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Preface

Shotgun Slate Watershed Analysis

This analysis follows the recommended procedures from the Federal Guide of Watershed Analysis, Version 2.2, dated August 1995. To fully understand this analysis the reader must be familiar with both the Record of Decision for Amendment to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, including Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Related Species (here-in called the "President's Forest Plan") and the Land and Resource Management Plan for the Shasta-Trinity National Forests (here-in called the "Forest Plan").

Announcements were published in three local newspapers and one regional newspaper inviting public input to this analysis. Over seventy letters were mailed to known interested people, organizations, and government agencies, inviting input to this analysis. No new resource information or issues were obtained as a result of public participation for this analysis.

The Upper Sacramento River Interdisciplinary Team included the following Resource Specialists:

Dennis Poehlman	Forester and Team Leader
Steve Bachmann	Hydrologist
Ron Toroni	Wildlife Biologist
Ed Hatakeda	Recreation Planner
Dale Etter	Fuels Officer
Abel Jasso	Geologist
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Vivian Parker	Botanist
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Chapter 1 - Watershed Characterization

The Sacramento Headwaters Sub-Basin

The Shotgun/Slate Watershed is part of the Sacramento Headwaters Sub-Basin. This basin drains a major portion of Northern California, with waters flowing into the Sacramento Delta and San Francisco Bay. The Sacramento Headwaters Sub-basin is that portion of the basin above Shasta Dam that includes the Upper Sacramento River and its tributaries (See Vicinity Map).

Some important characteristics of this sub-basin are:

- Terrain is generally steep and mountainous.
- The dominant vegetation cover is mixed conifer forest and evergreen brush.
- It is bisected by Interstate 5 and a mainline railroad.
- Prominent features include Shasta Dam and a portion of Shasta Lake, Castle Crags (a granite batholith), and a portion of Mt. Shasta.
- Ownership is divided approximately 50/50 between private and Federal.
- Recreation use is high, especially in the National Recreation Area at Shasta Lake and along the Interstate 5 corridor.
- All of the Castle Crags Wilderness and a portion of the Mt. Shasta Wilderness are within the sub-basin.
- The incident of human-caused wildland fires is high along the Interstate 5/ railroad corridor.
- The Klamath, Weaverville and McCloud mule deer herds utilize the sub-basin for winter and summer range.
- Five Late-Succession Reserves and one Managed Late-Successional Reserve are within the sub-basin.
- Port-Orford Cedar is present along some perennial streams within the sub-basin.
- The sub-basin supplies domestic water to the cities of Mt. Shasta, Dunsmuir and Castella.

Watershed Setting

The Shotgun/Slate Watershed includes Flume, Mears, Shotgun, Boulder, Slate, Mosquito and Dog Creeks. Some prominent characteristics of this watershed are:

- It contains approximately 66,500 acres of public and private lands.
- Approximately 50 percent of the watershed (33,400 acres) is Federal lands administered by the U. S. Forest Service.
- All of the watershed is within Shasta County.
- The two major private landowners are Roseburg Lumber Company and Sierra Pacific Industries.
- Elevations range from 1,100 feet along the Sacramento River to 6,500 feet along the western divide.

- Dominant physical features include a portion of the Upper Sacramento River and a portion of Interstate 5.
- Recreation use is high along the Sacramento River/ Interstate 5 corridor.
- The dominant vegetation type is Klamath Mixed Conifer, with Ponderosa Pine, Douglas fir, White fir, Cedar and Sugar Pine the major components.
- The dominant shrub species are Tan Oak, Brush Chinquapin and Green Leaf Manzanita.
- California Black Oak is a component of the Mixed Conifer type found
- Port-Orford Cedar is present along some perennial streams and spring areas.
- There are approximately 95 miles of fish bearing streams within the watershed
- Several plants listed as Forest Service sensitive as well as many rare plants occur in the watershed. Two of these plants do not occur anywhere else in the world.

Table 1. Land Allocations for Federal ownership are:

President's NW Plan	Shasta-Trinity Forest Plan	Approx. Acres	Approx. % Watershed
Administratively Withdrawn	Limited Roaded Motorized Recreation (Man. Prescription II)	600	(2%)
Late Successional Reserve	T&E, Sensitive Species Management (Man. Prescription VII)	11,800	(35%)
Matrix	Comm. Wood Products Emp. (Man. Prescription VIII)	9.000	(27%)
	Roaded Recreation (Man. Prescription III)	1,800	(5%)
	Wildlife Habitat Mgt. (6) (Man. Prescription VI)	2,600	(8%)
Riparian Reserves	Riparian Management (9) (Man. Prescription IX)	7,600	(23%)

Relationship of Watershed to Sub-Basin and adjoining watersheds:

- The Shotgun/Slate Watershed makes-up approximately 20 percent of the Sacramento Headwaters Sub-Basin.
- Terrain is similar within the watershed and the sub-basin.
- Vegetation types are generally similar within the watershed and the sub-basin.
- The Dog Creek Road, County Road 5G012, is the main east-west route between Interstate 5 and Whiskeytown Lake that traverses this watershed.
- Interstate 5 is the main north-south vehicle travel corridor for people traveling to and through the watershed.

Chapter 2 - Issues and Key Questions

Issue: River Access

Key Question: What are the opportunities to provide public access to the Upper Sacramento River?

Discussion: The Upper Sacramento River is well known for its recreation opportunities including fishing, swimming, rafting, kayaking and hiking. Currently there are a very limited number of locations where the public can access the river. Access routes are limited due to controlled vehicle exits off of Interstate 5, crossing of the main line railroad and the limited parcels of public lands within the river corridor. Currently the only legal and safe public access is at the Sims Campground on the east side of the river.

Issue: Vegetation Management

Key Question: What silvicultural treatments provide for continued stand vigor and meet desired conditions for commodities outputs?

Discussion: Approximately 40% of the National Forest System lands in this watershed, Approximately 13,200 acres, are in Prescriptions that emphasize or permit timber management. The management objective in the prescription eight allocation is to obtain optimum timber yields of wood fiber products from productive forest lands within the context of ecosystem management.

This watershed makes up a portion of Management Area 9 as described in the Forest Plan. Sustained forest products from the Management Area are estimated to be approximately 23 million board feet per decade. The Shotgun/Slate Watershed should be contributing approximately 58 percent of this output or approximately 13 million board feet per decade.

As is typical of vegetation types in this sub-basin, there are some areas of seral shrubland and Knobcone Pine that are the result of historic stand-replacing wildland fires. Some of these areas would be suitable for conversion to their historic vegetation type, Klamath mixed conifer.

Chapter 3 - Current Conditions

Human Use:

The main draw for a majority of Recreation use in the Shotgun-Slate sub-watershed is the Sacramento River. The major access route for users in this area is Interstate 5 which was constructed in the mid 1960's. This allowed easy access to the recreation resources in the area even though public access is very limited along the river.

The major recreation activities are fishing, hunting, watercraft use and gathering forest products such as firewood. The portion of the Sacramento River which flows through the analysis area is restricted to catch and release fishing with barbless hooks only. Hunting and fishing are regulated by the California Department of Fish & Game.

There are no developed public recreation facilities within the sub-watershed that are available for public use. The closest public facilities are at Castle Crags State Park and Sims Flat Campground which are adjacent to but outside of the watershed area. There are private facilities designed for transient overnight use located in Castella.

Commercial recreation use also occurs on the Sacramento River within the analysis area. There are 4 commercial outfitter/guides that operate on the river within the stream fishing season which runs from the end of April through mid-November. There are also 13 to 15 outfitter/guides that boat the river. The number varies from year to year depending on the river flow.

Transportation:

Today, the Sacramento River Canyon is a vital transportation corridor for goods and people. Large volumes of interregional, regional, and local commerce utilize Interstate 5 and the Southern Pacific Railroad mainline, both of which pass through the canyon more or less alongside the Sacramento River, and close to the eastern watershed boundary. Well developed secondary roads interlace the watershed, developed primarily from past resource extraction activities. The public uses these same roads for recreation including fishing, hunting, woodcutting, and other activities.

The presence of rough 4 wheel drive roads, usually on ridgetops, provide some access for firefighting and resource management activities. In addition these rough roads are utilized by 4 wheel driving enthusiasts and clubs. Numerous hiking trails are present, although none enjoy the stature of the Pacific Crest Trail, which passes just to the north of the watershed.

Open road density, considering gates and other closures is close to .5 miles per section. Based on Transportation maps and available transportation information, total road densities are based on 184 miles within 66,482 total acres, for a density of 1.75 miles per section. About 120 miles of level 2 roads are present. Cost share roads miles are just under 20 miles, along with 33 miles of level 3 road, and about 12 miles of aggregate road. Level 2 roads are native surfaced and receive minimum maintenance, while Level 3 roads may have varied surfaces, including chip seal, receive more maintenance, and are generally useable by 2 wheel drive vehicles.

Table 2. Registered Trails within the Watershed

Trail Name	Length (Miles)
Flume Creek Jeep and Bike	8.0
Gray Rock Lakes	0.6
Mears Ridge Fire and Jeep	3.2
Sugarloaf Mtn. Jeep Trail	1.5

Vegetation:

Vegetation data for this report is derived from the Forest GIS data base. This vegetation information originated from 1975 aerial photo type mapping with updates for plantation data only. The data presented is for National Forest System lands only.

The Shotgun/Slate Watershed contains approximately 31,000 acres of commercial forest land (93% of NFSL's), approximately 1,400 acres of shrublands (4% of NFSL's), 100 acres of rockland & water (0% of NFSL's), 900 acres of hardwoods (3% of NFSL's).

The commercial forest lands are dominated by mixed conifer forests. Tree species are Douglas fir, Ponderosa/Jeffrey Pine, Incense cedar, White fir, Sugar/Western White Pine and Knobcone pine. Hardwood species are California black oak, live oak and Pacific yew.

Within the fringe areas of some perennial streams are found small populations of willows, alder, Big Leaf Maple and Port-Orford Cedar.

Two major forest communities are found within this watershed:

Generally below 3500 feet elevation are mixed conifer forests associated with California Black and Live Oak. Conifer tree species are Douglas fir, Ponderosa pine, Incense cedar, White fir and Sugar Pine. Oak densities vary from none to pure stands with an occasional conifer tree. Shrub species found in the understory are generally White and Green Leaf Manzanita, Tan Oak and Whitethorn.

Between 3500 and 6000 feet elevation is a mixed conifer forest. Tree species are Douglas fir, Ponderosa pine, Incense cedar, White fir and Sugar pine. Some pure stands of Knobcone Pine are also found within this zone. The main shrub species are Tan Oak, Green Leaf Manzanita and Huckleberry Oak. Shrub species are found in the understory of many stands and as shrubfields with little or no conifer tree cover.

The following information is for commercial forest lands within the National Forest System lands and for the watershed as a whole:

Table 3. Size Class Distribution

Size Class	Description	Crown Diameter	Acres Present	% CFL
1	Seedling/Saplings		950	03
2	Poles	< 12’	2,250	07
3	Mature	12’ to 23’	25,700	83
4	Older Mature	24’ to 40’	2,100	07

(% CFL= Percent Commercial Forest Land)

Table 4. Stand Density Distribution

Density Code	Canopy Closure	Acres Present	% CFL
S & P	10%-39%	18,300	59
N	40%-69%	10.900	35
G	70%-100%	1,800	06

(% CFL= Percent Commercial Forest Land)

Seral Stage Distribution (as approximated from size/density classes)

- 4c older = 4G= 600 acres = 2% of Commercial Forest Lands
- 4b-4c = 4N + .5 of3G + .5 of 3N = 900ac + 650ac + 4500ac = 6050 = 20% CFL
- 4a = .5 of 3S + .5 of 3P + 4S + 4P = 1900ac+ 5800ac+ 0ac+ 600ac = 8300ac = 27% CFL
- 3b-3c = 2G + 2N + .5 of 3G + .5 of 3N = 100ac+ 500ac+ 650ac+4500ac = 5750ac= 18%CFL
- 3a = 2S + 2P +.5 of 3P +.5 of 3S = 550ac+ 1,100ac+ 5800ac+ 1900ac = 9350ac = 30%CFL
- plantations = 950 acres = 3% of CFL
- shrublands= 1400 acres = 4% of NFSL
- grass and forbs = 6 acres = 0% NFSL

Forest Plan Standards and Guidelines:

- Retain 15 percent old growth and late successional forest in fifth field watershed: Of the 31,000 acres of commercial forest lands in this watershed, 48 percent is in the mature and older size class within reserve prescriptions 2, 7 and 9. Of the 31,000 acres of commercial forest lands within the watershed, 27% is in late seral stage 4 within reserve prescriptions 2, 7 and 9. In addition it is estimated that half the commercial forest lands in matrix prescriptions will be maintained in mature size classes over time.
- Retain snags at published guidelines or at a minimum average of 1.5 snags per acre greater than 15 inches DBH and 20 feet in height. (No information on current snag densities within the watershed.)
- Retain coarse woody debris in amounts ranging from 5 to 10 tons per acre on matrix lands with slopes less than 40 percent. A portion of this to be in large material, 4-6 logs per acre over 10 feet in length. (No information is currently available on coarse woody debris amounts.)

Fire & Fuels:

The Shotgun/Slate watershed has evidence of a significant recurring fire history. Within the entire watershed approximately 9000 acres (13 % of the watershed) has a recorded large fire history since the early 1900's. Of this 9000 acres approximately 6300 acres are within current National Forest boundary, of which 2080 acres are in LSR, and 4220 acres are matrix lands. Starts both lightning and human caused show an overall frequency of between .3 to 5.5 fires per thousand acres per decade giving it a moderate risk rating.

The primary influence zone for human caused fire starts is along the I-5 corridor. Several of the large fire history appears to have its origin from this corridor.

Table 5. Fire History

Density Zone	Acres	Frequency by cause (20 years)	Fires/1000 ac./ Decade	Risk Rating
1	4,040	11- Lightning 33- Human	5.5	H
2	2,400	6- Lightning 7- Human	2.7	H
3	10,240	17- Lightning 3- Human	0.9	M
4	50,820	24- Lightning 2- Human	0.3	L

Fire Regimes:

The Southern Cascades Province is characteristic of a short return interval, low intensity surface fire regime. The mixed conifer series is the most common series found throughout the province which includes stands of ponderosa pine at the drier ends of the mixed conifer zones. Mixed conifer and ponderosa pine series as well are both characteristic of short interval fire adapted fire regimes. Pine sites may have shorter intervals of disturbance (5-15 years) due to drier site conditions and extended burn seasons where higher elevations and transitions zones to mixed conifer stands may experience longer intervals (5-30 years) due to climatic variables. Within the lower elevation and thus drier sites fire regimes have experienced a change from frequent low intensity surface fires to that of infrequent high intensity stand replacement fires. Correspondingly higher elevation moist sites within the same fire regime have changed from infrequent low to moderate intensity surface fires to infrequent low, moderate and high intensity stand replacement fires.

Fuel Profiles within this Regime:

There are several distinct fuel profiles within this fire regime that characterize probable fire behavior expected.

Mature mixed conifer/lower elevations: generally reflects one of the most vulnerable fuel profiles to catastrophic wildfires as drier moisture sites and fire exclusion promote high intensity fire behavior. General fuel loads are between 15-25 tons/ac.(NFFL Fuel Model-6/10)

Mature mixed conifer/midslopes-mountain tops: Higher elevations experience longer return intervals due to differing moisture regimes and climate. Heavier fuels are common due to lengthened fire intervals. General fuel loads are 20-30 tons/ac.(NFFL Fuel Model-6/10)

Small timber/mixed conifer: Fire is carried in the litter layer with less residual fuels than mature timber. Brush in the understory is more common. Can include plantations over 20 years old. General fuel loads are 10-15 tons/ac. (NFFL Fuel Model-6/10)

Shrub Fields: Fire is carried by the litter from the brush overstory. Includes plantations 11-20 years old. Commonly found on south slopes with low residual woody surface fuels but dense horizontal and vertical fuel ladders. General fuel loads are 0-10 tons/ac. (NFFL Fuel Model-4/5)

Knobcone: Footprints of past high intensity wildfires that occur at long intervals dependent on fuel build-up within the stand. General fuel loads are 15-25 tons/ac. (NFFL Fuel Model-9)

<u>Grasses:</u> New plantations, some south aspect mature stands at lower elevations. General fuel loads are 0-10 tons/ac. (NFFL Fuel Model-2)

<u>Heavy Insect mortality/Blow down/fuel load areas:</u> Heavy residual fuels develop high intensity fires. Intermixed within other fuel profiles occasionally on large scales. Can include past harvest areas without hazard reduction work. General fuel loads are 25-45+ tons/ac.(NFFL Fuel Model-11/12)

Note: Fuel loads are residual woody material only. generally 40-50% of this tonnage is 10"+ material. Fuel loads may vary depending on specific site.

Risk/Hazard Assessment

It will be useful to stratify the focus area into such vegetation types within a single fire regime. This will enable a Risk and Hazard analysis to be determined by projecting expected fire behavior outcomes coupled with the past history of expected ignition starts. Fire Risk and Hazard assessments can provide insight from a landscape perspective as to potential areas of concern to focus attention on fuels management, fire protection and Vegetation Management issues. The Risk and Hazard rating for the Shotgun/Slate watershed is as follows:

Table 6. Risk Hazard Rating

Complex	Vegetation Description	% Federal Land	NFFL Fuel Model	Hazard Rating	Risk Rating
1 & 2	Mature Timber (MC)	87	6/10	H	M
3	Small timber/poles (MC)	05	6/10	H	M
4	Shrub field	03	5	M	M
5	Knobcone	01	9	M	M
6	Grasses	0	2	H	M
7	High Fuel Loads	04	11/12	H	M

1) Hazard Criteria: A matrix of slope, aspect, and fuel model. Ratings are based on flame height from fire behavior modeling:
   - Low: flame lengths of 4 feet or less
   - Moderate: flame lengths of 4 to 8 feet
   - High: Flame lengths of 8 feet or more
2) Risk Criteria: 20 year fire occurrence based on density zones within the watershed
   - Low - one fire every 20 or more years per thousand acres
   - Moderate - at least one fire expected in 11-20 years per thousand acres,
   - High - at least one fire expected per thousand acres per decade.

The result is an overall Risk rating of moderate and a Hazard rating of high.

Plant Species of Concern

Plant Populations of Concern

There are no federally listed threatened or endangered plant species known to occur in this watershed. Four plant species which are listed as Sensitive by the Forest Service occur in the watershed. Several other sensitive plants occur just outside the watershed boundaries. Old-growth associated plants, fungi, and lichens which occur within the range of the northern spotted owl may also occur in the watershed. Systematic surveying and monitoring has not been done for any of these species except for the sensitive plant Scott Mountain phacelia. Known information about the current status of sensitive plants and other plants, fungi, and lichens of concern is summarized below:

TES Plants of Riparian Habitats

There are no known populations of obligate riparian TES plant species in the watershed.

TES Plants of Rocky Habitats

The sensitive plant Cantelow's lewisia (*Lewisia cantelovii*) occurs on the watershed boundary near the confluence of Whitlow Creek and the Sacramento River, on private land in the Lamoine area. This plant, also known as cliff maids, occurs on steep, rocky, inaccessible, moss covered cliffs above creeks. The water regime is described as mesic, indicating a more moist, riparian moderated habitat than exists in much of the watershed. This population is the northernmost range of the plant. All other known populations are in the Sierras. It is not restricted to any particular rock substrate, and has been found on granite as well as serpentine.

TES Plants of Forested Habitats

Three sensitive plants of forested habitats which may be affected by human activities occur in the watershed. Two of these are limited to serpentine soils.

Serpentine endemics of forested habitats

Three relatively distinct serpentine assemblages occur in the watershed, although there are many areas of intermediate forms, relative to disturbance patterns, fire, etc.

1. PIJE-dominant: Characterized by widely spaced Jeffrey pine and incense cedar in the overstory, with live oak, huckleberry oak, buckbrush, and Idaho fescue in the understory on the most highly serpentinized peridotite soils. *Penstemon filiformis* may be found in this assemblage.

2. PIPO-mixed conifer: Typified by open mixed conifer overstory dominated by ponderosa pine or Douglas-fir, with incense cedar, black oak, live oak, huckleberry oak, coffeeberry, tanoak, and greenleaf manzanita in the understory. White fir begins to appear at about 3000 feet and red fir at 4500 feet. *Penstemon filiformis* may be found in this assemblage.

3. ABMAS-PIMO: Typified by open red fir overstory with scattered western white pine, mountain hemlock, and lodgepole pine, with pinemat manzanita, huckleberry oak, and bracken in the understory. The soils are deeper and more weathered but the tree spacing is still wider than on non-serpentine. *Phacelia dalesiana* may be found in this assemblage.

Penstemon filiformis, thread-leafed penstemon, is endemic to the Trinity ultramafic sheet and grows in sunny openings or meadows in montane mixed conifer forest at elevations between 2000 and 6000 feet. The greatest concentration of this plant on the forest occurs in this watershed. Large populations occur between Tamarack Lake and the south fork of Slate Creek. It is usually associated with Jeffrey pine on poor sites which do not support the best commercial timber stands.

Phacelia dalesiana, Scott Mountain phacelia, also endemic to the Trinity ultramafic sheet, grows in openings or dry meadows of montane mixed conifer forest at elevations from 5300 to 7000 feet. Most populations grow on nearly level ground. Experimental data from plots on the Shasta-Trinity NFs indicate that infrequent, light to moderate soil disturbance and the creation of small canopy openings benefits the species by creating favorable microsites for seedling establishment, so long as part of the parent population is retained as a seed source. This species often is found in old skid trails and unmaintained roads. Heavy soil disturbance, such as site preparation of plantations by tractor discing, destroys the plant. A thorough survey of suitable habitat was done in 1991 by the Shasta-Trinity NFs and partners. Large populations of the species occur in the analysis area, notably near Tamarack Lake and other high elevation sites in the watershed.

Non-serpentine sensitive plant species of forested habitats

Arctostaphylos klamathensis, Klamath manzanita, is a perennial woody shrub in the heath family. It was first discovered in 1982 at Terrace Lake, near Cedar Lake, in Siskiyou County. It occurs in openings in mountain chaparral and mixed red fir forest at elevations ranging from 5500 to 6500 feet, and is presently known from six populations, all in Siskiyou County. The southernmost end of its range is in this watershed analysis area, just south of Tamarack Lake. From there it ranges northwest to Scott Mountain and into the Klamath National Forest.

This species grows with two other species of manzanita, pinemat manzanita and greenleaf manzanita, and may hybridize with them. It has been observed vigorously colonizing roadcuts and logged forests, so it is likely that these disturbance events have had a positive effect on this species.

Survey and Manage species: plants, lichens, and fungi

The President's Forest Plan includes standards and guidelines intended to protect and enhance habitat for certain late-successional and old-growth forest related species throughout the range of the northern spotted owl. These species are listed in Table C-3 of Attachment A to the Record of Decision (ROD); these are commonly known as the "survey and manage" (or S&M) species.

The subset of these species known or potentially occurring here on the Shasta-Trinity NFs is published as Appendix R of the Shasta-Trinity Land Management Plan (LMP).

Four survey strategies apply to the survey and manage species. Each strategy has its own timetable for implementation:

- **Strategy 1** (manage known sites) applies to activities implemented in 1995.
- **Strategy 2** (survey prior to ground disturbing activities and manage sites) is phased in for certain salamanders, red tree voles, and lynx for all projects implemented in 1997; for species in other groups, strategy 2 will apply to activities implemented in 1999. Survey protocols are currently being developed for these species.

- **Strategy 3** (conduct extensive surveys and manage sites) surveys must be underway by 1996, but standardized survey protocols are yet to be developed.
- **Strategy 4** (general regional surveys) will be initiated in 1996 and are to be completed by 2006.

Vascular Plants

No records exist for any vascular plants on the Survey and Manage old-growth associates list. However, none of these species have been surveyed for. The following plants from the list could potentially occur in the watershed: *Allotropa virgata, Botrychium minganense, Botrychium montanum,* and *Cypripedium montanum* and *C. fasciculatum* (documented from several places nearby).

Survey strategies 1 and 2 apply to all S&M vascular plants. Project level surveys for these vascular plants must be part of National Environmental Policy Act (NEPA) documentation for any project that will be implemented in 1999.

Bryophytes (liverworts and mosses)

Old growth associated mosses and liverworts require unique microsites usually in pristine riparian areas with complex dense tree canopies and abundant leaning and down trees. Two liverworts which may occur in the watershed require site-specific surveys prior to projects implemented in 1999 or later. *Kurzia makinoana* is associated with stream terraces and floodplains at low elevations and wetlands in California, although it occurs in montane forests in its northern range. It occurs on well-shaded rotten wood. It is thought to be virtually decimated due to logging, road building, and other developments on non-federal land throughout most of its range. It may occur in the Shotgun, Slate, Flume, or Meers Creek drainages, or any of the other smaller tributaries of the Upper Sacramento River. *Ptilidium californicum* is a liverwort which grows on conifer bark and logs, preferring old-growth white fir at elevations around 5000 feet. It requires cool, moist conditions. It is most abundant on the Hoopa Indian Reservation in California. Suitable habitat may occur for this species in the higher elevations where montane springs and shaded streams occur.

The only moss from the survey and manage list which may occur in the watershed is *Scouleria marginata*. This species occurs on rocks in splash zones of streams, just above the level of mean summer flows. It needs clean water and cool temperatures. Excessive sedimentation is thought to contribute to its decline, along with removal of riparian forest canopy and the subsequent increase in water temperature. It often occurs with the more common *Scouleria aquatica*.

For bryophytes, survey strategies 1-4 apply, depending on individual species. Since we have no known sites at present, strategy 1 does not apply here. Extensive surveys for most of these species should be underway by 1996, and project level surveys for these nonvascular plants must be part of NEPA documentation for any project that will be implemented in 1999.

Fungi

Old-growth associated fungi are extremely important to maintaining nutrient cycling and the food chain of the forest. Truffles are fungi which do not erupt from the ground and complete their life cycle completely below ground. Several species of mammals which are prime food prey for the northern spotted owl may obtain up to 90% of their diet from truffles. These include the northern flying squirrel and the California red vole (also a Survey and Manage species). These fungi in turn rely upon rodents for spore dispersal. Many other fungi including those which fruit above ground, on rotting wood, old stumps, etc. are also ectomycorrhizal and are essential to forest health. An estimated 50 to 70% of net annual growth can be attributed to the contribution of ectomycorrhizal fungi. The uptake of nitrogen, phosphorus, and many other trace minerals is achieved through the fungi, which in return receive carbohydrates from the tree roots. The fungi produce antibiotics and provides protection to tree roots from harmful pathogens, while also mediating the effects of toxic metal concentrations in the soil. This is particularly important on ultramafic substrates, which are abundant in the watershed (at least half of the watershed).

The conservation strategy developed for old-growth associated species under the amended Land Management Plan requires that extensive surveys be underway for all fungi by 1996. No surveys have been conducted for any of these species in the watershed at the present time. Suitable habitat for fungi species can be identified from the vegetation map where older and potential old-growth stands of conifers occur in the watershed.

Approximately sixty different species of mycorrhizal fungi which are old-growth associated species could potentially occur in the watershed. All are associated with conifer species although some have also been found growing with tanoak, madrone, manzanita, and liveoak, especially those which also occur on the coast in wetter habitats. Of these species, twenty-one are hypogeous or semi-hypogeous (fruiting underground) species which are probable food plants for the prey base of the northern spotted owl.

Elevation ranges for these species range from old-growth low elevation to alpine. Those species which are dependent upon old-growth low elevation forest habitat are the most at risk and have been completely eliminated due to logging and development in most areas. One of these is *Balsamia nigra*, a rare truffle which is one of the few known to occur on serpentine. This species occurs in low elevation xeric mixed conifer forest with oak understory. Another group of fungi, *Phaeocollybia*, occur in moist, low-elevation, well developed late successional forest habitats, such as might be considered coastal relict situations.

There are no records of occurrences for any of these species from the Shotgun/Slate watershed. However, fifteen species of S&M fungi are documented from sites in the Mt. Shasta area; these should be considered possible residents of the Shotgun/Slate watershed:

Mt. Eddy region:

- *Gastrosuillus* sp. nov. (Trappe #7516)
- *Gautieria magnicellaris*
- *Rhizopogon abietis*
- *Rhizopogon brunneiniger*
- *Rhizopogon evadens* var. *subalpinus*
- *Rhizopogon flavofibrillosus*

Soda Creek, Sacramento River canyon:

- *Gyromitra esculenta*

Mt. Shasta, McCloud area:

- *Arcangeliella lactarioides*
- *Nivatogastrium nubigenum*
- *Sedecula pulvinata*
- *Thaxterogaster pingue*

- *Gyromitra montana*
- *Gyromitra infula*
- *Sarcosphaera eximia*
- *Cortinarius verrucisporus*

Another fifty mushrooms which may potentially occur in the watershed and are old-growth associates are saprobic and are integral for the decomposition of organic material. Some of these occupy unique niches such as in moss at the headwaters of high montane springs or seeps, or in the channels of intermittent streams (moss-dwelling mushroom, jelly mushroom, elfin saddle). All are considered to be in decline due to loss of habitat. Jelly mushroom (*Phlogiotis helvelloides*) occurs in riparian zones on calcarious soils (limestone). It has been located in the Trinity Alps and it may occur on limestone based drainages in the watershed.

In addition to conducting extensive surveys and managing known sites, to be underway by 1996, for all fungi, one species *Bondarzewia montana* also requires site specific surveys for any project implemented in 1999 or beyond. These are polypores (shelf or bracket) fungi and fruit during the rainy season, on dead or living conifers. They are considered a vital element in the recycling of organic matter.

Lichens

Preservation of unique microsite elements in old-growth stands is essential to the preservation of these species. One class of rare lichens (pin lichens) all occur in sheltered microsites with high atmospheric humidity provided by old-growth forest conditions. Several only occur in the canopy. Others may occur only on the underside of large leaning Douglas-fir trees. Some occur on smooth hardwoods such as canyon maple, others require the rough textured bark of conifers. Each species is substrate and texture specific. We have no information as to which of these species might occur in the watershed. The ROD required broad regional surveys for these species to be underway by 1996 and be completed in ten years.

Other lichens are old-growth riparian dependent species occurring as epiphytes in the canopy of hardwood species. *Collema nigrescens* is found most commonly on *Quercus garryana* (white oak), usually on the larger, older trees. *Ramalina thrausta* has been identified once in California (Mendocino County), but may occur in the watershed. *Usnea longissima* ranges from Alaska to northwest California in low to mid-elevation wet coniferous or mixed coniferous-hardwood forests and swamps. Broad regional surveys for these species should be underway by 1996 also, and are to be completed in ten years.

Hydrothyria venosa is a true aquatic lichen which is found on rocks in streams where it provides habitat for aquatic invertebrate populations, at low to mid elevations. It is a good indicator of water quality and constancy of stream flow levels. The strategy for this species is to conduct extensive surveys and manage known sites, to be underway by 1996.

Twenty species of nitrogen fixing lichens occur in the canopy of conifers and are associated with coastal disjunct species such as occur in riparian areas of the watershed where Pacific yew and flowering dogwood occur. The survey strategy for these species is to conduct broad regional surveys, beginning in 1996.

One rare forage lichen, *Bryoria tortuosa,* has been collected from Shasta County but is considered rare in California. Like other conifer canopy epiphytes, it requires the retention of groups of standing trees to maintain suitable microclimate and for dispersal of the species. It is a prime winter forage food for the northern flying squirrel, which is important prey for the northern spotted owl. The survey strategy for this species is to manage known sites and to conduct extensive surveys, underway by 1996.

Management strategies 1-4 apply for lichens. The majority of late-seral associated lichens are to be managed under survey strategy 4, which means that the surveys likely will be contracted at the regional or province level. Project level surveys for these species may not be needed unless known sites are discovered nearby.

Noxious weeds & other exotic pest plants

Non-native plants can be extremely injurious to healthy, diverse, functioning ecosystems. There has not been widespread encroachment of non-native plants in this watershed. Typically the introductions begin in the lower elevations and work their way up into the mountains. Many weedy species cannot tolerate the climate extremes and habitat restrictions such as ultramafic or serpentine soils that characterize the upper reaches of this watershed. However, along the roads leading into the watershed, *Hypericum perfoliatum* (Klamath weed) is becoming abundant in places. This species will eventually take over sites where it has colonized, forming a tough fibrous root system which prevents other plants from taking root.

Another species which has the potential to move up into the mountains is *Cytisus scoparius*, or Scotch broom. This is widespread along Interstate 5 around Dunsmuir and Castella and can be seen moving upslope from there.

Naturalized non-native blackberries (*Rubus discolor*, *R. laciniatus*) have moved into many of the lower elevation drainages in the watershed.

Other exotic plant species which occur in the watershed are mullein (*Verbascum thapsus*, yellow star thistle (*Centaurea solstitialis*), and cheatgrass (*Bromus tectorum*). These weed invasions are of minimal concern at the present time, but will increase over time relative to the quantity of disturbed soil available for colonization and the increasing seed bank.

Animal Populations of Concern

Within the Shotgun Slate watershed 10 amphibians, 110 birds, 59 mammals and 14 reptiles have been identified as being associated with the habitat and elevations of the area. Species distribution and local knowledge contributed to this species list. Wildlife Habitat Relationships (WHR) habitat types found within the watershed include ponderosa pine/Jeffrey Pine, Incense cedar, closed-cone pine (knobcone pine), mixed conifer (Douglas-fir, ponderosa pine), montane shrubland, montane riparian, riverine (Sacramento River and associated tributaries).

Documentation from known or potential sightings and nest locations and habitat/distribution models have indicated the existence of 35 species of special concern within the Shotgun/Slate watershed. Species of special concern are defined as those listed under the Federal and State Endangered Species Act (including proposed Category 1 & 2), the California Dept. of Fish and Game "Species of Special Concern" program, the U.S. Forest Service Sensitive Species program, the Neotropical Migratory Birds (NTMB) program, and the Record of Decision (ROD). Each species or group of species has specific management guidelines designed to prevent the species from being listed or bring the species back to healthy population recovery levels so de-listing may occur.

The following discussions will describe the current condition for TE&S species, Survey and Manage (S&M) species, Riparian and aquatic dependent species, Neotropical migratory birds, and general wildlife species.

Threatened, Endangered, and Sensitive Wildlife Species (TE&S)

The following TE&S animal species have been located within the watershed or would be expected to inhabit suitable habitat that exists within this analysis area.

Table 7. TE&S animal species within the watershed

Species	Status
Bald Eagle	Federally threatened
Northern Spotted Owl	Federally threatened
Northern Goshawk	Forest Service sensitive
Marten	Forest Service sensitive
Fisher	Forest Service sensitive
Willow Flycatcher	Forest Service sensitive

Bald Eagles

Bald eagles have been observed within the analysis area on an infrequent basis. These birds most likely reside at Shasta Lake and had roamed into the canyon in search of prey. Presently, there are no known bald eagle territories or nest sites in the area. Habitat for bald eagles in this area is considered marginal at best and it is unlikely they would inhabit the upper canyon area on a regular basis given the close proximity of the lakes. Bald eagles are not considered an issue.

Northern Spotted Owl

The Shasta-Trinity National Forests definition of suitable habitat is mature and older forest stands having multi-layered conditions, a canopy closure of 70 percent or more and displaying obvious decadence. The overstory should be comprised primarily of trees 21 inches dbh or larger, and should occupy at least 40 percent of the canopy. A multi-layered canopy that simultaneously provides cover while allowing for easy flying passage is preferred. Spotted owls nest in cavities that form in decadent or broken topped trees and snags. Their prey base of small mammals depends on the presence of snags and large down woody material.

From 1981 to 1992 approximately 65 percent of the watershed was surveyed to protocol. From 1981 to 1994 district biologists and private individuals have conducted unofficial surveys within 70 percent of the watershed.

Two spotted owl sites (MST8) are located within the Shotgun/Slate watershed, and are considered an activity centers. Site (FS #13) has a breeding pair of birds verified in 1981, 1983, and 1992. Site (FS # 17) has a territorial single verified in 1991, 1992. The amount of suitable habitat for these activity centers at 0.7 mi. radius is 310 acres. At the 1.3 mi. radius there is 466 acres of suitable habitat. Both radius levels are below the incidental take threshold.

Suitable nesting, roosting, and foraging (NRF) habitat requirements for old growth dependent species such as spotted owls are expected to be provided through LSR, MLSA, Unmapped LSRs, and Matrix 'old-growth' retention guidelines. Suitable NRF habitat in this watershed is fragmented, existing in approximately twenty-two percent of the capable Federal lands in the watershed. Dispersal habitat is expected to be provided through management of suitable nesting habitat, riparian reserves and 11-40.

Northern Goshawk

Goshawks are opportunist and are found in a variety of habitats, but they prefer mature, dense conifer and deciduous forests interspersed with meadows and other openings usually near a source of water. Snags, large logs, and dead-topped trees are used for observation and prey-plucking perches. Goshawks usually nest on north slopes, near water in the densest part of the stand. Suitable goshawk habitat is present in the area, but is fragmented and dispersed. Goshawks have been sighted through out the watershed and they appear to be a relatively common visitor. There are no known confirmed nest sites within the watershed analysis area.

Marten

Suitable habitat consists of various mixed conifer forests types under 4000' elevation, with more than forty percent crown closure with large trees and snags. Martens use tree cavities, snags, stumps, logs, burrows, caves, and rocky crevices for cover and den sites. Habitat with limited human use is important. Small clearing, meadows, and riparian areas provide forage habitat. This species is mostly carnivorous taking small mammals and birds, but insects, fruit and fish are also consumed. Riparian reserves containing riparian or forested habitat are important dispersal corridors.

There is a high concentration of marten sightings within the upper western side of the watershed. Within the watershed, marten sightings and tracks are widely documented. American Pine marten detection are more abundant than Pacific fisher. This may be a function of a larger marten population than fisher, more suitable habitat for marten than fisher, or of marten having less secretive habits than fisher.

Habitat for martens is expected to be provided through management for Northern spotted owl habitat, riparian reserves, old growth reserves, dead/down, green-tree retention and snag management in matrix lands.

Fisher

Suitable habitat for fishers consists of large areas of mature dense forest stands below 6000', with snags and canopy closure greater than fifty percent Fishers use cavities in large trees, snags, logs, rock areas and brush piles for cover and den sites. This species is largely carnivorous taking small mammals and birds. Riparian habitats are used as travel corridors and key habitat. Preferred road densities are less than 1 mile per section, with 1-2 miles per section acceptable for maintaining moderate habitat. Presently, road density averages about 2 miles per section within the watershed.

In 1992 fishers were reported in the North Fork Shotgun, Mears Creek and Flume Creek areas. These observations suggested that fisher were more widespread than previously thought and ranged elevationally with snowmelt. A 'no detection' does not indicate an absence, instead it is assumed that fisher still utilize the area, though possibly in low numbers.

Habitat for fisher is expected to be provided through management for Northern spotted owl habitat, riparian reserves, old growth reserves, dead/down, green-tree retention and snag management in matrix lands.

Willow Flycatcher

Suitable nesting habitat for willow flycatchers is considered dense stands of willows and other shrubs associated with riparian areas and large, open wet meadows, at 2,000 to 8,000'. Trees and shrubs with low branches are required for nesting. The nesting site is usually near water as wet areas provide a diversity of insects on which to feed. This species also eats berries and seeds.

The Shotgun Slate watershed area was not surveyed for willow flycatchers. Habitat for this species is found within the analysis area, but the species presence has not been confirmed. Other isolated riparian habitats may also support willow flycatcher, but their size and condition is unknown.

Survey and Manage Animals

Amphibians

The Shasta salamander is known to occur to within the analysis area and around Shasta Lake. This salamander requires limestone outcrops, fissures, and mouths of caves surrounded by Digger pine, Douglas fir, and oak forests. As there is limestone in this area, the presence of the Shasta salamander in extremely likely. Because of small population size, any loss of local populations can be detrimental to long term persistence of species. Over a third of the species range is on nonfederal lands, so risk is great that local populations may be lost. The species is on California's sensitive species list, and this may confer some protection on nonfederal lands.

Birds

There are no known great gray owl sightings for this area. This species is only suspected to occur within the Forest and has not been confirmed. This species generally inhabits high elevation meadows, and nests in large stem diameter snags.

Mollusks

Eighteen species of mollusks are listed as possibly occurring on the Shasta-Trinity National Forests. Specific habitat requirements and ranges of these species is not presently known. From the 1995 S&M database, no known sites occur within the watershed.

Arthropods

No information is known about these species, nor have surveys been conducted. General regional surveys will be conducted prior to 2006.

Bats

There are five bats listed as S&M species, and all five have been found to occur within the watershed. These are the fringed myotis bat, silver-haired bat, long-eared myotis, long-legged myotis, and the pallid bat. All five species use caves, mines, buildings, crevices, trees, and dense foliage near water for roosting and nursery colonies. Silver-haired, long-eared, and long-legged bats prefer older forests where loose bark, snags, hollow trees, or dense foliage are present. The fringed and pallid bats appear to be more closely associated with early seral stage and open forests.

As a result of the recent interest in bats, several surveys have been completed. In addition to the S&M bat species, other species of concern include the western mastiff bat, small-footed myotis, Yuma myotis, Townsends big eared bat, and spotted bat. These other species are all Federal Category 2.

Riparian and Aquatic Dependent Species

Forty eight of aquatic and/or riparian dependent species are believed to occur within the Shotgun Slate watershed or, suitable habitat is present for them. These include, but are not limited to Pacific giant salamander, tailed frog, northern red-legged frog, foothill yellow-legged frog, American dipper, northwestern pond turtle, great blue heron, tree swallow, yellow warbler, mink, otter, and western aquatic garter snake. Some of these species are listed as Federal Category 2 or are state species of concern. These will be addressed in greater detail.

Habitat requirements vary from intermittent standing water with varied amounts of vegetation and vegetation type to permanent, cool water, with instream cover surrounded by dense riparian vegetation. Habitat elements essential to the survival of these species include perennial water, cool temperatures, and cover/shade. The Standards and guidelines for the management of Riparian Reserves is expected to provide for these species. Possible conflicts with aquatic conservation strategy objectives affecting these species may occur due to the mixed ownership.

Cascades Frog (Federal Category 2)

Suitable habitat for the cascades frog is defined as slow, permanent bodies of water surrounded by a moist forested habitat with herbaceous plants for thermoregulation and escape cover. Cascades frogs are strongly tied to water. This species has been observed within tributaries of the Shotgun/Slate watershed. Species abundance is not known, but suitable habitat for this species is common in the area.

Tailed Frog (Federal Category 2)

Suitable habitat for tailed frogs is considered permanent, clear, cold water within a steep drainage, bordered by a dense, moist forest habitat. Riffles with small, clean cobble are important for larval stage stages. Species is endemic and broadly distributed within range of the northern spotted owl. About 57 percent of its range is on federal land; of this, 65 percent is within Congressionally Reserved Areas or Late-Successional Reserves. Tailed frogs have been detected in the Shotgun Slate watershed and falls within their natural distribution. Observations made during past stream inventories indicated presence within this watershed.

Foothill Yellow-legged Frog (Federal Category 2)

This frog is found in or near rocky streams with fast moving water. Exposed rocks are used for basking and feeding while submerged rocks and crevices are used for hiding. No known surveys for this species has been conducted in this area, however they have been found in streams within the headwaters of the Sacramento River above Siskiyou Lake. Habitat for this frog is abundant in this study area. Population viability is potentially at risk due to global warming. Conditions on nonfederal lands, especially riparian habitat protection measures, will affect population size.

Northern Red-legged Frog (Federal Category 2)

This watershed lies within the known distribution of this species, but no sightings have been recorded. This species inhabits quiet pools of streams, marshes, and occasionally ponds with cold, slow-moving or standing water. Extensive emergent vegetation is needed to provide cover, and to serve as a substrate for the deposition of egg masses. This species does best in streams and ponds that lack bullfrogs and non-native fishes. Suitable habitat for this species is probably available on a limited basis within this area.

Northwestern Pond Turtle (Federal Category 2)

The northwestern pond turtle needs a combination of aquatic, riparian and terrestrial habitats in close proximity in order to maintain population viability. Northwestern pond turtles are known to occur along the Sacramento River. Suitable habitat is present in this watershed and they are believed to occur in portions of the upper and lower Sacramento River.

Neotropical Migratory Birds (NTMB)

Eighteen NTMBs are suspected to occur within the riparian habitats of the Shotgun/Slate watershed. The riparian habitat along the river serves as breeding habitat and a migration corridor. Because of alteration to breeding habitat and increased exposure to predation and parasitism many of these populations have undergone significant declines in this watershed. Habitat preservation and restoration is the backbone of maintaining current populations of NTMBs. The general Forests standards and guidelines states that habitat is to be managed for Neotropical migrant birds to maintain viable population levels. Management of riparian reserves and snags will help preserve habitat. Following proper management of breeding habitat, exposure to predation and parasitism is expected to become significantly reduced in this area.

General Wildlife

Of the 194 species thought to occur in the watershed, 20 are game species. Some of these species include blue grouse, California quail, mountain quail, common snipe, band-tailed pigeon, mourning dove, snowshoe hare, black-tailed hare, gray squirrel, coyote, gray fox, black bear, and mule deer. A majority are considered common species and are found, within suitable habitat, throughout the watershed. Viability of these species is expected to be provided through special management direction for riparian areas, downed logs, snags, old-growth species, green-tree retention, hardwood retention, seral stage diversity management, forest health, and management plans for special land allocations. In addition to these management directions are special land allocations and individual species management plans.

Deer

A deer management plan for the Whiskeytown Subunit Deer Herd was established in 1983 by the California Dept. of Fish and Game, Region 1 in cooperation with U.S. Forest Service, U.S. Bureau of Land Management and the U.S. Park Service. This plan discusses population trends, suitable fawning habitat, and management for winter and summer range. Optimal summer range includes natural or man-made openings which include palatable grasses, forbs, and shrubs. Browse species maintained in age classes less than 20 years old and within 600 feet or less of hiding cover are preferred by deer. Suitable hiding cover is early-to-mature seral stands of shrub or trees with 60% or more canopy closure and 600 to 1200 feet wide. Thermal cover is similar, but preferred size is 2 to 5 acres with minimum width of 300 feet.

Summer range is found throughout the watershed in such areas as Chicken Hawk Hill, Rattlesnake Hill and Cold Springs. Naturally occurring shrub fields, or those created through clearcuts or fire before 1970, are now considered in a decadent state, i.e. over 20 years old. Shrubfields in this condition removes potentially suitable summer forage. Mast from the remaining oak stands also provides forage. Suppression of oaks in the understory and invasion of oak stands by white fir also contributes to the declining amount of summer forage in the watershed. Specific fawning areas have not been identified for the watershed. Preferred fawning habitat includes low shrubs or small trees from 2 to 6 ft tall under a tree overstory of approximately 50% canopy closure. Areas are usually 2 to 5 acres and located where vegetation is succulent and plentiful. Within the watershed, forested areas near moist riparian areas could be considered suitable habitat.

Bear

Bear sightings have been recorded throughout the watershed. Suitable habitat includes interspersion of conifer, riparian, oak woodland, and mast or berry-producing vegetation. Den sites include large snags, scare-faced trees or hollow logs, talus slopes, caves or mine shafts. Mature to Late seral conifer and oak woodland habitats are important for thermal and hiding cover. Riparian habitats are required for thermal and escape cover, and travel corridors. Bears feed primarily on acorns, berries, fruits, nuts, terrestrial invertebrates, and plants high in protein and low in cellulose.

The mature brush fields found within the watershed as well as the remaining oak stands and medium to large dead/down material all provide suitable foraging and denning habitat. The bear population is believed to be at healthy levels.

Fisheries

Within the Shotgun/Slate Watershed Analysis Area there are about 95 miles of fish bearing streams. There are 9 streams tributary to the Sacramento River that are known to sustain fish life. The largest and most important fish streams include the 22.6 mile of the Sacramento River, and the Slate Creek, Shotgun Creek, and Dog Creek drainages. The other streams are of varying importance to fish with the smaller tributary streams providing fish habitat only within their lower most reaches. Some of the smaller streams as well as the upper portions of the larger streams become intermittent during low flow conditions and only provide habitat on a seasonal basis.

There are no high mountain or alpine lakes located within this area. There are three small ponds located on private lands, however they are not known to contain fish. Their small size and shallow nature makes them marginal fish habitat at best.

Fish habitat condition for streams is dependent on stream size, flows, and availability of "deep" pools. The Sacramento River has an abundance of all three and provides excellent fish habitat. This river is extremely productive and contains many large fish. Prior to the Cantara Spill in 1991, the Sacramento River was managed by the California Dept. of Fish and Game (DFG) as a trophy trout fishery. Presently, the river is understocked due to the spill and is now in a recovery mode. The Dept. of Fish and Game estimates that currently trout numbers are half of the pre-spill levels, or about 4,400 trout per mile. Seasonal fishing is permitted in the section of river within the analysis area as well as the tributaries on a catch and release basis (zero fish limit). Fish habitat conditions for Slate Creek, Boulder Creek, Shotgun Creek, Mears Creek, and Dog Creek is regarded as fair. In general, these steams are dominated by riffle habitats and relatively steep gradients. Large, deep pools and large woody debris is limited or lacking. Cover in the form of riparian vegetation and large rock is abundant. Spawning habitat is restricted to pockets behind boulders and debris, and within those streams sections with flat gradients. Some bank erosion and failure is known to occur on some of these streams. The remaining streams such as Mosquito Creek, Flume Creek, Pollard Gulch, and the unnamed tributaries to the Sacramento River are regarded (in general) as providing poor fish habitat. These streams are limited by their smaller size, steeper gradients and limited flows. Some of these streams are intermittent and probably only provide spawning habitat during spring run-off. Water quality in general, is regarded as good to excellent for all streams within the analysis area.

Fish species found within the Shotgun/Slate Analysis area include rainbow trout, brown trout, Sacramento squawfish, Sacramento sucker, riffle sculpin, hardhead minnow, smallmouth bass, and spotted bass. Most of these species are found only in the Sacramento River or the lowermost reaches of larger tributary streams. The rainbow trout is the only fish species found throughout most of the streams in the analysis area. Table 8 is a list of fish bearing streams and the species they presently contain as well as miles of suitable habitat.

Table 8. List of fish bearing streams and the species they presently contain

Stream/Lake	Miles Fish Bearing	Fish Species Present*
Boulder Creek	3.8	RT
Tributary	1.2	RT
Tributary	2.0	RT
Dog Creek	7.6	RT,SSQ,RS
Cavanaugh Creek	1.4	RT
Lt. S. Fork	1.8	RT
Saylor Gulch	0.4	RT**
Flume Creek	5.0	RT
Tributary	0.6	RT
Tributary	0.4	RT**
Mears Creek	5.8	RT
Tributary	0.5	RT**
Tributary	0.8	RT**
Mosquito Creek	3.8	RT,RS,SSQ
Pollard Gulch	0.5	RT**
Sacramento River	22.6	RT,BN,RS,SSQ,SSU,HH,BA
Shotgun Creek	1.0	RT,RS,SSQ,HH
North Fork	4.6	RT,RS
Tributary	1.2	RT
Tributary	0.4	RT**
South Fork	5.0	RT
Tributary	0.8	RT
Slate Creek	11.8	RT,SSQ,SSU,RS
Lt. Slate	2.8	RT
North Fork Slate	3.4	RT
Tom Neal	1.8	RT
Tributary	1.7	RT
Tributary	0.6	RT**
Unnamed Stream	1.6	RT

**Fish Codes: RT=Rainbow Trout, BN=Brown Trout, HH=Hardhead Minnow, RS=Riffle Sculpin, SSQ=Sacramento Squawfish, SSU=Sacramento Sucker, BA=Spotted and Smallmouth Bass*

*** Seasonal use anticipated*

Geology, Soil and Water Resources

Physiographic Setting

The Shotgun-Slate Watershed drains a 104 square mile area west of the Sacramento River. The watershed is bordered on its eastern side by a 21 mile stretch of the Sacramento River. The watershed is composed of seven sub-basins and several small composite watersheds, all of which are tributary to the Sacramento River (see sub-basin map). The Shotgun-Slate Watershed accounts for 24 percent of the 425 square mile area drained by the Sacramento River at its confluence with Dog Creek. The Sacramento River drains a combination of rural, forested and urban lands above Box Canyon Dam and mostly forested land between Box Canyon and the community of Delta. Several small communities are located within the watershed along the western slopes of the Sacramento River.

The climate of the watershed is characterized by hot, dry summers and cool, wet winters. Annual precipitation ranges from approximately 65 inches in the Sacramento River Canyon to approximately 75 inches at Damnation Peak in the southwestern corner of the watershed. The majority of precipitation falls as rain between elevations of 2000-5000 feet and snow between elevations of 5000-7000 feet. Snow depths in late winter average from 0 inches on the Sacramento River Canyon floor to 5 feet on the western divide.

The Shotgun-Slate Watershed is drained by a dendritic channel network, with the exception of the middle reaches of Slate Creek and the lower reaches of Dog Creek which are drained by a pinnate channel network. Large tributaries to the Sacramento River located within the watershed include Flume, Mears, Shotgun, Boulder, Slate, Mosquito and Dog Creeks. Together these creeks drain 84 percent of the watershed area. The remainder of the watershed area consists of smaller composite drainages tributary to the Sacramento River. The watershed contains approximately 147 miles of perennial streams, 126 miles of intermittent streams and 253 miles of ephemeral streams. Ephemeral streams differ from intermittent streams in that they flow only in response to high intensity precipitation events or rapid snowmelt. The drainage density of the watershed is approximately 5 miles of stream per square mile. Drainage densities are uniform throughout the watershed.

0ther hydrologic features occurring in the watershed include springs, seeps and wet meadows. Wet meadows range in size from approximately 0.1 to 6 acres. In addition to the wet meadows, smaller saturated areas containing vegetation typically found within wet meadows occur on steep slopes adjacent to intermittent and perennial stream channels. Concentrations of springs and seeps are highest in the headwaters of Mears, Shotgun and Slate Creeks. Several small ponds occur in the watershed including one constructed pond located in the Shotgun Creek sub-basin.

Several small communities receive drinking water from the watershed including Delta, Vollmers, Lamoine, Pollard Flat, Sims and Highland Lakes. Stream surveys conducted during the early 1970's indicated that water was withdrawn from Flume, Mears and Shotgun Creeks for domestic use for residences. The water use data base needs to be updated to determine if water is currently being withdrawn from these and other creeks for domestic use. One hydroelectric/water diversion project is located in the Slate Creek sub-basin. Water is diverted from the South and Middle Forks of Slate Creek and used to generate power at the main station located downstream on the Middle Fork of Slate Creek.

Geology, Geomorphology and Erosion Processes

The Slate Creek Watershed Analysis area lies within the Klamath Mountain geomorphic province. Lithic constituents include: Serpentine, peridotite and gabbro of the Trinity ultramafic sheet; meta-basalt of the

Copley Greenstone formation; sandstone, shale, slate, or mudstone of the Bragdon formation; Mt. Shasta andesite lava flows; and glacial and alluvial deposits. Lithic contacts have tended to form the major geomorphic boundaries. Slate Creek for instance runs along the Trinity/Bragdon/Copley contact.

The extreme upper reaches of the northwest portion of the watershed were glaciated during Pleistocene time, but considerably less so than the Watershed Analysis areas of Headwaters and Upper Sacramento immediately to the north. At the northern boundary of the watershed glaciers carved cirques or concave erosional depressions along some of the north-facing slopes.

The eastern boundary of the watershed is geomorphically demarcated by the Sacramento River and its associated alluvial terraces. The larger terraces are for the most part occupied by various towns and other cultural features. Lava flows from Mt. Shasta at one time flowed down the Sacramento. These flows are visible along road cuts of I-5 and contrast sharply with the surrounding rock types.

Erosion has been most effective within the serpentine and peridotite rocks of the area, followed by the more resistant rocks of the Bragdon and Copely Greenstone formations. The most resistant rocks are the gabbros, which tend to stand out as topographic ridges along the western boundary of the watershed.

Mass wasting has played a dominant role in shaping the geomorphic features of the watershed. Dormant mass wasting features cover the entire analysis area. Both active and dormant mass wasting features have been identified. These include: Debris slides, rotational/translational landslides, earth flows and valley inner gorges. The debris type of landslide is most prevalent within the more resistant rock types found within the Bragdon/Copley formations. The rotational/translational type is most common within the serpentine/peridotite areas of the Trinity ultramafic sheet. Inner gorge areas along streams such as Shotgun or Slate Creeks demonstrate both types of landsliding.

Although landslides occur over the entire watershed, most tend to be dormant. Active landslides tend to be relatively small (~1,000 cubic yards; in contrast to the Upper Sacramento W.A. area to the north) and found mostly adjacent to stream courses. The latter are for the most part a consequence of past management activities triggered by large precipitation events. Some are presently contributing sediment directly into tributaries to the Sacramento such as Shotgun and Slate Creeks.

Construction in the 1980's associated with a hydroelectric project mentioned in the Physiographic section above, initiated activity of some heretofore dormant landslides on Slate Creek. Since this time remedial work has succeeded in stabilizing these slides.

Soils and Surface Erosional Processes

The soils of the Shotgun-Slate Watershed are composed of two main types: Those derived from intrusive igneous rocks and those derived from metamorphic rocks. There are also relatively small inclusions of soils weathered from alluvium, volcanic rocks and glacial till.

The glacial landforms and mountain tops of the northwestern portion of the watershed can be characterized by shallow to moderately deep soils that are very gravelly and exhibit little development. Their intrinsic productivity is considered low. The erosion hazard and compaction potential of these soils is low.

Soils of the Sacramento alluvial terraces and the canyon andesite flows are typically deep, very fine-textured and highly productive. Their erosion hazard is low and their potential for compaction damage is high.

Soils weathered from intrusive igneous rocks can be separated into two types: Those weathered from ultramafic rocks and those weathered from basic igneous rocks. Much of the watershed is underlain by soils weathered from ultramafic lithology. These soils exhibit varying degrees of magnesium toxicity (termed serpentinization). Soils that are highly serpentinized are essentially barren. Soils with a moderate serpentine effect are usually sparsely vegetated and support a limited number of plant species. Soils with a mild serpentine effect are somewhat sparsely vegetated and some plant species are excluded. Highly and moderately serpentinized soils are prone to landslides and surface erosion because of the unstable nature of the bedrock and because they are sparsely vegetated.

Soils derived from basic igneous rocks are found on mountain side slopes throughout the watershed. These lithologies have developed deep, highly productive soils. Surface erosion hazard on these soils is considered moderate and compaction potential is considered moderate to high.

Soils derived from meta-sedimentary rocks are also prevalent in the watershed, particularly on the steep slopes above the lower reaches of the Slate and Shotgun Canyons. The canyon slopes are typified by shallow, extremely gravelly unproductive soils. These slopes have low erosion hazard and a low potential for soil compaction. The soils found on slopes above the canyons are also of meta-sedimentary parent material. Soils found on less steep slopes are generally moderately deep with very gravelly surface soils and developed subsoils. Their potential productivity is high. The erosion hazard is estimated as moderate and they have a high potential for compaction damage.

Hydrology

Streamflow characteristics are relatively similar in each of the seven sub-basins draining into the Sacramento due to similarities in climate, soils and geologic parent materials. Streams draining the Klamath Mountains generally drain shallow, impermeable soils with limited water storage capacities. High flow events occur during the winter months when heavy rainfall saturates the soil profile, melts the existing snowpack or runs off the frozen ground.

Base Flows

Streamflow data for the Shotgun-Slate Watershed and vicinity are available from several U.S. Geological Survey gaging stations located along the Sacramento River. The gaging stations and the periods of record are listed below:

Table 9. Streamflow data and gaging station locations

Sacramento River Station	Period of Record
at Mt. Shasta	1960 to 1987
at Castella	1911 to 1917, 1920 to 1923
at Delta	1945 to Present
at Antlers	1911, 1920 to 1941

The Delta gage is conveniently located approximately 0.2 mile downstream of the confluence of the Sacramento River and Dog Creek near the southern most point of the Shotgun-Slate Watershed. Beginning in 1969 streamflow in the Sacramento River was influenced by flow regulation at Box Canyon Dam located 40 miles upstream, however the overall effects of flow regulation are very small (Upper Sacramento Watershed Analysis, 1996).

Base flows for the Sacramento River at the Mt. Shasta gage located 1/3 mile above Stink Creek, the Sacramento River at Delta, and the Sacramento River at Antler are shown in Table 10. Average flows are highest during the late winter months and lowest during the summer months. It is interesting to note that despite the larger drainage area at Antler, average monthly base flows at Antler between 1920-1941 were lower than base flows at Delta between 1945-1994 for 10 out of 12 months. These differences could be due to variations in annual precipitation, water use and streamflow measurement methods. These differences may be due to increased water yield resulting from extensive logging activities throughout the watershed.

Table 10. Average monthly base

Base Flows (cfs)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
at Mt. Shasta	103	304	215	346	357	413	447	574	290	101	62	79
at Delta	365	803	1307	1687	2180	2142	1979	1649	768	325	229	229
at Antlers	231	789	945	1157	2197	2120	2209	1413	672	252	173	178

(Flows at Mt. Shasta Gage regulated by Box Canyon Dam beginning in 1969.)

Base flows along portions of the South and Middle Forks of Slate Creek are affected by a hydroelectric project. The project is designed to divert a flow of 75 cfs from Slate Creek and a flow of 25 cfs from the South Fork of Slate Creek (Hudson, 19??) (On file at McCloud Ranger Station). The diverted water is returned to Slate Creek approximately 1.5 miles downstream of the diversion sites where it is used to generate hydroelectric power. Minimum instream flows of 6 and 12 cfs (April 1 - June 15) and 3 and 4 cfs (June 16 - March 30) are maintained in the South and Middle Forks, respectively.

Peak Flows

Peak flows have significantly impacted channel morphologies and water quality in the Shotgun-Slate Watershed. Peak flows occurring at greater than 25 year intervals have caused large floods in the Sacramento River Canyon. The Sacramento River runs through a narrow, confined canyon that bisects the center of the watershed. The canyon walls are steep and flood plain space is limited (DWR, 1964). Small communities such as Delta that are located on abandoned terraces of the Sacramento River Canyon are vulnerable to flooding.

Streamflow data provide the information needed to estimate peak flow events in the Shotgun-Slate Watershed. In order to determine the magnitude and return interval of peak flows, estimates of instantaneous peak stream flows for 2, 5, 10, 25, 50 and 100 year recurrence intervals were calculated for each of the seven sub-basins and the Shotgun-Slate Watershed according to Waananen and Crippen, 1977 (Table 11). Peak flow estimates also are provided for the entire area draining into the Sacramento River at the Delta gage (Waananen and Crippen, 1977). Of the seven tributaries to the Sacramento River the largest flows were predicted to occur within the Slate Creek sub-basin. It is interesting to note that the predicted 100 year maximum peak flow for the Sacramento River at Delta of 55,900 cfs is 20,000 cfs lower than the peak flow of the 1974 flood.

Table 11. Estimated instantaneous peak flows for the Sacramento River at Delta and tributaries

Sub-Basin	Square Miles	2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
Sac. at Delta	425	17,400	27,000	33,700	42,400	49,100	55,900
Shotgun Slate	104	5,800	9,800	13,800	18,900	25,600	31,400
Flume Creek	006.5	440	800	1,160	1,670	2,300	2,900
Mears Creek	008.2	550	990	1,440	2,060	2,800	3,500
Shotgun Creek	011.7	770	1,360	1,980	2,830	3,900	4,800
Boulder Creek	006.4	450	800	1,150	1,640	2,200	2,700
Slate Creek	031.4	2,000	3,470	4,930	6,870	9,300	11,500
Mosquito Creek	004.4	400	680	960	1,310	1,700	2,100
Dog Creek	018.2	1,370	2,300	3,240	4,420	5,900	7,100

Stream Channel Morphologies

The current morphology of stream channels in the Shotgun-Slate Watershed is a consequence of geologic and fluvial processes occurring over large time scales. Stream channel morphologies in each sub-basin are very much alike because the channels have formed in similar parent materials and climatic conditions. The following discussion summarizes channel types and the current condition of stream channels in the Shotgun-Slate Watershed. Basin and channel characteristics were derived from past stream surveys, aerial photo interpretation and field inspection. Stream surveys were completed on the lower and middle reaches of each of the seven tributaries with the exception of Boulder Creek between 1972 and 1980 and are on file at the McCloud Ranger District. In most cases the surveys do not include data on the headwater reaches of the streams.

Channel Types

Stream channels within the Shotgun-Slate Watershed can generally be classified as cascade or step-pool channels according to the channel classification system devised by Montgomery and Buffington, 1993. Cascade channels generally occur in the upper and middle reaches of streams that have channel gradients ranging from 10-30 percent. The upper reaches of the South and North Forks of Shotgun Creek and the headwater tributaries to Dog Creek such as Lunch Gulch and Wild Bill Gulch are examples of cascade channels. Channel substrates in high gradient reaches are dominated by boulders and stones. These substrates form numerous waterfalls averaging 2-6 feet in height. Small amounts of cobbles and gravels are also found among the larger substrates in low gradient reaches.

Cascade channels evolve into step-pool channels at lower elevations in the watershed. Step-pool channels have gradients ranging from 3-8 percent. The channel bed generally consists of cobbles, stones and boulders. As their name implies step-pool channels generally consist of an alternating pattern of pools and bedsteps. Both cascade and step-pool channels are located within steep, incised drainages.

The Sacramento River exhibits a pool-riffle channel morphology. The river follows a sinuous path through a confined canyon surrounded by steep uplands. The channel substrate generally consists of cobbles, stones and gravels. Woody debris is noticeably absent from the active channel due to the high peak flows which transport most woody debris through the watershed to Shasta Lake. The river canyon has been modified substantially by the construction of Interstate 5 and the railroad grade.

Riparian Vegetation

Riparian vegetation occurs along most perennial and intermittent streams, adjacent to springs and in wet meadows. Riparian vegetation has also been observed to a limited extent within swales and ephemeral channels in upland areas such as Mosquito Creek. Dominant riparian species include alder, willow, big leaf maple, dogwood and Indian rhubarb. Riparian vegetation functions to preserve channel and bank stability and provide shade to stream channels. The majority of shade is provided by conifer species growing adjacent to or within stream inner gorges. The amount of stream channel canopy cover varies throughout the watershed. Shade canopies are particularly dense along smaller streams such as Little Slate Creek. In contrast to Little Slate Creek, canopy cover is very limited along portions of lower Slate Creek.

Several populations of Port-Orford Cedar occur in the northern half of the watershed. Port-Orford Cedar occurs in narrow bands along stream channels and in wet upland areas adjacent to springs. Port Orford Cedar does not occur in the Mosquito or Dog Creek sub-basins in the southern half of the watershed.

Channel Stability

Stream channels in the Shotgun-Slate Watershed generally exhibit unstable morphologies due to the inherently unstable nature of the watershed. Most of the streams lie within steep canyons and inner gorges with side slopes ranging from 30-80 percent. Channel gradients average 5 percent in the lower reaches, 15-20 percent in the middle reaches and 12 percent in the upper reaches. Channel gradients in the middle reaches are typically around 20 percent but in some cases exceed 50 percent. Stream channels such as the North Fork of Shotgun Creek and Slate Creek exhibit braided and sinuous channel patterns in low gradient reaches.

Generally channel stability is fair in the lower and middle elevations and poor in the upper elevations. Prominent features of instability present in all tributaries include steep channel banks, moderate mass wasting, channel scour and deposition, and deposits of colluvial material derived from bank failures. High cut banks are apparent in the mid-elevation reaches of Slate and Mears Creeks within confined inner gorges. In areas where Slate Creek is not confined the channel approaches widths of 120 feet. Terraces are common along the middle and lower reaches of Slate Creek.

Geomorphic Controls

The principle controls of channel morphology in the watershed are peak flows and mass wasting activity. These two processes often occur simultaneously during large precipitation events. Rain-on-snow events are responsible for triggering the largest runoff events in the watershed. The watershed area between 4-6,000 feet serves as the source area of the largest amount of runoff during peak flow events. Low gradient stream channels located below 4,000 feet are most susceptible to peak flow impacts.

Peak flows impact channel morphology in all streams in the Shotgun-Slate Watershed by redistributing large quantities of fine sediment and channel bedload. The largest peak flow impacts to channel morphology occur along reaches located near the source of mass wasting activity and along low gradient reaches of tributaries to the Sacramento River. Precipitation accompanying the peak flows often serves as the triggering mechanism for debris flows which deposit large volumes of sediment into stream channels. Channels occurring in upland areas transport large quantities of sediment downstream to larger channels during peak flow events. The material carried by the high flows is deposited in low gradient (response) reaches found in the lower elevations of the watershed or in the Sacramento River. The finest sediments are transported through the watershed eventually settling in Shasta Lake.

In addition to transporting large quantities of bedload and suspended sediments peak flows often erode stream banks, cause channel aggradation or degradation and scour riparian vegetation along channel banks and floodplains throughout the channel network. Riparian vegetation may be buried beneath large quantities of bedload and fine sediments that settle out in low gradient reaches.

Water Quality

Water quality is good to excellent in all of the major tributaries to the Sacramento River in the Shotgun-Slate Watershed. Most impacts to water quality occur during the winter months when large precipitation events introduce sediment laden runoff to the creeks. These events are of short duration and have short term impacts to water quality. In the past water quality has been impacted by road construction adjacent to stream channels. For example, stream surveys conducted during the early 1970's found evidence of increased siltation in Flume Creek due to road construction occurring in the Flume Creek sub-watershed. Good water quality must be maintained to provide for beneficial uses of water within the watershed. Beneficial uses include safe drinking water for residences and cool, clear water for fisheries and recreational activities. No water quality data are available for tributaries to the Sacramento River however several water quality studies have been done on the Sacramento River and its tributaries upstream of the watershed including Bertoldi, 1973; Poeschel, et. al., 1986; and Dong and Tobin, 1971. These studies indicate that water quality is very good in the Sacramento River and its tributaries.

The location of the Sacramento River adjacent to Interstate 5, the railroad and the small communities makes it vulnerable to water quality impacts. One of the worst water quality disasters to occur in Northern California during the last century occurred on a reach of the Sacramento River located above the Shotgun-Slate Watershed. In July, 1991 a train derailed at the Cantara Loop above Dunsmuir. Large quantities of metam sodium solution from a chemical tank car were released into the Sacramento River (Cantara Spill 1996 Grant Proposal, 1996). The solution completely eradicated all aquatic life in the Sacramento River between the Cantara Loop and Shasta Lake. Following large scale restoration efforts the fisheries and vegetation have begun to recover but populations have not returned to that of pre-spill levels. Tributaries to the Sacramento River within the vicinity of the spill play an important role in the recovery of the river by providing new populations of riparian plants and fish to the spill impacted portions of the river.

Chapter 4 - Reference Conditions

Human Use:

Prehistoric - Before 1850

The Sacramento River and the mountainous areas west of the river were used prehistorically by Native Americans. Archaeological investigations along the Sacramento River at Pollard Flat, LaMoine, and Vollmers have dated Native American use along the River from 5300 before the present (BP) to historic times (Basgall and Hildebrandt 1989). More than 30 prehistoric sites are recorded along the ridgetops, meadows and drainages west of the Sacramento River. Two of the largest are located on the south slopes of Rattlesnake Hill and in the saddle below Damnation Peak.

Artifacts at the non-river prehistoric sites include groundstone, obsidian projectile points and a large variety of tools. These sites probably represent seasonal hunting and plant gathering camps.

The latest Native American inhabitants of the area were the upper Sacramento River Wintu, known as the "Nomtipom" (DuBois 1935). DuBois (1935:28) notes that during April/May through November the Nomtipom went into the hills westward for short periods and established temporary camps from which to gather various resources. There are 44 Wintu names for locales between Delta and Pollard Flat and points westward. These include villages, residences, and place names (McCarthy 1989:85). Among them are Mosquito Creek Ridge where an old trail was located and Damnation Peak which had spiritual significance as a doctoring place.

There were frequent contacts between the upper Sacramento Wintu and Trinity River Wintu according to DuBois (1935). The sites and use of trails along Mosquito Ridge and Slate Ridge may demonstrate this contact.

The Native population began to dwindle after the Gold Rush in 1849 when miners swarmed over their territory and brought murder, mayhem and more disease. In addition, mining threatened the salmon spawning gravels.

Early Historic - 1850-1940

When gold was discovered in California in 1849 and in Yreka in 1850 many miners came through the upper Sacramento River Canyon on a pack trail and quickly discovered the placer gold deposits in the canyon. By the mid-1850's two gold camps were established. One was called Dogtown in the vicinity of Dog Creek and the other at Portuguse Flat. Gold was also discovered at the headwaters of Dog Creek, possibly as early as 1856 (Frank and Chappell 1881:26). Teixeira (1996:4) reports that the Dog Creek District (aka: Delta District) was active at a later date as well - in the 1890's and early 1900's. The District was connected to the Southern Pacific Railroad by a 6-1/2 mile-long narrow gauge railroad.

Following the early gold mining, a wagon route and stage coach line was established by 1860. Many stage stops and inns appeared along the route. In the early 1860's John Vart built a 16 room hotel/saloon at Portuguese Flat (Smith 1991:119-121). Robert Pitt arrived in 1864 and took over the hotel and established a mercantile store and a feed stable. The California and Oregon Coast Line Stage Company established a "home station" at Slate Creek.

Later gold mining occurred in the Slate Creek Mining District, organized in 1887 (Slate Creek Mining District, Location Notices, Book 1). Most claims were placer gold claims but some were quartz or "hardrock" claims and a few were chromite claims.

By the 1880's many of these gold claims were nearly exhausted and the focus in the Sacramento River Canyon was as a thoroughfare. The Central Pacific Railroad built their line to Delta, the terminus by September 1, 1884 (1982:15). By July 1886 trains were running as far north as Hazel Creek.

The railroad served as a connecting link for mineral extraction in those early years and later as a link for shipments of lumber to the centers of commerce in Oregon and California. One of the largest operators was the LaMoine Lumber and Trading company established in 1900-1927. Another thoroughfare, the Delta Toll road was established in 1902 from Delta to the Trinity Center.

Later mineral extraction occurred in the watershed in the Shotgun Creek drainage with the extraction of chromite during WWI and WWII. The Depression years also saw small gold operators, as demonstrated by historic archaeological cabins and mines along the Sacramento River.

The Shasta National Forest also had a presence in the Canyon. By 1916 a fire tool cache was established at Lamoine and a guard station along Slate Creek. By 1936 there was a guard station at Pollard Flat.

Modern Historic - 1940 to present

Following the immense timber harvest in the Sacramento Canyon in the 1880's and the harvest in the Slate Creek drainages by LaMoine between 1900 and the Depression, timber harvest became a major activity in the 1940's to the present. The Sacramento River also became a focus for recreation such as fishing, hunting, and river rafting. Native American use of key areas in the watershed that have bear grass (such as Rattlesnake Hill), an important plant material for basket making, is seeing a comeback.

Transportation:

The Shotgun Slate watershed comprises a significant portion of the upper Sacramento sub-basin. The Sacramento River forms the watersheds eastern boundary, and the entire watershed is within in the canyon. The Sacramento River Canyon has presented a natural geographic "funnel" for human activities in both prehistoric and historic times which continues to this day. Though rugged and winding, it provides the most direct land corridor between the Sacramento Valley and extreme northern California, Oregon, and other parts of the Pacific Northwest.

The transportation system here began with foot trails and early trade routes used by the original native inhabitants. As efforts to extract natural resources from the area grew, so did the number, and extent, of roads, railroads, and flumes. At one point, there was over 8 miles of operating flume in the watershed, 90 various trestles, and 23 miles of railroad in the Slate Creek drainage alone.

The following chronology shows the development of the system between 1852 and present (information gathered with the help of Julie Cassidy and Jerry Harmon): 1852 First mention of developed pack trails in canyon.

1860 Wagon road extended to Red Bluff. This toll road built by Stone & Son.

Included 17 river crossings (Combination of ferries, fords, and bridges?), not to mention innumerable side drainage crossings.

1862 Wagon road basically unchanged until 1916 when it was improved to "modern" auto road standards as part of the "Pacific Highway".

1863 California and Oregon Railroad Co. survey potential railroad route along stage road.

1880 Wells Fargo running stageline in canyon.

1886 Railroad completed from Redding to Shasta Springs.

1887 First passenger train over the Siskiyous as the California-Oregon railroad "Shasta Route" is completed. Regular stagecoach service discontinued. Dunsmuir gradually becomes important service center for steam locomotives.

1889 Resorts such as Ney Springs, Shasta Springs, and Lower Soda Springs become popular "destination" vacation spots via the railroad.

1891 Reports of multiple fires destroying timber and mills in upper Sacramento River canyon.

1894 Map shows approximately 20 miles of wagon road in the watershed area.

1897 Railroad from Sisson to McCloud is completed.

1906 San Francisco earthquake and reconstruction stimulate lumber market, bringing increased logging activity to the state in general, and this watershed in particular.

1909 Delta Consolidated Mining Company commences operations, including construction of railroad facilities within the watershed.

1916 Canyon road upgraded for autos.

1917 Fire burns out the town of LaMoine and its lumber mill.

1927 Decline in lumber market precedes Great Depression; Pacific Highway State Route 99 in canyon is upgraded.

1940 Automobile roads have improved to the point where railroad-dependent resorts are on the decline.

1944 Shasta Dam completed.

1950 to the Present

During this period, the change in human transportation use patterns had basically occurred, with altering uses resulting in altered conditions. Because of the nature of the Southern Pacific mainline system through the canyon, railroad use wasn't eliminated, however the emphasis on motor vehicle usage drove the more or less continuous improvement of highways within the watershed.

1952 Highway 99 upgraded once again. Southern Pacific notified by California Dept. of Fish and Game that years of oil dumping in rail yard has begun to impact Sacramento River with leakage; several "oil wells" are established to pump the contaminants out for proper disposal.

1956 Dunsmuir in decline as a service center as railroad switches from steam to diesel locomotion.

1962 Freeway completed through Sacramento River Canyon.

1985 Delta fire burns alongside Interstate 5

1987-1993 Additional construction on Interstate 5 upgrades highway safety, and speed.

1991 Cantara Loop chemical spill.

Vegetation

Historic vegetation patterns can be described in three eras based on the extent of human use of this resource. These descriptions include what is now both private, state and federal lands.

Prior to about 1880 vegetation in this watershed was dominated by late seral stage stands of mixed conifers. Stand composition generally had greater percentages of Ponderosa/Jeffrey and Sugar pine. The understory of many stands was open with mostly low growing grasses and shrubs. Older mature stands were found on approximately 70 to 80 percent of the commercial forest lands. Mature stands made up 10 to 20 percent and seedlings/saplings and pole size stands on 10 percent or less. Stand densities were probably about equally divided with the N and G densities on north and east aspects and S & P densities on south and west aspects. Vegetation found in riparian areas and rocklands was probably similar to current conditions.

Between about 1880 and 1950 initial timber harvest significantly changed the vegetation pattern and composition. Many of the older mature stands were harvested during this era. Ponderosa/Jeffrey pine, sugar pine and Douglas fir were the preferred species for harvest. In most areas the preferred species were removed leaving sparse to poorly stocked stands of predominantly cedar, fir and poor quality pine with shrubs as the dominant vegetative cover. At the end of this era it is estimated that only 10 to 20 percent of the closed canopy mature and older mature stands remained. The percentage of the watershed in shrubfields was between 30 and 50 percent. 1944 and 52 aerial photography shows the watershed dominated by shrublands, sparse and poorly stocked mature and older mature stands and dense stands of saplings and pole size trees. Riparian vegetation was only slightly impacted due to construction of railroad grades along streamcourses.

After 1950 timber harvest continued but at a reduced rate from the previous era. Again the emphasis was on removal of older mature stands and regeneration of some of the sparse and poorly stocked stands. By the end of this era many of the dense sapling and pole size stands had grown to an early mature size. Some shrubfields, as well as older mature stands had been converted to early seral stage seedlings and saplings. Selective removal of mature trees from many stands maintained the high percentage of sparse and poorly stocked stands, but a lower percentage than at the end of the pervious era. Riparian vegetation had recovered from impacts during early railroad logging as many of these grades were abandoned. Additional road construction did remove minor amounts of riparian vegetation.

General trends have been a reduction in the percentage of older-mature and closed canopy stands and an increase in the percentage of mature size class and open canopy stands.

Table 12. Percent of Commercial Forest Lands by Size Class (National Forest System Lands only)

Size Class	Description	Pre-1880	1880-1950	1950-Present
4	Older Mature	70-80	30-40	07
3	Mature	10-20	30-40	83
1&2	Seedling/Sapling	10-20	30-40	10

Table 13. Percent of Commercial Forest Lands by Canopy Cover (National Forest System Lands only)

Canopy Class	Canopy Type	Pre-1880	1880-1950	1950-Present
G	Closed	30-40	10-20	06
N	Medium	20-30	10-20	35
S&P	Open	30-40	70-80	59

Fire and Fuels

Pre-settlement

Mixed conifer forest contain a variety of vegetation species that can as well have a variety of responses to disturbance from fire. Such forest types make up one of the more complex regimes to describe a natural fire response. Both Native American and lightning were sources of fire disturbance in mixed conifer and ponderosa pine forest Native Americans burned such forest regularly as indicated from recorded accounts (Lewis 1973). Research on fire modeling based on long term climatic data including lightning frequency suggests that much of the early fire history can be explained by lightning occurrence alone (Van Wagtendonk 1972). It appears likely that Native American Indian influence as an ignition source ended by the late 1800's. Pre-settlement fire histories in mixed conifer forest show a pattern of lengthening of fire return intervals with increasing elevation. The intensity of these fires was generally low due to fire frequency that kept residual fuel loading down and eliminated vertical fuel ladders and were more limited to surface fires. Typical return fire intervals for this fire regime before human disturbance was likely at 8-30 years depending on geographical features.

Historical

Human influences have affected the natural disturbance patterns thus altering the fire regime. What was once a short return interval, low intensity regime has developed into one of moderate to high intensity at infrequent intervals. Fire return intervals have been calculated using a dendrochronology study which shows a fire return interval between 10-20 years. It is evident from the large fire history maps available that human cause ignitions along the I-5 corridor was a prevalent source from the 1920’ to present. With suppression influence starting in the early 1900's we can now see very long intervals between fires that are generally large and stand replacement events.

Relevance to Vegetation Management Decisions

Large ecosystems maintained by surface fires such as ponderosa pine and drier mixed conifer types are a result of primary and secondary succession. These regimes contain persistent successional species that generally are shade intolerant and have developed adaptations to survive fire and maintain a constant or fluctuating population in response to disturbance. In the absence of fire beyond the normal return interval, these fire adapted species are replaced by late successional species that are predominantly shade tolerant thus the development of fuel ladders that alter fire behavior and effects. There are notable mechanisms that have altered and effected the "natural" regime characteristics in this watershed:

Logging - A high grade logging era between 1890 to 1920 changed the forest landscape dramatically with altered fuel profiles. An agency regulated logging Era can be seen from the 1920's to the 1970's with continued fuels build-ups and stand structure changes that have altered natural fire regimes.

Suppression - With the establishment of the Shasta National Forest in 1905 an Era of fire exclusion by fire suppression policies had a dramatic effect on the forest. Several phases are evident in suppression technology that have done an efficient job toward fire exclusion: 1905-1920's horse and mule era, 1930's motorized era, and 1950's the aircraft era. The 1970's began an intense effort in "Fuels Management" for hazard reduction work with limited effects.

Conclusion: Fire exclusion coupled with logging impacts have altered the current fire regime from a short interval, low intensity regime to one of moderate to high intensity at infrequent intervals. It appears that natural fire regimes may have been intact in the early 1800,s with fire intervals at 5-30 years supported by lightning cause and perhaps Native American influence. We now have on the average a 10-22 year fire return interval with extended periods of 70 years without significant fire disturbance.

Table 14. Trends Contributing toward Current Conditions

Year	Logging	Suppression	Condition of Fire Regime
pre-1800's		X	
1850		X	
1880		X	Lightly Altered
1890	X	X	
1905	X	X	Moderately Altered
1930	X	X	
1946	X	X	
1950	X	X	Highly Altered
1975	X	X	
Present	X	X	

Plants Species of Concern

Sensitive Plants

Although there have been no ecological studies to date of the four sensitive species which occur in the watershed, several generalizations can be made about the causes of their rarity which are shared by other sensitive plants occurring on the Shasta-Trinity National Forests. Distribution and abundance of rare plants in this watershed is likely to be primarily a function of the amount of suitable habitat available, the connectivity of habitat for dispersal and colonization, and losses of local populations from human activities, climatic fluctuations, and catastrophic environmental events such as floods, fire, volcanic eruptions, etc. Other factors which may contribute to rarity include the presence or absence of insect pollinators and dispersal agents such as birds, small mammals, etc. Impacts from human activities may be direct, as with road building, off-road recreational use of habitat, clear-cutting and plantation planting, or they may be indirect, such as the loss of pollinators or dispersal agents due to pesticide poisoning, increase in herbivory or predation due to herbivore population explosions, increase in disease vectors due to habitat degradation, global warming, etc.

Prehistoric

The Klamath Ranges today are well known for their complex geology, which has given rise to a wide range of diverse topography, minerals and soils, hydrology, climate, and biological diversity. From approximately 24 to 1.5 mya, the area was altered by major movement of the underlying continental plates, with pulses of uplift and massive volcanic activity. In addition to granite, the ultramafic and serpentinitic rock (once sea floor) and soil which underlies the whole region also occurs as discrete intruded bands or islands which give rise to unique floristic adaptations. Ultramafic soils are toxic at high concentrations to most plants, primarily due to an imbalance of the calcium/magnesium ratio, and also to the presence of heavy metals such as nickel, chromium, and cobalt. Plants which became adapted to survival on serpentine- -some growing directly on the rock substrate itself were limited by the amount of suitable substrate available. When this is combined with a narrow range of elevation tolerance, moisture regime, and the disconnected distribution of these islands of suitable habitat, a pattern of rarity is established. A continuum exists in the watershed between soils which are highly serpentinized and rocky, and more weathered soils with little or no serpentinization, with associated assemblages of plants. The more highly serpentinized areas contain habitat for plants which are restricted to serpentine, or "serpentine endemics

Another factor which has shaped the flora of this region was climatic. The last Ice Age, 2.4 million to 13,000 years ago, was marked by about 48 cold-warm climate cycles, most lasting about 40,000 years. This period was marked by cooler wetter seasons, during which the entire North American continent was covered by temperate coniferous and deciduous forest. Redwoods extended across California as far south as the Los Angeles basin. Many of the plant genera in the Klamath Ranges have their closest relatives either in the eastern United States, or in temperate Eurasia. Today, many of these plants have become isolated as relicts, with their closest living relatives on the east coast or in Asia.

The current epoch, the Holocene, is an interglacial period which has seen three periods of little ice ages but has been mostly characterized by increasing aridity. The climate of the Klamath province today corresponds to the Mediterranean regime, characterized by hot, dry summers, with the bulk of the precipitation (over 90%) falling in the winter and spring months. The associated vegetation reflects this climate regime. Naturally occurring fires helped shape the characteristics of the flora. Plant species in the region are adapted to a fall fire regime.

Arctostaphylos klamathensis may be a recent speciation of the evolutionarily active manzanita genus. Since there are only six known populations of the species, and only one in the watershed analysis area, it is possible that it is a relative newcomer to the watershed. The species was likely not as abundant in prehistoric times, since it appears to prefer light disturbance, and openings in the forest. The primeval forest would have been considerably more dense and shaded than is suitable for this species' survival. Much suitable but unoccupied habitat may indicate that this species was less abundant in prehistoric times than in the present.

Lewisia cantelovii is disjunct from the rest of its known population center which occurs in the Sierra Nevada Mountains. It is not known if the Lamoine population is a relict of a previous geologic period or if the population is the result of random dispersal factors (eg., birds). Much unoccupied suitable habitat occurs for this and other closely related *Lewisia* species, but no other populations of this species has been found. It is not known what the prehistoric distribution of this species may have been, but it is likely that it has not changed significantly. A related species, *Lewisia rediviva*, or bitteroot, was popular as a food plant with Native American tribes, and it was said that a burlap bag full of bitteroots could be traded for a horse. It is a possibility that other species of *Lewisia* also had food value for Native Americans, but this has not been documented.

Penstemon filiformis may have had a slightly different distribution in prehistoric times, but the numbers of populations were probably roughly the same. It would also have benefited from wildfire spreading quickly across its habitat, reducing competition and releasing minerals in the ash, and from animal trails and naturally occurring openings such as windthrow.

Phacelia dalesiana would have had a wider distribution than in the present, due to the presence of much more suitable habitat which has currently been logged, and due to the occurrence of natural wildfire. On serpentine soils, wide plant spacing ensures that there will not be heavy fuels build-up, and it is likely that fire spread quickly across those sites, leaving openings and lightly disturbed sites which could be quickly colonized by the phacelia. Other sources of light disturbance such as windthrow and animal trails would have provided suitable habitat for the species as well.

Early Historic - 1850-1940

It is not known if ***Arctostaphylos klamathensis*** occurred in the watershed during this period, but it is likely that logging off the old-growth forest was beneficial to this species by creating openings and reducing competition.

The increased fire frequency associated with human activities up until the modern era of fire suppression may also have been beneficial to this species.

Lewisia cantelovii may have had a wider distribution in this era due to the greater quantity of habitat provided by the canopy of old-growth forested areas in riparian areas containing steep cliffs suitable for this species. It is unlikely, however, that distribution varied significantly from the current era, since there is currently a large amount of suitable but unoccupied habitat available for this species.

Penstemon filiformis may have suffered some losses during this period of logging and road building, but the intensity and duration of disturbances probably created more habitat ultimately than was destroyed. Use of horses to skid logs, and the selective cutting practiced at that time probably was not too detrimental to the species. Sheep and cattle grazing, however, may have eliminated populations of this species where it occurs in grassy openings and dry meadows.

The heavy logging which took place in this period would have had little affect on ***Phacelia dalesiana***, since most of the logging was concentrated at the lower montane level in the mixed conifer zone. However, large numbers of sheep and cattle were grazed around the mountain lakes of this region, and it is possible that populations were completely extirpated by sheep and cattle grazing operations.

Modern historic - 1940 to present

Arctostaphylos klamathensis may be increasing at the present time as it moves outwards from population centers into suitable habitat created by logging and roads present in the watershed. On the other hand, it is possible that competition from related species will result in this species becoming less prevalent than in the past. No trends have been presently identified.

Lewisia cantelovii has likely not changed significantly in distribution or density during this era. One impact which is a possibility for this species is collection by plant enthusiasts. Lewisias are a favored rock garden plant and there are many collectors who specialize in this species. Since this is a rare plant, it is possible that this has had an impact on the distribution and abundance of this plant. No trends have been presently identified.

Phacelia dalesiana has been impacted more during this period than at any other time, due to the increase in road building and logging occurring in the higher elevations, into the red fir zone where this species occurs. This plant is able to colonize old skid trails and spur roads which receive limited amount of traffic, but cannot survive in areas where disturbance is intensive and of long duration, such as site preparation for plantations on clear-cuts. The modern era of high-technology fire suppression has probably had a negative impact to this species also, since it is unable to reproduce in stands which have a thick duff layer. Older plants have been observed to resprout after a cool ground fire, but the effects of a hot, stand-replacing fire on this plant have not been documented. No trends have been identified for this species at the present time.

Penstemon filiformis may have been distributed somewhat differently historically, but since this species prefers openings in the forest, and occurs on ultramafic soils which are not heavily timbered, it has probably not suffered negatively from timber harvest activities. Where it occurs on serpentine meadow systems, populations have probably increased during this period due to the reduction in grazing which has occurred in the last forty years. Road building and selective timber harvest on serpentine sites where this species occurs has probably created habitat for this species, offsetting incidental losses which may have occurred to its population numbers. Current population monitoring data indicate that this species is stable in this watershed. Fire suppression has probably had a negative impact on this species also. It can be assumed that all the natural vegetation in the watershed is adapted to periodic fire.

Survey and Manage (Old-growth Associated Species)

Prehistoric - Before 1850

It can be assumed that all old-growth associated species were much more widespread in this period than in the present era, since this was the dominant vegetation community occurring across the landscape. Abundant populations of old-growth associated vascular plants such as orchids and saprophytes, and lichens, mosses, and fungi occurred in the understory of giant conifers. The climate was more mesic, with cooler temperatures prevailing. Periodic fires burned slowly across the understory, helping to reduce competing understory shrub species, reducing duff build-up, releasing fertilizing mineral ash, and leaving fire scars on the resistant bases of the big tree conifer species which dominated the landscape. Fire intolerant species like white and red fir grew in a mosaic pattern relative to the frequency of the fire return interval. Stands of these species which grew in areas which did not attract lightening, and were able to survive to old-growth mature status, developed another set of associated assemblages.

Early historic - 1850 to 1940

Logging in this period began to reduce population numbers of these species. Conversion of suitable habitat to early successional stages, fragmentation of suitable habitat, and edge effects would have decreased population numbers as well as successful pollination and dispersal of seeds and spores. Changes in microclimate and precipitation due to logging activities will have had indirect effects on these species also, causing further declines in population health and viability.

Modern historic- -1940 to present

The continued decline and fragmentation of old-growth habitat which started in the early historic period has continued to the present time. In addition to habitat conversion to early successional stages, modern fire suppression has also impacted old-growth associated species. Late-seral stage forests are somewhat immune to devastating fires, due to the resistance of big trees like Douglas-fir and ponderosa pine to fire effects, and the steady fire return intervals which served to keep the understory relatively clear of large build-ups of combustible fuels and competing vegetation. In addition, periodic slow, cool fires in the understory helped to promote certain types of fungi and other complex plant associations which were tied to mineral (ash) release, soil and duff health, as well as reducing canopy from competing vegetation in the understory of the big trees.

Noxious Weeds and Other Exotic Pest Plants

Prehistoric - Before 1850

Virtually no non-native plants will have been present in the watershed during this period, since "native" is generally defined as whatever was here before European settlement.

Early Historic - 1850 to 1940

Some exotic plants began to arrive during this period, primarily from the introduction of livestock to the area from grazing, and from pasture plants introduced in the valley which migrated up into the watershed. Most of these are European meadow or pasture grasses such as blue grass and timothy grass. Klamath weed probably arrived sometime in the 1940's in this watershed. European species of blackberries were introduced into the watershed during this period and quickly became naturalized.

Modern Historic - 1940 to present

Weeds continue to move up into the watershed from the valley, primarily through disturbance and the introduction of seeds from vehicles and heavy equipment, as well as via natural dispersal mechanisms, and from planting of non-native invasive plants for landscaping purposes. Scotch broom (***Cytisus scoparius***) was initially planted along Interstate 5 by CalTrans and is also widely planted by landowners. It has the potential to be extremely invasive and represents a genuine threat to native plant diversity. It is presently moving upslope from the I-5 corridor. Klamath weed, ***Hypericum perfoliatum***, occurs on disturbed sites along roads at the lower elevations of the watershed. It is another invasive perennial which eventually dominates sites where it becomes established. The banks of the Upper Sacramento and other regions of tributary creeks in the lower reaches are frequently infested with a variety of non-native weedy annual species, relative to the degree of disturbance from recreation, logging, road and railroad building activities, etc. Naturalized non-native blackberries are continuing to spread, thriving on disturbed riparian corridors and sprouting strongly after fire.

Other weedy or exotic plant species which have appeared in the watershed in recent times include mullein (***Verbascum thapsus***), cheat grass (***Bromus tectorum***), and yellow star thistle (***Centaurea solstitialis***).

Animal Species of Concern

Pre-1850

No historic records regarding wildlife population estimates, densities, or distribution are known to exist for the Shot-Gun Slate watershed. Wildlife use of the area, species composition and population trend information are inferred based upon habitat changes over time, known human influences upon the watershed, and some relatively recent wildlife sightings. Many wildlife species that we are familiar with today were present during this time. In addition, this area probably supported populations of large predators such as grizzly bears and wolves not found in California today.

Species that form large herds (deer and elk), were far roaming (black bear and mountain lion), or were restricted to special habitats (cavity nesters) were in greater numbers due to large expanses of habitat that was unencumbered by roads, settlements, or the mosaic of land use practices of the European settlers. Native Americans observed how natural fire improved forage for many wildlife species that they depended upon. Periodic fires encouraged the growth of forage, resulting in healthy herds of deer and elk.

Late successional and old growth forests, and their dependent species were much more abundant. Marten, fisher, goshawk, and spotted owl ranged widely over the area and were not restricted to isolated patches or riparian areas. Hardwoods were probable less common than today. Mast-dependent species such as gray squirrels, band-tailed pigeons, and quail would have been less abundant.

1850-1940

Wildlife populations requiring special habitats and those sought after for recreational or commercial use began declining with the increased accessibility and settlement in the watershed and surrounding areas. Wildlife that was considered dangerous or was perceived as a threat became the target of eradication programs that proved to be successful in eliminating species such as wolves and grizzly bears. As a result of land alteration and introductions, some species such as starlings, coyotes, and raccoons proliferated.

In 1886 the railroad from Redding to Sims was completed which opened up the area to timber harvest, settlement, and increased recreation. As timber harvest activities increased large stands of old growth timber were harvested and burned. Old growth dependent wildlife populations declined with the fragmentation and elimination of their habitat. Cavity nesters were also negatively affected when snags were harvested, removed or burned. Aquatic wildlife species declined as streams and riparian areas were damaged by sedimentation, fires, and logging practices. Logging activity peaked in the late 1920 and then became dormant until the later half of the century. Shrubs were allowed to revegetate the once forested lands so that by the early 1930s much of the area around the watershed analyses area was considered as unproductive brush fields. This condition was exacerbated by several large fires that had swept through portions of the area in recent years. Shrub dependent species such as mountain quail, bushtit, towhees, and chipmunks became abundant. While the brush was young other wildlife (deer and bear) would have taken advantage of the increased forage and the brush would have provided habitat for small to medium mammals and birds which serve as the prey base for aerial foragers such as hawks, owls and eagles. As the brush became decadent, its value to wildlife would decrease and eventually the brush would become a problem as wildlife would no longer be able to move through it.

Though grazing occurred in this area it was relatively small in scope and was scattered. Much of the grazing was concentrated around the meadows and other natural openings associated with lakes, springs and streams. These areas are not abundant in this watershed. The negative affects as a result of this activity was isolated and usually small having little permanent effect on the meadows and riparian areas.

Recreational use also negatively affected native wildlife populations. Amphibians were negatively impacted when streams and alpine lakes were stocked with non-native fishes. Riparian dependent species (warblers, herons) were affected when streamside habitats and meadows were used for camping and grazing of pack animals. Populations of generalist wildlife (raccoons, coyotes, crows) and those species capable of scavenging and adapting to the presence of humans, increased. Game species, predators and furbearers declined in abundance as they were hunted and trapped.

1940-Present

Some wildlife populations requiring special habitats and sought after for recreational or commercial use continued to decline (cavity nesters, furbearers) while others stabilized or improved (deer, bear, quail). Logging activity came out of its dormancy and peaked again during the 1950s and 1960s. Roads were developed to the point that railroad use to the area declined. Roads increased the use of the area for timber as well as recreation which caused further fragmentation of forest habitats. Those species (goshawks) that were dependent on mature forests declined in abundance as access to timber and harvest technology improved. This improved technology also improved fire suppression and reforestation techniques which help improve conditions for many other wildlife species in the long-run. Fire suppression, a vigorous reforestation program, and natural recovery changed the brush fields of the 1930s into a productive young forest so that today the Sacramento River canyon is dominated by trees. Hardwoods have become more abundant and the riparian habitats have recovered significantly. This has helped improve conditions for wildlife species dependent on mid-seral stage forests, mast producing trees and riparian corridors.

The completion of the freeway in 1962 brought about additional problems for the areas wildlife. With the freeway came further human disturbance, loss of habitat, noise, chemical spills, and air pollution. The freeway also served as a physical barrier to some species and for others, annual mortality increased sharply due to road kills. Problems related to the freeway will only grow worse as freeway use continues to increase.

Fisheries:

Pre-1880

Prior to 1880, the native fish assemblage within the Upper Sacramento River was largely intact and was used by the local Native Americans as an important source of food. Early white settlers began to inhabit the area in the mid and late 1800s. These early settlers also used the fish as an important food source. Large runs of Chinook salmon and steelhead ascended the river during this time and provided an important source of protein for Native Americans and settlers alike. Coho salmon were also present in the river, but in much smaller numbers. Records that specifically mention fish or fishing are very general in nature, but they do mention a large type of "trout" caught on a regular basis. This was likely the rainbow trout which was common. Moyle (1976) states that the rainbow trout as well as the Sacramento sucker and Sacramento squawfish were important food sources to the Native Americans and early pioneers. Hardhead minnow, which can become quite large, were also used as a food source. The sucker, squawfish, and hardhead minnow were common river inhabitants. Other fish species believed to occur in the river during this time were speckled dace, California roach, and riffle sculpins. These fish probably were not important dietary staples. By 1879, American shad had become established in the Sacramento River System, but where most likely uncommon in the upper river.

This early use had little impact on the river or on local fish populations as fishing, logging, and grazing were small in scope and were associated primarily with homesteading and native American use. This was soon due to change as the area was becoming settled and the fish hatcheries at Mt. Shasta (Sisson) and Bard had been completed.

1880-1940

Major changes to the fishery and aquatic habitat began taking place after 1880. Timber harvest was beginning in earnest and with the completion of the railroad through the Sacramento River canyon, timber harvest became more feasible and profitable. The increased human activity in the area brought with it an increase in fires. Several large fires burned significant portions of the watershed destroying timber and resulting in watershed degradation. Grazing in this area appears to have been confined largely to the ridges and meadows within the headwaters of Mears, Shotgun and Slate Creeks. The effects of this activity during this time are not documented, but most likely had some adverse effects on the upper streams reaches. Poor grazing practices have been shown to result in loss of bank stability, erosion, damage to riparian vegetation and other problems. Mining was a significant activity throughout much of the watershed. All of the streams with in the area were placer mined for gold at one time or another. Because mining was so widespread, the cumulative effects were potentially dramatic. Bank erosion, habitat simplification, loss of riparian vegetation and decreased food production for fish would have been some of the negative impacts. Logging activities which peaked for this time period during the late 1920s were responsible for much of the resource damage that occurred to the fisheries. Records indicate that much of the timberlands in the river canyon had been converted to brush fields by the early 1930s. Though fires were also responsible for some of this change, logging certainly had an impact. The effects of logging and fires would have included the loss of riparian habitat, reduction in shade canopy, increased peak flows, increases in water temperature, loss of bank stability, increased sedimentation, channel alterations, loss of aquatic habitat and reduced productivity of aquatic food organisms. These impacts on the aquatic environment would have resulted in habitat degradation and a reduction in fish populations. These effects would have been most apparent on the tributary streams, but certainly the effects on the Sacramento River would have been obvious.

The establishment of the Sisson hatchery and the hatchery at Baird on the McCloud River signaled the beginning of fisheries management in northern California. These hatcheries were originally used to collect and hold salmon and steelhead eggs which were shipped nationwide, but eventually the emphasis shifted to the rearing of trout and salmon for stocking onto local waters (Fish and Game Commission, 1910 and 1914). This brought about the introduction of exotic fish species which had an effect on local native fish populations. The first recorded release of hatchery fish into the upper Sacramento River occurred in 1911 with the release of an unidentified trout species. Since then brown trout, brook trout, cutthroat trout, and non-indigenous rainbow trout were stocked into local waters on a regular basis. The introduction of exotic fish and a regular stocking program had a profound effect on local native fish populations. Competition, predation and diseases have changed the areas local aquatic ecology and were major causes of population declines in native fishes.

In the early 1900s salmon were extremely abundant and easily caught, this coupled with their high palatability made then a favorite food item. This opened the way for a commercial fisheries that in the beginning seemed boundless, but, after a couple of decades of over-fishing and habitat destruction the runs of salmon in the Sacramento River were greatly reduced.

1940-Present

The completion of Shasta Dam in 1943 brought the runs of salmon and steelhead in the upper Sacramento River to a halt. The dam effectively blocked access to approximately 110 miles of spawning habitat on the upper river drainage. The elimination of the anadromous fish runs changed the ecology of the area by removing an important food source, by altering fish community structure, and by genetically "isolating" the rainbow trout as steelhead no longer had assess to the upper river. The loss of this spawning habitat set the stage for further declines in the rivers salmon populations. Even though salmon runs had declined to this point, the run size was still much larger than what occurs today.

The completion of the dam and the creation of Shasta Lake brought about the development of a warm water lake fisheries which has adversely affected native fish populations even more. From the lake, spotted and smallmouth bass have moved into the river and prey on young native fish species and compete with the older ones. It is probable that other fish such as channel catfish also move into the river to feed. Like the bass, adult channel cats are highly predaceous on other fish.

Logging activities which had been dormant since the depression sharply increased during the 50s and 60s. This increased logging resulted in adverse impacts to the aquatic environment and associated fish populations which had been slowly recovering from the previous timber harvests and fires. This renewed activity would affect the fisheries in the same way, but the cumulative effects would have been greater as the fisheries had not recovered from the previous impacts. Pool filling, lateral channel scour, channel aggradation and simplification, and the reduction in the production of fish food organisms had profound impacts on the aquatic habitat and on resident fish populations. Again these effects would be the most obvious on the tributary streams. As environmental awareness increased during this time, the effects on the habitat were diminished, to where fish habitat in the Sacramento River is presently in very good condition.

The floods of 1964 and 1974 were major flow events for this drainage. Slate Creek in particular was hard hit by the 1974 flood. This area still has not recovered and the effects are very evident to this day. These floods have resulted in the reduction of pools and cover and have caused significant changes in the larger stream channels. The effects of these floods were probably compounded by the increased peak flows that were a result of land management activities.

Pollution and litter were to become serious problems in this area even prior to the completion of the highway. In 1952 years of oil dumping in the rail yard at Dunsmuir by Southern Pacific lead to a "clean up" order from the Department of Fish & Game. Oil was beginning to seep into the river and was having an effect on the fisheries. Chemical spills associated with the railroad and eventually the highway have continued to plague the rivers fisheries since that time. In 1991 a major chemical spill at the Cantara loop resulted in the elimination of all aquatic life in the upper Sacramento River below the spill site. Presently, the fisheries is slowly recovering from the effects of the spill, but complete recovery will take decades.

Geology, Soil and Water Resources

Prehistoric Conditions - Before 1850

Natural Processes

Natural processes that control channel and hillslope morphologies in the Shotgun-Slate Watershed today are nearly identical to those that occurred prior to European settlement. Natural processes such as mass wasting and peak flows have been affected by land-use activities that commenced following European settlement of the Sacramento River Basin. Natural processes occurring in the Shotgun-Slate Watershed are similar to the processes that controlled hillslope and channel morphologies in the Upper Sacramento and Headwaters Watersheds to the north (see Upper Sacramento Watershed Analysis, 1996; Headwaters Watershed Analysis, 1995).

Large scale geologic processes responsible for forming mountain and channel morphologies in the watershed include the uplift of the Klamath Mountains and the Pleistocene glaciations. The Klamath Mountains have been continuously eroded by a combination of glacial activity, mass wasting and fluvial processes. The frequency and magnitude of these processes was largely influenced by changing weather patterns, or more specifically cyclical variations in precipitation and temperature. The extent of glacial activity in the Shotgun-Slate Watershed was much less than in the neighboring watersheds to the north.

Glacial activity was mostly confined to the north facing slopes and ridgetops in the northwestern portion of the watershed.

Changes to channel and hillslope morphologies occurring over the last 10,000 years are mainly the result of peak flow and mass wasting processes. These processes occurred more frequently at shorter time intervals than the processes mentioned previously. Peak flows and mass wasting often occurred simultaneously in response to large precipitation events.

In contrast to the gradual uplift of the Klamath Mountains, changes in channel morphology in the Sacramento River Canyon may have occurred instantaneously as a result of catastrophic volcanic eruptions from Mount Shasta. Geologic records indicate that lava flows from Mt. Shasta flowed down the Sacramento River Canyon. Some of these flows may have melted large quantities of snow and caused flooding and mudflows within the canyon. These flows probably eradicated most of the flora and fauna in the canyon.

The majority of mass wasting features found in the Shotgun-Slate Watershed are a consequence of the natural processes mentioned above. About ninety-percent of these features are presently dormant. Mass wasting served as the mechanism responsible for the downslope movement of sediment in the watershed. Mass wasting processes were particularly active between contacts of differing lithologies and in the inner gorges of the major streams. These locations have been and will continue to be high hazard areas for mass wasting activity. Common mass wasting features occurring before and after European settlement include debris slides and torrents, and rotational and translational landslides.

Peak flows and bank full flows (occurring approximately once every 1.5 years) were the dominant control of channel morphologies within the watershed. Peak flows were responsible for the movement and redistribution of sediments within the channel network. The natural instability of hillslopes and inner gorges and the steep channel gradients facilitated the transport of large amounts of hillslope materials, channel bedload and suspended sediments through the watershed during peak flow events. Large floods occurring at intervals of 25 years or more significantly impacted channel morphologies within the watershed. Impacts to water quality from these peak flows were probably limited to the duration of high flow events.

Historic Conditions - 1850-1996

Land-use Activities

The introduction of land-use activities following European settlement affected natural processes and conditions within the watershed. Land-use activities that impacted hillslopes and stream channels included mining, timber harvest, road and railway construction, fire suppression, grazing, water diversion and the establishment of permanent settlements in the Sacramento River Canyon. Of the processes mentioned above timber harvest and road construction had the most significant impacts to stream channels and hillslopes in the watershed. A summary of how each of these activities affected mass wasting, hydrology, channel condition and water quality is presented on the next page.

Mining activity has occurred within the Shotgun-Slate Watershed from 1850 to the present. The majority of the mining operations were active at the turn of the century. Mineral commodities that were mined or known to occur in the watershed included gold, chromite, asbestos and molybdenum. Only one small molybdenum mine was known to exist in the Boulder Creek sub-basin. Sand and gravel deposits also were present in the larger drainages.

The location of mineral deposits in the watershed varied according to differences in geologic parent material in the northern and southern portions of the watershed. Chromite and asbestos deposits were prevalent in the ultramafic rocks located north of Slate Creek. Gold and sulfide bearing quartz vein deposits occurred south of Slate Creek within the Copley Greenstone in the historic Dog Creek District (Teixeira, 1996).

Placer mining began in the watershed in the mid-1800's. Historical accounts indicate that prospectors searched for gold in almost every stream channel in the Sacramento River Canyon. By the turn of the century numerous gold mines were operating in the headwaters of Dog Creek including the Delta Advanced Consolidated Mine, Trinity Advance Consolidated Mine, Siskiyou Mine, Nightingale Mine and Rickard Mine. These mines and others were located within the Dog Creek Mining District and were active in the late 1890's and early 1900's. During this period placer mining occurred in Dog Creek and in the Sacramento River with the majority of the activity concentrated downstream of the small community of Gibson (Teixeira, 1996). Historical accounts indicate that some hydraulic mining occurred in the Pollard Flat area. The exact location and extent of the hydraulic mining operation is not known.

Several asbestos mines occurred in the Mears and Boulder Creek sub-basins. Asbestos mines including the Stock Asbestos Claims, Sylvester Asbestos Deposit, and the Blas Corporation Asbestos Claims were active during the 1940's and 50's. Mining of asbestos became unprofitable in the 1960s due to increased awareness of health problems associated with asbestos (Teixeira, 1996).

During WWI, WWII and the Korean War the federal government paid a price premium for domestic ore which made the small chromite deposits in the watershed economical to mine. Two chromite mines were active during these periods in the Shotgun Creek sub-basin (Teixeira, 1996). These mines were not nearly as productive as those in the Upper Sacramento Watershed to the North (Upper Sacramento Watershed Analysis, 1996).

The overall mineral resource potential for the Shotgun-Slate Watershed is low. Currently only 17 placer mining claims occur in the watershed. These claims are located along the Sacramento River between Gibson and Delta, Slate Creek between Incline and Dam Gulch, and Dog Creek upstream from Cavanaugh Canyon. All claims are placer claims and are probably located for gold and worked by use of suction dredges (Teixeira, 1996). For additional information regarding mining activities refer to Teixeira, 1996, "Mining History and Mineral Potential, Shotgun-Slate Watershed Analysis" on file at the McCloud Ranger Station.

Impacts to water quality from mining activities undoubtedly occurred during the early 1900s. Lingering impacts to water quality may be present in the form of acid mine drainage in the headwaters of Dog Creek where numerous mining operations were concentrated. Other impacts related to placer mining have been obscured by subsequent high flows and stream channel recovery.

Timber harvest began in the watershed in the late 1880's. Very little ground was left untouched by harvest activities. Along with timber harvest came the development of roads, railways and settlements. Historical documentation attests to the incredible amount of activity that took place in the watershed during the early 1900's. For example, most of the Slate Creek sub-basin was logged by the LaMoine Lumber & Trading Company between 1900-1923. Logging at similar intensities also took place in other parts of the watershed during the early 1900's.

Large scale logging contributed to active mass wasting. The removal of large amounts of vegetation and the roading of hillslopes resulted in hillslope destabilization and stream sedimentation. An analysis of aerial photos taken in 1944 shows the imprudent incidence of logging and roading along creeks.

Landslides along major creeks such as Slate and Shotgun, all of a common age, are likely the result of both direct and indirect effects of the major logging efforts that were undertaken in the early 1900's.

Timber harvest activities and road construction occurring adjacent to stream channels impacted the channels by removing riparian vegetation and shade trees, raising water temperatures and destabilizing inner gorges and stream banks. This in turn led to channel widening and aggradation, loss of pool habitat and a deficit of woody debris needed for channel stabilization and fish habitat. These impacts were most pronounced in tributaries to the Sacramento River. Old stumps present within the active channel of streams such as the South Fork of Shotgun Creek testify to the harvesting of timber in riparian areas.

Road and railway construction accompanied timber harvest activities throughout the watershed. Impacts to stream channels and hillslopes from the development of these transportation networks were equally, if not more significant than those of timber harvest. Railroad grades occurred in the Sacramento River Canyon, Dog, and Slate Creek drainages. Large trestle bridges were constructed over many of the larger streams in the Slate Creek sub-basin. In addition to roads and railways, flumes and log chutes were also constructed to transport lumber to the mills (Roy and Braun, 1992).

Roads altered the timing and amount of runoff to stream channels by intercepting groundwater flow and providing additional pathways for surface runoff. Flood peaks increased as a result of the increased efficiency with which storm runoff was routed to stream channels. The direct impacts of road construction were sometimes severe. Large quantities of sediment were sidecast into stream channels during the construction of roads adjacent to stream courses. Road construction activities often degraded water quality and fish habitat for the duration of construction. Impacts to water quality were reduced following stabilization of road beds however many roads continued to be chronic sources of fine sediments to stream channels.

The construction of Interstate 5 and the railroad affected water quality and increased the potential risk of water quality impacts in the Sacramento River Canyon. In addition to altering the morphology of the river canyon these transportation corridors resulted in impacts to water quality in the form of chemical spills, stormwater runoff containing oil and gas residues and stream sedimentation from road cut failures.

Grazing occurred at the upper elevations of the Shotgun-Slate Watershed from the early 1900's until approximately 1980. Grazing activities were concentrated around the high elevation meadows in the headwaters of Mears, Shotgun and Slate Creeks. Currently there are no grazing allotments in the watershed. Conditions in riparian meadows have improved following the closure of grazing activities in the 1980's. Impacts to the wet meadows from grazing included bank erosion, trampling of riparian vegetation and increased nutrient inputs to streams. Grazing activity was relatively limited in scope, however wet meadows were probably impacted by grazing activity due to the tendency of cattle to concentrate near available water sources.

Water use for domestic purposes and for hydroelectric power altered the hydrology of several streams within the watershed. Road and pipeline construction in the 1980's associated with a hydroelectric project initiated activity of some dormant landslides on Slate Creek. Remedial work has succeeded in stabilizing these. With the exception of the Slate Creek diversions and some minor flow regulation at Box Canyon Dam, other land-use activities have had little affect on base flows in the watershed.

Urban development within the watershed along with the transportation corridor within the Sacramento River Canyon brought about profound changes to the terraces adjacent to the river. Water quality was undoubtedly impacted by the urbanization. Other effects from urbanization included an increase in surface runoff from urbanized areas and travel corridors and significant restructuring of terraces and hillslopes along the river for highway and railroad grades. Impacts to water quality included urban runoff, trash and litter disposal, discharge of mill and sewage effluent, chemical and oil spills and the increased incidence of mass wasting along travel corridors. Air quality was also affected by vehicle exhaust and wood burning stoves. Impacts associated with small communities in the Sacramento River have lessened considerably from the early 1900's due to a decline in mining, logging and population decreases in historic towns such as LaMoine and Delta.

Flood History

Streamflow data from two gaging stations were used to develop a peak flow history for the Sacramento River from 1920 to 1995. Streamflow data from the Sacramento River at Antler and the Sacramento River at Delta are displayed on the next page. Peak flow events with daily mean maximum flows greater than 24,000 cfs occurred in water years 1940, 1956, 1965, 1974, 1978, 1986 and most recently 1995. Historical records indicate that large floods also occurred in 1915 and 1941, with the 1941 flood cresting within a foot of the record flood of 1940. These flood events were sometimes very localized in nature. For example, during the March 1915 event 8.64 inches of rain fell at Lamoine in a 4 hour period. This event caused widespread flood damage within the Sacramento River Canyon from Lamoine downstream to the town of Kennet now beneath Shasta Lake.

Knowledge of the magnitude and frequency of peak flows makes it possible to determine the frequency at which significant changes to stream channel morphologies occur. The largest impacts to channel morphologies are believed to have occurred during peak flow events occurring at 25 year intervals or greater. The largest flood for the period of record at Delta occurred in 1974. The instantaneous discharge at the Delta gage peaked at 69,800 cfs on January 16th, 1974 (Note that the discharges depicted in Figure 1 represent daily mean maximum flows as opposed to the instantaneous peak flows displayed in Table 2). The 74' Flood caused widespread damage to small communities located along the Sacramento River and to many stream channels throughout the watershed. Although the instantaneous discharge of the 1940 flood is unknown it is likely that the flood also produced similar damage throughout the watershed.

Comparison of streamflow data from Mt. Shasta and Delta with estimated peak flows for the watershed suggest that the 1974 and 1940 floods approximate 30-100 year peak flows for the Shotgun-Slate Watershed. Smaller flows occurring at intervals of 10-25 years also play a significant role in shaping channel morphology due to the higher frequency at which they occur. The magnitude of floods has been changed by land-use activities in the watershed. No quantifiable data is available but it is likely that peak flows have increased in the watershed due to the development of the road system.

Chapter 5 - Synthesis and Interpretation

Human Use

The focus of human use in the watershed is still within the Sacramento River corridor and along Highway 5. However, the focus is on recreation rather than mining and timber extraction. The river draws innumerable fisherman to the few public accesses along the River such as Pollard Flat and below Delta. The most popular stretch of white water during the spring runoff for rafts and kayaks is the Sims to Gibson or LaMoine stretch.

Resource extraction to the west of the river is largely conducted by individual firewood cutters and some Forest Service timber sales.

Transportation:

In recent times, roads and trails created by and for early mining activities promoted accessibility to resources such as timber along the canyon. With the catastrophic fire in San Francisco at the turn of the century, and the general boom in growth in California, the demand for wood and wood products greatly increased. The large timber stands adjacent to the Sacramento River canyon were very tempting, and relatively easy targets. The need for roads and railroads to transport products to the various markets developed rapidly. In addition, the position of the river canyon relative to the Pacific Northwest and the Pacific Southwest resulted in a strong need to develop regional transportation facilities through the area, especially railroads at the turn of the century. The river along this section has the greatest drop in elevation of any river of comparable length in America. The railroad grade from Redding to Dunsmuir runs about 2% within the canyon, and raised serious engineering challenges. The discovery and subsequent exploitation of large mineral deposits within the area, known by then as the "Copper Belt", further drove a steady improvement and expansion roads and railroad facilities within the watershed. Many of the original railroad spurs, and all the small railroads that existed in the past are now gone, with only Southern Pacific Railroad's mainline still operating within the canyon.

An extensive road system was developed within the watershed to support logging activities. Most of this system is still useable, and is being used regularly for recreational purposes and some management activities, including fire control. Minimal road maintenance occurs within these areas, and the quality of the roads, in terms of safe speed and types of vehicles that can use them, is declining.

The demand for commerce between the Pacific Northwest and the Pacific Southwest served to drive the construction of first Highway 99, and then Interstate 5 in part through the Sacramento River canyon. Since World War Two the highway has been steadily upgraded to higher standards in speed, driver comfort, and safety. It is reasonable to forecast such actions will continue in the future.

Vegetation

Probably the single most significant event that influenced the change in vegetation patterns in this watershed was completion of the Southern Pacific Railroad through the Sacramento River Canyon north of Redding, California in 1890. This rail-line provided reliable transportation for movement of people and resources both into and out of the region. Within several years of its completion, several high production sawmills were constructed in the area.

Prior to 1880 changes in vegetation patterns for this watershed were almost completely due to natural disturbance. Lightning fires, floods, wind, insects and diseases were the common influencing agents. Native Americans may have also contributed to some changes by the use of fire to improve habitat for game species of wildlife and edible plants. Lightning fires were probably the greatest factor in changes to vegetation patterns and structure. Most of these fires were low intensity, removing shrubs and reproduction. Occasionally a large stand replacing event would impact 100 to 500 acres.

About 1900 large production sawmills were constructed and operated near the Lamoine area on Slate Creek. These mills employed upwards of 200 people and produced 100 to 120 thousand board feet of lumber daily. The mills were supported by over 20 miles of railroad in the Slate Creek and adjoining drainages. Several geared steam engines and 6 to 8 steam donkeys operated to supply these mills with logs. These mills operated to the mid 1920's and removed as much as 20 to 24 million board feet of logs annual from this watershed. Silvicultural practices during this time were to remove all desirable size and species of trees, mainly large diameter ponderosa/Jeffrey and sugar pine, leaving the area poorly stocked with trees and a heavy undergrowth of shrubs. It can be speculated that the heavy slash and shrubs combined with wood fired steam boilers for engines caused many of the historic wildland fire patterns that can be discerned today.

In 1927 approximately 20,000 acres of cut over lands in the Slate Creek Drainage owned by the Lamoine Lumber Company were acquired by the Federal Government under the General Exchange Act of 1922.

Many of the private lands in the watershed were logged during the late 1940's to mid 1950's. Selection harvest was used over large areas, removing large diameter trees. Starting in the 1960's timber harvest was again active on National Forest System lands. Road systems were constructed and various types of selection harvest were used. This resulted in reduced stand densities and removal of more older-mature size trees. Species composition in mixed conifer types was changed to more shade tolerant species such as fir and cedar. Between 1970 and 1979, approximately 28 MMBF of timber was removed from this watershed.

Starting in the 1980's, clearcutting became the popular silvicultural method on National Forest System lands. Almost all the current conifer tree plantations were created during this time. Between 1980 and 1989, approximately 42 MMBF of timber was removed From National Forest System lands within this watershed.

From 1990 to the present there have been approximately 12 MMBF of timber removal from National Forest System lands within this watershed.

Key Question Discussion: Timber products from this watershed will come from private and Federal lands designated for that purpose. On the Federal lands that will be those lands in prescriptions 3, 6 and 8 as designated in the Forest Land and Resource Management Plan. Primary goals and treatments are:

1. Ensure existing plantations become established at required stocking levels and have a mix of species representative of natural stands in the general area. Treatments include release, interplanting and precommercial thinning.

2. Maintain stocking levels that obtain optimum tree growth and minimize mortality. Treatments are commercial thinning, uneven age management, salvage /sanitation and regeneration harvest (including site clearing and planting).

3. Restore previously forested lands that have converted to shrublands as a result of wildland fires or other natural disturbances. Treatments will be site clearing and tree planting. Depending on market conditions, knobcone pine stands could be treated with a regeneration harvest.

Over the next four decades a combination of the above treatments should create overall vegetation conditions that increase the percent of commercial forest lands in the mature and moderate to closed canopy size/density and reduce the percent of these lands in the mature and open canopy size/density. Old growth and late-successional forests will be found in lands designated to prescriptions 2, 7, and 9.

Port-Orford Cedar in this watershed is exclusively associated with perennial streams and spring areas. Riparian reserve widths for these streams offer the greatest protection to POC from the root disease. Currently most roads crossing perennial streams on National Forest System lands have structures (culverts and bridges) that minimize the probably of this disease spores entering the stream.

Steam cleaning of any commercial equipment used on National Forest System lands is required, however, most traffic using roads in this watershed are privately owned recreational vehicles.

Fire/Fuels

Watershed Overview

The current condition of the Shotgun/Slate watershed reflects a transition from a short return interval, low intensity surface fire regime to one of moderate to high intensity stand replacement fires and infrequent intervals. There are several mechanisms that have contributed to this condition. Of primary contribution is undoubtedly the exclusion of fire as a recurring disturbance in a historical fire dependent ecosystem. Fire exclusion as well as other contributing factors such as past harvest activities have cumulatively altered fuel profiles thus altering fire behavior and their effects upon shifts in species, diversity, stand health, and promotion of late succession forest. Such causal mechanisms have developed overstocking not found under pre-settlement conditions and a transition towards fire intolerant species in a once fire tolerant ecosystem. Results of this is characterized by vertical fuel ladders and horizontal fuel continuity that encourage stand replacement fire behavior. Most affected by this are the lower and mid elevations where fire return intervals were typically shorter but now as a result of the absence of perhaps three to four fire cycles reflect moderate to high fuel profiles. Higher elevations have been affected only moderately where recurring fires had longer intervals although described within a like regime. A primary change in the vegetation complex in this watershed is the encroachment of brush in the understory. The development and maintenance of a forest relatively free of crown fire potential is primarily dependent on the management of the structure of the crown fuels. Topography and weather, The other "legs" of the fire behavior triangle are either fixed or uncontrollable. Therefore the efforts to reduce crown fire behavior should be focused on stand structure conditions that promote this behavior as well as surface fuel conditions that contribute to intensities that allow it. It is these elements within the fuel profile coupled with high risk from the I-5 corridor that places the watershed at risk to stand replacement fires.

Table 15. Fire Return Intervals

LMP Desired Condition	Current Condition	Causal Mechanism	Trend
MA-9: Forest stand densities are managed to maintain forest health recognizing the natural role of fire. (LMP 4-118)	Overstocking vertical fuel ladders, heavy brush encroachment.	Fire exclusion, past harvesting practices.	Continued stand density. Continued development of stands that support replacement fires.

Plant species of concern

Threatened, Endangered, and Sensitive Plants (TES)

TES plants of rocky habitats

No trends have been identified for Cantelow's cliff maids. The single population at Whitlow Creek appears to be healthy and under no immediate threat. It is not known whether or not the population was extant in pre-historic times, and its reasons for rarity have not been identified. Suitable but presently unoccupied habitat occurs throughout the Sacramento River canyon and tributaries.

TES plants of forested habitats

Serpentine soils

The two ultramafic endemic species which occur in the watershed, *Phacelia dalesiana* and *Penstemon filiformis,* have similar habitat requirements and often occur together. Both occur on xeric serpentine sites with low competition from associated plants, in sunny openings, frequently on sites which have been disturbed within the last ten years but subsequently have been left alone, and often with some moderating shade (up to 30% canopy is optimal). Their populations have probably contracted and expanded during modern times, both declining in response to direct habitat alteration and expanding in response to renewal of suitable habitat from tree cutting and road building. The net response is probably neutral.

Reasons for rarity for these species seems to be related primarily to their substrate and the amount of suitable habitat available. Also, suppression of fire in serpentine habitats can lead to shrub or tree canopies sufficiently dense to shade out these plants. Both are limited to the Trinity ultramafic sheet. *Penstemon filiformis* ranges widely between the elevations of 1400 and 6000 feet, with over 90% of populations occurring between 5000 and 6000 feet. *Phacelia dalesiana* occurs only between elevations of 5000 and 7000 feet. There have been no studies of the reproductive biology of these plants which would determine their reproductive rate, pollinators, dispersal agents, etc. and help to define other factors which might contribute to the rarity of these species.

A preliminary study (S-T NFs 1991) of disturbance factors relating to *Phacelia dalesiana* has validated the positive response to limited disturbance which observers have reported for this species. There are presently no trends which indicate that either species is in decline at this time.

Non-serpentine

Klamath manzanita appears to be a relatively stable species which is increasing in the watershed in response to an increase in suitable habitat due to road building, logging, and other human caused disturbance events. The species itself is not thought to be a recent hybrid (Edwards 1985). It was probably always rare, not competing as well as the more common *Arctostaphylos* species such as pinemat manzanita and greenleaf manzanita.

Survey and Manage species: plants, fungi, and lichens

Vascular Plants

There are no known populations of the list of vascular plants from Table C-3 in the ROD. However, *Cypripedium californicum* is known to occur in the watershed, and it is possible that *C. montanum* or *C. fasciculatum* occur in the watershed also. Other vascular plants which may occur include *Allotropa* *virgata*, *Botrychium minganese*, and *B. montanum*. *Allotropa virgata* has been located within three miles of Flume Ridge, just outside the watershed boundary.

Dysfunctional elements in their habitats include degraded habitat, loss of closed canopy, lack of advanced decay woody debris, and crowded understory and competition from small diameter younger tree species. The complex elements of mycorrhizal associations that these species require before they appear in the ecosystem may take a century or more to build up, depending upon the climate and growth rate of the forest.

Bryophytes (liverworts and mosses)

Loss of canopy and loss of decaying woody debris are the primary causes of declining populations of old-growth associated liverworts and mosses. Many of these species require pristine conditions such as would have existed around lower elevation springs and seeps during pre-historic times. Grazing livestock, recreational use of springs and seeps, and alteration of historic hydrologic flows and patterns from logging and associated activities have all contributed to habitat losses for this group of species. Higher elevation ephemeral streams and their associated springs and seeps are the most likely to contain remnants of suitable habitat for old-growth associated bryophytes at this time.

Fungi

All old-growth associated fungi are experiencing a declining trend due to the removal and fragmentation of their habitats by logging, development of private land, recreation, and associated activities such as road building. Loss of canopy, loss of woody debris, and soil disturbance are the fundamental reasons why these species are in decline. These elements and processes are all interlinked with forest health, biodiversity, and the food chain.

Canopy fundamentally affects the microclimate of the forest through moderation of temperature, humidity, light spectrum, and the flow and impact of precipitation and air movement. It supplies coarse and fine woody debris which provide fast and slow nutrient release, as well as substrate, food, and shelter for many species of microfauna (arthropods) and mollusks. This in turn supplies the food and shelter base for higher animals such as salamanders, birds, and ultimately small and large mammals and birds of prey. Canopy loss from logging is also associated with the attendant loss of a continuous supply of standing dead or dying snag trees, and large down logs, which provide food and shelter for a host of species.

Soil disturbance, especially when combined with canopy loss, is extremely detrimental to the healthy forest biocycle. Removal of duff, cover, stirring the soil or overturning it and exposing it to the sun results in the death of bacteria which are sensitive to ultraviolet light. These bacteria are at the very bottom of the food chain, providing nitrogen to mycorrhizal fungi. Forest nutrient recycling begins here. In addition, removal of shade and duff, and turning the soil results in a loss of water and the ability to hold it. Erosion potential is also increased. On unstable soils and those which have a calcium-magnesium imbalance (ultramafic soils), the mediating effect of organic matter and mycorrhizal fungi is removed, resulting in a sterile soil with slower recovery time (or recovery may not be achieved at all).

Lichens

As noted in Chapter 3, Current Conditions, preservation of unique microsite elements in old-growth stands is essential to the preservation of these species. Loss of canopy, loss of aggregations of old-growth conifers and hardwoods in suitable habitat, loss of all classes of woody debris and especially complex structures of large standing, leaning, and down logs, and fragmentation of dispersal mechanisms have all contributed to habitat loss for this group of species.

Exotic pest plants and noxious weeds

A survey of exotic pest plant invasions in the watershed has not been undertaken to date. However, there is a trend towards increasing invasion and loss of native plant diversity throughout wild ecosystems on this continent. The brooms are especially invasive and increase after fire. Their establishment along the freeway in the Dunsmuir area indicates that they will continue to move up and down the I-5 corridor and upslope. Portions of northern Oregon have been invaded with these species to the complete exclusion of native plants in some areas. Exotic blackberries have completely overtaken areas alongside several creeks in the area. The trend for these weeds is continued invasion and spread. Other exotic species appear to be relatively stable; however, it is likely that these species will increase over time as the seed source grows in size, and available habitats open up from road usage, recreational impacts, logging, and natural disturbances such as land slides.

The following table summarizes the differences between current and reference conditions of special plant and fungi populations, trends, and causal mechanisms. **Only species or assemblages of species which appear to differ significantly between current and reference conditions are included here.**

Condition	Trend	Causal Mechanism
Loss of old-growth associated vascular plants, bryophytes, and fungi	Population decrease	▪ Clearcut logging practices ▪ Road/railroad construction ▪ Development of private land ▪ Fire suppression
Entry of exotic pest plant species into watershed	Population increase	▪ Road construction and use ▪ Use of non-native plants for landscaping and erosion/rehab, increase of habitat whenever there are soil disturbances and vegetation removal.

Wildlife:

The wildlife and the associated terrestrial and aquatic habitats within the Shot-Gun Slate Watershed analysis area has changed from historic conditions through relatively recent events. These changes, brought about by a growing human population, land use changes, and natural events, have resulted in adverse impacts to native wildlife and their habitat. Present condition, causal mechanisms, and trends with respect to these changes will be discussed.

Present Condition

The alteration of the aquatic and terrestrial habitats within the Shot-Gun Slate area has been significant. Though land management techniques have improved and most of the brush fields have been replace with conifers and hardwoods, the wildlife habitat of the area little resembles that of a century and a half ago.

The biggest change has been the loss of old-growth habitat and the fragmentation and reduction of late-successional forests. Late-successional stands in the watershed are highly fragmented and isolated from each other by younger stands that lack late-successional characteristics. Habitat for late-successional species is very limited and generally found along riparian corridors. Human-made features such as roads. railroads, and powerline corridors add to the fragmentation. This has resulted in a lack of habitat available for TE&S and S&M species dependent upon late-successional and old-growth forests. Those species dependent on these forest types are currently below their historical distribution and population size. There is 2% known old-growth stands remaining in the watershed and late-successional forests comprise approximately 47 percent of the watershed's forests. Approximately 50% of the watershed is occupied by younger stands that have the potential to develop into late-successional forests in the future. Large downed logs and snags are generally missing as are large diameter trees from which they could be recruited. Protection of the remaining late-successional habitat is important for the continued existence of these species in this watershed.

Timber harvest, roads, fires, and floods have reduced the quality and quantity of the riparian and associated aquatic habitats. This reduction has not been near as severe as the loss of older forest types, but the impacts of previous land management activities and natural events has resulted in a degradation of these water dependent habitats. Past timber harvest focused on the removal of large trees, some of these from riparian areas. This has resulted in a reduction of the multi-layered canopy and more importantly has resulted in the lack of recruitment of large woody debris, especially logs, into the aquatic and riparian ecosystem. Large logs are an important habitat component for many riparian dependent species and also serve to lessen the impacts of large storm events by dissipating flows and acting as sediment basins or filters. Past management activities have also resulted in accelerating erosion rates within the watershed. Excessive sediments alter the streams habitat characteristics and can eliminate habitat for those species dependent on clean cobble and gravel substrates. The Cantara spill in 1991 had a dramatic effect on the riparian and aquatic habitats along much of the upper Sacramento River. Those species that could not leave the river died. These populations are still below pre-spill levels. The spill also affect the riparian vegetation as many plant species were damaged or killed.

Disturbance to intrusion sensitive animal species has increased sharply. Though this is difficult to measure and quantify, the effects on these wildlife species is significant and often interferes with foraging activities and reproductive success. Roads, in particular Interstate 5, has resulted in increased mortality to a number of wildlife species. Deer, squirrel and bear are especially affected as the highway serves as a migration/movement barrier and many animals are killed when they try to cross.

Causal Mechanisms

These existing or current conditions of the wildlife habitat has been precipitated by the land management practices that have taken place over the last century. Logging, road construction and fires have resulted in the loss of old-growth stands and the reduction and fragmentation of late-successional forests. Logging and large fires have change the vegetative component and structure of the watershed. Many old-growth stand, especially along the river, were degraded to brush fields, which through intensive management and recovery have been largely converted to early and mid-seral stage conifer and hardwoods stands. These vegetative changes have been detrimental to some wildlife species and to other species, these changes have been beneficial. Those species that have suffered are now largely on some list that denotes a special management emphasis.

Logging and roads have also resulted in changes to other environments as well. Increased sedimentation, loss of bank stability and reduction of the vegetative canopy, especially large trees, has resulted in degradation and simplification of the riparian and aquatic habitats. Species that rely on these habitats generally have very specific requirements that are easily altered through land management activities. Once these requirements or conditions are lost they can be difficult to recapture. Roads have also created other problems which are a reflection of the increasing human population and the desire to recreate and be mobile. Roads and the resulting traffic have brought us roadkills, pollution, chemical spills and an invasion of what was once a remote wildland.

Trends

Fragmentation will slowly decrease as younger stands continue to develop into late-successional forests and abandoned road-beds become revegetated. The risk of further fragmentation due to the potential for stand replacing fires will remain. The amount of late-successional forest, and the habitat it represents will slowly increase and eventually become old-growth forest types. Those TE&S and S&M species dependent on these forest habitats will also increase as their habitat is expanded or improved. Large downed logs and snags will slowly increase over time. This will be of particular benefit to snag dependent wildlife species and to riparian and aquatic dependent species as large logs and snags can be important habitat components. The amount and condition of riparian habitat will slowly improve over time as the vegetative condition recovers from past logging. Intrusion sensitive wildlife will benefit as the current road density is expected to decrease. Erosion is also expected to decrease as old road-beds become vegetated and failing stream banks associated with roads eventually stabilize. Those species dependent on early and mid-seral stage conifer forests will slowly decrease as these forest types become older and trees encroach on meadows and other openings. Populations of these species will then stabilize as a balance is reached between early, mid and late seral forest types. Interstate 5 will continue to act as a barrier to some wildlife species and will continue to contribute to wildlife mortality. Riparian habitat along the Sacramento River continues to recover from the Cantara loop spill. Most of the riparian vegetation will recover quickly if it already hasn't done so, but some of the larger species such as cottonwoods will require a decade or more.

Fisheries:

The fisheries and the associated aquatic habitats within the Shotgun/Slate watershed analysis area have changed from historic conditions through relatively recent events. These changes, brought about by a growing human population and natural events, have resulted in adverse impacts to native fishes and the aquatic environment. Present condition, causal mechanisms, and trends with respect to the areas fishery and aquatic habitat will be discussed.

Present Condition

The alteration of the aquatic habitats within the "upper" Sacramento River basin has been significant. Though water quality problems are relatively isolated, much of the fish habitat remains in varying degrees of alteration or degradation. This is particularly evident within several of the tributary streams and to a much less degree in the mainstream Sacramento River. Specifically, there has been a reduction in the quantity and quality of pools, a decrease in the quality of riparian habitat, and a reduction in the amount of large woody debris and cover. These changes in the aquatic environment especially within the tributary streams has contributed to a reduction in local native fish populations. Pool habitat and cover is still limited in streams like Slate and Shotgun Creeks and will probably remain that way for a long time to come. In these and other streams, habitat enhancement projects would improve habitat conditions and reduce recovery time provided the stream gradient was not too steep.

Fish populations within the analysis area have undergone dramatic changes. Non-native fish species have become established, while some native populations have declined or in the case of the salmon and steelhead, have been eliminated. These exotic introductions have been a mixed blessing. While exotic fish species compete or prey on native fishes within the streams, their introduction has been positive for recreationists as their presence provides anglers an opportunity that did not historically exist. Their presence has been of some benefit to several wildlife species as well. Recently though, there has been some concern about the effects that non-native fishes have on local amphibians.

The Sacramento River has not fully recovered from the relatively recent spill and fish populations in the river remain below pre-spill levels. Habitat damage as a result of the spill was confined to the riparian area. Though some species of plants will recovery slowly, most of the damaged vegetation is expected to recover in a short period of time, if it already has not done so. The tributary streams have been important in restocking fish and benthic invertebrates back into the river. These streams were not affected by the spill and during the spill they provided refugia for fish trying to leave the river. Full recovery of the aquatic animal populations in the river will probably take decades.

Causal Mechanism

Current conditions in the aquatic environment have been brought about by natural events and land management practices that have taken place over the last century. Logging, road construction, fires, grazing, mining, and floods have resulted in changes in sediment yield, as well as changes to the stream channel and substrate composition, and have resulted in habitat simplification. The alteration of streamside and riparian vegetation has also reduced cover, shade, and bank stability, as well as reduced the amount of large woody material available to the stream. Large wood is important in influencing channel processes and often serves as a key habitat component.

The introduction of exotic fish species and the loss of the anadromous fish runs in this area has probably had as large of an effect on the native fishes as the environmental changes. These biological impacts have resulted in a major change in the aquatic community structure as some native populations were reduced or eliminated, while other populations increased. The introduction of exotic fish species such as brown trout and bass has resulted in an increase in predation and competition, and in some cases has increased the likelihood of disease. The introduction of hatchery rainbow trout and the elimination of native steelhead runs has resulted in the alteration of the native rainbow trout gene pool. The effects of this genetic alteration are unknown.

The Cantara spill of 1991 was responsible for the extirpation of all aquatic life in the Sacramento River between the Cantara Loop and Shasta Lake. While the numerous large trout were the most obvious casualties, thousands of other fish and millions of aquatic insects also succumbed to the toxic chemical. The spill also resulted in the localized destruction of riparian vegetation along the river corridor.

Trends

The trend for the fisheries within the Sacramento River is a slow recovery that involves rebuilding from the most basic trophic levels. Seasonal fishing is presently allowed in portions of the river, but all captured trout must be released. The habitat in the river is in excellent condition and has but to be occupied. Within tributary streams, the habitat is also recovering, not from a spill, but from past management activities and floods. Here the recovery process is also slow, but underway, and available habitat is generally occupied though it is not in as good a condition as the habitat in the river. Though habitat quality is not as high, the tributary streams are key to the recovery of the river in that fish and insects from these streams will serve as the "seed" source for future river populations.

Recreational stream fishing has been on the rise during the last three to four decades. Prior to the spill, the upper Sacramento River was considered a trophy trout stream. Since the spill, fishing has declined dramatically, but recently there has been a renewed interest in fishing on the river. As the river undergoes further recovery and the "large" trout return, fishing pressure is expected to increase above pre-spill levels. It is anticipated that special angling regulations will be able to handle the additional demand.

Geology, Soil and Water Resources

Geology, Geomorphology and Erosional Processes

Hillslope and channel morphologies in the Shotgun-Slate Watershed are governed by processes that occur over different time scales. Dominant controls of hillslope and channel morphologies occurring over large time scales include tectonism, and to a lesser extent volcanism and glaciations. Dominant controls occurring over shorter time scales and at higher frequencies include peak flows and mass wasting processes.

It is expected that mass wasting will continue to occur on heavily roaded hillslopes. Mass wasting from these slopes will gradually be reduced with regular maintenance and hillslope stabilization. While mass wasting activity associated with roads will be reduced, natural mass wasting will continue to occur on unstable slopes throughout the Shotgun-Slate Watershed.

A comparison of active slides with fires occurring over the past 100 years does not show any direct correlation between fires and mass wasting activity. Catastrophic fires do result in additional sediment inputs to streams but most of the sediment is derived from surface erosion from denuded hillslopes rather than hillslope failures.

A comparison of current system roads with active landslide sites only showed several areas where roads intersected active landslides. This comparison is only partially accurate because the transportation map does not show old roads or skid trail networks. Field investigation indicates that some mass wasting activity is associated with roads located on steep hillslopes and within the inner gorges of steeply incised streams.

Watershed impacts from land-use activities occurring in the latter part of this century have not been as severe as those that occurred in the early 1900's. Compared to even a decade ago, vegetation treatments are occurring on fewer acres. Clearcutting and road construction have also been significantly reduced. Standards and guidelines have been developed that provide resource protection to hillslopes and riparian areas. Highly unstable areas have been identified and guidelines have been developed that limit management activities on these areas. Therefore the risk of hillslope and channel degradation from management activities is expected to be significantly less than in the past.

Hydrology

Peak flows and base flows have been increased by the combined effects of timber harvest, roads, water diversions and to a lesser extent by small urban developments. Of these activities the road system has had the greatest long term impact to peak flows. Impacts from timber harvest were quickly reduced following vegetative recovery of cutover areas. As with mass wasting processes fire suppression actually reduced peak and base flows by increasing the amount of vegetation and evapotranspiration.

With the exception of the lower reaches of the South and middle forks of Slate Creek, base flows within the watershed are not believed to have changed appreciably from reference to current conditions. Base flows in the Sacramento River are only slightly influenced by flow regulation at Box Canyon Dam. Losses or increases in discharge from flow regulation are largely attenuated by additional flows from tributaries such as Castle, Soda and Hazel Creeks. Base flows have increased for short periods of time following the removal of vegetation from timber harvest and wildfires. Base flows gradually return to pre-fire/harvest levels following vegetative recovery.

Flood peaks in the watershed are higher today than they were prior to European settlement due primarily to the construction of the road system. Road surfaces intercept rainfall that normally would have infiltrated into the soil profile. The intercepted runoff is quickly transported to the channel network resulting in increased flood peaks. Other land-use activities are not believed to have significantly increased peak flows within the watershed. Small changes in peak flows have occurred in response to harvest activities and wildfires however these impacts are of short duration and do not significantly alter the basic hydrology of the watershed.

Stream Channel Morphologies

Stream channel morphologies are governed by peak flows and mass wasting processes. The influence of mass wasting activity is greatest in upstream reaches where winter flows are not large enough to transport hillslope colluvial material downstream. Peak flows exert the greatest control over channel morphologies at lower elevations where high flows are capable of transporting large amounts of sediment through the channel network.

Stream channel morphologies have been affected by nearly every land-use activity that has occurred in the watershed. Significant changes in channel morphology have taken place during peak flows occurring at intervals of 25 years or greater (see flood history). The full meaning of cumulative impacts is illustrated during peak flow events. Large precipitation events trigger mass wasting processes on hillslopes that have been impacted by roads, fires and timber harvest. The magnitude of peak flows is increased due to the cumulative impacts of timber harvest, road construction and urbanization in the watershed. The high flows mobilize channel bedloads and move large amounts of sediment through the channel network causing bank erosion, channel widening, channel degradation and aggradation, loss of riparian vegetation and modification of channel bedforms.

The most significant changes to channel morphologies during the past 50 years occurred in response to the floods of 1964 and 1974. These floods spawned mass wasting events and significantly altered the morphology of stream channels in the watershed. Major impacts included the removal of riparian vegetation, bank erosion, channel aggradation and widening in unconfined reaches, and a dramatic increase in sediment from flood associated mass wasting events. There is little doubt that peak flows have increased due to land-use activities, however large floods are a natural occurrence and impacts are inevitable regardless of the level activity occurring in the watershed.

Water Quality

The quality of water in the Shotgun-Slate Watershed is excellent. Water quality has occasionally been degraded for short periods of time by mass wasting and peak flows; and land-use activities including mining, timber harvest, roads, grazing and historic settlements. Water quality impacts from land-use activities include acid mine drainage, increased turbidity and sedimentation, increased nutrient inputs, and increased stream temperatures. Some lingering impacts such as acid mine drainage associated with historic mining activity may still be occurring in the watershed. Impacts to water quality from activities occurring during the early 1900's are believed to have been substantial at the time of their occurrence but have lessened considerably since then due to increased environmental protection and a decline in land-use activities in the watershed.

In the early 1900's water quality was affected by timber harvest and road construction occurring adjacent to stream channels. Stream temperatures were affected by timber harvest activities that removed surrounding shade trees however the impacts were gradually reduced as vegetation recovered. The road system in the Shotgun-Slate Watershed continues to effect water quality during the rainy season. Unpaved roads are a chronic source of sediment to streams throughout the watershed. Opportunities exist to improve the existing road system and to reduce the amount of fine sediment removed from roads during runoff events.

Impacts to water quality have been greatest in the Sacramento River Canyon. Oil and chemical spills associated with the transportation corridor periodically contaminated water in the river. Despite these impacts the overall quality of water in the Sacramento River remains high.

Cumulative Watershed Effects Analysis (CWE)

Cumulative watershed impacts consist of the additive impacts of land-use activities and their influence on natural processes and resource condition. A cumulative watershed effects analysis was undertaken for the Lower Sacramento 5th field watershed according to Haskins, 1986. The 5th field watershed contains the entire Shotgun-Slate Watershed as well as the entire area draining into the Sacramento River from adjacent eastern watersheds. The results of this analysis are displayed in the FEIS for the Shasta-Trinity National Forests LMP (Shasta-Trinity National Forest FEIS, 1994). The results indicate that the existing equivalent roaded area (ERA) for the Lower Sacramento River Watershed of 6.0% is well within the threshold of concern of 16% ERA for the watershed.

The size of the Lower Sacramento River Watershed (approximately 55,000 acres) is too great to allow for extrapolation of the CWE data to smaller basins for the purpose of evaluating impacts at the project level. In order to properly evaluate the cumulative watershed effects of future management activities it will be necessary to conduct CWE analyses for smaller sub-basins during the project planning phase. Conducting CWE's at the project level will allow for a more accurate evaluation of existing and potential cumulative impacts.

Chapter 6 - Recommendations

Human Use

Project Opportunity: Provide public access to the Sacramento River

Objective: Provide public recreation opportunities on a major river along a major California thoroughfare.

Priority Areas:

- Sims Flat
- Pollard Flat
- Delta.

Project Opportunity: Undertake an underburn in areas that support bear grass.

Objective: Improve the health of the beargrass understory for use in traditional basket making.

Priority Area:

- Rattlesnake Hill

Transportation

Numerous other recommendation are made by the other input disciplines relative to roads within the watershed. Their primary emphasis is stabilization of erosion and erosive potential, and reduction of road associated disturbance of wildlife.

Project Opportunity: Insure that all stream crossings within the watershed are upgraded to meet 100 year flood volumes, consistent with current standards.

Objective: Prevention of catastrophic/serious erosion events due to failure of culverts and/or stream crossings.

Priority Area:

- All crossings and culverts need to be checked
- Stream crossings priority

Vegetation

The following recommendations apply to prescriptions 3, 6 and 8 within the watershed:

Project Opportunity: Treat overstocked stands by thinning and uneven aged management. (Thinning stands in Prescription 7 is also an opportunity)

Objective: Maintain optimum stocking and provide an output of timber products. Improve fuel profile (horizontal and vertical). Improve stand growth and move more rapidly to an older-mature size class.

Priority Areas:

- Size/density classes 2G, 3G, 3N and 4N
- Consider stands on greater than 40% slopes first.

Project Opportunity: Treat mature and poorly stocked stands by regeneration harvest, site clearing and planting.

Objective: Improve stocking and increase overall percentage of moderate and closed canopy stands. Improve fuel profile (horizontal and vertical). Provide an output of timber products.

Priority Areas:

- Size density classes 3S, 3P, 4S, 4P, some 4N
- knobcone pine stands where site quality can support greater density stands.

Project Opportunity: Treat young plantation by release, interplanting and precommercial thinning.(also an opportunity for plantations in Prescription 7)

Objective: Ensure establishment of young trees. Optimize tree growth to reach closed canopy conditions. Maintain a mix of species representative of historic natural stands in the surrounding area.

Priority Areas:

- All plantations

Project Opportunity: Convert shrublands to mixed conifer forests by site clearing, brush disposal and tree planting. (also an opportunity in Prescription 7)

Objective: Increase the percent of commercial forest lands in the watershed.

Priority Areas:

- Shrubfields determined by field investigation to be capable of supporting closed canopy mixed conifer forest.

Inventory, Monitoring and Research Needs, Vegetation

Recommended Actions:

Action: Complete a timber inventory using most recent aerial photography (1995)

Objective: Establish current condition of forested lands within the watershed and establish a trend in stand development when compared with 1975 inventory and 1944 air photos.

Action: Complete survival exams for all planted areas based on existing protocol.

Objective: Verify attainment of stand composition and density as described in silvicultural prescriptions and forest standards and guidelines.

Action: Establish permanent plots or photo points in areas of Port-Orford Cedar.

Objective: monitor trends in development of these stands (trees) and determine presence or absence of the root disease.

Action: Inventory for snags and downed woody material as part of developing silvicultural prescriptions for vegetation management.

Objective: Determine existing conditions for snag density and downed woody debris (fuel loading) for comparison with forest standards.

Fire/Fuels

Recommended Actions

Project Opportunity: Promote stand vigor and meet desired conditions by thinning densely stocked stands

Objective: Reduce vertical fuel ladders that promote crown fire events.

Priority Areas:

- 3N and 3G Stands
- Focus on high/moderate risk and hazard area stands

Project Opportunity: Understory burning in unthinned and previously thinned stands.

Objective: Maintain acceptable fuel profiles recognizing fire’s natural role.

Priority Areas:

- Previously thinned and unthinned stands where opportunity exists.
- Focus on high/moderate risk and hazard areas.

Project Opportunity: Develop a fuel reduction zone near populated communities for protection from wildfire.

Objective: Provide a defensible fire zone for rural/urban interface areas

Priority Areas:

- Delta
- Pollard Flat
- Shotgun Creek
- Sims
- Other populated areas adjacent to National Forest lands.

Project Opportunity: Manipulate fuel profiles in high hazard areas such as heavy mortality and blowdown (40 tons/acres plus) and decadent shrubfields.

Objective: Reduce the current high residual fuel loads for the protection from stand replacement wildfires.

Priority Areas:

- High mortality and blowdown stands

- Decadent shrubfields
- Knobcone stands

Plant Species of Concern

Threatened, Endangered, and Sensitive Plants (TES)

Old-growth Forest Related Plants and Fungi

Project Opportunity: Cooperate with County Agricultural Department to reduce and control weed invasions.

Objective: Remove source and prevent the spread of invasive plants

Priority Areas:

- Main road access areas from Interstate 5 corridor.

Inventory, Monitoring, and Research Needs

Recommended Actions

Action: Evaluate known populations of PHDA, PEFI, and ARKL

Objective: Identify habitat needs, suitability, and health of populations

Priority Areas:

- Rattlesnake Hill
- Cold Creek vicinity

Action: Survey for old-growth associated plants and fungi.

Objective: Determine which species occur in watershed, assess health of populations and habitat.

Priority Areas:

- Springs and headwaters of Slate Creek
- North Fork Slate Creek
- Little South Fork Dog Creek
- Dog Creek
- Headwaters Mosquito Creek

Action: Survey for exotic pest plant invasions. Focus on Scotch Broom, Klamath weed, yellow star thistle, black locust, tree-of-heaven, blackberries, mullein and cheatgrass.

Objective: Determine which species occur in watershed, find centers of expansion.

Priority Areas:

- Main access roads into watersheds

Wildlife Recommendations

Project Opportunity: Close roads and create line-of-sight barriers in areas where fawning and cubbing occur or road densities exceed habitat capability model guidelines.

Objective: To provide for quality hunting conditions and to reduce poaching. Mitigate for disturbance in shrublands and other areas used by deer and bear that will be converted to late-seral stages. Provide areas of minimal disturbance for fawning and cubbing.

Priority Areas:

- Wet Meadows
- Areas important to deer and bear for fawning and cubbing.
- Chicken Hawk Hill
- Rattlesnake Hill
- Cold Springs

Project Opportunity: Provide for a mosaic of habitat for deer (40% cover and 60% foraging area) and bear as well as mature berry producing brushfields.

Objective: Mitigate for conversion of shrublands to late-seral stage forests.

Priority Areas:

- Cold Springs
- Chicken Hawk
- Rattlesnake Hill
- Slate Mountain drainages

Project Opportunity: Increase dispersal habitat in sub-watersheds

Objective: Provide dispersal habitat throughout the watershed for wildlife. Fulfill Fish and Wildlife dispersal habitat requirements and eliminate need for informal consultation. Meet dispersal objective of CHU CA-7.

Priority Areas:

Townships of:

- T37N R5W
- T37N R4W
- T36N R5W
- T36N R4W

Inventory, Monitoring and Research

Action: Protect suitable habitat late-successional forest stands and 100 acre unmapped LSR by using the appropriate silvicultural treatments to reduce environmental hazards (i.e. fire, disease, insect infestations) around these special forest stands.

Objective: Meet Forest Plan, LSR and Matrix objectives for old-growth dependent species.

Priority Areas:

- Activity Center 017
- Activity Center 013
- Suitable habitat and old-growth forests within matrix lands and areas of high fire risk.

Action: Retain snags in project areas as recommended by the Snag Model. For areas of surplus snags, determine use of snag(s) by wildlife before marking for harvest, this includes under the bark. Consider maintaining additional snags for snag and dead/down recruitment. In areas where snag densities are less than the model, follow Forest Plan guidelines for snag recruitment.

Objective: Meet objectives of Matrix standards and guidelines for cavity nesting species. Determine snags suitable for harvest when there is a snag surplus fire salvage. Maintain those snags most often used and most important to wildlife.

Priority Areas:

- Matrix lands where silvicultural treatments would involve removing snags or large dying trees or snag densities
- Areas where snag densities are below snag model recommendations.

Action: Educate the public about the value of snags (Adopt-a-Watershed) and the effects of unregulated wood cutting.

Objective: Reduce the felling of snags for woodcutting and reduce illegal wood cutting. Improve public relations.

Priority Areas:

- Entire watershed

Fisheries:

Recommended Actions

Project Opportunity: Improve habitat for fish and enhance stream and riparian condition.

Objectives:

- Improve pool habitat and cover.

Priority Areas:

  - Slate Creek
  - Shotgun Creek
  - Boulder Creek
  - and other areas as identified

Develop spawning habitat and improve the condition of existing gravels.

Priority Areas: Within the larger streams such as Slate Creek, and Boulder Creek.

Reduce sources of fine sediment and stabilize failing banks.

Priority Areas: Slate Creek and other locations as identified.

Improve riparian vegetation condition.

Priority Areas:

- Slate Creek
- Shotgun Creek.

Provide for the recruitment of large woody debris

Priority Areas: Basin -wide, but along larger streams and the Sacramento River.

Inventory, Monitoring and Research

Action: Inventory fish habitat condition in tributary streams.

Objective: Determine habitat improvement needs and opportunities.

Action: Identify and address sources of fine sediment entering the stream.

Objective: Improve habitat condition and overall stream health

Action: Monitor fish habitat improvement projects.

Objective: Determine effectiveness of improvement efforts.

Geology, Soil and Water Resources

Recommended Actions

Project Opportunity: Maintain, repair and close/decommission roads with emphasis in areas containing populations of Port Orford cedar.

Objective: Reduce fine sediment sources to streams and riparian areas. Restore natural drainage. Decrease cutslope erosion and road failure.

Priority Areas:

- Tom Neil Creek
- Slate Creek
- Boulder Creek
- South Fork Shotgun Creek

Project Opportunity: Use biotechnicial remediation techniques to reduce slope erosion in unstable area located adjacent to stream channels and roads.

Objective: Reduce sediment supply to streams and reduce hillslope erosion in areas that are unstable and have been impacted by land-use activities.

Priority Areas:

- Slate Creek

Project Opportunity: Clean, replace, and improve stream crossings.

Objective: Restore natural sediment transport regime.

Priority Areas:

- Areas identified in pending W.I.N. inventory.

Inventory, Monitoring, and Research Needs

Action: Conduct channel stability surveys in conjunction with fish habitat surveys.

Objective: Assess stream channel stability and identify opportunities for instream and hillslope restoration.

Priority Areas:

- Shotgun Creek
- Slate Creek
- Upper Dog Creek

Action: Conduct Watershed Inventory Needs (W.I.N.) assessment.

Objective: Identify restoration opportunities related to roads/culverts and stream crossings. Evaluate road closure opportunities.

Priority Areas:

- Entire Shotgun Slate Watershed

Action: Assess water quality in the Dog Creek headwaters.

Objective: Determine if acid mine drainage is occurring from abandoned mines.

Priority Areas:

- Dog Creek sub-basin

Action: Update water quality use map for watershed and forest.

Objective: Determine the locations of water withdrawal on private and public lands.

Priority Areas:

- Forest-wide

Action: Monitor effects of land use activities occurring in or adjacent to riparian reserves.

Objective: Insure compliance with Aquatic Conservation Strategy.

Priority Areas:

- Where ever activities are occurring.

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