
Fire severity & survival/Forest floor biomass & germination

REFERENCE :
Kauffman, J. B.; Martin, R. E. 1987 [22]

SEASON/SEVERITY CLASSIFICATION :
early spring/low-severity
late spring/moderate-severity
early fall/moderate-severity
late fall/low-severity

STUDY LOCATION :
The study site was located in the Blodgett Forest Research Station near Georgetown, California.

PREFIRE VEGETATIVE COMMUNITY :
The forest was composed of second-stand growth, approximately 70 years of age, and codominated by ponderosa pine (Pinus ponderosa), white fir (Abies concolor), and incense-cedar (Libocedrus decurrens). Very old California black oak (Quercus kelloggii) and young, shrub-like individuals were present. Understory species were not reported.

TARGET SPECIES PHENOLOGICAL STATE :
NO-ENTRY

SITE DESCRIPTION :
Soil is classified as occurring in the Holland family, Moderate Deep Basic (fine-loamy, mixed mesic Ultic Haplo eralfs). Fuel loading ranged from 134 to 181 tons per acre (131-177 t/ha). Organic horizons accounted for 60 to 80 percent of total fuel load. Slopes were nearly level (<10%), elevation was 4,330 feet (1,300 m), and mean annual precipitation was 68 inches (1,700 mm).

Burn day conditions were as follows:

Date of burn	Relative humidity (%)	Temperature (deg C)	Wind speed (km/hr)	Lower Duff moisture content (%)
early fall (9/20/84)	25-48	19-23	0-8	23.2 +/- 4.6
late fall (10/8/83)	49-63	16-18	0-3	90.1 +/- 7.8
early spring (5/17/84)	31-57	16-17	0-3	135.0 +/- 16.3
late spring (6/26-29/84)	21-72	17-27	0-3	51.6 +/- 10.6

FIRE DESCRIPTION :
Six 0.25-hectare blocks with four treatment units per block were established. The treatments included four different prescribed fires of varying season and fire severity levels and a control (no burn).

Survival of existing California black oak was established by randomly tagging 15 to 50 individuals in each treatment unit from each block prior to burning. Trees were examined for mortality and survival for the next 2 years after burning.

Density of seedlings was calculated by two measurements in 15 2-meter- squared, permanent plots in each treatment subunit of each block. Plots were measured prior to burning, and at the second growing season after fire.

Burn treatments resulted in the following fuel consumption:

early fall/moderate-severity	74.7 %
late fall/low-severity	67.8 %
early spring/low-severity	16.3 %
late spring/moderate-severity	61.1 %

FIRE EFFECTS ON TARGET SPECIES :
Moderate-severity fall fire resulted in the lowest survival rate. Results were as follows:

	Early fall mod-burn	Late fall low-burn	Early spring low-burn	Late spring mod-burn	Control
survival (%)	9.0	35.0	69.0	28.0	100
comsumption (%)	93.5	64.2	11.3	75.9	---
biomass consumption (tons/hectare)	110.4	68.0	11.1	63.2	---

At two postfire growing seasons, California black oak seedlings appeared in significantly (p>0.05) greater densities at all burn sites except the early spring/low-severity fire. Results were as follows:

	#/ha	% Seedlings in population	Postfire biomass of duff layers(t/ha)
early fall/mod-sev.	367(+/-327)	79	7.7
late fall/low-sev.	333(+/-152)	67	37.8
late spring/mod-sev.	267(+/-200)	80	20.1
early spring/low-sev.	67(+/- 67)	15	86.4
control	133(+/-133)	17	100.0

FIRE MANAGEMENT IMPLICATIONS :
California black oak seedling density increased as a result of the prescribed fire. Optimum seedling establishment was realized when the duff component was reduced to 15.5 tons per acre (38 t/ha) or less. Few California black oaks were killed by low-intensity prescribed fire. Late fall, low-intensity burning probably represents a good compromise between loss of existing trees and increased seedling establishment.

Canyon Live Oak (Quercus chrysolepis)

FIRE MANAGEMENT CONSIDERATIONS :

Fuels and flammability: Although the heat content of the outer bark of canyon live oak is relatively low when compared with other California oaks (Quercus spp.), its low density and flakiness contribute to heat buildup around the trunk [72]. The heat content of canyon live oak has been calculated as follows [70]:

	density (lb/ft 3)	heat content (lb/ft 3)	moisture content (%)
flaky outer bark	41	7175	11
outer bark	48	7525	--
inner bark	43	6575	65
wood	45	7875	60

Prescribed fire: Plumb [70] reports that "the use of prescribed fire in the management of canyon live oak does not appear to be promising" where primary goals include maintenance of oak woodlands. Trees are sufficiently sensitive to trunk girdling that even ground fires can kill the trunk surface. Prescribed fire can be used in stands of larger trees where fuel loading is low, or where trunks are protected from the direct effects of heat [70]. Repeated fires at frequent intervals can maintain shrubby canyon live oak chaparral.

Postfire harvest: A correct determination of the degree of damage is essential before appropriate harvest recommendations can be made. Plumb and Gomez [72] suggest waiting at least one growing season, and if possible three, before cutting larger, more valuable trees which have uncertain potential for crown survival. The following postfire harvest guidelines have been developed for canyon live oak [70]:

	tree size and degree of trunk char		
	light	medium	heavy
< 6 inches dbh	cut	cut	cut
6-12 inches dbh	leave	cut	cut
> 12 inches dbh	leave	cut	cut

Harvesting may be recommended if 75 percent or more of the trunk is girdled on trees less than 6 inches (15.2 cm) d.b.h. or if more than 50 percent is girdled on oaks larger than 6 inches (15.2 cm) d.b.h. [70].

Wildlife: Fire in California oak woodlands can create favorable, although transitory, habitat for birds such as the flicker and hairy woodpecker which feed on insects present in the branches of fire-killed trees [14].

Bigcone Douglas-fir communities: Bigcone Douglas-fir forests with a canyon live oak understory are susceptible to frequent ground fires [62]. In certain areas, canyon live oak grows in tree-sized form with bigcone Douglas-fir. Here, the relatively nonflammable oak serves as a buffer against fire [58]. Where burned at frequent intervals, bigcone Douglas-fir forests may be replaced by a canyon live oak woodland or chaparral dominated by multi-stemmed clumps of oak [55]. Conversion of treelike canyon live oak to a shrublike growth form results in greater cumulative damage to the bigcone Douglas-fir overstory [58]. Minnich [13] notes that the "success of [bigcone Douglas-fir] seems dependent on tree-sized canyon live oak escaping fire."

Regeneration of bigcone Douglas-fir appears best in shade provided by a canyon live oak canopy [58,59]. However, with time, continuous shade proves detrimental to the development of regenerating conifers [55]. The growth of bigcone Douglas-fir is often suppressed under the shade of the canyon live oak canopy until pole-sized conifers grow above the oaks [60]. Bigcone Douglas-fir may not regain dominance for several hundred years [55] [see Successional Status].

Coulter pine stands: Where canyon live oak occurs with Coulter pine, the oak contributes to higher fuel levels which produce fires necessary for the regeneration of this conifer [60].

California white oak savanna: Certain higher elevation valley oak (Q. lobata) savannas of California are currently being invaded by such species as canyon live oak. Fire suppression is frequently cited as a probable cause of this vegetative change. Frequent fires would presumably kill many of the young canyon live oak sprouts and maintain a California white oak savanna [27].

FIRE CASE STUDIES

1. Marble - Cone Fire
2. Village Fire, California

1st CASE NAME :

Marble - Cone Fire

REFERENCE :

Talley, S. N.; Griffin, J. R. 1980 [88]

SEASON/SEVERITY CLASSIFICATION :

August 1977/severe.

STUDY LOCATION :

The study site is located in the Ventana Wilderness Area of California and includes the north slope of Junipero Serra Peak. Two primary areas were considered: 1) Summit Forest, and 2) Slope Forest.

PREFIRE VEGETATIVE COMMUNITY :

Montane forests were dominated by sugar pine (Pinus lambertiana). These forests were surrounded by shrubby mixed hardwoods and chaparral. On steep slopes Coulter pine (P. coulteri), canyon live oak (Quercus chrysolepis), and eastwood manzanita (Arctostaphylos glandulosa) were important vegetative components on some plots. Important herbs and subshrubs included rockcress (Arabis breweri), Indian paintbrush (Castilleja foliosa), lipfern (Cheilanthes covillei), bedstraw (Galium angustifolium), bedstraw (G. clementis), hawkweed (Hieracium argutum var. parishii), deervetch (Lotus argophyllus var. fremontii), Abrams lupine (Lupinus abramsii), lupine (L. hirsutissimus), red beardstongue (Penstemon corymbosus), western swordfern (Polystichum munitum), and crested stipa (Stipa coronata). Density of canyon live oak was estimated at 73 percent, with a basal area of approximately 30 percent.

On gentler slopes within the summit forest, sugar pine, Coulter pine and canyon live oak were dominant, with scattered eastwood manzanita. Common herbs included dusky onion (Allium campanulatum), fleabane (Erigeron petrophyllus), biscuitroot (Lomatium macrophyllum), oceanspray (Holodiscus microphyllus), needlegrass (Stipa spp.), bedstraw (Galium clementis), Micranth alumroot (Heuchera micrantha var. pacifica), and western swordfern. Basal area of canyon live oak was 6 percent, with an estimated density of 23 percent.

TARGET SPECIES PHENOLOGICAL STATE :

not reported.

SITE DESCRIPTION :

Slope Forest -
- slope - average 57 percent
- preburn vegetation - sparse
- topography - broken and steep
- elevation - average 5,215 feet (1,590 m)

Summit Forest -
- slope - moderate, average 42 percent
- preburn vegetation - no more than 25 percent cover
- elevation - average 5,576 feet (1,700 m)

FIRE DESCRIPTION :

Fire crowned in some parts of the Summit Forest. Fire changed from a crown-type fire to a surface fire below 5,412 feet (1,650 m). Here the burn was somewhat patchy. Portions of the canyon bottom characterized by steep, rocky slopes or mineral soil remained unburned.

FIRE EFFECTS ON TARGET SPECIES :

Nearly all canyon live oaks in burned areas were killed. However, burned stems sprouted vigorously and on some slope plots acorns also germinated. Prefire and postfire constancy and cover values are as follows:

constancy - (%) /modal cover - abundance values

	Slope Forest		Summit Forest	
	preburn	postburn	preburn	postburn
from sprouts -	20 / +	100 / 1	60 / +	100 / +
from seed -	--	100 / 1	--	100 / 1

FIRE MANAGEMENT IMPLICATIONS :
Canyon live oak sprouted prolifically after fire. In some areas seedlings were also present. Response suggests a relatively rapid recovery after fire.

SECOND FIRE CASE NAME:
Village Fire, California

REFERENCES :
Plumb, T. R. 1980 [70]

SEASON/SEVERITY CLASSIFICATION :
November, 1975/not reported

STUDY LOCATION :
The study site is located in the Angeles National Forest of California.

PREFIRE VEGETATIVE COMMUNITY :
Preburn vegetation consisted of an almost pure stand of canyon live oak (Quercus chrysolepis). Most trees ranged between 6 and 12 inches (15-31 cm) d.b.h.

TARGET SPECIES PHENOLOGICAL STATE :
presumably dormant.

SITE DESCRIPTION :
not reported.

FIRE DESCRIPTION :
not reported.

FIRE EFFECTS ON TARGET SPECIES :
The basal 1 to 5 feet (0.8-1.5 m) of most trunks were charred and one-third to two-thirds of the leaves in the crown were killed. Many leaves close to the ground were killed by heat but were not actually consumed. The bark of some trees was burned through exposing the wood beneath. Larger trees often exhibited crown kill over a relatively long period of time. Approximately 55 percent of the larger trees were still alive at the end of 18 months. During the next 18 months, 50 percent of the trees with "live crowns" turned brown. Many more were expected to die later. Results were as follows:

condition of trees 1-1/2 years after basal trunk damage -

tree diameter (dbh in.)	number of trees	apparently dead (%)	basal sprouting only (%)	basal sprouting + live crown (%)	live crown only (%)
0-3	10	10	90	0	0
3-6	59	3	73	22	2
6-12	97	1	25	70	4

decline over a 3 year period in % of living crown -

tree diameter (dbh in.)	# of trees	% alive after 18 months	% alive after 36 months
0-3	10	0	0
3-6	59	24	15
6-12	97	74	46

FIRE MANAGEMENT IMPLICATIONS :
Aboveground vegetation of canyon live oak is sensitive to fire. Even low intensity ground fires can create high heat intensity on the surface of the trunk due to the flammability and heat conductivity of the flaky, outer bark. A correct determination of fire damage is important in assessing postfire survival potential of canyon live oak stems (See Discussion and Qualification of Fire

Effect). Crowns and trunks of larger canyon live oak with only light to medium char sometimes survive. However, several growing seasons may be necessary to determine the actual degree of damage. Postfire harvest of smaller trees, or those suffering greater trunk char, is generally recommended since survival of stems is unlikely.

Oregon Bigleaf Maple (Acer macrophyllum)

FIRE MANAGEMENT CONSIDERATIONS :
NO-ENTRY

Oregon White Oak (Quercus garryana)

FIRE MANAGEMENT CONSIDERATIONS :
Fire appears to be the dominant controlling factor involved in converting invading coniferous forests back to Oregon white oak woodland. If a conifer forest is the objective, managers can simply allow young invading conifers to grow. In order to halt conifer establishment and facilitate oak regeneration, a minimum frequency of prescribed burning every 5 years is recommended. Ideally, prescribed fire should be set annually. When existing conifers are 10 feet (3 m) or more in height, oak woodlands can be restored by removing conifers, by cutting or girdling. A program of prescribed burning is then necessary for long-term maintenance [48].

Pacific Madrone (Arbutus menziesii)

FIRE MANAGEMENT CONSIDERATIONS :
Broadcast burning: Where conifer regeneration is a primary management concern, broadcast burning is generally an ineffective site preparation tool following clearcutting in stands where madrone is widespread in the understory. Not only is madrone difficult to control with repeated burning, but sprouts often grow faster than many associated hardwoods [33,40]. Even though burning delays the recovery of madrone for approximately one growing season, removal of logging debris promotes sprouting by exposing basal buds to solar heating and permits sprouts to grow unimpeded [40]. Sites where the preburn vegetation consists of low conifer stocking combined with high densities of madrone are particularly prone to the rapid development of a dense madrone understory.

Underburning: Pacific madrone seedlings establish readily following logging and burning of conifer-hardwood stands [59]. Light underburning at sometime during the rotation may minimize seedling establishment, thereby reducing the density of madrones capable of sprouting after future disturbances. Control of madrone seed trees should accompany such prescribed fire treatments (See Management slot under Value and Use subframe.)

Hardwood management: Burning should not be used as a method of slash disposal in partially cut hardwood stands where madrone is managed for timber production. Instead, logging debris should be lopped and scattered, or piled [40].

Wildlife management: Burning initially increases the palatability of Pacific madrone browse; spouts are utilized for up to 2 growing seasons [11,61].

White Alder (Alnus rhombifolia)

FIRE MANAGEMENT CONSIDERATIONS :
NO-ENTRY

SHRUBS

Buckbrush (Ceanothus cuneatus)

FIRE MANAGEMENT CONSIDERATIONS :
Since most seed germinates after a single fire, wedgeleaf ceanothus can be significantly reduced if an area is reburned prior to maturation of a second seed crop [8]. Frequent fires can eliminate this species [44], although single fires appear to favor species such as wedgeleaf ceanothus [36]. To ensure good vigor and adequate regeneration potential, managers recommend against burning wedgeleaf ceanothus at less than 20 to 25 year intervals [9].

Wildlife considerations: Open brush created by burning stands of wedgeleaf ceanothus provides extremely favorable deer habitat [8]. However, deer relish seedlings during the first few years after fire and can adversely impact regeneration, particularly on small burns. Managers recommend burning 5 to 10 acre (2-4 ha) patches, and providing as much edge effect as possible to maximize value to deer [8].

Production: Postfire production of wedgeleaf ceanothus was found to average approximately 145 lbs. per acre (27 kg per ha) 5 years after a fall burn [25].

California Hazel (Corylus cornuta var. californica)

FIRE MANAGEMENT CONSIDERATIONS :
Fire would destroy California hazel only under the most extreme fuel and weather conditions. Repeated spring burning conducted when the soil is moist simply increases the number of stems present [12]. However, repeated summer fires destroy hazel's ability to sprout by exposing and destroying underground root systems and exhausting stored food reserves [7].

Deerbrush (Ceanothus integerrimus)

FIRE MANAGEMENT CONSIDERATIONS :
Deer brush fuels: When deer brush is overtopped by trees, dead and decadent deer brush in the understory can create a severe fuel hazard. Repeated light-severity surface fires are needed to remove dead and dying shrubs and to thin the developing understory of shade-tolerant trees [75].

Fuel accumulation, fire frequency, and fire severity (as well as aspect, soil type, and soil moisture) play major roles in determining patch size and elevational limits of treeline and chaparral. The transition zone between mid-elevation Coulter pine forest and lower-elevation chaparral is a dynamic mosaic of Coulter pine, oaks, deer brush, and manzanitas. The mosaic contains so much dead and decadent deer brush, presumably as a result of fire exclusion, that subsequent wildfires are expected to be abnormally hot. Severe fire is expected to kill Coulter pine and reduce the oaks, thereby increasing chaparral coverage and raising the lower limit of treeline [82].

In the Klamath Geographic Province of Oregon and California, deer brush occurs in the moderate fuel type [7]. When prescribed burning in ponderosa pine with an understory of deer brush and manzanita, Biswell [12] recommended broadcast burning in one or more of three steps: (1) broadcast burning; (2) in heavy timber, piling coarse dead material by hand and burning; (3) in open areas, crushing coarse dead material with a bulldozer and burning. In order to keep fire severity low, he recommended burning in fall, winter, or spring when soil is thoroughly wet, and setting fires so that they burn downhill. Pine needles may be dry enough to carry fire within a day or so after rain. After broadcast burning, remaining coarse dead fuels are piled in open areas within timber. In areas open enough for a bulldozer, the bulldozer can be used to crush the slash. Slash is broadcast burned after it is dry.

Broadcast burning was used on a brushfield on the El Dorado National Forest to enhance forage for livestock and wildlife. A dense deer brush stand originated following a 1924 wildfire in ponderosa pine and incense cedar. By postfire year 18, browse was inaccessible to ungulates. Small ponderosa pine and incense cedar that survived the previous fire were slashed to enhance fuels. Prescribed burning was conducted in July 1942 and resulted in "an intense fire that consumed most of the plant material." Deer brush seedling establishment and survivorship was as follows [22]:

postfire year 1	300,000
postfire year 2	150,000
postfire year 8	1,500

FIRE CASE STUDIES

1ST CASE NAME :

Understory Composition by Season of Burning/Plumas NF

REFERENCES :

Kauffman, J. B. 1986 [35]
Kauffman, J. B.; Martin, R. E. 1985 [36]
Kauffman, J. B.; Martin, R. E. 1985 [37]
Kaufman, J. B.; Martin, R. E. 1990 [38]

SEASON/SEVERITY CLASSIFICATION :

early spring/moderate
late spring/moderate
early fall/moderate
late fall/moderate

STUDY LOCATION :

Prescribed fires were set at two locations, the Challenge site and the Quincy site. The Challenge site is on the Challenge Experimental Forest on the La Porte Ranger District, Plumas National Forest. The site is approximately 2.5 miles (4 km) southeast of Challenge, California [35,36,37,38].

The Quincy site is on the Massak Unit of the Quincy Ranger District, Plumas National Forest. It is located 9.9 miles (16 km) east of Quincy, California [35,36,37,38].

PREFIRE VEGETATIVE COMMUNITY :

Challenge site - The overstory was a mature mixed stand of Douglas-fir (Pseudotsuga menziesii), incense-cedar (Libocedrus decurrens), ponderosa pine (Pinus ponderosa), and sugar pine (P. lambertiana) with occasional mature California black oak (Quercus kelloggii) and tanoak (Lithocarpus densiflorus) [35,37]. The site was logged in the late 1870's. Mean basal area of the stand was 80.52 sq m/ha; productivity class was I - II [35]. The shrub layer was predominantly tanoak. Other common shrubs included deer brush (Ceanothus integerrimus), waveyleaf ceanothus (C. foliosus), poison oak (Toxicodendron diversiloba), and Pacific dogwood (Cornus nuttallii). The herb layer was dominated by rainbow iris (Iris hartwegii) and was sparsely populated with Bolander's bedstraw (Galium bolanderi) and deervetch (Lotus spp.) [35].

Quincy site - The overstory was a mixed forest of Jeffrey pine (P. jeffreyi), ponderosa pine, Douglas-fir, and incense cedar [35,37]. Except for select insect damage cuts in the 1960's and 1970's, the site has never been logged [35]. Mean basal area was 48.01 sq m/ha; productivity class was III - IV [35]. The most common understory shrubs were deer brush, California black oak, thimbleberry (Rubus parviflorus), and sharpleaf snowberry (Symphoricarpos acutus) [38]. Dense thickets of stunted Douglas-fir and incense-cedar were also present in the understory. The most abundant herbs were western fescue (Festuca occidentalis) and broadleaf lupine (Lupinus latifolius ssp. latifolius) [35].

TARGET SPECIES PHENOLOGICAL STATE :

Season of burning was timed to correspond with the phenological development of understory shrubs. Season of burning by phenological stage was [35]:

Season	Phenological stage
early spring	dormant
late spring	active growth
early fall	aboveground growth has stopped
late fall	leaf abscission in deciduous shrubs; since deer brush is drought-deciduous, leaf drop may have already occurred

SITE DESCRIPTION :

Challenge - The study area is on the Yuba River watershed. Elevation is 3,317 feet (1,005 m). Mean annual precipitation is 72 inches (1,800 mm). Aspect is generally west (280-300 deg). Slopes vary from 35 to 55 percent [35].

Quincy - The study area is on the Plumas River watershed. Elevation is 4,053 feet (1,351 m). Mean annual precipitation is 36 inches (900 mm). Half of the study area is on north- to northwest-facing slopes (310-340 deg), and half is on south- or west-facing slopes (170-180 deg and 260 deg). Slopes vary from 35 to 75 percent [35].

FIRE DESCRIPTION :
The purpose of the prescribed fire treatments was to determine understory vegetation response to varying season and consumption levels of fire. Four fire treatments were used: (1) early spring, moderate-consumption; (2) late spring, high-consumption; (3) early fall, high-consumption (4) late fall, moderate-consumption. Prescriptions called for the early spring fire to be implemented as soon as it was possible to carry a fire; the late spring fire to be implemented as late in the spring as safely possible; the early fall fire to be implemented as early in fall as possible and before a major precipitation event; and the late fall fire to be implemented as late in the fall as possible and after a major precipitation event had occurred. If other variables could be met to ensure a safe burn, high-consumption fires were to be conducted when duff moisture content was less than 15 to 20 percent, and moderate-consumption fires were to be conducted when duff moisture content was greater than 30 percent. Strip- and backfires were used. Fall burning was conducted from mid-September to mid-October, 1983. Spring burning was conducted from April to June, 1984. Fire and fuel variables are given below. Data are means. Different letters indicate a significant difference ($p < 0.1$) among means [35,36,37].

Challenge Site:

Variable	early fall (high)	late fall (moderate)	early spring (moderate)	late spring (high)
duff consumption (%)	93.6	83.4	91.6	69.7a
duff consumption (t/ha)	111.2	105.8	111.3	72.3
total fuel consumption(%)	92.1a	77.5b	82.4b	56.2c
total fuel consumption (t/ha)	148.2	117.2	135.8	69.2a
duff moisture (%)	15.7	43.4	30.9	119.5a
soil moisture (%)	11.1a	22.3b	25.7b	44.1c
flame length (cm)	30.5a	56.3ab	97.1c	70.9bc
fireline intensity (kj/m/s)	21.2a	85.9ab	272.7b	125.8ab
residence time (sec)	47.8	51.2	83.6a	55.9

Quincy Site:

Variable	early fall (high)	late fall (moderate)	early spring (moderate)	late spring (high)
duff consumption (%)	72.4	70.0	86.2	82.8
duff consumption (t/ha)	47.9	40.1	53.1	50.6
total fuel consumption(%)	77.2	56.2	77.4	77.3
total fuel consumption (t/ha)	79.7	49.5	58.9	59.3
duff moisture (%)	8.7a	63.0c	18.3a	35.0b
soil moisure (%)	3.6a	11.3b	11.0b	20.3c
flame length (cm)	44.3	31.0	60.1	50.7
fireline intensity (kj m -1 s -1)	56.0ab	20.8a	110.6b	63.9ab
residence time (sec)	91.5	37.0	49.5	49.5

FIRE EFFECTS ON TARGET SPECIES :
Mature deer brush experienced 100 percent mortality on both sites under all four fire treatments [35,36]. Deer brush seedlings established on fall-burned sites but not on spring-burned sites. An early/late seasonal pattern of seedling establishment was not apparent with the fall burns: On the Challenge site, more seedlings established on late fall-burned sites; on the Quincy site, more seedlings established on the early fall-burned site. Number of deer brush seedlings before and after treatment follows [36].

	early spring		late spring		early fall		late fall	
	before	after	before	after	before	after	before	after
Challenge	0	0	0	0	0	215,977	0	264,486
Quincy	0	0	0	0	0	17,893	0	1,534

FIRE MANAGEMENT IMPLICATIONS :
Sprouting: Decadent deer brush in the understory of a mature forest is unlikely to sprout after prescribed fire.

Seedling establishment: spring fire - Few, if any, deer brush seedlings are liable to establish after spring prescribed fire. Deer brush seed requires stratification following scarification, and spring fire may not allow enough time for the complete embryonic development that occurs with overwinter stratification.

fall fire - Early to late fall prescribed fire will result in good deer brush seedling establishment if deer brush seed was present in the soil before fire. Although seedling establishment on the late fall-burned Quincy site was low relative to the other fall-burned site, seedling mortality on such thinner stands probably will not be as great as on sites where deer brush seedlings establish in larger numbers. Over a decade's time, deer brush density will probably be similar on both sites.

2nd CASE NAME : Mixed conifer - Sierra Nevada 2. Kauffman, J. B.; Martin, R. E. 1985 [9796]

SEASON/SEVERITY CLASSIFICATION : early spring/moderate late spring/high early fall/high late fall/moderate

STUDY LOCATION : Challenge Site: This prescribed burn took place in the Challenge Experimental Forest on the LaPorte Ranger District, Plumas National Forest. The study site was located approximately 2.5 miles (4.0 km) southeast of Challenge, California. Quincy Site: The Quincy burn site is located 9.9 miles (16 km) east of Quincy, California in the Massak Unit on the Quincy Ranger District, Plumas National Forest.

PREFIRE VEGETATIVE COMMUNITY : Challenge Site: Preburn overstory was dominated by ponderosa pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziesii), and sugar pine (Pinus lambertiana). Common preburn plant associates include tanoak (Lithocarpus densiflora), incense cedar (Calocedrus decurrens), and bear clover (Chamaetia foliolosa). The site is described as productive. Quincy Site: Preburn stands were dominated by ponderosa pine, Jeffrey pine (Pinus jeffreyi), and Douglas-fir. Common associates included black oak (Quercus kelloggii), incense cedar, and squaw carpet (Ceanothus prostratus). This site is less productive than the Challenge Site.

TARGET SPECIES PHENOLOGICAL STATE : burn phenological state early spring burns prior to period of active growth late spring burns coincided with period of active leaf growth and stem expansion early fall burns aboveground shrub growth has ceased late fall burns leaf abscission was occurring in deciduous shrubs

SITE DESCRIPTION : Challenge Site: elevation - 3,280 feet (1,000 m) aspect - generally west slope - 1 to 12 percent site index productivity class - I to III Quincy Site: elevation - 4,428 feet (1,350 m) aspect - 50 percent on north slopes 50 percent on south slopes slope - 35 to 75 percent site index productivity class III to IV

FIRE DESCRIPTION :

Challenge Site:

Variable	early fall	late fall	early spring	late spring
duff consumption %	93.6	83.4	91.6	69.7
duff consumption t/ha	111.2	105.8	111.3	72.3
total fuel consumption %	92.1	77.5	82.4	56.2
total fuel consump. t/ha	148.2	117.2	135.8	69.2
duff moisture %	15.7	43.4	30.9	119.5
soil moisture %	11.1	22.3	25.7	44.1
flame length cm	30.5	56.3	97.1	70.9
fireline intensity (kj m -1 s -1)	21.2	85.9	272.7	125.8
residence time sec.	47.8	51.2	83.6	55.9

Quincy Site:

Variable	early fall	late fall	early spring	late spring
duff consumption %	72.4	70.0	86.2	82.8
duff consumption t/ha	47.9	40.1	53.1	50.6
total fuel consumption %	77.2	56.2	77.4	77.3
total fuel consump. t/ha	79.7	49.5	58.9	59.3
duff moisture %	8.7	63.0	18.3	35.0
soil moisture %	3.6	11.3	11.0	20.3
flame length cm	44.3	31.0	60.1	50.7
fireline intensity (kj m -1 s -1)	56.0	20.8	110.6	63.9
residence time sec	91.5	37.0	49.5	49.5

FIRE EFFECTS ON TARGET SPECIES :

density of deerbrush (numbers/ha) before and after burning – treatment

	early spring		late spring		early fall		late fall	
	before	after	before	after	before	after	before	after
Challenge Site	0	0	0	0	0	215,977	0	264,486
Quincy Site	0	0	0	0	0	17,893	0	1,534

FIRE MANAGEMENT IMPLICATIONS : Fall burns appeared to promote increases in deerbrush density whereas spring burns did not. Fall fuel conditions and moisture regimes apparently produced fires at both the Challenge and Quincy sites which were sufficient to scarify vast numbers of deerbrush seed stored in the soil. Spring burns may have provided inadequate scarification to promote germination, or subsequent weather conditions may have been unfavorable for good germination and establishment. Spring burns may be most effective in reducing deerbrush where brush reduction is a primary management goal.

Himalayan Blackberry (Rubus discolor)

FIRE MANAGEMENT CONSIDERATIONS :
Wildlife species which consume large amounts of blackberries are often benefited by fire [20].

Manzanita, Greenleaf (Arctostaphylos patula)

FIRE MANAGEMENT CONSIDERATIONS :
An understanding of the dynamics of shrub reestablishment after fire is an important fire management concern. This is dependent upon an understanding of shrub reproductive strategies [33].

When fire is used for brush control, consumption level, as well as shrub phenology, is an important factor contributing to mortality. Phenologically, shrubs are more resistant to fire in fall, but more fuels are generally available for consumption at this time. Therefore, more destructive heat can be generated around meristematic tissues and root crowns [28]. It has been reported that the greatest mortality of shrubs occurred during high consumption burns regardless of season, and that burning during the active aboveground growing season appeared to increase mortality regardless of the amount of duff consumed. Timing controlled burns to coincide with dryer fuel conditions and active aboveground growth may result in the highest mortality rates [29].

Fire can also be used to reduce or eliminate the greatly increased fire hazard of the standing dead brush, to set back resprouting brush a second time, and to remove the impenetrable mass of dead brush resulting from herbicide application [15].

Prescribed burning in the early spring, before active shrub growth, can be used to increase palatability of foliage to wildlife [29].

Studies indicate that prescribed understory burning can used successfully to kill or reduce the vigor of greenleaf manzanita shrubs and seedlings, deplete the amount of viable residual seed in the soil, and thus prepare a better seedbed for pine and white fir (Abies concolor) regeneration [28,68]. An increase in understory slash depth may reduce the density of manzanita seedlings [68].

Manzanita, Whiteleaf (Arctostaphylos viscida)

FIRE MANAGEMENT CONSIDERATIONS :
Timber and grazing: Annual prescribed burning can convert whiteleaf manzanita brushfields to timber or pastureland if the site is otherwise suitable. Yearly fires prevent whiteleaf manzanita seedlings from maturing and gradually reduce the residual seed stock. Eventually, whiteleaf manzanita is eradicated from the site [20,26]. Safe conditions exist for a late winter or early spring burning if each of these elements is within the following range [19]:

Element	Intensity low	Intensity high
fuel stick moisture (%)	15	5
relative humidity (%)	58	26
wind speed (mi/h)	0	10
air temperature (degrees F)	40	84

Fire suppression: Fire suppression in whiteleaf manzanita chaparral results in unnaturally high fuel levels. This eventually results in severe wildfires that are extremely difficult to contain. Prescribed burning is recommended for reducing fuel loading in whiteleaf manzanita communities [20].

Poison Oak (Toxicodendron diversilobum)

FIRE MANAGEMENT CONSIDERATIONS :
Urushiol volatilizes when burned, and human exposure to poison-oak smoke is extremely hazardous [40]. The smoke often poisons people who think they are immune to the plant [46].

Poison-oak vines are a ladder fuel [61].

Goats can be used as an alternative to prescribed fire for fire hazard reduction at urban-wildland interfaces. Near Oakland, California, goats were put on a Monterey pine-redgum (Eucalyptus camaldensis) forest with a heavy shrub understory and on an adjacent site where the forest was managed as a fuelbreak and had less shrub cover in the understory. Goat utilization of poison oak was in the fuelbreak 67 percent, somewhat lower than utilization of toyon, California blackberry, and coyotebrush. Annual production of poison-oak biomass before goat browsing in the fuelbreak was 99 kilograms per hectare; it was 33 kilograms per hectare afterwards. Total biomass of forage species was significantly ($p<0.05$) reduced [61].

A stocking rate of 600 goats per hectare on the Oakland site broke the vertical live fuel continuity in the dense shrub stand. Initial goat browsing to reduce biomass and vertical fuel continuity could be followed up by prescribed fire [61].

Snowberry (Symphoricarpos albus)

FIRE MANAGEMENT CONSIDERATIONS:

Common snowberry is one of the first species to recolonize a postburn site. New growth provides forage and often bears increased fruit crops. Cover is provided for small wildlife species and lush vegetation can protect soil surfaces from splash erosion, but can also offer severe competition to new tree seedlings. The living rhizome systems can be important in retaining nutrients released by fire [77]. One study [5] found that planting grass seed to control erosion reduced coverage of common snowberry and other native shrubs on several burned sites in Oregon.

In Saskatchewan, to burn common snowberry it is recommended waiting 4 days after heavy rains. In addition, if spring burning, a minimum temperature of 55 degrees Fahrenheit (13 ^oC), wind speed of 2-12 mi hr^{-1} (3-19 km hr^{-1}), and a maximum relative humidity of 50% is suggested. After burning, a 2-year wait is needed to build up enough fuel to burn again [9]. Common snowberry may be susceptible to frequent burning [100]. If planting common snowberry, prompt, early spring planting is required or it may experience moisture stress in the short term [36].

Common snowberry has a low surface to volume ratio and will have a high flammability if there are many dead stems [18]. It is capable of producing firebrand material. When located near fire control lanes, it should be red-flagged as spot fire potential [83].

Tanoak (Lithocarpus densiflorus)

FIRE MANAGEMENT CONSIDERATIONS :
Broadcast burning: Where conifer regeneration is a primary management concern, broadcast burning is generally an ineffective site preparation tool following clearcutting in conifer-tanoak stands [30]. Even though burning delays the recovery of tanoak for approximately one growing season, removal of logging debris promotes resprouting by exposing basal buds to solar heating and permits sprouts to grow unimpeded [15,31]. Sites which are particularly prone to the rapid development of a dense tanoak understory are those where the preburn vegetation consists of low conifer stocking combined with high tanoak densities [49].

Preharvest underburning: Tanoak sprouting may be more effectively controlled by preharvest underburning treatments [18,19,49]. Preliminary research indicates that preharvest underburns are effective in killing at least a portion of the tanoak understory when conducted in late spring (June) under conditions which result in high duff consumption [18,19].

Fires aimed at suppressing the tanoak understory can be expected to be most effective when conducted in 30 to 75 year old conifer stands. Harvesting conifer-tanoak stands over 70 years of age typically results in a dense cover of tanoak resprouts. On many sites, resprouts from delayed seedling regeneration are often responsible for high post disturbance tanoak coverages [49]. This younger, shrublike component of the tanoak understory is an abundant (commonly exceeding 3,000 per/ha) but inconspicuous component of many stands prior to disturbance. Resprouting capabilities are greatly enhanced as suppressed seedlings increase in age. When released from dense shade, suppressed tanoak over 70 years of age commonly produce more than 30 sprouts per plant; these typically reach heights of from 3.2 to 6.6 feet (1 to 2 m) within three years. By comparison, most 40 to 50 year old tanoak produce an average of only five resprouts ranging from 12 to 27 inches (30 to 68 cm) in height 3 years after burning. Furthermore, development of a tanoak understory capable of vigorous, postdisturbance sprouting may take upwards of 100 to 137 years [31]. The sprouting potential of tanoak develops slowly and substantial tanoak seedling establishment is often delayed until conifer stands are 20 to 35 years old. These factors suggest that on sites with 60 to 80 year conifer rotations, one, well-timed, effective underburn can eliminate tanoak as a competitor to conifer regeneration for two rotations. Subsequent tanoak seedling establishment must be controlled in order to realize the full benefits of burn treatments; resprouted individuals can produce acorns within at least 9 to 13 years of clearcutting and burning [49].

Hardwood management: Burning should not be utilized as a method of slash disposal in partially cut hardwood stands where tanoak is managed for timber production. Instead, logging debris should be lopped and scattered or piled and burned [30].

FIRE CASE STUDIES

CASE NAME :
Mixed conifer - Sierra Nevada

REFERENCES :
1. Kaufmann, J. B.; Martin, R. E. 1985 [18]
2. Kauffman, J. B.; Martin, R. E. 1985 [19]

SEASON/SEVERITY CLASSIFICATION :
early spring/moderate
late spring/high
early fall/high
late fall/moderate

STUDY LOCATION :
This prescribed burn took place in the Challenge Experimental Forest on the LaPorte Ranger District, Plumas National Forest. The study site was located approximately 2.5 miles (4.0 km) southeast of Challenge, California.

PREFIRE VEGETATIVE COMMUNITY :
Preburn overstory was dominated by ponderosa pine, Douglas-fir, and sugar pine. Common understory associates included black oak, incense cedar (Calocedrus decurrens), and bear clover (Chamaebatia foliolosa). The site is described as productive.

TARGET SPECIES PHENOLOGICAL STATE :

burn	phenological state
early spring burns	prior to period of active growth
late spring burns	coincided with period of active leaf growth and stem expansion
early fall burns	aboveground shrub growth has ceased
late fall burns	leaf abscission was occurring in deciduous shrubs

SITE DESCRIPTION :
Elevation: 3,280 feet (1,000 m)
Aspect: generally west
Slope: 1 to 12 percent
Site index productivity class: I to III

FIRE DESCRIPTION :

season	early fall	late fall	early spring	late spring
duff consumption %	93.6	83.4	91.6	69.7
duff consumption t/ha	111.2	105.8	111.3	72.3
total fuel consumption %	92.1	77.5	82.4	56.2
total fuel consump. t/ha	148.2	117.2	135.8	69.2
duff moisture %	15.7	43.4	30.9	119.5
soil moisture %	11.1	22.3	25.7	44.1
flame length cm	30.5	56.3	97.1	70.9
fireline intensity (kj m -1 s -1)	21.2	85.9	272.7	125.8
residence time sec.	47.8	51.2	83.6	55.9

FIRE EFFECTS ON TARGET SPECIES :
Density of tanoak (numbers/ha) before and after burning are as follows:

	preburn	postburn
early spring	2,801	1,400**
late spring	1,934	167**
early fall	1,234	233*
late fall	1,934	600*

* P <0.10
** P <0.05

FIRE MANAGEMENT IMPLICATIONS :
Prescribed, preharvest underburning can be an effective method of controlling tanoak. Greatest tanoak mortality generally occurs following high consumption burns regardless of season of burn. Increased mortality can be expected when high consumption burns coincide with seasons of active growth. Late spring (June), high consumption burns produced highest shrub mortality. This Sierra Nevada site tends toward the dry end of the moisture range.

APPENDIX E

ANDERSON FUEL MODELS

Fuel Model 1

Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured grass and associated material. Very little shrub or timber is present, generally less than one third of the area. Grasslands and savanna are represented along with stubble, grass-tundra, and grass-shrub combinations that met the above area constraint.

Annual and perennial grasses are included in this fuel model. Refer to photographs 1, 2, and 3 for illustrations.

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 0.74
- Dead fuel load, 1/4-inch, tons/acre .74
- Live fuel load, foliage, tons/acre 0
- Fuel bed depth, feet 1.0

Fuel Model 2

Open ponderosa pine stand with annual grass understory.

Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to litter and dead-down stemwood from the open shrub or timber overstory, contribute to the fire intensity. Open shrub lands and pine stands or scrub oak stands that cover one-third to two-thirds of the area may generally fit this model; such stands may include clumps of fuels that generate higher intensities and that may produce firebrands. Some pinyon-juniper may be in this model.

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 4.0
- Dead fuel load, 1/4-inch, tons/acre 2.0
- Live fuel load, foliage, tons/acre 0.5
- Fuel bed depth, feet 1.0

Fuel Model 5

Chaparral along the western slope of the Sierra-Nevada Mountain Range.

Photo by Dave Sapsis

green, low shrub fields within timber stands.

regeneration shrublands after fire or other disturbances have a large green fuel component

Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Usually shrubs are short and almost totally cover the area. Young, green stands with no dead wood would qualify: laurel, vine maple, alder, or even chaparral, manzanita, or chamise.

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 3.5
- Dead fuel load, 1/4-inch, tons/acre
- Live fuel load, foliage, tons/acre 2.0
- Fuel bed 2.0

Fuel Model 6

Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than 8 mi/h (13 km/h) at midflame height. Fire will drop to the ground at low wind speeds or at openings in the stand. The shrubs are older, but not as tall as shrub types of model 4, nor do they contain as much fuel as model 4. A broad range of shrub conditions is covered by this model. Fuel situations to be considered include intermediate stands of chamise, chaparral, oak brush, low pocosin, Alaskan spruce taiga, and shrub tundra. Even hardwood slash that has cured can be considered. Pinyon-juniper shrublands may be represented but may overpredict rate of spread except at high winds, like 20 mi/h (32 km/h) at the 20-foot level.

Chaparral along the western slope of the Sierra-Nevada Mountain Range.

Photo courtesy of Sean Griffis

Low pocosin shrub field in the south

Frost-killed Gambel Oak foliage, less than 4 feet in height, in Colorado

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 6.0
- Dead fuel load, 1/4-inch, tons/acre 1.5
- Live fuel load, foliage, tons/acre 0
- Fuel bed 2.5

(Source: "Aids to Determining Fuel Models for Estimating Fire Behavior, Hal Anderson, National Wildfire Coordinating Group, 1982.)

Fuel Model 8

Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. 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 occasionally twigs because little undergrowth is present in the stand. Representative conifer types are white pine, and lodgepole pine, spruce, fir, and larch.

Surface litter fuels in western hemlock stands of Oregon and Washington.

Understory of inland Douglas fir has little fuel here to add to dead-down litter load

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 5.0
- Dead fuel load, 1/4-inch, tons/acre 1.5
- Live fuel load, foliage, tons/acre 0
- Fuel bed 0.2

Fuel Model 9

Fires run through the surface litter faster than model 8 and have longer flame height. Both long-needle conifer stands and hardwood stands, especially the oak-hickory types, are typical. Fall fires in hardwoods are predictable, but high winds will actually cause higher rates of spread than predicted because of spotting caused by rolling and blowing leaves. Closed stands of long-needled pine like ponderosa, Jeffrey, and red pines, or southern pine plantations are grouped in this model. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning.

Photo by Dave Sapsis

Western Oregon white oak fall litter, wind tumbled leaves may cause short-range spotting that may increase ROS above the predicted value

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 3.5
- Dead fuel load, 1/4-inch, tons/acre 2.9
- Live fuel load, foliage, tons/acre 0
- Fuel bed 0.2

(Source: "Aids to Determining Fuel Models for Estimating Fire Behavior, Hal Anderson, National Wildfire Coordinating Group, 1982.)

Fuel Model 10

The fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead-down fuels include greater quantities of 3-inch (7.6-cm) or larger limbwood resulting from overmaturity 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 if heavy down material is present; examples are insect- or disease-ridden stands, windthrown stands, overmature situations with deadfall, and aged light thinning or partial-cut slash.

Spruce habitat type where succession or natural disturbance can produce a heavy downed fuel load

Fuel model values for estimating fire behavior:

- Total fuel load, < 3-inch dead and live, tons/acre 12.0
- Dead fuel load, 1/4-inch, tons/acre 3.0
- Live fuel load, foliage, tons/acre 2.0
- Fuel bed 1.0

(Source: "Aids to Determining Fuel Models for Estimating Fire Behavior, Hal Anderson, National Wildfire Coordinating Group, 1982.)

APPENDIX F

WILDFIRE HOME PROTECTION

DEFENSIBLE SPACE GUIDELINES

A. The Home Zone   0 feet to 6 feet

Goal: To prevent the spread of fire from vegetation to the structure or from the structure to vegetation.

Treatment:
1. Remove all fuels within this zone. Examples are conifer trees, brush, dry grass, leaves, needles, woodpiles and flammable ornamentals.
2. Remember to clean leaves and needles from roofs and gutters.
3. This zone can be landscaped with gravel, concrete or left bare to mineral soil. Replacing vegetation with less flammable plants, green lawn, and flowerbeds, if well watered, is a good choice.

B. The Yard Zone   6 feet to 30 feet

Goal: To prevent a fire from moving from ground fuels to brush or tree crowns and to slow the rate of fire spread. (This zone should be sufficient for grasslands and is integrated into fuel reduction treatments for brush and timberlands.)
Reduces fuels so reduces fire intensity
Reduces potential danger to fire crews
Preserves overstory vegetation

Treatment:
1. Limit the litter layer to less than 3 inches.
2. Remove fine, dead, standing vegetation.
3. Clip dead twigs and branches from brush and trees.
4. Eliminate fuel ladders (continuous fuel from ground to tree crowns).
5. Prune tree limbs to at least 10 feet above the ground.
6. Remove tree limbs overhanging roof eaves and within 15 feet of chimneys.
7. Thin trees to separate crowns by 15 feet*. Favor hardwoods over conifers.
8. Break up the horizontal continuity of fuels by use of low-flammability plants, flowerbeds, green lawns, gravel or concrete. Watering reduces flammability.

* The distance between tree crowns should increase with increasing slope steepness. The recommended distances are:

Recommended Distances Between Tree Crowns by Percent Slope	
Percent Slope	Distance Between Tree Crowns
Level to 20%	10 feet
21% to 40%	20 feet
41% to 60%	30 feet

C. The Brush or Screen Zone   30 feet to 75 feet

Goal: To keep a wildland fire on the ground, thereby minimizing intense burning and damage to overstory trees. (This is the primary zone for fire suppression. Although 75 feet of fuel reduction appears adequate for brush covered lands, further effort is necessary on forested lands.)

Treatment:
1. Separate patches and clumps of understory vegetation so they are spaced horizontally and vertically from overstory trees.
2. Eliminate fuel ladders (continuous fuel from ground to tree crowns)

3. Prune tree limbs to at least 10 feet above the ground.
4. Thin trees to separate crowns by at least 12 feet*. Favor hardwoods over conifers.
5. Use vegetation to screen for privacy.

D. The Woodland or Forest Zone   75 feet to 150# feet

Goal: To provide a space in which a fire will cool down, slow down, and stay on the ground, thereby maintaining fire safety in the community. (This zone can provide cover for wildlife. Views within this zone can be enhanced to be more aesthetically pleasing.)

Treatment:
1. Separate patches and clumps of understory vegetation so they are spaced horizontally and vertically from overstory trees.
2. Remove dead material from brush and trees.
3. Eliminate fuel ladders (continuous fuel from ground to tree crowns)
4. Prune tree limbs to at least 10 feet above the ground.
5. Thin trees to separate crowns by at least 10 feet*. Favor hardwoods over conifers.

This distance varies depending upon slope steepness. The recommended distances are:

Defensible Space Distances			
	Distance From House		
Percent Slope	Uphill	Sidehill	Downhill
Level to 20%	100 feet	100 feet	100 feet
21% to 40%	150 feet	150 feet	200 feet
41% to 60%	200 feet	200 feet	400 feet

After evaluating your property and talking with your neighbors, you can use the *FOUR Rs* to meet defensible space guidelines.

Removal: Eliminate entire plants, particularly trees or shrubs. Example: Cut understory white firs and manzanita.

Reduction: Remove parts of plants to reduce available fuels. Example: Prune limbs and twigs. Mow dry grass.

Replacement: Substitute less flammable plants for those that are more flammable. Example: Remove some conifers and plant oaks. Remove tall manzanita and plant pinemat manzanita or squaw carpet.

Re-arrangement: Combine the above methods. Include regular watering of plants.