Lower Clear Creek Watershed Analysis

Bureau of Land Management
Redding Resource Area

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Comments on previous drafts are on file and available for review at the WSRCD office. Full color sets of maps are also available.

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Thank you to everyone who contributed to the production of this document.
If we have inadvertently missed listing a contributor, we do apologize.

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CHAPTER 1 - Introduction

INTRODUCTION TO A WATERSHED ANALYSIS

A watershed analysis is an analytical process used to develop and document a scientifically-based understanding of the interactions and functions occurring within a watershed. This analytical process focuses on specific issues, values, and uses within the watershed. The watershed analysis is not a decision making process requiring impact assessment and public review under the National Environmental Policy Act (NEPA), but becomes a basic element for future management decision making. Watershed analyses serve as the basis for developing project-specific proposals, and for determining monitoring and restoration needs in a watershed. Proposed projects may require subsequent NEPA documentation.

In April 1993, President Clinton commissioned an interagency scientific team to develop a set of alternatives to manage ecosystems within the range of the northern spotted owl. This effort culminated in the report by the Forest Ecosystem Management Assessment Team (FEMAT) entitled: "Forest Ecosystem Management: An Ecological, Economic, and Social Assessment", in July 1993 (Thomas, 1993).

Due to heightened concern about the declining fish populations, protection and improvement of aquatic and riparian ecosystems are key components of the FEMAT report. The report presents a broad strategy for maintaining or restoring the distribution, diversity and complexity of watershed and landscape-scale processes and characteristics.

The FEMAT report was used as the cornerstone in the Final Supplemental Environmental Impact Statement (FSEIS) titled "Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl". The Record of Decision (ROD) for this FSEIS was signed in April, 1994 [United States Department of Agriculture - Forest Service (USDA - FS), and United States Department of the Interior - Bureau of Land Management (USDI - BLM), 1994b]. The ROD requires a watershed analysis on Forest Service and Bureau of Land Management lands.

A significant part of the President's Plan is the Aquatic Conservation Strategy. As defined in the ROD, there are four critical components of the Aquatic Conservation Strategy:

1. Riparian Reserves: These are lands along streams, unstable, and potentially unstable areas where special standards and guidelines direct land use.

2. Key Watersheds: A system of large refugia comprising watersheds that are crucial to at-risk fishes species and stocks and provide high quality water.

3. Watershed Analysis: Procedures for conducting analysis that evaluates geomorphic and ecological processes operating in specific watersheds. This analysis should enable watershed planning that achieves Aquatic Conservation Strategy objectives. Watershed analysis provides the basis for monitoring and restoration programs and the foundation for Riparian Reserve delineation.

4. Watershed Restoration: These are comprehensive, long-term programs to restore watershed and aquatic ecosystem health, including the habitats supporting fish and other aquatic and riparian dependent-organisms.

According to the ROD, watershed analyses should be conducted in all watersheds on federal lands as a basis for ecosystem planning and management. Initial watershed analyses used "A Federal Guide for Pilot Watershed Analysis" (FEMAT, 1994). A newer "Ecosystem Analysis Guide" will be used in analyses initiated in fiscal year 1996.

THE LOWER CLEAR CREEK WATERSHED ANALYSIS

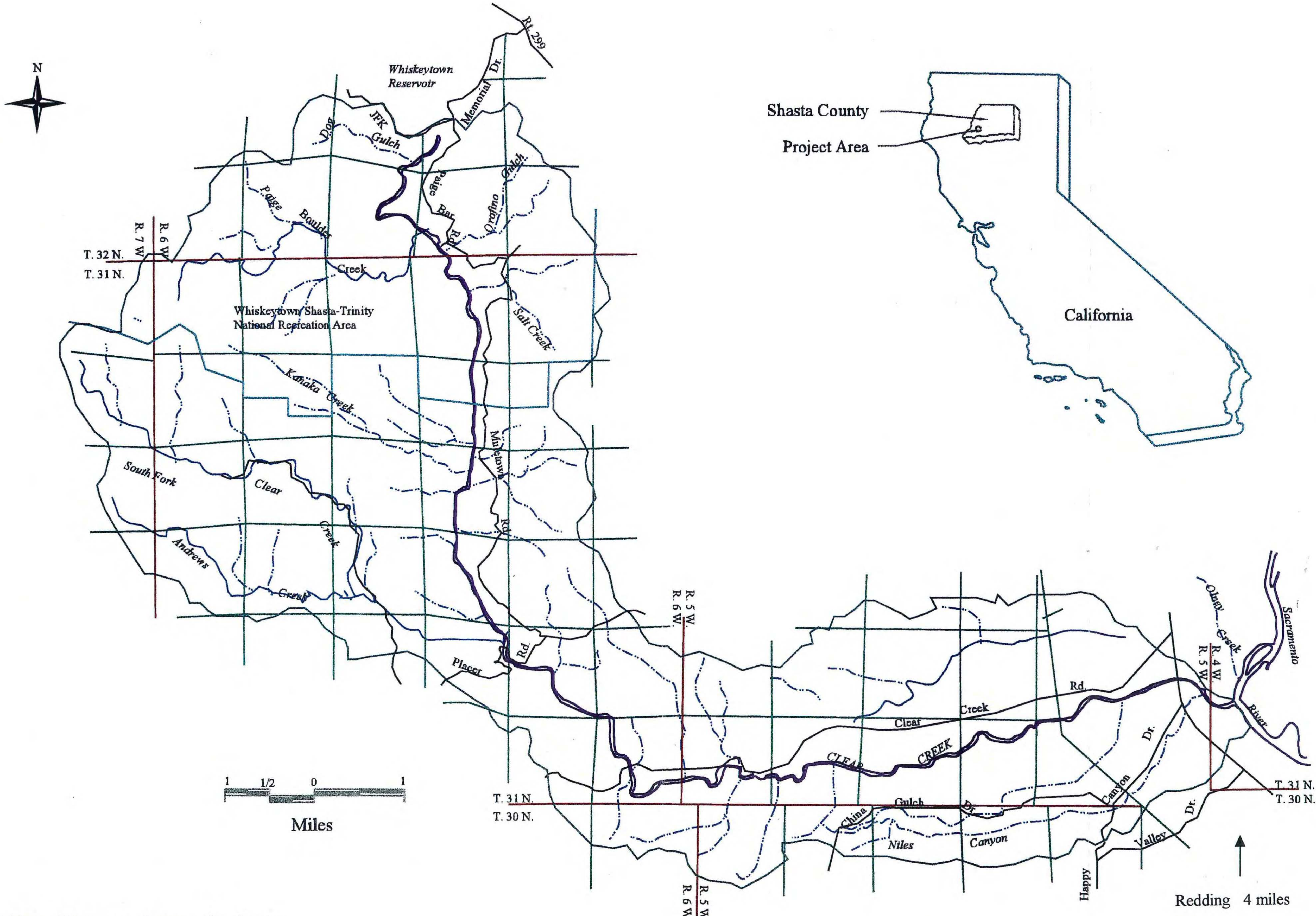
This watershed analysis is limited to the portion of Clear Creek downstream of Whiskeytown Dam. See Map 1-1 "Location of the Lower Clear Creek Watershed." The existence of Whiskeytown Dam effectively divides the watershed into two parts. These areas function differently, particularly when analyzing hydrological processes, the fishery, recreation and land use, etc.

MISSION STATEMENT

Using the concept of managing entire ecosystems, develop and document the watershed and ecological processes and the interactions that occur. Integrate the information available and provide the broad, landscape-scale information needed for project planning and decision making for the lower Clear Creek watershed.

The interdisciplinary team divided the Lower Clear Creek Watershed Analysis into three sections for analysis purposes: (1) the Aquatic Domain, (2) the Terrestrial Domain, and (3) the Human Domain. The lower Clear Creek Watershed analysis was performed according to requirements from the FY 1994-96 Watershed Analysis Guidelines. The lower Clear Creek Watershed analysis used processes and technical modules from both the "Federal Guide for Pilot Watershed Analysis" and the draft "Ecosystem Analysis Guide (Regional Ecosystem Office, 1995)."

Map 1-1: Location of the Lower Clear Creek Watershed



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Redding Field Office 1995

NEED FOR THE LOWER CLEAR CREEK WATERSHED ANALYSIS

The ROD (B-20) requires the performance of a watershed analysis in riparian reserves. Projects funded under the Jobs in the Woods (JITW) programs administered by the BLM and the U.S. Fish and Wildlife Service (FWS) require the completion of a watershed analysis. Both agencies funded restoration projects in riparian reserves in lower Clear Creek during 1995. The BLM contracted with the Western Shasta Resource Conservation District (WSRCD) to perform the analysis in order to comply with the JITW requirement.

Northern spotted owls (NSO) are known to occur in the portion of Clear Creek upstream of Whiskeytown Dam. Approximately half of the portion of the watershed under consideration is within the range of the NSO, however, no NSO's are known to occur downstream of the dam. The emphasis of the watershed analysis is on the anadromous fish resources, fuels and land development. Although lower Clear Creek is not a "key watershed" as defined in the ROD, it is the subject of considerable interest and regulation as follows:

1. Townsend Flat Water District owns a Pre-1914 water right and the Bureau of Reclamation water contract totaling 55 cubic feet per second (cfs) to the natural flows of lower Clear Creek. Their diversion occurs at McCormick-Saeltzer Dam, about 12 miles downstream of Whiskeytown Dam. G.E. Oakes claimed a riparian water right of 11 cfs downstream of McCormick-Saeltzer Dam.

2. Clear Creek became a portion of the Trinity River Division of the Central Valley Project (CVP) in 1955.

3. There is a 1960 Memorandum of Understanding between the Bureau of Reclamation (BOR) and the California Department of Fish and Game (DFG) concerning minimum flows released to lower Clear Creek from Whiskeytown Dam.

4. In 1963, BOR, U.S. Fish and Wildlife Service (FWS), and the National Park Service (NPS) reached a tentative schedule agreement (never formalized) to increase releases from Whiskeytown Dam.

5. The Shasta Tehama Bioregional Council identified lower Clear Creek as a watershed of "critical importance" with an emphasis on enhancing the anadromous fishery.

6. More generally, the USFS and BLM jointly developed an interim aquatic conservation strategy known as PACFISH. PACFISH was developed to halt the degradation and initiate recovery of Pacific salmon and steelhead habitats on federal lands administered by the FS and BLM. This strategy impacts management options considered for BLM land in lower Clear Creek.

7. The Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575) -- Upper Sacramento River and tributaries' section, California Senate Bill 1058 specifically lists lower Clear Creek as needing restoration activities. California Senate Bill 2261, Central Valley Salmon Restoration also impacts lower Clear Creek. See Appendix A for more information on this Act.

8. The Shasta County General Plan recognizes current erosion and salmon spawning gravel problems county-wide and will consider these problems during the permitting process.

The high level of interest in lower Clear Creek is due to its mixture of valuable public and private natural resources. The Shasta Tehama Bioregional Council committee felt the lower Clear Creek watershed analysis would provide an opportunity to establish better cooperation among multiple federal, state, and local agencies, and private land owners.

The Shasta Tehama Bioregional Council is an outgrowth of both the President's Option 9 initiatives and a State emphasis on biodiversity. It is a cooperative group of local, private, state, federal and municipal interests which use the forum for information sharing, problem solving and project prioritization. They are supportive of the unique opportunities to cooperatively conduct habitat enhancement and upland restoration, fuel reduction, fisheries restoration, sedimentation control, and GIS inventory in the lower Clear Creek area.

The lower Clear Creek watershed analysis contains landscape level analyses with subsequent restoration projects which will benefit resource values and stimulate the local economy by providing employment opportunities and diversification. Since lower Clear Creek watershed is predominately privately owned, Western Shasta Resource Conservation District (WSRCD), an entity that traditionally represents the private landowner's interest, is leading this multi-agency effort.

SCOPE OF THE ANALYSIS

Information and analyses provided in the lower Clear Creek Watershed Analysis are based on best available data for the lower Clear Creek area. The document identifies issues and key questions pertaining to the watershed; describes the historic and present condition of the watershed; and, discusses trends and likely future conditions. It also contains recommendations, future information needs, watershed management opportunities, monitoring programs, and restoration projects.

The proposed restoration projects reflect a range of opportunities, some of which are outside the authority of local agencies to approve.

RELATION TO LOCAL AND REGIONAL PLANS

Proposed restoration projects will be consistent under an umbrella of Standards and Guidelines contained in the ROD; the BLM's Redding Resource Management Plan (RMP) and Record of Decision (6/93), the Shasta County General Plan, and the Upper Sacramento River Fisheries and Riparian Habitat Management Plan (Resources Agency 1989).

BLM LAND RESOURCE OBJECTIVES (from the RMP)

The BLM manages scattered parcels of land in the Lower Clear Creek watershed. The objective of the Lands program is to transform this scattered land base into consolidated resource management units to meet the needs of the public land users. Exchange opportunities (including purchase or donation) and land transfers (for long term stewardship, not disposal) are the means to reach this goal. The RMP shows the parcels in the Clear Creek drainage effected by this objective.

For the Clear Creek Uplands, BLM has the following objective:

Enhance the resource management efficiency and public service mission by transfer of administrative responsibilities, via the Recreation and Public Purposes Act, to a qualified organization or government entity.

For Lower Clear Creek and Mule Mountain the resource objectives are:

1. Enhance anadromous salmonid habitat.

2. Restore the quality and quantity of riparian vegetation to Class I and Class II.

3. Enhance non-motorized recreation opportunities by establishing a greenway from the Sacramento River to the National Recreation Area along lower Clear Creek.

4. Maintain the scenic quality of the canyon above Clear Creek Road Bridge.

5. Protect the native plant communities and associated fauna of the area.

6. Protect the historical values of the area.

OTHER AGENCY OBJECTIVES AS SET FORTH IN PLANS

Natural Resource Conservation Service

The mission of the Natural Resource Conservation Service (NRCS) is to provide statewide leadership in the conservation and wise use of soil, water and related resources. A balanced cooperative program that protects, restores and improves those resources for the benefit of California and it's people is achieved.

NRCS support for the lower Clear Creek Watershed Analysis, future inventories, and restoration activities on public and private land is a component of the NRCS Salmon Initiative. The Redding Field Office is participating in this initiative and plans to provide technical assistance to landowners in conjunction with the Western Shasta Resource Conservation District's long range and annual work plans.

National Park Service -- Whiskeytown Unit of the National Recreation Area

The management objective of the NPS is to identify, protect and perpetuate the diversity of existing ecosystems in the Whiskeytown Unit which are representative of the area (USDI NPS, 1990). To accomplish this objective, the NPS will:

1. Enhance knowledge and expertise of ecosystem management through research and experimental programs relating to wildlife, prescribed burning techniques exotic plant and animal reduction, regulation and control of resource use and pollution control.

2. Manage renewable resources for disposal to economical use so that such use will not have a substantial effect on recreation while preserving the natural and cultural resources.

3. Manage non-renewable resources under mineral leasing activities so that such use will not have substantial effect on recreation while preserving the natural and cultural resources.

U.S. Fish and Wildlife Service

The FWS interest in lower Clear Creek focuses on:

1. implementation of the Central Valley Project Improvement Act (CVPIA), and
2. implementation of the Northwest Forest Plan including the Aquatic Conservation Strategy.

The CVPIA (Title 34 of Public Law 102-575) amends the authorization of the Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancements as a purpose equal to power generation. Whiskeytown Dam and the Trinity River reservoirs are CVP features. Section 3406(b)(12) of the act specifically singles out Clear Creek for restoration

California Department of Fish and Game

1. Protect fish and wildlife resources held in trust for the people of the State of California.

2. Restore degraded fish and wildlife habitats. The U.S. National Research Council defines habitat restoration as "the return of an ecosystem to a close approximation of its condition prior to disturbance."

NORTHERN SPOTTED OWL LAND ALLOCATIONS IN THE LOWER CLEAR CREEK WATERSHED

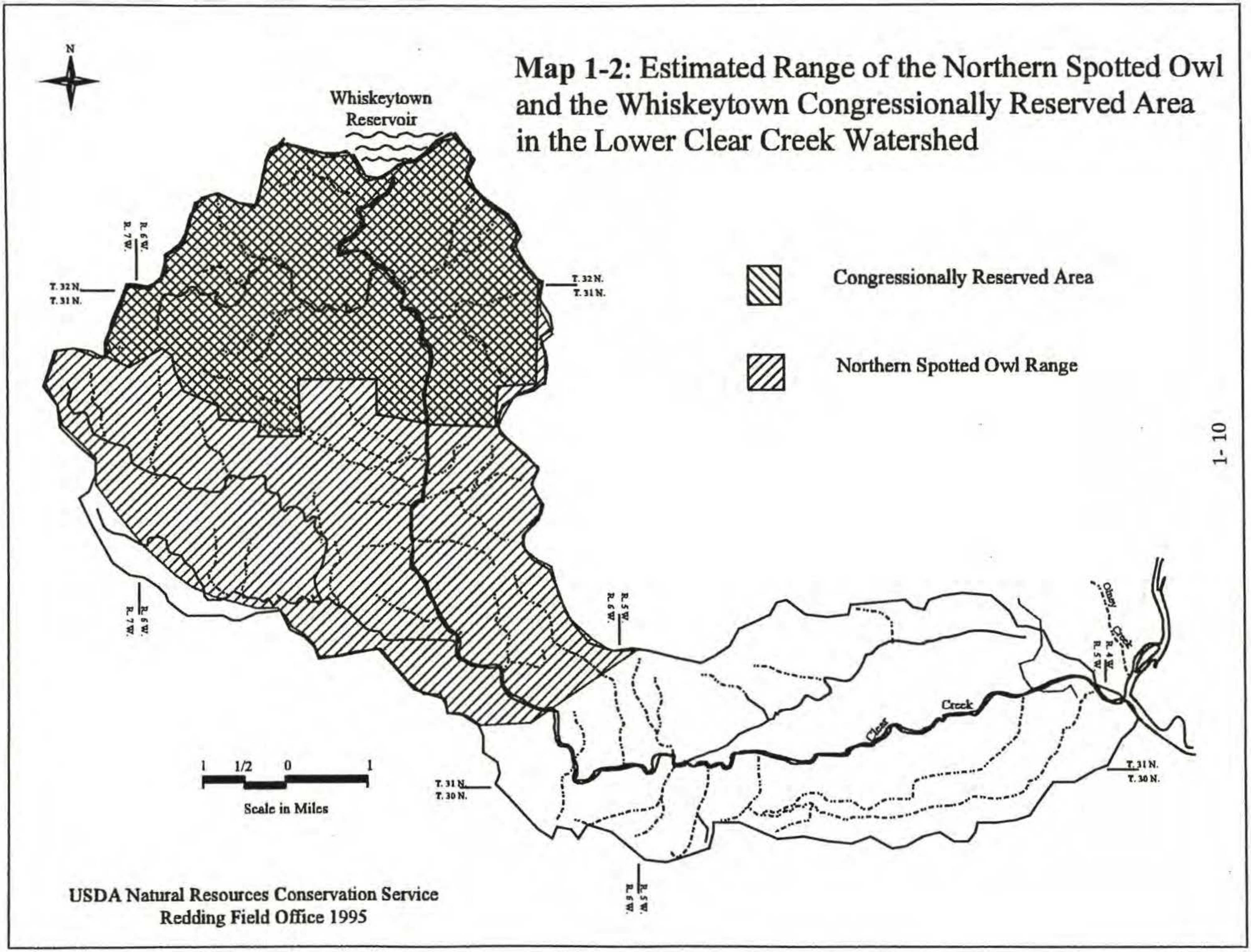
In April of 1994, the BLM and the Forest Service released the Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA FS and USDI BLM, 1994b). The purpose of the guidelines are: to take an ecosystem approach to forest management; to maintain a healthy forest ecosystem which supports native species; and to maintain a sustainable supply of timber and other forest products. Use of the guidelines will help maintain the stability of local and regional economies.

A watershed analysis must identify the range of the northern spotted owl (NSO) and any federal land allocations. In the lower Clear Creek watershed, the NSO's range includes approximately 12,000 acres. Two thousand, three hundred seventy-one acres of potential nesting, roosting and foraging habitat are within the range. Douglas-fir (1,066 acres), Klamath Mixed Conifer (171 acres), and Ponderosa Pine (68 acres) comprise these acres. This habitat is not contiguous. It is in the northwestern part of the watershed.

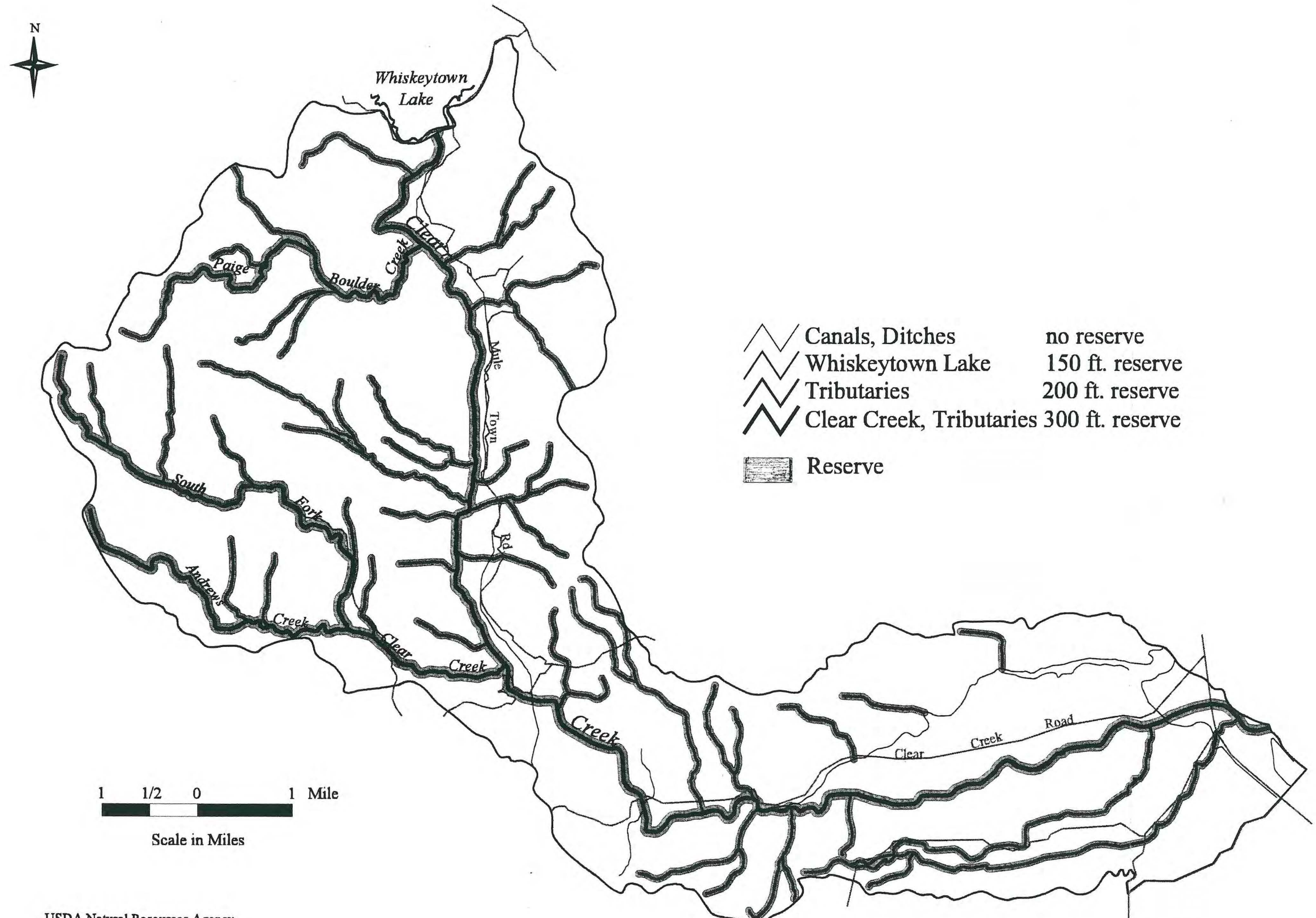
In the lower Clear Creek watershed, federal land within the range of the NSO is allocated to specific land uses. These include Congressional Reserved Areas, matrix areas, and riparian reserves. The Whiskeytown Recreation Area, administered by the National Park Service, is the only Congressional Reserved Area in the lower Clear Creek watershed and comprises 8,000 acres. Please see Map 1-2, "Estimated Range Of The Northern Spotted Owl In The Lower Clear Creek Watershed And The Whiskeytown National Recreation Area."

Matrix is defined as "all remaining federal land apart from Reserves, Withdrawn Areas, and Managed Late Successional Areas that are available for timber harvest at varying levels." BLM land in lower Clear Creek within the range of the NSO is considered matrix.

Riparian reserves are designated along perennial and intermittent streams and wetlands where cutting of trees is limited to silvicultural treatments with the objective to maintain suitable habitat for fish and other aquatic organisms.



Map 1-2: Estimated Range of the Northern Spotted Owl and the Whiskeytown Congressionally Reserved Area in the Lower Clear Creek Watershed



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Map 1-3: Riparian Reserves in the Lower Clear Creek Watershed

Comparisons were made between the riparian buffer recommended by the April 1994 Standards and Guidelines and the riparian buffer recommended by The Upper Sacramento River Stream Corridor Protection Program (DFG, et al, 1994). The latter document's recommended reserve for lower Clear Creek is "50 feet beyond the dripline of riparian vegetation or 100 feet from the bank, whichever is greater." The April 1994 Standards and Guidelines defines the reserves as "the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge; or, to the outer edges of the 100-year floodplain; or, to the outer edges of riparian vegetation; or, to a distance equal to the height of two site-potential trees; or, 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest." Using a map of the riparian vegetation in the lower section of the Clear Creek watershed, the width of the vegetation perpendicular to the creek was measured in two-inch (2000 foot) intervals. The April 1994 Standards and Guidelines usually allowed for a wider riparian reserve than The Upper Sacramento River Stream Corridor Protection Program.

The average buffer using The Upper Sacramento River Stream Corridor Protection Program guidelines was 640 feet, while the April 1994 Standards and Guidelines reserves averaged 815 feet. While maps of riparian vegetation upstream of Clear Creek Road are not available, the required buffer was estimated to be either the Standards and Guidelines' 300 foot default or the Stream Corridor Protection Program's 100 foot default. These estimates were based on the dearth of riparian vegetation in the Clear Creek canyon and exemplify the typically larger buffer afforded by the April 1994 Standards and Guidelines.

Map 1-3 depicts the riparian reserves for the lower Clear Creek watershed. The map illustrates a 600 foot buffer (300 feet on each side) for lower Clear Creek and all other permanently flowing creeks. Intermittent streams have a 200 foot buffer (100 feet on either side) and Whiskeytown Reservoir has a 150 foot buffer around its perimeter.

No other land in the lower Clear Creek watershed has a specific land allocation.

WATERSHED SETTING

LOCATION OF THE WATERSHED

Clear Creek is a tributary of the Sacramento River situated in the northwestern portion of the upper Sacramento River Basin. Clear Creek is unique among west side streams tributary to the Sacramento River because it is a perennial stream near a growing metropolitan area, yet it isn't extensively developed. The Clear Creek watershed is approximately six miles west of Redding in Shasta County, California and encompasses approximately 154,820 acres.

Clear Creek begins in the Trinity mountains east of Clair Engle Lake, and runs approximately 35 miles to its confluence with the Sacramento River, just south of the city limits of Redding. The Whiskeytown and McCormick-Saeltzer Dams regulate the natural flow of Clear Creek.

Whiskeytown Reservoir, part of the Trinity Division of the Central Valley Project, impounds Clear Creek and also stores water diverted from the Trinity River through the Clear Creek tunnel. All the Trinity River diversion and 87 percent of the natural flow of Clear Creek are diverted from the reservoir through the Spring Creek Tunnel into the Sacramento River above Keswick Dam. The remaining 13 percent of the water flow now comprises lower Clear Creek.

Estimates show Clear Creek could have contributed as much as 6 percent of all anadromous salmonids within the entire Sacramento River watershed.

The canyon between Clear Creek Road crossing and Whiskeytown Dam is eligible for inclusion in the National Wild and Scenic River System.

LOWER CLEAR CREEK WATERSHED GENERAL DESCRIPTION

Lower Clear Creek starts at Whiskeytown Dam eight miles west of Redding. It terminates six miles south of Redding where it enters the Sacramento River. Lower Clear Creek flows in a southerly direction from Whiskeytown Dam to the Clear Creek Road, a distance of 9.3 miles. At this point, the creek flows in an easterly direction for 7.9 miles until it enters the Sacramento River (See Vicinity Map 1-1). The lower watershed is 31,302 acres in size.

LAND USE PATTERNS

The lower Clear Creek watershed consists of approximately 42% publicly owned and 58% privately owned land. The National Park Service administers approximately 92% of the public land, which consists of the southern part of the Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area. The Bureau of Land Management and California Department of Fish and Game administer the remaining public lands. Private lands are primarily owned by timber companies, mining companies and rural residents.

Past gold and gravel mining activities have left significant dredge tailings below Clear Creek Road Bridge. Most of the commercial forest stands have sustained at least some logging. Logging and gravel mining activities continue in portions of the watershed but at levels below historical rates. Industrial (sand & gravel) and commercial enterprises (lumber mills, electrical generation, and auto repair and wrecking) occur along Clear Creek Road at the southern city limits of Redding.

Recreation is the largest industry in the area with a focus on and around Whiskeytown Reservoir and McCormick-Saeltzer Dam. Lower Clear Creek presently receives substantial public recreation use at several locations even though almost all land along the creek is privately owned. This use includes swimming, hiking, fishing, gold panning, and limited kayaking. Most private land is posted against public use. If private landowners enforce their no-trespassing postings, most future public use will be restricted to public land.

The lower Clear Creek flood plain is presently designated as Rural Residential A and B, Industrial, and Suburban Residential. An area of undefined width centered on the channel of clear Creek is designated in the General Plan as a "Significant Creekside Corridor."

The zone district , in which the development site is located, prescribes which uses do not require permits, which uses require use permits, and which uses are prohibited. If a use permit is required, depending upon the results of the initial study phase of environmental review under the California Environmental Quality Act (CEQA), the County may require and EIR, or adopt a negative declaration (i.e. a finding that there is no expected environmental impact), or adopt a mitigated negative declaration, which would require specific measures to mitigate the potential adverse impacts identified in the initial study. The zone districts in the lower Clear Creek watershed are:

1. The Unclassified District combined with the Restrictive Flood District;
2. The Limited Residential District combined with the Restrictive Flood District (20 ac minimum);
3. The Limited Residential District combined with the Restrictive Flood District (10 ac minimum); and,
4. The General Industrial District combined with the Design Review District and the Restrictive Flood District.

A portion of the lower section of Clear Creek is within the city limits of the City of Redding, and subject to the City's General Plan and zoning ordinance, which may differ from the County's. (Bill Walker, Associate Planner)

Currently, a limited number of home sites or businesses interrupt the natural riparian landscape along the stream. However, rural residential development is pushing into Clear Creek below Whiskeytown Dam. These dispersed residences place new demands on public services.

Mapping of the vegetation and habitat types for all the streams in the Urban Stream Corridor Protection Program revealed that lower Clear Creek has the highest remaining acreage of riparian and wetland vegetation of the urban streams in the Redding area. It can still provide unfragmented habitat for species which prefer this habitat type. Lower Clear Creek also provides the only stream corridor connecting to the Whiskeytown Unit of the National Recreation Area in the Redding-Anderson area.

The lower Clear Creek watershed below Whiskeytown Dam is largely an unincorporated area of the County of Shasta. Land ownership is approximately 11,336 acres public and 19,966 acres private (See Map 4-1 in Chapter 4). Paige Bar is the site of the Whiskeytown National Environmental Education (NEED) Camp administered by the National Park Service and the Shasta County Office of Education. This facility is used for conducting environmental education classes for 5th and 6th grade students of Shasta and nine surrounding counties.

CURRENT DEMOGRAPHICS

The population of lower Clear Creek is spread out in various rural residential, single-family developments outside the Clear Creek corridor. Exceptions to this are the residential area of Girvan Road, located between the Sacramento River and highway 273, and the Redding Rancheria.

The Redding Rancheria was established in 1922 and belongs to members of the Wintu, Pit River and Yana people. These Native Americans were forced onto these lands as later settlers usurped their historic hunting and fishing grounds. The current Rancheria encompasses 38 acres and includes homes, an Indian Health Care Clinic and a newly opened Bingo Hall and Casino (Dolan, H., 1991).

HISTORY

NATIVE AMERICAN

Native Americans are thought to have settled in this region of California as early as 12,000 B.C., living in unsettled bands and subsisting mostly by hunting. By 6,000 B.C., milling stones for grinding seeds were being used. People began to settle into more permanent communities. By 3,000 B.C., food sources were much more diversified and daily living included fishing, hunting and plant gathering. It is estimated some 12,000 to 14,000 Native Americans resided in west central California in 1830.

The Wintu people lived in semi-subterranean earth and bark lodges that were circular or conical. Primarily a river people, they lived off the products of the river and adjacent lands, including: acorns, salmon, steelhead, most species of large and small animals, tubers, roots, bulbs, seeds, insects, berries, fruit, clover, nuts, larvae, eggs, worms, crawfish and mussels. Their lives were intimately connected with the environment and centered on religion and mythology.

The Native Americans' first contact with Europeans occurred around 1828 when American, British and French trappers reached what is now Shasta County. Early interaction with the white settlers was positive, with trading occurring between the two peoples.

However, in the following decades, growing numbers of trappers drastically reduced the number of fur-bearers. Native Americans were exposed to small pox and influenza resulting in epidemics that killed hundreds (possibly thousands). The Native American lifestyle was further disrupted by the sudden arrival of gold miners whose activities adversely affected the fishery. Indian women were forcibly taken as spouses because there were no white women in the early camps.

When miners began arriving in large numbers, there was competition between them and the Indians for food and land. Indiscriminate killings of Native Americans occurred, and their homes, belongings, supplies and food caches were also destroyed. The Native Americans were considered obstacles to progress, and because of it, were either removed or eliminated (Smith, D., 1991).

MINING

In 1844, Pierson B. Reading applied for and received the Rancho Buena Ventura land grant from Mexico. It encompassed 26,632 acres which included lands within the lower Clear Creek watershed. Reading discovered the first gold in Shasta County in 1848. The discovery site was located five miles up Clear Creek on Reading bar at the mouth of the Clear Creek canyon.

This discovery expanded the Gold Rush into northern California. The prospectors early living conditions were spartan. Housing consisted of lean-to's, tents, and a few log cabins. The gold discovery area was first known as Clear Creek Diggins or One Horse Town. In 1849 it was settled and named Horsetown. The 36-acre town quickly became the principal mining town of southwestern Shasta County and was home to a population of over 1,000 during the height of the gold rush.

Duffy's Ditch, a principal branch of the Clear Creek Canal, brought water 40 miles from the North Fork of Cottonwood Creek along the southern ridge of Clear Creek to Horsetown in 1853. At one point, eleven hydraulic cannons, known at Little Giants, Giants or Monitors, were working in the Horsetown area. Much of the town was destroyed by fire in 1868.

Another noteworthy mine of the era was the Hardscrabble Mine located at the site of Piety Hill across Conger Gulch from the town of Igo. This hydraulic mine opened in 1853 and was worked until 1880. Over 600 Chinese laborers were used here and at Horsetown to build the ditches supplying water to the mines. By 1858, the white miners expelled the Chinese from the Horsetown mines.

Hydraulic mining was very effective but resulted in substantial contamination of the area's streams with silt and mercury. By 1883 hydraulic mining was outlawed with the passage of the Anti-Debris Act. As gold became harder to find, many miners turned to agriculture, becoming farmers, ranchers or orchardists. By 1897 copper became the number one mineral produced in Shasta County. Fumes from copper smelting at Keswick damaged orchards as far south as Anderson.

LOGGING

After mining, the timber industry is known as the "second" Shasta County industry. The enormous stands of trees in northern California were the source of raw materials for a flourishing timber industry which provided products to local citizens and the nation. With the increasing population of miners and settlers in the mid-1800's, lumber products were in great demand. Lumber was used in all types of construction and manufacturing, ranging from mine structures to businesses, houses, furniture, paper, industrial and domestic fuel, railroad ties, bridges, sidewalks, flumes and large trestles. At one time a flourishing timber economy provided over half of the jobs in the county and over 80 percent of its manufacturing employment.
Early harvesting occurred in the lowlands and foothills, with timber fallers using axes and hand-saws. The logs were moved with large wood-wheeled arches drawn by horses and oxen, or by water in flumes and rivers. Lumber was transported by wagon teams to water-powered sawmills.

The resource was so extensive, only the largest, clearest, and most accessible conifers were selected. Large Douglas-fir, found in the upper portion of the watershed, was the most valuable timber species.

As technological advances in logging equipment came about, harvesting methods utilized steam-powered machinery. This involved "steam donkeys" for moving logs to landing sites, where they were loaded onto wagons drawn by steam tractors. As sawmills converted to steam power, the expansion of sawmills increased, using waste wood for fuel. With increased demand for lumber, extensive railroad systems were developed, expanding into higher elevations. Steam locomotives could haul logs more efficiently than wagons, and sawmill products could be transported on major railways to larger cities.

The development of gasoline and diesel engines made the harvesting of timber easier. With gas-powered chain saws to cut trees, bulldozers to build roads and yard logs to landing sites, and trucks to haul the logs to sawmills, harvesting was expanded farther into steeper terrain. With increased machine efficiency, the railroad logging system was gradually abandoned.

The construction boom which accompanied and followed the Second World War greatly increased the rate of logging in northern California. During this period, the timber industry was interested in getting trees to market and the short-term view left little concern for fisheries, wildlife, soil erosion, and ecosystem health. Many stream channels were used as convenient paths to remove logs from the steep terrain. This method of log transport caused severe damage to the stability of many forest streams. Past logging activity has altered the vegetative composition and caused soil erosion rates to increase. These areas may not recover to their original forested condition in our lifetimes.

Prior to 1970, there was relatively little regulation to protect the forest resources. Between 1970 and 1973, legislation was passed increasing regulation. In 1973, the Z'Berg-Nejedly Forest Practice Act was adopted. This legislation provided resource protection and long-term productivity. Additional amendments have been added over the years making the California timber industry one of the most highly regulated forest businesses in the nation.

Extensive forest resources remain across northern California and concern for forest health is being stressed. Land owners and resource managers are giving more consideration to the environmental impacts of logging activities. With development and implementation of sustainable management practices, the future use of the forest resources will continue.

ISSUES AND CONCERNS

PUBLIC ISSUES AND SUGGESTIONS

The Western Shasta Resource conservation District (WSRCD) held public meetings on October 19, 1994, and June 21 and 24, 1995. The purpose of these meetings was to inform people of the pending watershed analysis and to solicit input and concerns from property owners and interested citizens. Below are consolidated lists of issues and concerns, as well as suggestions, brought up during the three public meetings (in no particular order).

Issues:

1. Property along the creek is gradually being converted to public ownership (by BLM and DFG) without sufficient law enforcement and without signed public access.
2. There is chronic misuse of the watershed; for example: fire starts, trash dumping, illegal shooting, drug dealing, long-term camping, trespassing, wildlife harassment by dogs, and uncontrolled use of ORV's and motorcycles.
3. There is a need to educate the public concerning private property rights, fire prevention and risk assessment, and catch and release fishing.
4. There is a need for watershed restoration projects which enhance salmon and steelhead fisheries and help landowners maintain resource values.
5. Landscape level planning is needed to manage biodiversity (fish, wildlife, oak woodlands). Planning should promote public/private partnerships and encourage a voluntary approach to use of coordinated databases and adaptive models.
6. McCormick-Saeltzer Dam has a negative impact on fisheries.

7. There are concerns that federal money would be better spent addressing non-resource related problems.

Suggestions:

1. Conduct an inventory of the watershed.
2. Find effective ways to use programs already available such as CCC's, state clean-up money, and the Adopt-a-Watershed Program.
3. Reduce or eliminate dump fees to reduce illegal dumping.
4. Purchase water rights to McCormick-Saeltzer Dam and remove it for free flowing passage of lower Clear Creek from the Sacramento River to Whiskeytown Dam.

Many of these issues are beyond the scope of a Watershed Analysis and cannot be resolved by the restoration projects that are recommended. However, they have been identified and can be addressed by appropriate planning, zoning, and regulatory agencies.

REGIONAL ISSUES

The watershed analysis team began discussions of issues by focusing on the entire region, with the realization that all the regional issues needed to be addressed before narrowing the discussion to watershed specific issues. Please see Appendix A for a list of the analysis team members and contributors. Below is a partial list of how lower Clear Creek relates to the upper Sacramento basin area.

1. Lower Clear Creek is an important anadromous stream within the upper Sacramento basin and also an important resident fishery.
2. Whiskeytown Dam provides hydroelectric power, flood control, and a steady municipal, industrial and agricultural water supply to the Central Valley.
3. Whiskeytown Reservoir is an important recreation destination for the region.
4. Land disturbing activities in lower Clear Creek watershed produce sediment impacts in the Sacramento River.
5. Whiskeytown and McCormick-Saeltzer Dams lessen gravel recruitment into the Sacramento River.
6. There is a significant loss of riparian habitats within the upper Sacramento basin which has had a negative impact on endangered plant and animal species, and candidate and listed species.
7. There is a continued boom in rural, residential, and industrial development in the north state.
8. Restoration of the fishery (both anadromous and resident) can provide employment, economic opportunities, and recreation dollars from Redding to the mouth of the Sacramento River.

INTERDISCIPLINARY TEAM ISSUES AND KEY QUESTIONS

The analysis team identified three issues specific to the lower Clear Creek watershed. These issues will be addressed and analyzed in greater detail in the following portions of this document. Key questions were developed to address these issues and the analysis and recommendations beginning in Chapter 2 will focus on these issue areas.

Issue 1

Clear Creek's natural instream flow has been disrupted due to damming and diversion at McCormick-Saeltzer Dam and Whiskeytown Dam. Anadromous fisheries in lower Clear Creek have declined due to disruption of instream flow and other impacts.

Key Questions

1. What areas of the watershed are currently exhibiting accelerated erosion and off-site sedimentation that is or could impair aquatic habitat and anadromous fish spawning and rearing? What impacts are occurring?

2. To what extent are existing roads and trails adversely affecting riparian resources, water quality, and fisheries?

3. What factors caused by damming Clear Creek have limited anadromous fish populations?

4. What actions can be taken to reverse the decline of anadromous fish in lower Clear Creek? What type of restoration projects, and to what extent, would be needed to restore the salmonid spawning and rearing habitat of lower Clear Creek?

5. How will possible actions to restore anadromous fish in lower Clear Creek affect resident fish, other aquatic species, indigenous riparian and terrestrial plants and animals, threatened & endangered species, and land use plans?

6. What are the possible riparian habitat restoration actions and biological benefits on lower Clear Creek?

7. What riparian boundaries will be used to protect fish and wildlife resources?

Issue 2

The natural fire regime has been interrupted from years of fire suppression, timber harvest, grazing, the introduction of exotic plant species and development.

Key Questions

1. What are the historic and current roles of fire in the Clear creek watershed? What is the effect of the lack of fire?

2. What wildfire control techniques are effective and compatible with our goal of minimizing sediment delivery into Clear Creek?

3. Where in the watershed will the effects of a high-intensity fire be most severe?

4. Where are the ignition sources and likely ignition points?

5. How would a high-intensity wildfire affect the watershed's hydrological integrity, anadromous fish habitat, sediment yield, and other resource concerns?

6. How long would the affects of a high-intensity wildfire be felt?

7. What kinds of erosion control activities are needed to control accelerated erosion and the sediment such sites generate? What are the long-term affects of these restoration efforts?

Issue 3

Consumptive land use practices in the watershed have led to several resource problems such as sedimentation, habitat loss, and disrupted the natural channels of the creek.

Key Questions

1. What are the trends of land uses that impact erosion and sediment delivery in the watershed? What is the potential for accelerated erosion and sediment from potential land uses?

2. What level of recreation would be consistent with restoration goals? Which type of physical infrastructure improvements would be needed to enhance the recreation value of the watershed?

3. What transportation network is necessary for resource management and fire control?

4. What type of parking should be provided along Clear Creek Road to provide access to the creek? What is the best way for pedestrians, equestrians, etc. to cross Clear Creek considering that the Clear Creek Bridge is narrow and traffic is heavy?

5. How does Whiskeytown Dam affect the lower watershed related to human use and water rights issues?

6. How will planned watershed restoration and fishery improvement activities impact current social conditions?

7. What values does society place on improved fishery habitat, safer fuel conditions, or public uses of land in the watershed?

8. What interest groups would support or oppose actions to improve natural resource conditions in the watershed? What are their main interests?

9. What changes would be needed in laws, policies, incentives, funding, social norms or other institutions in order to improve fishery habitat and decrease fuel loading? Would these changes be acceptable, equitable, and efficient?

Answers to these questions are found in Chapters two through four.

These key questions seem to be pointing to specific restoration products or other projects before the watershed processes are evaluated.

CHAPTER 2 - The Aquatic Domain

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CHAPTER 2 - The Aquatic Domain

INTRODUCTION TO THE AQUATIC DOMAIN

Chapter 2 is devoted to a description of the watershed's current and reference conditions as related to the Aquatic Domain. Included are natural disturbance events and regimes, processes, and human influences and values. The major factors involved in environmental changes through time are described following each resource section of this chapter. The latter portion of the chapter reiterates the issue and key questions related to the aquatic domain and provides answers to the key questions.

MAJOR ISSUE

Disruption of instream flow

Clear Creek's natural instream flow has been disrupted due to damming and diversion at McCormick-Saeltzer Dam and Whiskeytown Dam. Anadromous fisheries in lower Clear Creek have declined due to disruption of instream flow and other impacts.

HYDROLOGY - CURRENT CONDITIONS

GEOGRAPHIC SETTING

South Fork Mountain is the highest point in the watershed at 5,149 feet elevation. The mouth of Clear Creek at the Sacramento River is the lowest point at an elevation of 440 feet.

The lower Clear Creek watershed has been divided into 13 sub-watersheds, shown on Map 2-1. The largest sub-watershed is sub-watershed number 6, the South Fork of Clear Creek and Andrews Creek complex, containing 5,755 acres. The South Fork of Clear Creek is 18.4 miles long and enters Clear Creek near the Placer Road bridge. Andrews Creek enters the South Fork of Clear Creek 1.9 miles upstream from the confluence of the South Fork of Clear Creek and Clear Creek. The smallest sub-watershed is sub-watershed number 7, containing 882 acres, composed of two small, intermittent drainages in the west-central portion of the watershed. The remaining 11 sub-watersheds lie within this range, mostly between 1200 and 2300 acres. The watershed study area can be roughly divided into two zones by the Clear Creek Road Bridge. The eight sub-watersheds upstream from this bridge can be characterized as mountain sub-watersheds, whereas the five sub-watersheds below the bridge can be characterized as foothill or valley sub-watersheds. More information on sub-watersheds can be found in Chapter 3, Table 3-4.

CLIMATE

Generally, the climate of the lower Clear Creek Watershed is characterized by warm, dry summers and cool, wet winters. Average temperature and precipitation vary greatly within the watershed due largely to change in elevation. Climatic data from Redding is representative of the lower portion of the watershed. Average annual precipitation for Redding is 38.7 inches ranging from 14.9 inches to 67.8 inches. Average annual temperature is 63.2 degrees F. with lows and highs seasonally ranging from 17 to 114 degrees F. Snow is not uncommon but rarely persists in the lower elevations.

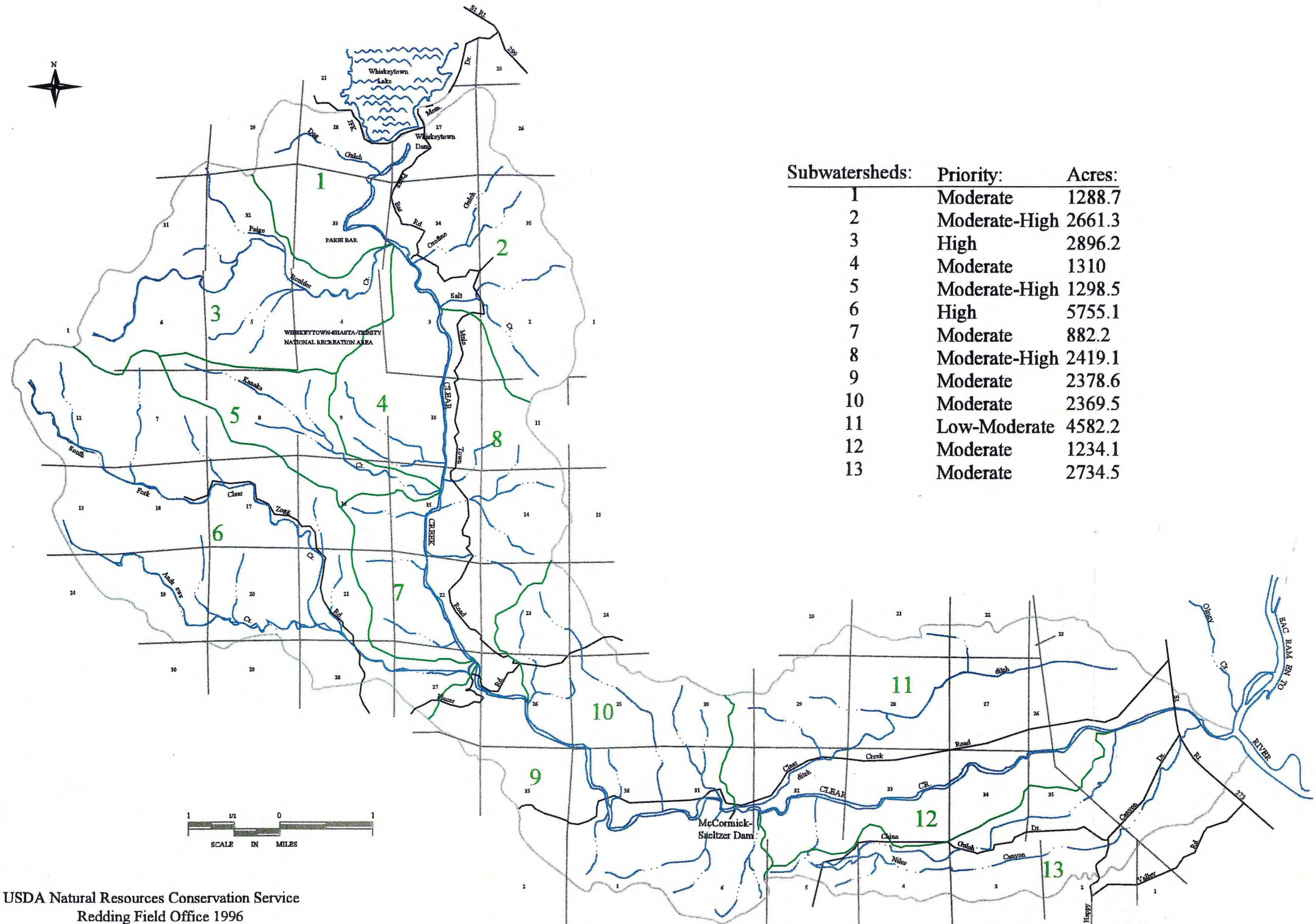
Climate data has been collected since 1964 at the headquarters for the Whiskeytown Unit of the National Recreation Area. These data include temperature, rainfall, wind speed and direction, cloud cover, and evaporation. Records are available at the Unit headquarters.

STREAM CONDITIONS

Within the analysis area, Lower Clear Creek consists of two general stream types: the lower reach has a lower gradient and the upper canyon-bound reach has a higher gradient. The lower reach has lost it's natural meander pattern. In places the stream runs in straight highly entrenched channels dug perhaps to facilitate gravel mining. Steep bluffs, composed of Riverbank and Red Bluff formations, occur where Clear Creek has cut into these formations and where hydraulic placer mining has historically occurred. For example, for a distance of several hundred yards immediately below McCormick-Saeltzer Dam, Clear Creek has cut a narrow canyon into the exposed metamorphic rocks of the Eastern Klamath Terrane. The lower reach also has areas where the stream channel has become braided due to past dredger-mining for gold and current gravel mining activities. This reach also contains sections of more natural riffle-pool sequences with alternating point bars, corresponding to Rosgen's "C" type stream morphology (Rosgen, 1994). Riparian vegetation (alder, willow and blackberry) has encroached on the stream channel in parts of the lower reach. In these areas, shrubby vegetation has grown right up to the water's edge. Large woody debris is not common in the stream channel. A few beaver dams exist in areas of channel braiding.

The upper reach runs fairly straight through steep sloped canyons. While there are some reaches with a more natural riparian area (e.g. the Paige Bar area), much of this reach has been altered by human activity. Soils tend to be thin and poorly developed. These soils are derived from metamorphic rock types and are clayey and rocky with erosion potentials ranging from slight to moderate. Those areas underlain by the Mule Mountain stock and Shasta Bally Batholith form "decomposed granite" types of sandy soils. These tend to be highly erosive when disturbed. In general, the upper reach is dominated by sections corresponding to Rosgen's "B" type stream morphology. The stream channel and surrounding stream bottom have been scoured down to bedrock many places. Little soil exists for the establishment of vegetation. Riparian vegetation consists primarily of willow

Map 2-1: Subwatersheds in the Lower Clear Creek Watershed



Subwatersheds:	Priority:	Acres:
1	Moderate	1288.7
2	Moderate-High	2661.3
3	High	2896.2
4	Moderate	1310
5	Moderate-High	1298.5
6	High	5755.1
7	Moderate	882.2
8	Moderate-High	2419.1
9	Moderate	2378.6
10	Moderate	2369.5
11	Low-Moderate	4582.2
12	Moderate	1234.1
13	Moderate	2734.5

USDA Natural Resources Conservation Service
Redding Field Office 1996

and alder, with little vegetation overhanging the stream channel. Instream structure is provided by boulders, because large woody debris is uncommon.

WATER QUANTITY

Hydroelectric water use associated with Whiskeytown Dam and Spring Creek Powerplant has reduced instream flows at the Igo gauge to 13 percent of average flows recorded from 1940 to 1963. Currently, a minimum flow of 100 cfs is released from Whiskeytown Reservoir during November and December, and 50 cfs is released the remainder of the year, for a total of 42,000 acre-feet per year. Pre-Whiskeytown Dam flows averaged 260,000 acre-feet per year.

The current flow regime encourages the growth of riparian vegetation right up to the water's edge. Flushing flows which remove vegetation are rare in the current flow regime. This vegetative encroachment on the stream has several negative effects including stream bed entrenchment, reduced channel width, increased velocity, reduction of shallow, near-shore habitat, and reduction of recreational opportunities. Entrenched streams have lower habitat diversity and complexity, which are important qualities for fish (Pelzman, 1973).

The Trinity River Division of the Central Valley Project (CVP) was authorized on August 12, 1955, to increase the supply of water available for irrigation and other beneficial uses in the Central Valley. Facilities were authorized for control and storage of water from Clear Creek and Trinity River flows. Hydroelectric powerplants and transmission facilities were authorized to furnish energy to the CVP and to Trinity County. The enacting legislation recognized that the operation of the Trinity facilities would be integrated and coordinated with the operation of other CVP features. The legislation also provided "appropriate measures to insure the preservation of fish and wildlife and the maintenance of the flow of lower Clear Creek."

Under the Trinity Division, Trinity River water is stored in Clair Engle Lake behind Trinity Dam. Releases from this reservoir are used to generated power at Trinity, Lewiston, Spring Creek, Judge Francis Carr, and Keswick Powerplants. Lewiston Dam regulates flows to meet the downstream requirement of the Trinity River Basin. The remainder of the Trinity River water is diverted to the Sacramento River, to provide irrigation service to lands in the Sacramento Valley and other areas of the CVP.

The mean annual inflow to Clair Engle Lake from the Trinity River is about 1.2 million acre feet (maf). As much as 90 percent of this inflow is diverted to the Central Valley (average annual diversion for the last 28 years has been 1.049 maf per USGS water records). Approximately half of the average annual inflow occurs from April through September as a result of snowmelt runoff. The operation of Clair Engle Lake is influenced by the need for hydroelectric power (produced in the cross-basin diversion of water) and water supply. Clair Engle Lake is operated to minimize releases to the Trinity River in excess of minimum fishery requirements while attempting to fill the lake by the end of

June. Storage in Clair Engle Lake is reduced to about 1.85 maf by November 1 annually to avoid spill and flood flows to the river. During the winter flood season, storage is regulated within the capacity of the five powerplants unless the Bureau of Reclamation (BOR) "Safety of Dams" criteria require excess releases.

The mean annual inflow to Whiskeytown Lake from the Trinity River is 1.049 maf. The mean annual inflow to Whiskeytown Lake from Clear Creek itself is approximately 260 thousand acre feet (kaf) (see table 2-1). Scheduled annual releases to lower Clear Creek are about 42 kaf, and average annual deliveries to the Clear Creek South Unit are 15 kaf. The remaining water supply is diverted through Spring Creek Powerplant to the Sacramento River. In the winter months, BOR lowers Whiskeytown Reservoir about 10 feet. This provides more flexibility in operating for higher inflow during rainfall events and also allows BOR to capture additional Clear Creek flow for water supply and power generation. There is no minimum pool requirement, however, benefits to maintaining a higher reservoir include: avoiding adverse impacts to the reservoir fishery, local water deliveries, reservoir recreation, power production through reduced head pressure, and flood control. BOR has a general agreement to not lower the Whiskeytown Reservoir below 1,198 feet except as required under extraordinary circumstances.

TABLE 2-1
ANNUAL FLOW OF LOWER CLEAR CREEK TO WHISKEYTOWN RESERVOIR
FOR PERIOD 1922-1991 IN ASCENDING RANK - THOUSANDS ACRE FEET (kaf)

YEAR	ANN. TOT.	YEAR	ANN. TOT.	YEAR	ANN. TOT.	YEAR	ANN. TOT.
1923-24	60.00	1936-37	133.00	1971-72	204.00	1970-71	366.00
1930-31	62.00	1975-76	139.00	1961-62	205.00	1924-25	378.00
1928-29	71.00	1963-64	141.00	1988-89	210.00	1941-42	383.00
1938-39	74.00	1984-85	150.00	1956-57	218.00	1974-75	394:00
1931-32	79.00	1934-35	152.00	1945-46	227.00	1926-27	396.00
1932-33	79.00	1925-26	154.00	1967-68	230.00	1966-67	396.00
1943-44	82.00	1927-28	157.00	1980-81	247.00	1969-70	411.00
1990-91	84.00	1935-36	158.00	1950-51	276.00	1937-38	426.00
1922-23	85.00	1942-43	158.00	1965-66	280.00	1968-69	435.00
1921-22	88.00	1959-60	161.00	1962-63	295.00	1955-56	446.00
1976-77	90.00	1944-45	162.00	1952-53	301.00	1972-73	456.00
1933-34	95.00	1987-88	171.00	1964-65	304.00	1981-82	482.00
1946-47	100.00	1947-48	179.00	1953-54	317.00	1939-40	512.00
1949-50	101.00	1978-79	188.00	1983-84	333.00	1977-78	580.00
1929-30	116.00	1948-49	196.00	1979-80	344.00	1957-58	688.00
1986-87	118.00	1958-59	196.00	1951-52	347.00	1940-41	693.00
1989-90	122.00	1960-61	**200.00	1985-86	364.00	1973-74	771.00
1954-55	130.00					1982-83	884.00

** Median Value 200.00 kaf   260.20 kaf is the Mean Value

Secretarial Decision. BOR has three agreements on Clear Creek that govern the releases from Whiskeytown Lake. A 1960 Memorandum of Understanding between the California Department of Fish and Game (DFG) and the U.S. Bureau of Reclamation (BOR) set the following minimum flows to be released to lower Clear Creek at Whiskeytown Dam (shown in Table 2-2).

TABLE 2-2
MINIMUM FLOWS TO LOWER CLEAR CREEK AT WHISKEYTOWN DAM

TIME PERIOD	MINIMUM FLOW (cfs)
Jan. 1 - Feb. 28,29	50
Mar. 1 - May 31	30
June. 1 - Sep. 30	0
Oct. 1 - Oct. 15	10
Oct. 16 - Oct. 31	30
Nov. 1 - Dec. 31	100

The 1960 agreement specifies that releases for fish and wildlife purposes will be added to amounts necessary to satisfy existing or recognized downstream water rights. Under their 1960 water agreement, Townsend Flat claimed a pre-1914 water right of 55 cfs to the natural flows of lower Clear Creek. Their diversion is made at McCormick-Saeltzer Dam, which is about 12 miles downstream from Whiskeytown Dam. G.E. Oakes claimed a riparian water right of 11 cfs. These are the legally specified minimum flows required under the permit with the State Water Resources Control Board.

In 1963, BOR discussed a tentative release schedule with the U.S. Fish and Wildlife Service (FWS) and the National Park Service to increase the annual releases from Whiskeytown Dam. This release schedule would enhance the recreational and fishery values for the Whiskeytown National Recreation Area (established in 1965 by an act of Congress). The release schedule provides for reduced releases in critical dry years as defined by Shasta inflow criteria. Although the release schedule was never formalized, BOR has operated according to the schedule since May 1963 (see Table 2-3 below) (USDI BOR, 1992).

TABLE 2-3
CURRENT RELEASE SCHEDULE
WHISKEYTOWN DAM

PERIOD	NORMAL YEAR cfs	CRITICAL YEAR cfs
Jan. 1 - Oct. 31	*50	30
Nov. 1 - Dec. 31	100	70

*The schedule and rates have fluctuated over the last few years up to 70 cfs to accommodate Redding's Whiskeytown Power Plant.

At Trinity Dam, a direct diversion of 4,500 cfs is permitted throughout the year under CVP water rights. No seasonal storage restriction exists at Clair Engle Lake. From November 1 through March 31, a direct diversion of 3,600 cfs is permitted at Whiskeytown Dam. Storage in Whiskeytown Lake from Clear Creek flow is only allowed during that same period. No seasonal storage restriction exists at Whiskeytown Lake. Whiskeytown Lake is drawn down 20,000 acre feet from full capacity (241,000 acre feet) annually during the flood season.

WATER QUALITY

Clear Creek is a major west side tributary of the Sacramento River. For salmon and steelhead to thrive in this stream system, the quality of the water must be within certain limits of temperature, turbidity, chemical purity, acidity, and oxygen content. General guidelines for environmental requirements for Chinook salmon and steelhead, including optimal and lethal temperatures, were presented in the CVPIA Doubling Plan working paper (FWS 1995; Vol. 2, section VI, p 39-44). The following temperatures (degrees Fahrenheit) are recommended for fish in Clear Creek:

TABLE 2-4
ENVIRONMENTAL REQUIREMENTS FOR
CHINOOK SALMON AND STEELHEAD

	Chinook Salmon	Steelhead
Upstream migration	51-67	-
Holding	<60	-
Spawning	<56	46-52
Incubation	<56	-
Rearing	53-64	55-60
Downstream Migration	-	44

At the existing low summer flow release of 50 cfs from Whiskeytown Dam, higher-than-suitable water temperatures occur in the lower reaches during most summer months, and maximum water temperatures occur during August. Peak water temperatures reached 60 degrees F at Paige Bar, 65 degrees F at Placer Road, 79 degrees F at Little Mill Road, and 82 degrees F at the mouth. These data show that the majority of water warming occurs between creek miles 8 and 5, where the stream exits from a steep, shaded canyon to an open, flat valley terrain.

Chemical analysis of the water revealed several heavy metals, including copper and zinc. These were not present as dissolved concentrations that are the toxic form of the metal. Dissolved metals could potentially be detrimental to fish life under certain conditions such as abnormally high acid concentrations.

Numerous samples taken on Clear Creek show that turbidity levels are relatively low and clearing after a storm is normally rapid. Whiskeytown Reservoir acts to reduce turbidity levels and sediment input to the creek. Also, most of the inflow to the reservoir comes from the Trinity River Diversion which is clear water, except when the Carr Tunnel is being sluiced.

Water samples collected from various depths in Whiskeytown Reservoir show dissolved oxygen levels in the normal range. The reservoir exhibits a typical temperature distribution relationship of decreasing temperature with increasing depth with the greatest temperature variation occurring during summer. In August, surface water temperatures reach a maximum of around 75 degrees F, with bottom temperatures of 52 degrees F at a depth of about 150 ft.. Flow releases to lower Clear Creek from the reservoir can be made from two outlets, one at elevation 972 ft.(238 ft. deep) and the other at elevation 1,110 ft. (100 ft. deep). Presently, BOR has the capability to release water from either outlet level. The release level can vary and is not necessarily simultaneously from both levels (on January 5, 1995, the release was being made from the upper level). BOR can operate for temperature considerations, but no real time temperature monitoring capabilities exist at the dam or downstream on Clear Creek. Changes are often made for turbidity considerations.

HYDROLOGY - REFERENCE CONDITIONS

Prior to the installation of the Whiskeytown Dam, high flow periods for Clear Creek normally fell between the months of November and May coinciding with rainfall and snowmelt runoff (see Table 2-5 following).

TABLE 2-5
MEAN MONTHLY FLOW TO WHISKEYTOWN RESERVOIR
IN THOUSANDS OF ACRE FEET (KAF) FOR THE PERIOD 1922-1991

MONTH	MEAN FLOW (KAF)	PERCENT
OCT.	4.66	1.7
NOV.	13.18	5.0
DEC.	26.18	10.0
JAN.	41.19	15.8
FEB.	50.66	19.4
MAR.	48.02	18.4
APR.	37.88	14.5
MAY	17.90	6.8
JUN.	8.85	3.3
JUL.	4.99	1.9
AUG.	3.34	1.2
SEP.	3.37	1.3
TOTAL	260.20	99.9

Highest mean daily flows and peak flow events most likely occurred between December and March. See Table 2-6. The highest recorded flow occurred on December 21, 1955 with a peak flow of 24,000 cfs. The highest flood flow since Whiskeytown Dam was completed was on March 3, 1983, with a flow of 19,200 cfs. A peak flow of 5,400 cfs (like that recorded January 10, 1995) has an estimated recurrence interval of about one in five years (State of California Department of Water Resources memo 3/7/95).

TABLE 2-6
STORM FLOWS ON LOWER CLEAR CREEK NEAR IGO
IN CUBIC FEET PER SECOND

DATE	MEAN DAILY FLOW	PEAK FLOW
Dec. 21, 1955	-	24,500
Dec. 22, 1964	5,450	9,940
Jan. 27, 1970	6,410	8,260
Jan. 16, 1974	3,510	8,430
Jan. 17, 1978	4,920	5,660
Mar. 3, 1983	15,000	19,200
Feb. 17, 1986	2,710	4,700
Jan. 20, 1993	3,000	6,960
Jan. 10, 1995	*4,350	*5,400

* Interim data

Prior to Whiskeytown Dam, occasional flooding flushed silt out of gravel and deposited new gravel and boulders which enhanced fish habitat. Periodic floods also remove encroaching riparian vegetation which trap and hold gravel in root mats, making construction of spawning redds difficult.

FACTORS INVOLVED IN CHANGE

WHISKEYTOWN DAM

Prior to Whiskeytown Dam, Clear Creek was one of two tributaries in the upper Sacramento River that could provide habitat for three races of salmon and steelhead. Historically, a regular flow of Clear Creek provided habitat and temperature requirements for fall-run and late fall-run Chinook salmon and to a lesser extent for spring-run salmon and steelhead. The latter two species are presently extirpated from the stream. Necessary temperatures for salmon and steelhead include 65 degrees Fahrenheit for juvenile rearing, 60 degrees Fahrenheit for holding of pre-spawning adults, and 56 degrees Fahrenheit for egg incubation. Stream conditions were suitable for:

1. Steelhead over-summer rearing of juveniles, and spawning and incubation in the foothill reach of the stream;
2. Spring-run Chinook habitat for over-summer holding of adults, and spawning and incubation in the foothill reach of the stream; and
3. Fall-run and late fall-run Chinook habitat for spawning, incubation, and juvenile rearing in the valley.

Lower Clear Creek is now a highly regulated stream system that presently receives less water at the Whiskeytown Dam site on an annual basis than it did during the worst drought on record. During the dry season a low flow regime raises water temperatures to levels lethal for adult and egg spring-run Chinook and sublethal for yearling steelhead (USGS Water Quality Records, DWR 1986, Aceituno, 1991). The warmer temperature regime favors the development of large populations of warm water predator fish known to feed on juvenile salmon and steelhead, such as black bass and squawfish.

The current flow regime also lacks a springtime flushing flow. This flushing flow removed harmful sediment deposits, prevented encroachment of riparian vegetation, maintained the proper channel configuration, distributed new spawning gravel throughout the stream bed, facilitated timely juvenile outmigration, and attracted adult spring-run and steelhead into the stream.

Whiskeytown Dam permanently eliminated approximately 12 miles of spring-run Chinook and steelhead habitat. Construction of the dam greatly reduced the recruitment of spawning gravel to the creek. This resulted in a 90 percent reduction in spawning habitat in the first ten miles below the dam as indicated by a comparison of pre-project and post project spawning gravel surveys (DWR 1986). In addition, the stream below the dam site was mined for dam building materials, including boulders and rubble during construction of Whiskeytown Dam. This also reduced the quality of the habitat in this reach.

The construction of Whiskeytown Dam also resulted in the blockage and inundation of approximately 12 miles of stream suitable for salmon spawning (Hanson, et al,1940). Surveys of the stream reach above Whiskeytown done in the 1950's indicated that less than one percent was suitable for spawning, yielding an estimated capacity to support a run of approximately 700 salmon (Hanson, et al, 1940). These surveys did note that the stream was impacted by mining wastes.

McCORMICK-SAELTZER DAM

The McCormick-Saeltzer Dam, constructed in 1903 for gold mining and later agriculture, is located approximately 10 miles downstream from Whiskeytown Dam. Water is diverted into the Townsend Flat water ditch under pre-1914 water rights and an additional water rights settlement contract with the BOR. The typical diversion rate is approximately 10 cfs. Most of the present service area has been subdivided for housing or mined for gravel leaving little beneficial use for the entire water right. The dam and diversion appear to be greatly oversized for the current water use serviced by the canal. McCormick-Saeltzer Dam is a partial barrier to fish passage that is further compounded by some difficult passage areas in the bedrock stream channel immediately below the dam. There are historic records of a salmon run above the town of Whiskeytown at the turn of the century (DFG 1956).

GRAVEL MINING

Approximately 12% of lower Clear Creek habitable by anadromous fish has been heavily mined for gravel. Another 10% of the stream is threatened by future instream mining. The adverse effects of instream gravel mining have been well documented (DWR 1986, DWR 1994). Specific problems on lower Clear Creek include:

1. formation of a highly unstable braided and pitted channel harmful to anadromous fish. The braided sections are shallow because they split the flow. Excavation pits entrap juvenile outmigrants when the water level fluctuates during spring storm periods. In addition, the excavation pits support large populations of predator fish, including bass and squawfish, that reduce the chances of juveniles escaping to the stream channel. During periods of high runoff the excavation pits also trap new gravel that comes from upstream areas making it unusable for fish spawning.
2. reduction of sufficient supplies of spawning gravel.
3. reduction of spawning riffles.

Mining outside the 100-year floodplain has no adverse effect on the anadromous fishery unless it causes erosion that could change the course of the stream channel by weakening the bank.

SEDIMENTATION AND URBANIZATION

Approximately one-third of the creek's watershed below the dam is comprised of decomposed granite soils (DWR 1986). Poor land use practices for timber harvest, residential development, mining, and road building on steep slopes and erosive soils below Whiskeytown Dam have led to serious sedimentation problems in spawning and rearing areas. These problems are compounded by Whiskeytown Dam's effect on reducing flushing flows and blocking gravel recruitment.

FISHERIES - CURRENT CONDITIONS

ANADROMOUS AND RESIDENT FISH HABITAT

Lower Clear Creek is now considered a "squawfish-sucker-hardhead" zone (Moyle 1984). This zone is characterized by low summer flows, deep rocky pools, and wide, shallow riffles. Restoration of salmon and steelhead populations in lower Clear Creek has been the focus of fishery management efforts for most of the Twentieth Century. Interest and concern regarding the status of salmon and steelhead in this stream began shortly after the construction of the McCormick-Saeltzer Dam, and has continued to the present. Early restoration efforts attempted to provide suitable adult fish passage at McCormick-Saeltzer Dam, but as watershed and instream habitats continued to decline, the need for additional habitat restoration efforts expanded. The cumulative effects of water export, gold mining, gravel extraction, logging, road building, residential development, and the construction of Whiskeytown Dam have contributed to the decline of the lower Clear Creek anadromous fishery. Only in recent years has there been a recognition of the complexity of the problem and a multi-agency cooperative effort to seek corrective actions designed to restore habitat and fish passage in lower Clear Creek. Local environmental groups and individuals have also been seeking solution to the problems limiting lower Clear Creek's fishery potential.

A major task of lower Clear Creek fishery restoration is to determine the flow needs (relationship between flow levels and the amount of fishery habitat available) for three target species: Chinook salmon, steelhead trout, and smallmouth bass. Salmon and steelhead were chosen with the objective of improving habitat conditions, while bass was selected to evaluate the possibilities of limiting their predation impacts on salmon and steelhead. The method used to make this determination in Clear Creek Fishery Study (Aceituno, 1985) is called the Instream Flow Incremental Methodology (IFIM). This model was developed by the US Fish and Wildlife Service Cooperative Instream Flow Service Group at Ft. Collins, CO. This methodology is commonly regarded among fisheries biologists as the most advanced and accurate means of predicting changes in the amount and quality of fish habitat resulting from various levels of stream flow.

The IFIM technique uses computer modeling to simulate stream system variations in fishery habitat at different flow release levels. Basically, it creates a computer model of the stream, using data collected at three different flow levels. These data define such stream characteristics as water depth and velocity, stream bottom composition (substrate), and fish cover. Additional data defining the range of stream conditions at which Chinook salmon, steelhead, and smallmouth bass are found through their various life phases (fish preference curves) are also supplied to the computer. The program then compares existing stream conditions at various flow levels with the range of conditions preferred by the target fish species at various life stages and calculates the amount of usable fishery habitat (called weighted usable habitat - WUH) available to these fish. The procedure is fairly complex and is continually being improved by the Instream Flow Group to more closely model actual stream conditions. A detailed description of the IFIM is contained in the US Fish and Wildlife publications listed in the References Chapter. Figures 2-1 through 2-4 give the results of this modeling for lower Clear Creek.

Due to lower Clear Creek's potential, the California Department of Fish and Game (DFG) currently manages for fall, late-fall, and spring-run Chinook salmon, and steelhead trout. The stream below McCormick-Saeltzer Dam is suitable for fall- and late-fall-run Chinook salmon but unsuitable for over-summering spring-run Chinook salmon or for year-round residence by steelhead. Conditions above the dam are suitable for steelhead and spring-run Chinook salmon. To optimize benefits for all anadromous species, fall-run salmon will not be allowed access to the upper reach above McCormick-Saeltzer Dam during spring-run spawning (Sept. 1 to Oct. 15). Experimental stocking of juvenile spring-run Chinook salmon below Whiskeytown Dam began in 1991 and continued for two additional years.

The fish ladder constructed at McCormick-Saeltzer Dam has never been effective at passing salmon or steelhead into the creek above McCormick-Saeltzer Dam. The DFG has modified the existing fish ladder several times, most recently in 1992. There is existing technology to provide effective passage over a dam the size of McCormick-Saeltzer, including four alternative designs currently being developed (Bates, 1991).

Spawning gravel in the lower Clear Creek drainage has been significantly depleted due to excessive mining. Recruitment of any new gravel into the area has been restricted by McCormick-Saeltzer and Whiskeytown dams. This has resulted in Shasta County adopting an ordinance in 1977 prohibiting new gravel mines in lower Clear Creek below McCormick-Saeltzer Dam. Although the future of this ordinance is uncertain, it presently constitutes the best protection of gravel for spawning and incubation. It does not, however, prohibit or limit existing gravel mining operation.

% Optimum Spawning Habitat by Discharge
Clear Cr. Rd. Bridge to Whiskeytown Dam (7.9 mi.)

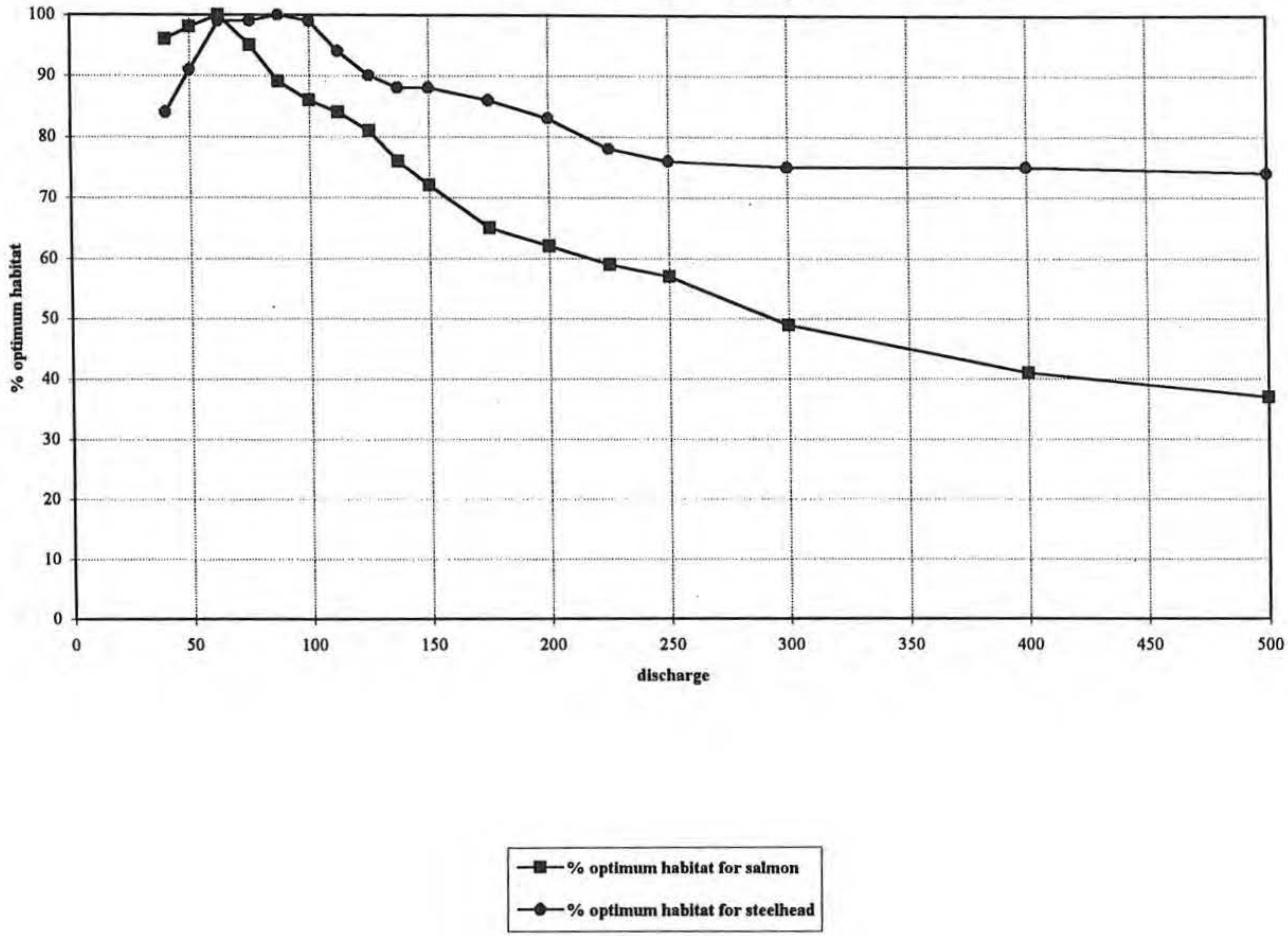


Figure 2-1

% Optimum Spawning Habitat by Discharge
Mouth to Saeltzer Dam (6 mi.)

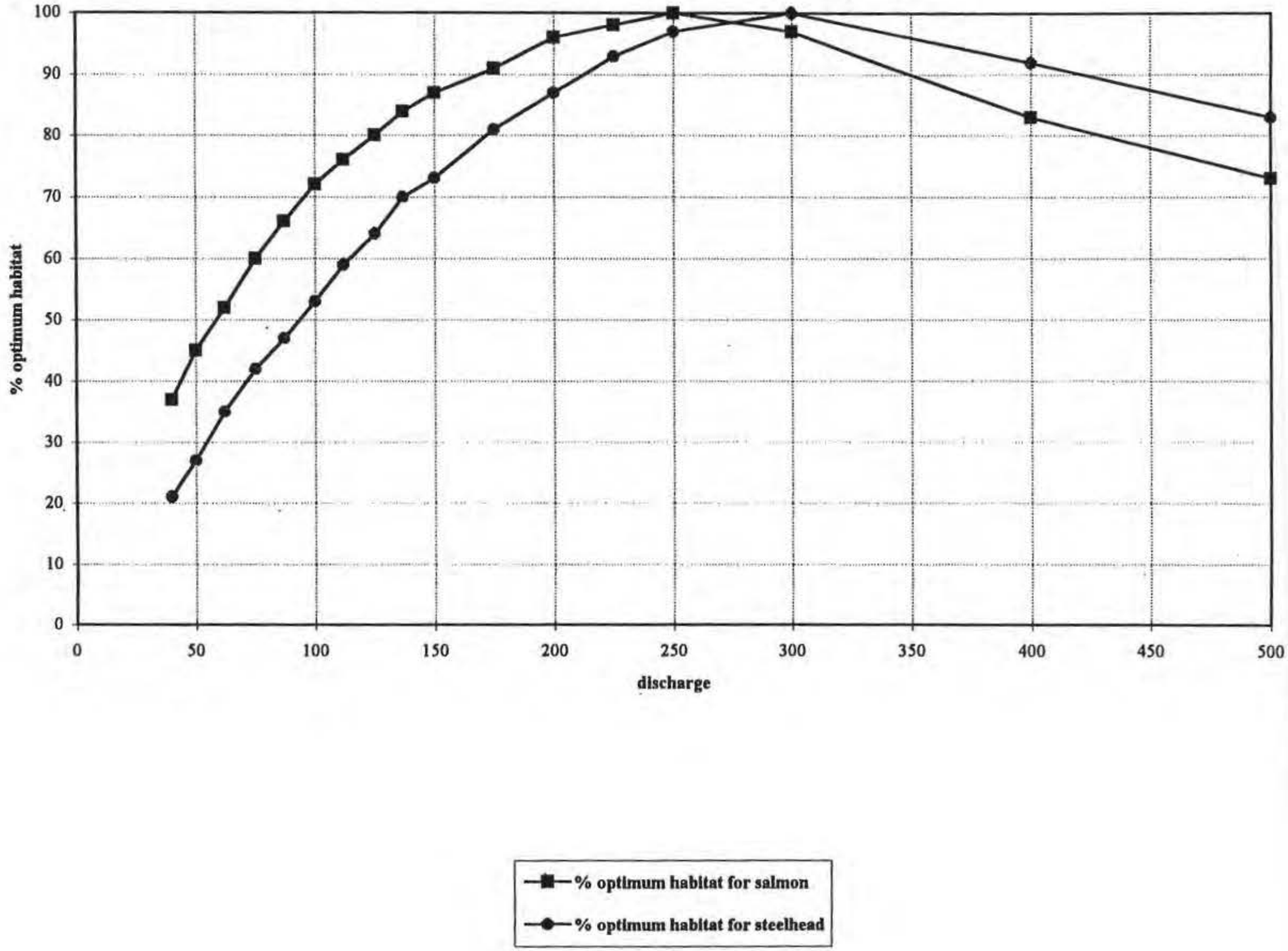


Figure 2-2

% Optimum Spawning Habitat by Discharge
Mouth to Whiskeytown Dam (16.5 mi.)

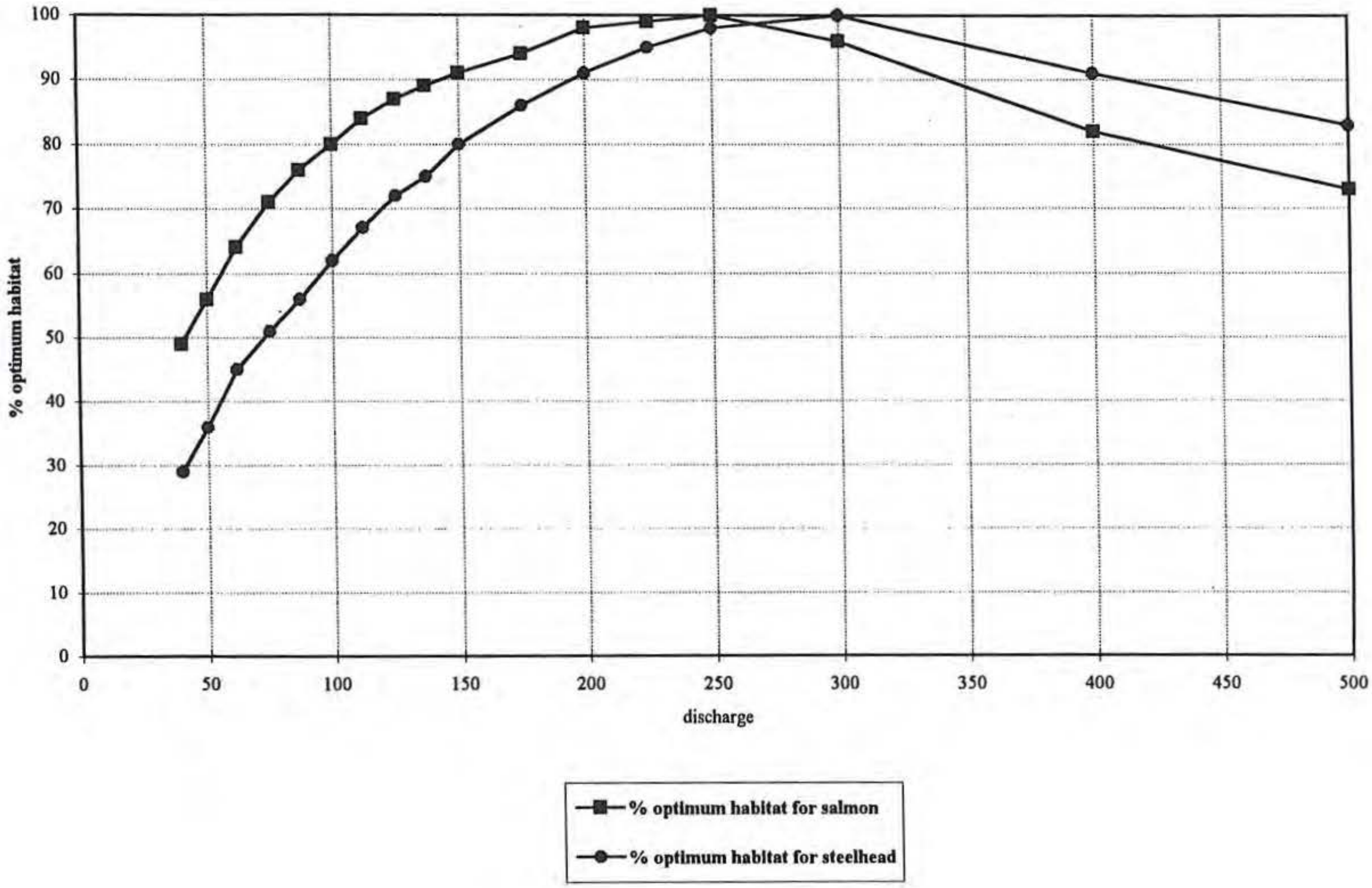
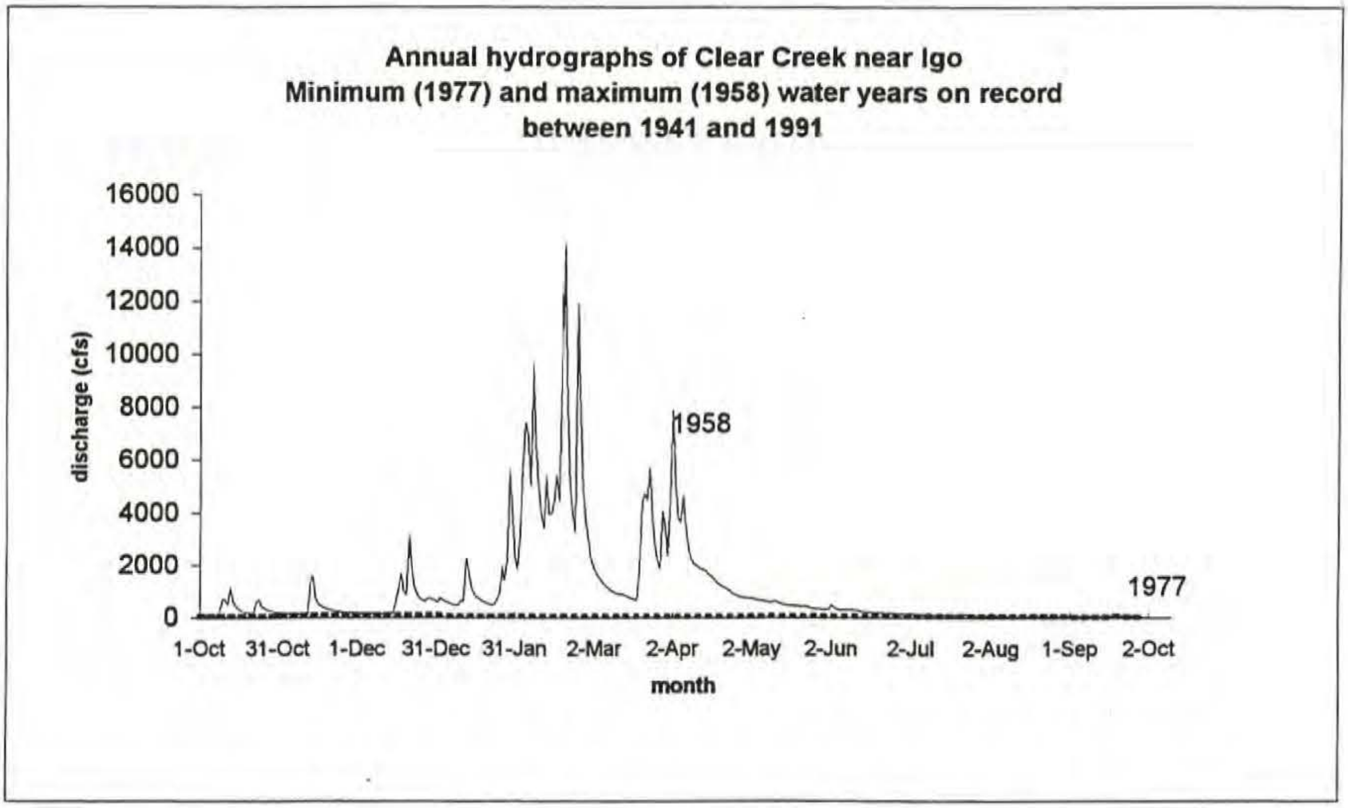
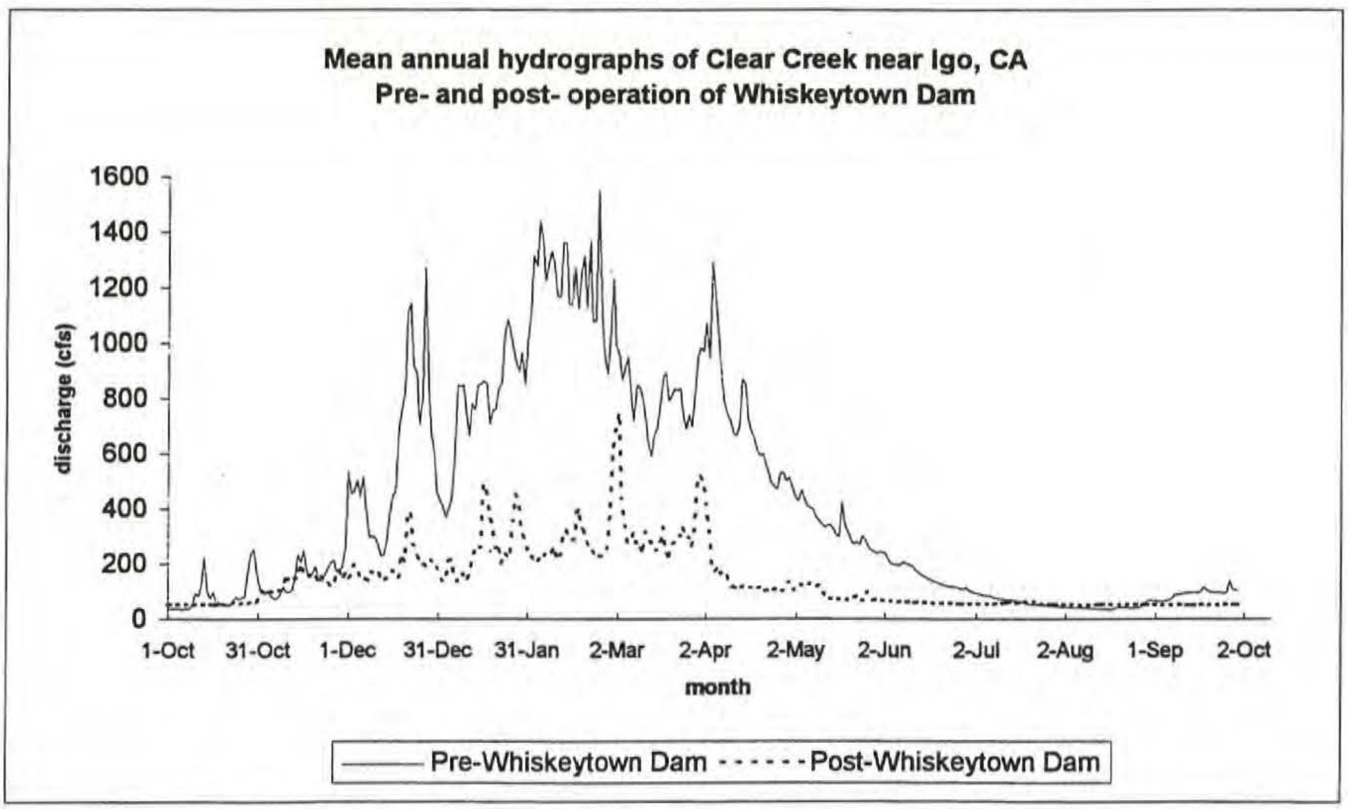


Figure 2-3

Figure 2-4



Annual hydrographs of Clear Creek near Igo
Minimum (1977) and maximum (1958) water years on record
between 1941 and 1991
16000
14000
12000
10000
8000
6000
4000
2000
0
discharge (cfs)
1958
1977
1-Oct 31-Oct 1-Dec 31-Dec 31-Jan 2-Mar 2-Apr 2-May 2-Jun 2-Jul 2-Aug 1-Sep 2-Oct
month



Mean annual hydrographs of Clear Creek near Igo, CA
Pre- and post- operation of Whiskeytown Dam
1600
1400
1200
1000
800
600
400
200
0
discharge (cfs)
1-Oct 31-Oct 1-Dec 31-Dec 31-Jan 2-Mar 2-Apr 2-May 2-Jun 2-Jul 2-Aug 1-Sep 2-Oct
month
Pre-Whiskeytown Dam
Post-Whiskeytown Dam

ANADROMOUS FISH STOCKS

Steelhead runs in lower Clear Creek are currently small because of the fish ladder at McCormick-Saeltzer Dam. The excessively high summer water temperatures also affect juveniles that must remain in freshwater their first summer before migrating to the ocean. Opportunity for increasing steelhead runs on tributaries to the Sacramento River is extremely limited. Few Sacramento River tributaries remain cool enough for steelhead juveniles during the summer.

Fall-run Chinook salmon spawning stock estimates from the mouth to McCormick-Saeltzer Dam for the period 1951-93 are shown in Table 2-7 below (from DWR, 1986 and Colleen Harvey, DFG personal communication). Survey techniques varied from year to year and included aerial survey redd counts, counts of fish planted from the Keswick fish trap, and carcass survey efforts of 2 to 23 trips. Missing years were either not surveyed or no estimate could be made.

TABLE 2-7
FALL-RUN CHINOOK SALMON SPAWNING STOCK ESTIMATE

YEAR	TOTAL	YEAR	TOTAL
1951	700	1968	800
1952	550	1969	1,240
1953	1,500	1976	1,013
1954	3,000	1977	1,362
1955	500	1978	60
1956	2,650	1981	3,672
1957	330	1982	785
1958	1,600	1984	4,000
1959	755	1985	700
1960	900	1988	4,453
1962	5,400	1989	2,154
1963	10,000	1990	799
1964	2,500	1991	2,027
1965	2,500	1992	600
1966	900	1993	1,246
1967	370	1994	2,486

OTHER FISH STOCKS

Twenty-two species of fishes were observed in surveys conducted in 1981 and 1982 (Villa, 1984) (see Table 2-8 below). Nine of these species are non-native. In addition to the 13 native species indicated in Table 2-8, river lamprey, brook lamprey, Sacramento splittail, and riffle sculpin probably inhabited lower Clear Creek prior to European settlement. The Sacramento splittail, once found at least as far north as Redding on the Sacramento River, has declined throughout its range and has been petitioned for listing as threatened under the Endangered Species Act. Splittail have declined due to human-induced hydrological changes in the Sacramento-San Joaquin estuary, severe drought years, introduced aquatic species, and loss of shallow water habitat to reclamation. Loss of slow velocity spawning and rearing habitats may be the primary reason for declines I the upper Sacramento River. The river lamprey and the hardhead are both species of special concern in California.

TABLE 2-8
FISHES OBSERVED IN LOWER CLEAR CREEK*

COMMON NAME	SCIENTIFIC NAME	ABOVE MCCORMICK-SAELTZER DAM	BELOW MCCORMICK-SAELTZER DAM
Pacific lamprey	*Lampetra Tridentata*	NF**	A**
Chinook salmon	*Oncorhynchus tshawytscha*	NF	C
Rainbow trout	*Salmo gairdneri*	C	U
Steelhead	*Salmo gairdneri gairdneri*	NF	U
Speckled dace	*Rhinichthys osculus*	A	U
Carp	*Cyprinus carpio*	C	A
California roach	*Lavinia symmetricus*	U	C
Hitch	*Lavinia exilicauda*	U	U
Hardhead	*Mylopharodon*	C	A
Sacramento squawfish	*Ptychocheilus grandis*	A	A
Sacramento sucker	*Catostomus occidentalis*	A	A
White catfish	*Ictalurus catus*	U	U
Black bullhead	*Ictalurus melas*	C	C
Brown bullhead	*Ictalurus nebulosus*	C	C
Mosquitofish	*Gambusia affinis*	A	A
Threespine stickleback	*Gasterosteus aculeatus*	C	C
Green sunfish	*Lepomis caynellus*	C	C
Bluegill	*Lepomis macrochirus*	A	A
Smallmouth bass	*Micropterus dolomieui*	C	C
Largemouth bass	*Micropterus salmoides*	C	C
Tule perch	*Hysterocarpus traski*	U	C
Prickly sculpin	*Cottus asper*	A	C

* Villa, 1984

** A = Abundant, C= Common, U= Uncommon, NF= Not Found

The most abundant non-game fishes found above McCormick-Saeltzer Dam were sucker, squawfish, and prickly sculpin, while the most abundant game species were rainbow trout and bluegill. Below the dam, the most abundant non-game fishes were sucker squawfish and hardhead, while bluegill and green sunfish were the most abundant resident game fish. Large and smallmouth bass were also present in large numbers.

FISHERIES - REFERENCE CONDITIONS

There are few records of fish abundance in Clear Creek prior to the 20th century. However, the abundance of anadromous fish was likely much greater before the 20th century. Prior to European settlement, Clear Creek probably supported three runs of Chinook salmon and one run of winter steelhead (anadromous rainbow trout). Spring-run Chinook spawned and probably reared in areas upstream of Whiskeytown Dam that are no longer accessible to anadromous fish. Both fall-run and late fall-run Chinook probably spawned in areas between the Sacramento River confluence and creek mile 8. Upstream of creek mile 8, lower Clear Creek enters a canyon-bound reach. This higher gradient reach does not have suitable gravel for Chinook and steelhead spawning. The reach above creek mile 8 supports a strong resident rainbow trout population. Fall-run and late fall-run Chinook currently can only spawn below creek mile 6, where most fish passage is blocked by McCormick-Saeltzer Dam. Only a handful of spring run Chinook have returned to the area above McCormick-Saeltzer Dam.

FACTORS INVOLVED IN CHANGE

MCCORMICK-SAELTZER AND WHISKEYTOWN DAMS

Whiskeytown Dam is a 282 ft high dam that has completely and permanently blocked fish and gravel recruitment and dramatically changed the flow regime in lower Clear Creek. McCormick-Saeltzer Dam is 15 ft high and has not permanently or completely blocked fish passage (provided an effective ladder is installed) or gravel recruitment.

The current flow regime below Whiskeytown Dam lacks a springtime flushing flow which previously accomplished removal of harmful sediment deposits, prevented encroachment of riparian vegetation, maintained the proper channel configuration, distributed new spawning gravel throughout the stream bed, facilitated timely juvenile outmigration, and attracted adult spring-run and steelhead into the stream.

Dense growth of riparian plants, especially willows, affects fish habitat by binding gravel. Binding the gravel makes redd digging difficult or impossible. Cattail and common tule have rhizomes that grow inward from the stream side, interlace, and secure a firm hold on the substrate. Dense growth of riparian vegetation also presents large root mats in the stream that slows the velocity of stream flow. Reduced stream flow increases sediment deposition and reduces gravel transport.

MINING

Mining in the stream channel has resulted in the existence of large gravel-extraction pits; the general absence of large gravel terraces; and, a relatively flat cross-section to the flood plain. Extraction pits trap and kill juvenile Chinook during high flows. The flattened flood plain allows lower Clear Creek to easily shift its course and become braided, straight and shallow.

Braided, straight and shallow streams are poor anadromous fish habitat because they:
1. inhibit fish passage. Adult salmon prefer to move upstream in water at least a foot deep. They have a hard time negotiating braided streams because they are led into channels that are not deep enough to pass. Downstream migration of juveniles may be slowed or blocked in braided streams.
2. lack habitat complexity required for the different life stages. These degraded streams have a) reduced pool habitat important for holding and staging, b) reduced cover for juveniles, c) reduced shaded riverine aquatic habitat that provides food inputs for juvenile salmonids and other fish; and d) reduced habitat for prey items such as invertebrates, and amphibians.
3. have higher temperatures, which can be lethal to salmon and steelhead. High temperatures can also slow growth that can lead to reduced survival in the ocean. Higher temperatures due to poor stream morphology can increase the amount of water needed to maintain the fishery making less available for other uses.
4. reduce food availability.
5. prevent the establishment of mature riparian plant communities.
6. do not move and sort sediment efficiently. Shallow slow-moving water contributes to smothered spawning habitat, armoring, and otherwise poor gravel quality.

RIPARIAN VEGETATION - CURRENT CONDITIONS

Riparian areas produce economic, social, and biological benefits. Economic benefits include: increases in property values and tax revenues, and increased expenditures by residents, managing agencies and tourists. Socially, riparian areas provide opportunities for hiking, bicycling, jogging, fishing, photography and picnicking as well as many other activities. Biologically, riparian areas provide critical habitat and migration corridors for many species of birds and mammals including several endangered and threatened species of fish and wildlife. Riparian vegetation also protects stream banks from erosion, provides shade, helps reduce water temperatures for fish, and provides a source of woody and organic material important for food and habitat needs.

The riparian habitat of the last 4 miles of lower Clear Creek to the confluence with the Sacramento River was typed by the California Department of Fish and Game as part of the Upper Sacramento Stream Corridor Protection Program. Descriptions are general to the entire upper Sacramento River. The typing of the plant communities is based on a classification system developed for the California Department of Fish and Game's Natural Diversity Database. The riparian plant communities that occur are listed and described below and displayed on Map 2-2 following the descriptions.

Riparian vegetation is very sparse in the upper portion of the watershed. Most riparian vegetation (approximately 90%) exists in the lower section already mapped. It is expected that one or more of the descriptions below will fit the riparian vegetation existing along lower Clear Creek and its' tributaries outside the area shown on the map. Acreage for mapped units is shown in Table 2-9 following. There were several small polygons amounting to 0.2 acres which appeared to be riparian vegetation but were not labeled.

TABLE 2-9
ACRES BY RIPARIAN VEGETATION TYPE

TYPE	AREA IN ACRES
Open Water	6.7
Gravel Bar	5.2
Mixed Forest	10.5
Marsh	0.6
Disturbed	26.7
Disturbed Riparian	141.8
Cottonwood Forest	2.5
Riparian Scrub	16.6
No Label	0.2

OPEN WATER

This mapping unit constitutes water, either standing or moving, and does not necessarily imply vegetation. Lower Clear Creek and several pools of standing water in mined areas make up this unit.

GRAVEL BAR

This mapping unit consists of gravel and sand bars either in open non-vegetated areas or gravel and sand bars that have several annual and short-lived perennial species of sun-loving herbs, grasses and sub-shrubs requiring this habitat. Bars reflect recent gravel deposition, but the new bars eventually will be colonized as meanders migrate downstream. This map unit is common in the lower Clear Creek watershed, especially below Clear Creek Road bridge. Large deposits of gravel can be found approximately 3-4 miles upstream from the confluence with the Sacramento River. These areas are described as tailings and placer diggings in the Shasta County Soil Survey (USDA, Soil Conservation Service, 1974). In lower Clear Creek, these areas can be long, parallel, steep ridges of cobblestones and gravel from 6 to 25 feet high and a few long narrow troughs 5 to 25 feet deep that are filled with water in winter. In most places this land type is not vegetated. However, thin stands of cottonwoods and willows may be found in some troughs.

GREAT VALLEY MIXED RIPARIAN FOREST

In the mixed riparian forest, neither willows nor cottonwoods dominate. In addition to these species, forests also contain a mixture of more upland, later successional species that may include valley oak, black walnut, Oregon white ash, tree of heaven (non native) and California sycamore. This map unit occurs only within 4 miles of the confluence of the Sacramento River.

MARSH LAND

Freshwater marshes are dominated by perennial emergent monocots 4-5 meters tall. Cover may be very high, approaching 100%. Cattails or tule usually are dominant, often forming monotypic swards that are sparingly punctuated with additional taxa such as sedges, cane (non native), or blue vervain.. These marshes are to be expected in oxbows or low areas in high-water channels, wherever water stands on the surface through most of the summer growing season. There may or may not be any open water associated with marshes. If there is open water, it will be in areas too deep for emergent aquatic plants. Marsh areas occur in three areas of the mapped portion of the watershed. Two occur within 500 feet of the creek and the third occurs approximately 2,000 feet north of the water's edge (please see map 2-2 following descriptions).

DISTURBED

This unit identifies areas that have undergone (and may still be undergoing) major disturbances and are now either completely devoid of riparian vegetation or contain only small remnants of it. The majority of this map unit occurs within a three-mile stretch just upstream from the confluence with the Sacramento River.

DISTURBED RIPARIAN

This unit is similar to the above, except that the disturbance occurred long ago and riparian vegetation has become re-established.

COTTONWOOD FOREST

This unit represents the earliest successional stage and if undisturbed, persists through all seral stages. These forests are dominated by Fremont cottonwood and one or more willow species. California grape is the only conspicuous vine. This riparian forest type can be found on fine-grained alluvial soils near perennial or early perennial streams that provide subsurface irrigation even when the channel is dry. These sites are inundated yearly during spring, resulting in annual input of nutrients, soil, and new germination sites. This unit occurs just upstream from the Highway 273 bridge and also near the Horsetown-Clear Creek Preserve.

RIPARIAN SCRUB

This unit consists of dense shrubby thickets dominated by several shrubby willow species. It may also contain cottonwood, alder, and ash species under 4 meters in height. Dense stands typically have little or no understory. Open stands usually have some herbaceous understory, typically dominated by introduced grasses such as Bermuda, ripgut brome, or other weedy species common in disturbed areas at low elevations. Larger trees may be present as scattered individuals. Willow scrub represents the earlier and drier phases of plant succession along the topographic-flood frequency-succession catena. This unit occurs throughout the riparian corridor, from the confluence to Whiskeytown Dam. In the lower part of the study area, it occurs in very wide, blocky areas. Upstream from Clear Creek Road bridge to Whiskeytown dam, it occurs as very narrow "stringers" adjacent to the creek.

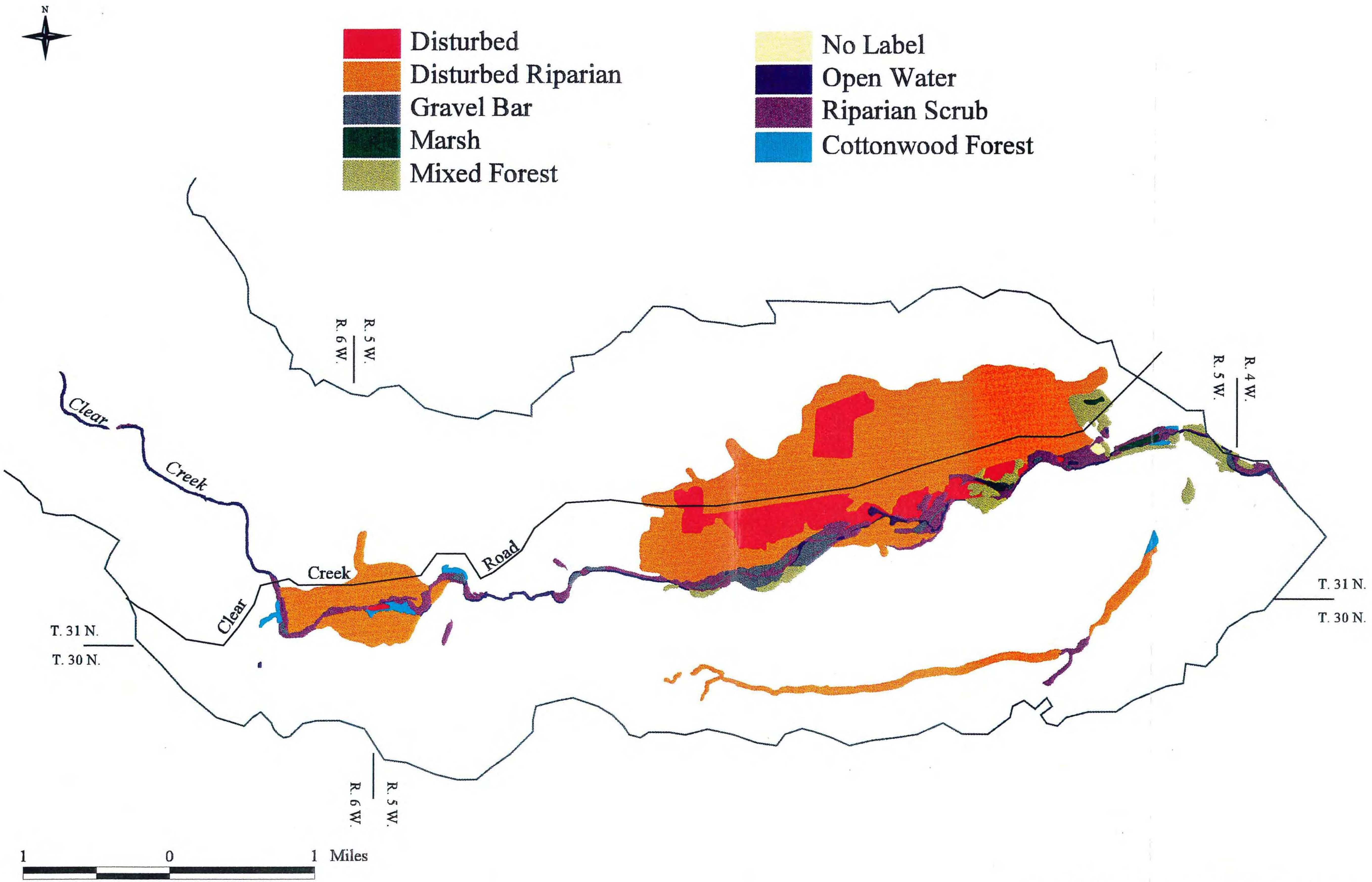
RIPARIAN VEGETATION - REFERENCE CONDITIONS

It is likely that the eight riparian vegetation types listed above have occurred in the lower Clear Creek watershed for centuries. However, one would expect that the acreage distribution was considerably different prior to gold and gravel mining and the building of Whiskeytown Dam. Prior to these activities, the riparian vegetation was disturbed by annual peak runoff events between December and April and 5 to 10 year flood cycles. Great Valley and Cottonwood forests were probably much more common. Gravel bar and Disturbed vegetation types were less common.

Lower Clear Creek has experienced encroachment of riparian vegetation along segments of stream banks and gravel bars since the creek was controlled by Whiskeytown Dam. Approximately seven years after the completion of Whiskeytown, lower Clear Creek riparian vegetation encroachment below McCormick-Saeltzer Dam was subjectively evaluated as moderate to heavy. Prior to Whiskeytown, little riparian encroachment was observed (Bureau of Reclamation, 1986).

FACTORS INVOLVED IN CHANGE

Encroachment of riparian vegetation on the stream channel in the lower reaches of Clear Creek is due to the altered flow regime created by Whiskeytown Dam. Steady summer flows have encouraged growth of alder, willow and Himalaya berry. The lack of flushing flows allows them to remain right up to the low flow waters edge. Tree cutting, prevention of normal seed dispersal by spring flooding, and loss of soil due to mining and logging are also among the factors that have resulted in the current size and distribution of the riparian vegetation community. Additional factors are the same as those discussed under Hydrology and Fisheries.



Map 2-2: Riparian Vegetation in the Southern Half of the Lower Clear Creek Watershed

USDA Natural Resources Conservation Service
Redding Field Office 1995

THE KEY ISSUE - AQUATIC DOMAIN

Clear Creek's natural instream flow has been disrupted due to damming and diversion at McCormick-Saeltzer Dam and Whiskeytown Dam. Anadromous fisheries in lower Clear Creek have declined due to disruption of instream flow and other impacts.

KEY QUESTIONS AND ANSWERS

1. What areas of the watershed are currently exhibiting accelerated erosion and off-site sedimentation that is or could impair aquatic habitat and anadromous fish spawning and rearing? What impacts are occurring?

Portions of the watershed with steep topography, highly erodable granitic soils, and moderate to high levels of disturbance are currently contributing most to the sediment problem. Those portions of the watershed of greatest concern in this regard are sub-watersheds 3 and 6 (see Table 3-3). These sub-watersheds are contributing substantial amounts of sand and silt to lower Clear Creek, resulting in infilling of gravels that could be used by salmon and steelhead for spawning, thereby reducing potential anadromous fish habitat. Sub-watersheds 2, 5, and 8 are also a concern in terms of erosion and sedimentation. A systematic erosion and sedimentation inventory would be required to more precisely quantify and prioritize the relative erosion and sedimentation rates from these sub-watersheds.

2. To what extent are existing roads and trails adversely affecting riparian resources, water quality, and fisheries?

Roads and trails are probably the main source of sediment for lower Clear Creek. Sedimentation is a result of deterioration of both active and abandoned roads, and surface runoff from inboard ditches, cut-banks, fill slopes and culvert run-out zones. An erosion control inventory (recommended in Chapter 6) would have to be completed to determine the extent of erosion from these and other sources.

3. What factors caused by damming Clear Creek have limited anadromous fish populations?

There are two dams on Lower Clear Creek that have limited anadromous fish population. Whiskeytown Dam is a 281 foot high structure that permanently blocked access to all the historical spring-run Chinook and steelhead habitat (approximately 12 stream miles of habitat); halted the transport of gravel bedload to downstream spawning areas and reduced the flow in the creek by 87 percent including the elimination of the large flushing flows necessary for maintaining the creek channel. all of these effects can be mitigated by operational changes.

McCormick-Saeltzer Dam is a 15 foot high structure that causes a fish passage problem because a proper fish ladder has never been installed. There is a minor diversion of water from the creek at this site that is to be supplied by releases from Whiskeytown Dam under water rights agreements. The passage problem can be solved by constructing an effective fish ladder.

4. What actions can be taken to reverse the decline of anadromous fish in lower Clear Creek? What type of restoration projects, and to what extent, would be needed to restore the salmonid spawning and rearing habitat of lower Clear Creek?

There are several actions which would reverse the decline of anadromous fish to lower Clear Creek, such as: A) Operating Whiskeytown Dam in a manner that provides suitable flow and temperature for three races of Chinook salmon (spring, fall and late fall runs) and steelhead. B) Adding gravel to the bedload of the stream below the blockage at Whiskeytown Dam, and eliminating the instream extraction of gravel below Whiskeytown Dam. C) Providing effective and durable fish passage at McCormick-Saeltzer Dam. D) Make land use practices compatible with salmon restoration by acquiring land in the watershed and implementing erosion control practices, the stream corridor protection plan and other appropriate land use planning.

5. How will possible actions to restore anadromous fish in lower Clear Creek affect resident fish, other aquatic species, indigenous riparian and terrestrial plants and animals, threatened & endangered species, and land use plans?

The actions to increase the productivity of the aquatic ecosystem, such as increased flow and distribution of anadromous fish above McCormick-Saeltzer Dam will benefit the health of river dependent wildlife species. Recreating a more natural flow regime with large flows in the spring will produce a more natural riparian community since the plants evolved re-seeding times and methods adapted to these types of flow regimes. There are no conceivable negative effects on threatened and endangered species that will benefit from the abundant food supply created by the salmon, such as the bald eagle, and from the maintenance of open space in the watershed as a result of the efforts to create a protected stream corridor and parkway.

6. What are the possible riparian habitat restoration actions and biological benefits on lower Clear Creek?

Providing a flow regime that includes the pattern of flows that riparian vegetation evolved under will establish a more diverse vegetative community with more diverse canopy heights. Providing the high spring flows during the seeding time for riparian tree species will locate seedlings on higher terraces where they can grow out of the range of severe scouring flood flows. In addition, reclamation of the 12 percent of the stream channel subjected to severe gravel mining activities will establish stable stream course that still maintains a diverse riparian community. Providing a stable and diverse riparian habitat benefits all types of fish and wildlife.

7. What riparian boundaries will be used to protect fish and wildlife resources?

Riparian boundaries set in the ROD will be the minimum boundaries on BLM and possibly NPS land. The ROD guidelines provided a greater reserve area than the stream corridor protection plan. No attempt was made in this watershed analysis to determine the appropriateness of the ROD guidelines.

CHAPTER 3 - The Terrestrial Domain

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CHAPTER 3 - The Terrestrial Domain

INTRODUCTION TO THE TERRESTRIAL DOMAIN

MAJOR ISSUE

Disruption of the natural fire regime

The natural fire regime has been interrupted from years of fire suppression, timber harvest, grazing, the introduction of exotic plant species and development.

AIR QUALITY - CURRENT AND REFERENCE CONDITIONS

The Clean Air Act is the primary legal instrument for air resource management. It establishes a strategy of managing widespread air pollution to maintain standards for ambient air quality. Particulate matter and specifically Pm-10 (particulate matter exceeding a threshold of 10 microns or larger), is a primary focus of regulation under this law. Pm-10 is measured in tons per day (NPS, 1994). Ninety percent of the total mass emitted from wildfires is water and carbon dioxide, neither of which are classified as a pollutant. Therefore, Pm-10 is the most important category of pollutant from fire. These particles are the major cause of reduced visibility, and are also a respiratory irritant (Prescribed Fire and Fire Effects Working Team, 1985).

Under some state implementation plans, Pm-10 standards can be exceeded easily by even low particulate levels generated by small prescribed natural fires and management-ignited prescribed fires. Management-ignited prescribed fires conducted to restore or maintain ecological integrity, reduce fuel loading, or forest health may be regulated under the same restrictions used for agricultural such as rice stubble burning.

Although air quality in the lower Clear Creek watershed is comparable to or slightly better than that of the rest of the upper Sacramento Valley, a few minor concerns exist. These concerns mainly arise from industrial sites in the lower watershed. According to the Shasta County Resource Management Department, Air Quality Management District (AQMD), gravel and sand production in the lower watershed, as well as the sawmills in this area increase fugitive dust in the airshed around lower Clear Creek. In addition, local residents complain about asphalt odors from the manufacture of rubberized asphalt at the sand and gravel plants.

Overall, the AQMD states that Pm-10 values in the lower Clear Creek area have been improving over the last several years. Much of this improvement could be attributed to the conversion of the Redding Power Plant to natural gas. Conversely, automobile traffic, control burns, and wildfires increase air pollution in the area.

Officials at AQMD state that it would benefit air quality in the lower Clear Creek area if excess vegetative fuels from the watershed were removed manually and burned in a co-generation plant. This action would result in cleaner combustion than disposal of these fuels through prescribed burning or wildfire, which have the potential to greatly increase air quality problems.

FIRE - CURRENT CONDITIONS

ABSENCE OF THE NATURAL FIRE REGIME

In general, fire is less prevalent on today's landscapes than in prehistoric times, due to effective fire control policies and the subsequent alteration of the natural fire regime. Ironically, success in fire suppression has allowed for more uniform and increased fuel loading across the landscape, shifting forest fire effects from low and moderate severity in historic fires to more severe effects today.

Today, dense thickets of trees have developed in many parts of the watershed. Grass has been reduced, and dry branches and needles have accumulated to such an extent that any fire is likely to be a stand replacing fire.

Some results of the absence of fire include the following:

1. increase potential for catastrophic fire.
2. widespread decadence and stagnation of the communities.
3. decline of the species that require fire to germinate.
4. decline in overall plant diversity.
5. increased potential for severe erosion after catastrophic fire.

INCREASE IN POPULATION IN THE WATERSHED

The population of the Redding area increased 58% from 1980 to 1990. During this time period the population of rural areas of the watershed also increased. The public's attitude about fires is largely dependent upon the impacts of fire on private property. While people move to these rural areas for the scenery, clean air and water, abundant vegetation, and slower pace of life, wildfire negatively impacts all of these amenities. More people also have been using these areas for recreation. This increased use leads to more accidental fires. Thus, the public acceptance of the shift in policy from immediate suppression of all fires to the use of fire as a management tool has been slow because of the effectiveness of earlier campaigns in convincing the public that all fires should be immediately suppressed. The way in which fires are suppressed has also changed dramatically. In the recent past, fires were controlled by hand. Today, there are fire fighters on call to fight fires along with engines, power tools, heavy machinery, and aircraft.

VEGETATIVE SPECIES COMPOSITION CHANGES RELATED TO FIRE

Fire exclusion since the early 1900's has left the vegetation on most parts of the watershed very dense and "fire ladders" within the vegetation communities well-developed. For example, the upper watershed is characterized by a mixed conifer overstory and a dense cover of understory shrubs. This distinct layered structure of the vegetation results in high fuel loads. The vegetative communities in the upper watershed are at climax, in most cases. Primary succession following disturbances such as fire begins with a dense shrubby stage dominated by taller broad-leaved species. The stand gradually increases in height, simultaneously developing into two canopy strata with faster growing conifers above and broad-leaved species below (McDonald 1980). Secondary succession following disturbance is vigorous, with shrubs and trees regenerating together. The conifer component develops into relatively large, mature trees within 30-50 years. The broad-leaved component normally requires 60-90 years. Eventually, the conifer component should dominate the broad-leaved component in most parts of the watershed.

Griffin (1976) described areas similar to the area near the confluence of the Sacramento River containing valley oak communities. He found that the current absence of low intensity surface fires encourage the invasion of evergreen oaks and gray pine. Young valley oaks will sprout when fire damaged. Given natural perturbations such as fire, and assuming successful regeneration of valley oaks, this community would probably remain the climax community. Some traits that enable this vegetation to regenerate after a fire include: bud protection and sprouting; on-plant seed storage; in-soil seed storage; and fire-stimulated germination.

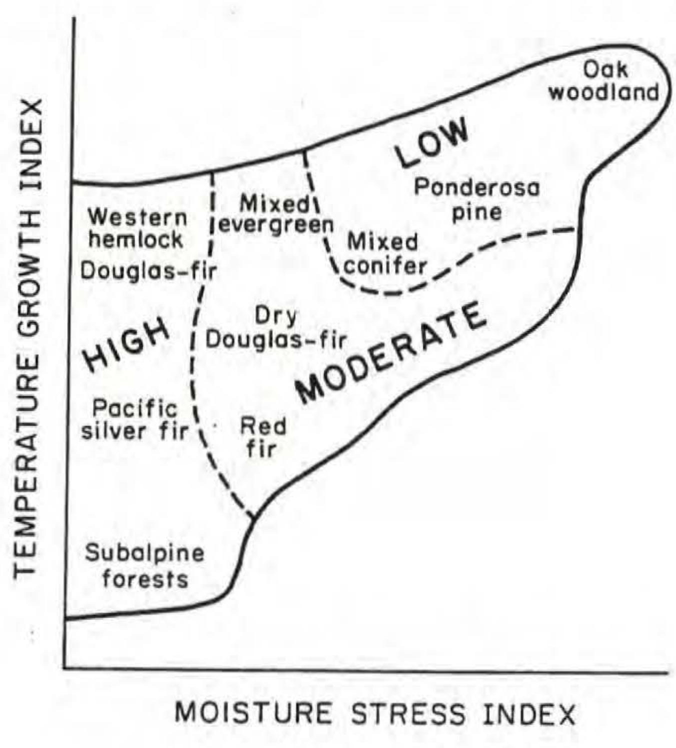
FIRE - REFERENCE CONDITIONS

Fires have burned through the area for thousands of years, as evidenced by pollen and charcoal deposits from early forests, fire scars on trees, analysis of stand age classes, and early settler and explorer accounts. Native Americans also used fires to increase the yield of desired seeds and vegetable foods, to drive game, facilitate the collection of seeds, improve visibility, and reduce populations of perceived pests, like snakes.

Fires left impressions not only on early visitors but also on the vegetation. Fire frequency and extent can be deduced from such evidence as stand age class distribution, fire scars on tree boles, or in the rings of tree stumps. In some cases, the age of fire-dependent trees stands can be a measure of fire severity. Fire scars are the most valuable means of determining fire history when fires are frequent but of low severity. Age class analysis of stands across the landscape is most valuable when fire history consists of infrequent but high-severity fires. Both techniques are valuable in studying the fire history of forests in the watershed because both types of fires were historically dominant in different forest types. Where fires of similar frequency, severity, and extent occur, such forests are said to have similar fire regime. Fire regimes are a function of growing environment (temperature and moisture patterns), ignition pattern (lightning, human), and plant species characteristics present in the area. Conifer cross sections extracted from mature Shasta Bally ponderosa pines northwest of lower Clear Creek suggest that fire recurrence historically averaged 13.5 years (Johnson, 1980). This average is based upon fire scars found within a 200 year growth increment.

Fire regimes of the Pacific Northwest are shown in Figure 3-1 below (Agee 1981). The figure accounts for all moisture regimes along which all Pacific Northwest Forests can be found. The two general types of vegetation communities that occur in the lower Clear Creek watershed are oak woodland and mixed conifer forests. Based on the figure by Agee, these two communities occur within the low-severity regimes in comparison to all Pacific Northwest Forests. In this low-severity fire regime, low-intensity fires are frequent (1-25 year recurrence) with few overstory effects. Fire regimes for the vegetation communities have also been characterized by Wright (1978). He states the average fire recurrence frequency in pre-settlement ponderosa pine forests varied from 2-19 years throughout its range. Also, Sweeney (1957) has suggested a recurrence frequency of 20-25 years for manzanita in Northern California below 4,000 feet. Above 4,000 feet, recurrence frequencies may be as high as 50-100 years (Vogl and Schorr, 1972).

FIGURE 3-1 SEVERITY OF FIRE REGIMES IN THE PACIFIC NORTHWEST



EFFECTS OF FIRE SUPPRESSION ON THE NATURAL FIRE REGIME

Most forest and many shrub and savanna ecosystems have adapted to or are dependent on fire to maintain their long-term stability. Fire helps to sustain these ecosystems in the following ways:

1. Fires help to select the type of plants that grow in these communities and fosters diversity.
2. Fire creates conditions necessary for regeneration of many fire-adapted species.
3. Fire regulates the amount of fuel that accumulates so that the timing, burning pattern and intensity of wildfire remain within the normal range of variability.
4. Fire controls nutrient cycles and energy balance in these systems.
5. Fire encourages the growth of young shrubs and promotes species diversity needed for wildlife habitat.
6. Fire maintains insect and disease populations at endemic levels.

EFFECTS OF FIRE ON VEGETATIVE COMMUNITIES

Fire has had a major influence on many of the species and plant communities that occur in the lower Clear Creek watershed. Many of these species have evolved and co-existed with fire for many years and are either dependent on fire or have adapted to the natural fire regime associated with the watershed. An example of the adaptation to fire is the ability for many of these species to sprout from the root crown after a fire. Other species require scarification of the seed to break dormancy and allow germination (Hanes 1977). All plant communities in the lower Clear Creek watershed are dependent on fire either directly or indirectly. The natural fire frequency tends to invigorate some species, and reduces fuel loading which reduces the intensity of fire even during extreme fire conditions.

Historical vegetation communities in the watershed are assumed to have been very different from today's conditions. Lewis (1973) describes that fire was used to reduce brush cover to favor a park-like area of grasses, trees, and intermittent stands of brush within the woodland-grass belt of the state. The maintenance of a youthful stage of succession provided a favorable environment for deer and other plants and animals. Following fires, mature chaparral (found in the upper watershed) may have been "softened" by a dramatic growth of early successional species of grasses and forbs, along with the rapid re-growth of sprouts from many species of chaparral. These new sprouts, especially herbaceous species, provide food for browsing animals and a renewed life cycle for plants.

Historical mixed conifer communities in the watershed have been described as open and park-like forests arranged in a mosaic of discrete groups, each containing 10-30 trees of a common age. Small numbers of saplings were dispersed among the mature pines, and luxuriant grasses carpeted the forest floor. Fires, when they occurred, were easily controlled and seldom killed a whole stand. These frequent surface fires were set by lightning or Native Americans. The forests were in a stable equilibrium, immune to extensive crown fires. Low-intensity fires were a natural feature of mountain environments and frequent burning prevented long-term destruction by wildfire at some later time. The general effect of this fire regime was to check succession, reduce competition, and remove aged and diseased trees.

FACTORS INVOLVED IN CHANGE

COMPARISONS OF PREHISTORIC AND CURRENT FIRES

The importance of fire as an ecological factor in our local forests is clear. The role of fire differs considerably from one forest type to another, but whether the last fire occurred in 1980 or in 1480, that role is reflected in the structure of current forests. Few of today's forests are managed for natural conditions such as those created by fires of the past, yet fire can be used to achieve socially desirable conditions for a variety of purposes: site preparation for commercial forest regeneration, forest stand management, park management, wildlife habitat, range improvement, fuel reduction, etc. A comparison of the prehistoric and current roles of fire can place today's uses of fire in perspective. Generally, today's fires are smaller in acreage, burning only about 30% of the average annual area burned in prehistoric times. However, today's fires often burn with a higher intensity, reducing forested areas to bare ground.

GEOLOGY - CURRENT CONDITIONS

BEDROCK AND SURFICIAL GEOLOGY

This watershed occurs at the intersection of two distinct geologic and geographic provinces of northern California. These provinces are: (1) the Klamath Mountains, a complicated basement consisting of Paleozoic and Mesozoic oceanic and island arc terranes unconformably overlain by shallow to deep marine Lower Cretaceous sedimentary rocks of the Great Valley: and, (2) the Great Valley, a forearc basin filled with a thick sequence of shallow to deep marine sedimentary rocks and sediments of the Jurassic to Recent age; also overlaying a composite basement of Mesozoic Coast Range ophiolite on the west, and a granitic and metamorphic Sierran basement on the east.

The northern portion of the lower Clear Creek watershed occurs within the Eastern Klamath Terrane of the Klamath Mountains geologic province, while the southeastern portion occurs in the Great Valley geologic province. The Eastern Klamath Terrane consists of island-arc volcanic rocks plus intercalated sedimentary rocks of Devonian through Middle Jurassic age. This terrane forms an eastwardly plunging, homoclinal, and internally deformed sequence which is overlain to the east and south, with a great angular unconformity, by Cretaceous sedimentary strata and unconsolidated sediments of the Great Valley sequence. The southeastern portion of the watershed is almost exclusively within the Great Valley sequence.

The following description of the watershed is divided into the "upper" watershed, from Whiskeytown Dam to Reading Bar, and the "lower" watershed, from Reading Bar down to the confluence with the Sacramento River. This division roughly corresponds to the watershed's location in the two separate geologic/geographic provinces.

The major geologic formations within the watershed have been mapped and described by Fraticelli, et al (1987), and are as follows, from oldest to youngest:

Eastern Klamath Terrane

Copley Greenstone - Mostly keratophyte and subordinate spilite pillow lavas (altered andesite and basalt, respectively, in which the feldspars are albitized and the ferromagnesian minerals are altered to chlorite), and volcanic breccia, with lesser quantities of metaandesites and metabasalts. This formation is typically light to dark green, massive and locally schistose. It is locally interlayered and intruded by the Balaklala Rhyolite, which is probably Devonian in age. This formation is exposed in the upper watershed along Clear Creek and generally on the watershed's western side.

Balaklala Rhyolite - Devonian in age silicic flows, breccia, and tuff, with smaller quantities of dikes and mafic flows. All of the rocks are intensely albitized. Fresh flow rock is typically very hard, siliceous in appearance, and light green or gray. It is also very fine-grained and contains phenocrysts of quartz or feldspar that vary in abundance and size between flows. It is considered to be a cogenitic extrusive equivalent of the Mule Mountain Stock, with portions of the rhyolite intruded by the stock. An outcrop occurs in an area from Whiskeytown Dam to about one mile south, and as large scattered lenses within the Copley Greenstone further downstream.

Mule Mountain Stock - A highly altered, megascopically crystalline igneous intrusive body consisting of trondhjemite, albite granite, and quartz granite. This granitic rock is characterized by numerous quartz veins two inches to several feet thick, and by less abundant dikes of aplite. Its crystal size is medium to fine and is composed of quartz, epidote, chlorite and sodic plagioclase. It has been dated using U/Pb isotopic ratios and is 400 million years old, which makes it Devonian in age. This formation underlies and is exposed in the majority of the northeastern portion of the upper watershed.

Shasta Bally Batholith - Composed of quartz diorite and granodiorite, this large intrusive body has been dated at 136 million years old, making it early Cretaceous in age. It also includes other small plutons of similar composition and age, such as the Clear Creek Pluton. The crystal size within this batholith is generally coarse-grained and composed of quartz, hornblende, biotite, and plagioclase feldspar. The vast majority of the western side of the upper watershed is underlain by this erosive formation. The Clear Creek Pluton measures one by one and a half miles in size, and is centered just south of the Stony Gulch-Clear Creek confluence.

Great Valley Sequence

Undivided Sedimentary Rocks - Consists of Cretaceous in age sandstone and conglomerate. Not mapped by Fraticelli, et al, but shown by others (Hollister & Evans, 1965, and Albers, et al, 1964) to crop out in small areas, mostly on the north side of the lower watershed and near the junction of the two watersheds.

Tehama Formation - Pliocene in age, pale green, gray, and tan sandstone and siltstone with lenses of crossbedded pebble and cobble conglomerate. Occurs on both sides of the lower watershed.

Nomlaki Tuff - Lowermost member of the Tehama Formation, this white or light gray dacitic pumice tuff and pumice lapilli tuff has limited exposure on the north side of the lower watershed. Thickness varies in this area from three to 30 feet.

Red Bluff Formation - A thin veneer of distinctive, highly weathered, bright red gravel deposit overlying the Tehama Formation. This formation has been interpreted as a Pleistocene sedimentary cover on a piedmont surface. The Red Bluff Formation caps the dissected ridges of the southern edge of the lower watershed and the west side of the watershed near the joining of the upper and lower portions.

Riverbank Formation - Pleistocene in age, weathered reddish gravel, sand, and silt, forming alluvial terraces and fans. This formation occurs in two areas: on the south side of the east end of the lower watershed; and on the north side of the boundary area between the upper and lower watersheds.

Overbank Formation - Holocene in age, sand, silt, and minor lenses of gravel deposited by floods and during high water stages. Occurs along the entire length of Clear Creek in the lower watershed and on the north side of the east end of the lower watershed.

Alluvium and Overbank Deposits, Undivided - Deposits of Overbank Formation and unconsolidated silt, sand and gravel in the contemporary stream channel of Clear Creek and on associated low terraces in the lower watershed.

Placer tailings - Random, hand stacked, or machine deposited coarse cobbles and gravel resulting from placer mining. Also includes placer-mined areas and alluvium which has been disturbed by aggregate mining. The largest areas occur in the lower watershed adjacent to Clear Creek and on the terraces to the north. Small, unmapped tailings deposits are ubiquitous along Clear Creek and in its tributaries, particularly to the north and east.

MINERAL RESOURCES

Present day placer mining in and along Clear Creek and many of its tributaries still occurs, but on a limited scale. Mining methods include hand sluicing and in-stream suction dredging. Some mechanized placer mining using bulldozers, backhoes and portable wash plants also likely occurs.

Large aggregate operations are located on the north side of the lower watershed. These operations primarily process the residual placer tailings left behind from the large bucket ladder dredges, which processed the alluvium during the first half of this century. These operations must comply with State and local mining and reclamation requirements and may leave the property in better condition, particularly in areas with ridges and troughs of old dredger tailings. Some of the private aggregate producers in the lower watershed may be using placer gold recovery devices in their washing/sorting cycles. The lower watershed has also been the most impacted by humans in the form of mechanized placer dredging operations in the Clear Creek stream bed and its adjoining low terrace deposits.

Lode gold mining of low-sulfide, gold-bearing, steeply dipping quartz veins has occurred in the upper watershed. The Potosi and Mt. Shasta mines in the Muletown Mining District are examples of this type of underground mine. Also, underground mining of a high silver variety of the above deposit type has occurred in the southwestern portion of the upper watershed, west of Zogg Mine Road, in the South Fork Mining District. Most of the lode mining in the watershed occurred between 1860 and 1942. Even though tailings, waste rock, and mine drainage from these operations have not been identified as a hazard or detriment to the watershed, elevated levels of arsenic may occur locally.

SOILS - CURRENT CONDITIONS

The soils of the lower Clear Creek Watershed are similar to soils in nearby adjacent watersheds. These following factors are responsible for the development of all soils: parent material, topography, climate, biological activity, and time. Each soil is affected by all of these factors, but the relative effect and importance of each of these varies from one soil to another.

The soils in the lower Clear Creek watershed have been grouped into five associations. These associations are based primarily on physiography and differences in parent material. In addition to the five soil associations there are six miscellaneous land types that occur in the watershed. These include: tailings, gravel pits, rock lands, colluvial land, riverwash, and cobble land. Table 3-1 and Map 3-1, following the soil association descriptions, depicts the soil associations and their relative erosivity. Appendix B contains the soil mapping units.

SOIL ASSOCIATIONS

Mountain Soils

Soils in this association include the following: Chaix, Sierra, Kanaka, Corbett, Holland, Auberry. These soils are located in the upper watershed usually above the 1800 feet elevation. They are steep, well-drained to very well-drained loams and loamy sands. They are underlain by weathered granite at a depth of 20 - 40 inches. Weathered granites are structurally weak and are easily broken down. However, weathering has not progressed to the point of clay formation. The result is coarse textured, easily eroded soils and a predominance of weak bedrock that is easily broken down into sands with very little silt and clay. The very low clay content, coarse texture and steep slopes combine to create a high erosion hazard.

Concentrated water flow is the major factor resulting in accelerated erosion in granitic soils. The primary cause of concentrated flows are roads. Roads create an artificial overland network and also intercept and divert subsurface flow. Removal of vegetative cover and rapid decomposition of forest litter also alters the hydrologic processes on upland slopes.

Foothill Soils

Soils in this association include the following: Auburn, Neuns, Goulding, Boomer, and Diamond Springs. The soils in this association are rolling to very steep, well-drained gravelly loams and clay loams. Depth to the volcanic rock and greenstone parent material is 25 - 50 inches. Many of these soils have a stony or rocky surface. They are located in the middle reach of the watershed usually between the 1000 - 1800 ft. elevation. Because of their steepness and rocky or stony surface, these soils are not conducive to timber management.

High Terrace Soils

Soils in this association include the following: Red Bluff, Newtown, Moda, and Millsholm. These soils are well-drained to moderately well-drained clays and clay loams that are up to 40 - 60 in. deep to old alluvium parent material. They are located in the lower watershed on the higher terraces south and north of Clear Creek between the 600 - 1000 ft. elevation. The Red Bluff and Moda soils are nearly flat to rolling and are associated with the tops of terraces, while the Newtown soil is moderately steep to steep and is on the sides of the terraces.

Lower Terrace Soils

Soils in this association include the following: Perkins, Churn, Tehama, Honcut. This association is located in the lower watershed generally between the high terraces and the alluvial floodplain. They are nearly level, well-drained and moderately well-drained clay loams and silty clay loams, with a 40 - 60 in. depth to parent alluvium material. This association is suitable for agricultural production as well as for residential development.

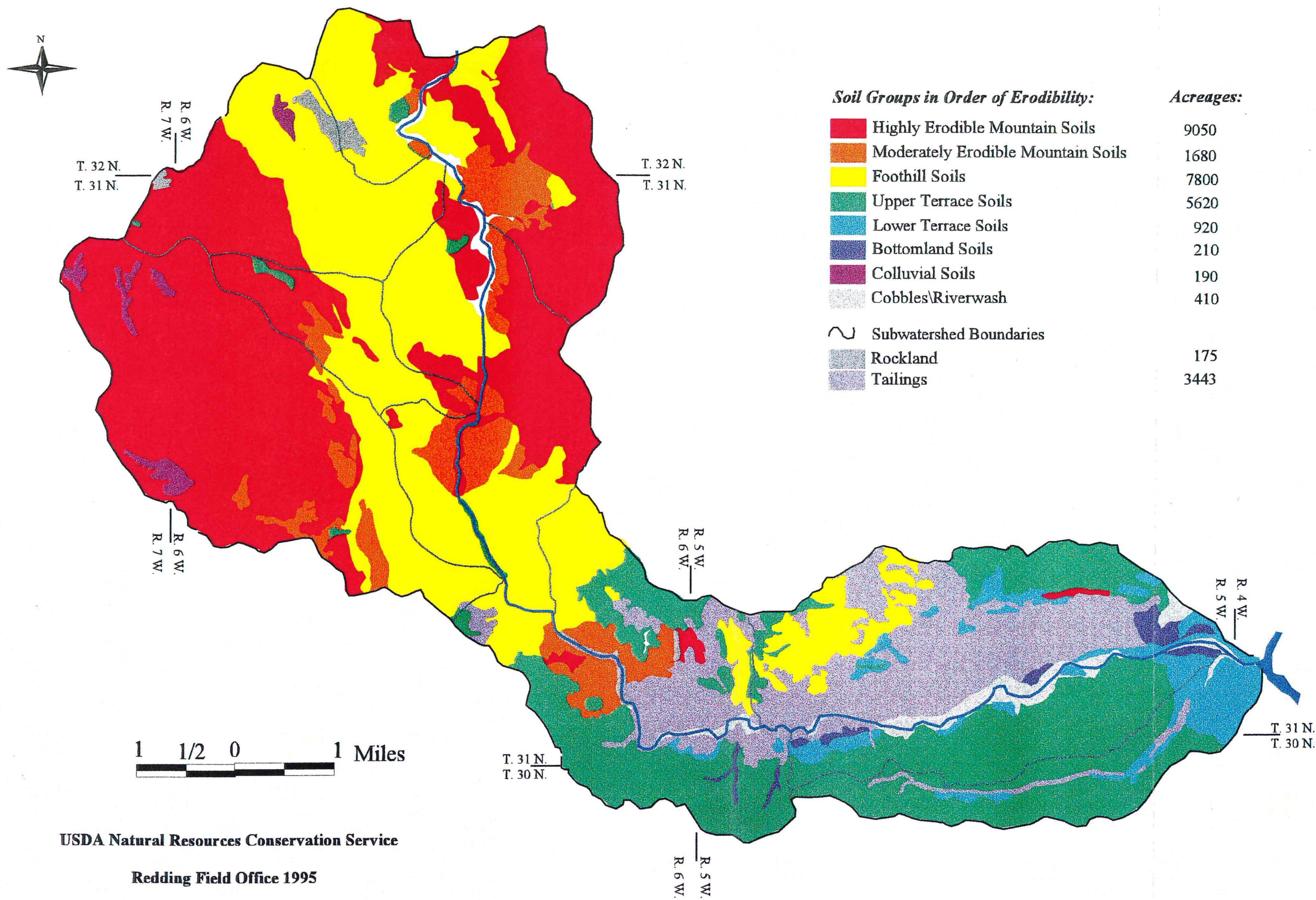
Bottomland Alluvium

Soils in this association include the following: Reiff, Anderson. These soils are nearly level, well-drained to somewhat excessively drained loamy fine sands and loams. They are 50 - 60 in. deep to recent alluvium parent material. They are located adjacent to streams and are subject to flooding. These soils are well-suited for agricultural production.

TABLE 3-1
RELATIVE SOIL ERODIBILITY INDEX

SOIL GROUP	SLOPE CLASS (%)	SOIL SERIES	R FACTOR	K FACTOR	L/S	RK* L/S
Mountain						
	8-70	*Auberry*	80	0.28	5.85	131
	5-70	*Chaix*	115	0.24	5.85	161
	50-80	*Corbett*	115	0.17	8.87	286
	15-70	*Holland*	115	0.28	5.85	188
	5-70	*Kanaka*	115	0.32	5.18	190
	3-50	*Sierra*	115	0.28	3.46	111
Foothill						
	8-70	*Auburn*	55	0.15, 0.24, 0.32	5.85	77
	15-70	*Boomer*	65	0.1, 0.2	5.85	76
	8-30	*Diamond Spring*	80	0.1	2.46	20
	10-70	*Goulding*	55	0.05	5.85	16
	10-60	*Kidd*	55	0.17	4.84	45
	8-80	*Neuns*	55	0.1	6.67	37
High Terrace						
	3-30	*Millsholm*	40	0.24	1.82	17
	0-3	*Moda*	35	0.37	0.16	2
	8-50	*Newtown*	35	0.20	3.81	26
	0-8	*Red Bluff*	35	0.2, 0.32	0.30	3
Low Terrace						
	0-8	*Churn*	30	0.2, 0.32	0.30	3
	0-3	*Honcut*	30	0.24, 0.32	0.16	2
	0-30	*Perkins*	35	0.2, 0.32	1.82	20
	0-8	*Tehama*	35	0.43	0.30	5
Bottom-land						
	0-3	*Reiff*	30	0.32, 0.37	0.10	1
	0-3	*Anderson*	30	0.20	0.10	1

* RKL/S is the product of the topography, rainfall energy and inherent erodibility of the soil. The greater the value the higher the erosion potential of the soil.



Map 3-1: Soil Erosion Potential in the Lower Clear Creek Watershed

MISCELLANEOUS LAND TYPES

Tailings and Placer Diggings

This land type is a result of past mining activity. It is a significant land type in the lower reaches of the watershed. Dredge tailings occur in the low terrace and floodplain areas, while the placer diggings are in the high terrace areas. Dredge tailings usually occur as a series of long, steep, parallel ridges and shallow troughs consisting of cobble and rock. Placer diggings occur as irregular steep piles of cobble and rock which vary greatly in size. Areas of steep, eroded slopes of cobble alluvium are also present. These areas are in different stages of re-vegetation depending on the type of material and moisture regime present. Some areas are being actively mined for rock and gravel.

Rock Land

This land type occurs adjacent to Clear Creek, normally above the riverwash land type. It typically consists of rock outcrops with shallow soils. The composition is variable and site specific. The land use capability of this type is dependent upon moisture conditions from Clear Creek and upland areas. In some areas, this type will support stream-side riparian vegetation.

Riverwash

This land type is associated with Clear Creek and makes up the actual stream channel. It is located along stream courses throughout the watershed. It is gently sloping and consists of varying amounts of sand, gravel, and cobbles. It is excessively drained, has a rapid permeability, and is subject to flooding. Often, this land supports riparian vegetation. However, the amount and type is dependent upon the moisture regime and flow conditions in the stream.

Gravel Pits

This land type consists of excavated pits from which sand and gravel have been mined. It is limited to the lower reaches of Clear Creek. The material in the pits consists of sand, gravel and cobblestones. In several cases, existing pits have disrupted the flow of the stream and have had a significant impact on stream hydrology and aquatic habitat. These effects are discussed more fully in Chapter 2 - the Aquatic Domain.

Colluvial Land

This land type is located in the upper elevations of the watershed and is usually associated with steep granitic soils at the base of steep slopes. It is comprised of a mixture of different soil materials and is typically high in gravel. The depth of material varies greatly depending on the accumulation and stability of the material. The looseness and composition of this material make it excessively well-drained and erosion potential is high.

The capability of this type is dependent upon the type of material which has accumulated and the available moisture regime.

Cobbly Alluvial Land

This land type is located in the lower reaches of the watershed, adjacent to active streams and is usually associated with bottom land areas. It consists of gravelly, cobbley, or stony coarse-textured material and is excessively well-drained. Permeability is rapid. Much of this type of land is subject to flooding and is channeled in places. A variety of vegetative communities can exist on alluvial land, depending upon moisture conditions.

SOILS - REFERENCE CONDITIONS

It is difficult to determine reference conditions for soils in the watershed and relate them to the conditions which now exist. In order to do this, one would have to evaluate the factors which have affected soil formation over time; namely: parent material, topography, climate, biological activity, and time. This process could be time-consuming, and likely would be inconclusive.

Overall, there probably have been no changes in any one of these factors in the recent past that have resulted in actual changes in soils present on the watershed. This is not to suggest that over time, there have been no changes in the factors which affect soil development, only that these changes were so far in the past that the environment (biological and physical processes) has reached a new equilibrium from which one should base reference conditions. For the purposes of this watershed analysis, reference conditions should be considered the current condition which now exists. Going back any further than this would set reference conditions which are not useful as a frame of reference. This does not mean the soils have not changed or altered since human occupation of the watershed, only that the primary soil genesis factors have not changed significantly from reference conditions.

FACTORS INVOLVED IN CHANGE

IMPACTS OF HUMAN ACTIVITIES ON THE SOIL RESOURCE

Large Scale alteration

Human activities in more recent history have induced changes in the existing soils. Human impacts which have led to accelerated erosion and mass wasting are very apparent in certain areas of the watershed. Tailings and placer diggings have significantly altered the soil mantle, removing the soil fines and leaving only gravel and rock in place. Also, as previously mentioned, gravel pits left after gravel mining have altered stream flow hydrology. Many of these areas will gradually reach stability if current environmental conditions remain stable. It is difficult to estimate what the final characteristics of this equilibrium will be and how long it will take for these landscapes to stabilize.

Erosion

Less evident than the historical impacts from mining is the accelerated erosion which has occurred in the past as a result of soil disturbing activity. Some of these areas appear on the soil map unit as an eroded phase of an identified soil series. These series include the Chaix and Kanaka soils of the Mountain group and the Goulding, Kidd and Diamond Springs soils of the Foothill group.

It is important to remember that within any ecological system there is a steady-state or geologic erosion rate which is naturally occurring. It is only when human activities occur that this erosion rate greatly increases. When this occurs, the system may become unbalanced and must therefore compensate for changes in the system.

In many cases, if the activity that created the accelerated erosion is stopped, the area may heal and resume normal function. However, in some cases, particularly on very fragile soils, the healing may take a very long time or the soil may actually reach a new equilibrium at a level (in regards to stability and productivity) below that which previously existed. If these changes occur over a large area, they may be significant enough to affect the functioning of the overall system, in which case, the entire system must reach a new equilibrium. For example, erosion of the surface soil may render a soil incapable of supporting a conifer forest and instead a shrub/hardwood community is now the climax.

SEDIMENTATION

One of the most damaging factors to Sacramento River basin salmonid fisheries is the degradation of spawning substrate through sedimentation. Stream and river sedimentation may be accelerated by erosion resulting from agriculture, forestry, or industrial and residential development. Fish populations in small tributary streams are most vulnerable to sedimentation because of decreased stream sediment transport capability especially when large dams prevent winter and spring flushing flows. Sediment in streams can fill in spaces between gravels in which these fishes lay their eggs and spawn. In substantial amounts, sediment infilling can smother fish eggs and alevin and keep them from hatching and emerging. In addition, because these fishes require clean, well-aerated gravels to reproduce, they will avoid gravels which are buried by sediment, thereby resulting in reduced spawning habitat (Burns, 1970). Food availability for fish, such as primary production and benthic invertbrate abundance, may also be reduced as sediment levels increase. In addition, social and feeding behavior can be disrupted by increased levels of suspended sediment. Pools, a habitat type especially important for Sacramento River Spring-run Chinook salmon and steelhead, may be lost due to increased levels of sediment. In Northern California, only one stream currently supports self-sustaining runs of winter-run Chinook salmon. Only three tributary streams reliably support spring-run Chinook.

Other species of salmonid fishes are also declining. One stream which historically supported substantial runs of salmon and steelhead is Clear Creek. Clear Creek has good potential to provide habitat for these species of declining fishes. Therefore, it is important to study sources of sedimentation on the lower Clear Creek watershed in order to assess where future erosion control efforts might focus to improve lower Clear Creek as anadromous fish habitat.

For the purpose of analyzing erosion, the watershed of lower Clear was divided into 13 sub-watersheds. The largest sub-watershed in the lower watershed is the South Fork of Clear Creek /Andrews Creek complex. This sub-watershed contains 5,755 acres. The South Fork is approximately 6.9 miles long and enters Clear Creek just above the Igo Bridge on Placer Road. Andrews Creek enters the South Fork 1.9 miles upstream from the confluence of the South Fork and main stem of Clear Creek. The South Fork of Clear Creek and Andrews Creek usually run year-round, as does Paige Boulder Creek, the only other reliable perennial stream in the study area. The other sub-watersheds in the study area are composed of various intermittent drainages, which may run for varying time periods annually, depending on annual rainfall amounts.

After delineation, these sub-watersheds were analyzed qualitatively to describe various site-specific features related to erosion. Evaluation criteria included topography, geology, soils and current level of disturbance. Table 3-1 shows the relative erodibility of the soil groups and Table 3-2 shows the amount and type of current disturbance for each watershed. Disturbance and erosion potential were given a relative rating of low, medium, high or severe. These ratings were then weighed against the other criteria and an overall priority rating was assigned to the sub-watershed. This information is summarized and displayed in Table 3-4 (following this section). The priority rating represents the current erosion status and locations where possible land treatment efforts would be most beneficial and effective.

Roads

Paved roads on the watershed include portions of Mule Town, Zogg Mine, South Fork, and Placer Roads in the upper watershed; and Honeybee, Texas Springs, Clear Creek Road, Canyon Drive, China Gulch Drive, Cloverdale Road, and Route 273 in the lower watershed.

The majority of the roads in the upper watershed are unimproved or paved with gravel. Many of these roads are composed of highly erodible material and are ineffectively graded to control erosion. In steep areas like those found in the upper watershed, large volumes of high-velocity runoff water can seriously erode these road, cutbank, and fill surfaces. In addition, many of the road culverts are improperly sized or improperly spaced to provide sufficient drainage. To solve these problems, a variety of techniques could be used to improve drainage including outsloping, establishing rolling dips and water bars, or installing overbank flumes and energy dissipaters.

Trails

A network of road-like trails from past and ongoing logging and fire-fighting activities interlaces portions of the watershed. These trails are in active use or in various states of natural revegetation. Those roads and fuel breaks which were properly decommissioned are revegetating well. However, those which were improperly constructed, or severely compacted, or where access was not restricted, continue to exhibit accelerated erosion and are revegetating more slowly. Erosivity of these roads depends upon local topography and soil type.

In addition to the logging roads and trails, the National Park Service maintains a series of hiking trails for recreational use in the National Recreation Area. Many of these Park Service trails are located upon former logging roads or fire control fuel breaks. Since many of these logging roads were constructed without adequate drainage measures, they continue to exhibit various levels of accelerated erosion. Fire breaks designated as recreational trails in the Kanaka Peak area currently exhibit severe rill erosion.

Landings

A series of landings accompanies the logging road network within the watershed. These landings are intended for use as staging areas for logging logistics operations. Many of these landings on the watershed were constructed without integration of erosion control systems. These areas will persist as sources of erosion until they revegetate substantially, a process which is slowed on these sites due to excessive compaction of the soil by heavy logging equipment and trucks.

Home lots on the watershed also form a sort of landing which can accelerate erosion. Many of these house pads have little vegetative cover and are poorly graded or located on steep slopes. Therefore, these lots and their associated driveways also pose a hazard for erosion potential.

Industrial Runoff

Gravel mining is a major land use in the lower part of the watershed. While much of the sediment from these mines was washed downstream during the placer mining period, the truck traffic and road system associated with the current activities pose a moderate sedimentation risk to Clear Creek. Other industrial sites on the lower Clear Creek watershed are located in the Highway 273 corridor and pose a low sedimentation risk.

TABLE 3-2
ESTIMATED DISTURBED AREA
IN CLEAR CREEK SUB-WATERSHEDS
Source: 1993 & 1994 Aerial Photos

Sub-Water-shed #	Paved Roads	Unpaved Roads, Trails, Fire Breaks	House Pads, Construction Sites
1	None	41,000 ft. = 7.8 mi.	9 sites at 4 ac. ea. = 36 ac.
2	Muletown: 5,400 ft = 1.0 mi.	91,324 ft. = 17.3 mi.	None
3	None	70,400 ft. = 13.3 mi.	12 sites at 4 ac. ea. = 48 ac.
4	None	30,800 ft. = 5.8 mi.	2 sites at 10 ac. ea. = 20 ac.
5	None	55,800 ft. = 10.6 mi.	3 sites at 10 ac. ea. + 1 sites at 5 ac. ea. = 35 ac.
6	None	116,828.6 ft. = 22.1 mi.	1 site at 5 ac.
7	None	30,800 ft. = 5.8 mi.	2 sites at 10 ac. ea. = 20 ac.
8	Muletown: 16,333 ft. = 3.1 mi.	26,672 ft. = 5.1 mi.	9 sites at 5 ac. ea. = 4.5 ac.
9	30,600 ft. = 5.8 mi.	109,000 ft. = 20.6 mi.	3 sites at 5 ac. ea. + 1 sites at 10 ac. ea. + 8 sites at 2 ac. ea. = 41 ac.
10	Placer: 4,999.8 ft. = 0.9 mi. Clear Creek: 7,499.7 ft. = 1.4 mi.	95,829.5 ft. = 18.1 mi.	11 sites at 4 ac. ea. = 44 ac.
11	Clear Ck. = 28,000 ft. = 5.3 mi Rt. 273 = 3960 ft. = 0.75 mi. Other = 13,600 ft. = 2.6 mi.	120,000 ft. = 22.7 mi.	36 sites at 4 ac. ea. = 144 ac. appx 2,000 ac. of dredge tailings
12	43,200 ft. = 8.2 mi.	95,600 ft. = 18.1 mi.	159 sites at 1 ac. ea. + 3 sites at 10 ac. ea. = 189 ac.
13	34,800 ft. = 6.6 mi.	98,200 ft. = 18.5 mi.	83 sites at 1 ac. ea. + 4 sites at 5 ac. ea. + 2 sites at 10 ac. ea. =123 ac.
Total	**188,452.5 ft. = 35.75 mi.**	**982,253.6 ft. = 186 mi.**	**2,709.5 ac.**

Quantitative Sediment Delivery Analysis

There is insufficient information available to quantify actual erosion rates on the watershed. Therefore, to utilize the information which we have gathered through this study, we looked to another study which did estimate actual erosion rates. The Middle Creek Erosion Inventory, conducted by the Soil Conservation Service in 1993, provides a method of quantitative sediment delivery analysis. Situated on similar bedrock and adjacent to the lower Clear Creek watershed, the Middle Creek watershed provides an image of how sediment delivery may take place on the lower Clear Creek watershed (USDA SCS, 1993). We utilized the estimated erosion rates for different land disturbances as outlined in the Middle Creek document. Each of these sub-watersheds was then evaluated quantitatively to determine the current erosion/sedimentation status. Criteria used for this analysis includes overall topography, geology, channel network, current type and level of disturbance, and erosion potential (combined effects of rainfall energy, topography, and inherent soil erodibility). These attributes were summarized and a rating was assigned to each sub-watershed (see Table 3-4). This rating is only relative to other sub-watersheds, and does not attempt to quantify erosion or sedimentation rates.

Representative erosion rates for typical land disturbance activities common to both watersheds are shown in Table 3-3 below. These rates are relative rather than absolute, as there have been no actual sediment measurements made in Middle Creek.

TABLE 3-3
SOIL LOSS (TONS/ACRE/YEAR)

MIDDLE CREEK TYPE OF DISTURBED AREA	AVERAGE	RANGE	
		LOW	HIGH
Narrow private road	100	83	132
Wide private road	105	88	134
Undeveloped lot	112	90	123

As the table shows, erosion rates for the different types of disturbances are relatively consistent and uniform. Most activities that remove vegetation and expose soil will have similar effects on soil erosion.

Problems

Normally, peak stream flows on Clear Creek would increase forty to fifty-fold each winter and spring due to increased rainfall and snowmelt. These annual high peak flows would normally flush much of the sediment deposits from Clear Creek into the Sacramento River. However, due to the operation of the Whiskeytown Dam, lower Clear Creek can no longer naturally flush its bed of gravels and sediments. The

TABLE 3-4 Clear Creek Sub-Watersheds

Sub-watershed #	Location and Acres	Miles of channel	Geology	Slope (%)	Current disturbance	Erosion potential	Priority
1	SW of Whiskeytown Dam ; northernmost part of watershed contained within NRA. 1288.7 ac	Dog Gulch: 3.2 mi. (interm.) Unnamed intermittent streams: 1.7 mi.	Copley Greenstone with Balaklala Rhyolite underlain by Shasta Bally batholith quartz diorite & granodiorite	50-70	Moderate	Moderate-High	Moderate
2	SE of Whiskeytown Dam; northern part of watershed 2661.3 ac	Orofino Gulch: 2.37 mi. (interm.) Salt Creek: 3.31 mi. (interm.) Buck Hollow: 1.55 mi. (interm.) Unnamed intermittent streams: 2.2 mi.	Copley Greenstone & Mule Mountain stock granites	50-70	Moderate	Moderate-High	Moderate-High
3	Paige Boulder Cr., contained within NRA, northern part of watershed , west of Clear Cr. 2896.2 ac	Paige Boulder Cr.: 4.7 mi. (perenn.) 9.1 mi. (interm.)	Copley Greenstone with Balaklala Rhyolite underlain by Shasta Bally batholith	50-80	High	Moderate-High	High
4	Series of small, steep, intermittent drainages on west side of Clear Cr., in northern half of watershed 1310 ac	Unnamed intermittent streams: 5.0 mi.	Copley Greenstone with Balaklala Rhyolite underlain by Shasta Bally batholith	20-70	Moderate-High	Moderate	Moderate
5	Kanaka Creek, West of Clear Cr., in northern half of watershed 1298.5 ac	Kanaka Cr.: 5.6 mi. (interm.)	Shasta Bally Batholith, Copely Greenstone	40-70	Moderate-High	High	Moderate-High
6	S. Fork of Clear Creek (3545.4 ac.) and Andrews Creek (2209.7) combined, most western and largest sub-watershed 5755.1 ac	South Fork Clear Cr.: 8.9 mi. (perenn.) 9.5 mi. (interm.) Andrews Cr.: 4.5 mi. (perenn.) 4.5 mi. (interm.)	Shasta Bally Batholith	40-70	High	High	High

7	Little Kanaka Cr. and two small intermittent drainages; on west side of Clear Creek in central portion of watershed 882.2 ac	Little Kanaka Cr.: 0.95 mi. (interm.) Unnamed intermittent streams: 2.5 mi.	Shasta Bally Batholith, Copely Greenstone	15-70	Moderate-High	Moderate	Moderate
8	Stony Gulch and small intermittent drainages on east side of Clear Cr. in northern half of watershed 2419.1 ac	Stony Gulch: 3.7 mi. (interm.) Unnamed intermittent streams: 5.1 mi.	Mule Mountain granites	40-70	Moderate	Moderate-High	Moderate-High
9	SW portion of watershed, including substantial mine tailings and two major roads 2378.6 ac	Unnamed intermittent streams: 9.1 mi.	Tehama sandstones, siltstones, conglomerates; Red Bluff gravels; placer tailings	10-40	High	Low	Moderate
10	On north side of Clear Cr. in southern half of watershed; opposite to sub-watershed 9 2369.5 ac	Unnamed intermittent streams: 8.7 mi.	Great Valley sandstones, siltstones, & conglomerates; Tehama sandstones, siltstones, conglomerates; Red Bluff gravels; placer tailings	10-70	High	Low	Moderate
11	On north side of Clear Cr., in southern portion of watershed, including small intermittent drainages and majority of dredge tailings 4582.2 ac	Unnamed intermittent streams: 10.9 mi.	Great Valley sandstones, siltstones, & conglomerates; Tehama sandstones, siltstones, conglomerates; Unconsolidated sand, silts, & gravels; placer tailings	5-40	High	Low	Low-Moderate
12	On southern side of Clear Cr., in the lower half of the watershed opposite sub-watershed 11 1234.1 ac	Unnamed intermittent streams: 3.3 mi.	Tehama sandstone & siltstone; Riverbank sands, silts, & gravels	0-50	High	Low	Moderate
13	SE portion of watershed, separated from main stem of Clear Creek by sub- watershed 12; two intermittent drainages form 'inverted Y' which enter Clear Creek near Sacramento River 2734.5 ac	Niles Canyon: 9.4 mi. (interm.) Unnamed intermittent stream: 4.6 mi.	Tehama sandstone & siltstone; Red Bluff gravels	0-40	High	Low	Moderate

McCormick-Saeltzer Dam on the lower watershed can also reduce peak flows on the creek, thereby reducing the creek's natural flushing capacity. Due to this reduction in natural flushing capacity, sediments can accumulate to unnatural depths in the bed of Clear Creek, thereby further impacting anadromous fish populations.

While most industrial-scale logging has ceased on the watershed, recent logging of low-value species on the watershed does pose a hazard of increased sedimentation. Members of our analysis team have noticed the logging of gray pine, used for making railroad ties, and blue oak, used for firewood, on private land in the central part of the watershed. At this time, a timber harvest plan is not required to harvest gray pine or blue oak. Therefore, it is uncertain whether sufficient erosion and sediment control measures are being adopted on these private operations. Also, future wildfire protection on the watershed through fuels reduction operations has the potential to increase erosion if heavy machinery is used. Care must therefore be exercised during these operations to insure that soil disturbance is minimal.

VEGETATION - CURRENT CONDITIONS

The vegetation within the study area was described using the California Wildlife-Habitat Relationships (WHR) System (Timossi, eit al, 1994). This section describes the various wildlife habitats that occur in the lower Clear Creek watershed. The goal of the classification system is to identify and classify existing vegetation types important to wildlife. It was developed to recognize and logically categorize major vegetative complexes at a scale sufficient to predict wildlife-habitat relationships. It has been modified to describe the lower Clear Creek watershed environment.

Data for this analysis came from the Timberland Task Force Klamath Province habitat database, which was created from 1991 satellite immagery. An assessment of the database (Resources Agency of CA, 1993) indicated that the database was not very accurate. Overall, only 47% of the WHR types were absolutely correct. Only 45.8% of the WHR size class and 54.7% of the WHR canopy closure data were absolutely correct. In lower Clear Creek, the ponderosa pine was interpreted as Jeffrey pine. Gravel bars and mine tailing were interpreted as "rock" and gravel or grassland areas were interpreted as prairie. Map 3-2 (Vegetation Communities in the Lower Clear Creek Watershed) is approximately 55% accurate due to the topographic and vegetative complexity. Table 3-5 following the descriptions lists the acreage of each habitat type. Appendix C has a list of known plant species found during soil/vegetation surveys conducted cooperatively by the USDA - FS and the CDF (see Chapter 6, References, for a list of the maps used in the lower Clear Creek analysis).

WHR HABITAT TYPES

Closed Cone (knobcone)pine

This habitat type consists of stands including a number of species of evergreen and needle-leafed trees. The height and canopy closure of these stands are variable and depend upon site characteristics, soil type, the age of the stand, and the species composition. Knobcone pine habitats typically reach heights of 66 feet. Most pine stands have a shrub layer of chaparral species with a high relative cover (up to 100%) and a sparse herbaceous layer.

The knobcone pine type is usually associated with gray pine, leather oak, scrub oak, whiteleaf manzanita and/or wedgeleaf ceanothus; the herbaceous layer may support a number of grasses and forbs. Knobcone pine frequently grows in small dense patches with chamise, ceanothus, leather oak and manzanita occurring between patches or in openings.

Knobcone pines retain their seeds in closed (serotinous) cones which remain on the branches. This species is truly fire-climax or fire-dependent, but fire may occur at any phase of the community. The heat from fire causes the cones to open and release their seeds which fall on the bare mineral soil. Full sunlight provided in early successional stages is excellent for seedling establishment and promotes the dense even-aged stands typical of all types of closed-cone pine habitats. Knobcone pine has a short life span. Individual knobcones which escape fire rarely live to 100 years of age.

Douglas - fir

This habitat forms a complex mosaic of forest species due to the geologic, topographic, and successional variation typical within its range. Typically, there is a low overstory of dense, sclerophyllous, broad-leaved evergreen trees (tanoak, Pacific madrone) up to 114 feet tall, with an irregular, often open, higher overstory of Douglas-fir and in our study area ponderosa pine up to 295 feet tall. A small number of pole and sapling trees occur throughout stands.

Overstory composition varies with soil parent material, moisture, topography and disturbance history. Dry steep slopes on metamorphic and granitic parent materials are dominated by canyon live oak. Less rocky, dry soils support Douglas-fir, tanoak, and Pacific madrone in association with sugar pine, ponderosa pine, California black oak, and canyon live oak. Deep mesic soils support an overstory of Douglas-fir with a tanoak-dominated understory. In this analysis area, ponderosa pine becomes a major co-dominant with Douglas-fir and the occurrence of California black oak increases.

Klamath Mixed Conifer (KMC)

This habitat type consists of tall, dense to moderately open, needle-leafed evergreen forests with patches of broad-leaved evergreen and deciduous low trees and shrubs. On more moist sites, the habitat is dominated by tall conifers up to 200 feet in height with a rich shrub layer and well-developed herbaceous layer. On drier sites, the habitat is generally open with a diverse and well-developed shrub layer.

The overstory layer is characterized by a mixture of conifers. In the study area, dominant conifers are ponderosa pine, Douglas fir, white fir, incense-cedar and sugar pine. Occasional broad-leaved trees include canyon live oak and California black oak. At our analysis area elevation, ponderosa pine becomes more prevalent and white fir and Douglas-fir are reduced. Other shrubs that occur in the sub-canopy include pinemat manzanita, squaw carpet, and greenleaf manzanita.

Montane Hardwood-Conifer

The montane hardwood-conifer (MHC) habitat type consists of a broad spectrum of mixed conifer and hardwood species. Generally, conifers dominate the upper canopy and represent at least one-third of the area. Broad-leaved hardwoods comprise the lower canopy and at least one-third of the area. The habitat often occurs in a mosaic-like pattern with small pure stands of conifers interspersed with small stands of broad-leaved trees. Relatively little understory occurs under the dense canopy. However, considerable ground and shrub cover can occur in edge areas or following disturbances such as fire or logging. Steeper slopes are normally devoid of litter; however, gentle slopes often contain considerable accumulations of leaf and branch litter.

In our analysis area, California black oak, bigleaf maple, Pacific madrone, and tanoak are common with ponderosa pine, white fir, incense-cedar, Douglas-fir, and sugar pine forming the overstory.

While this habitat is climax in most cases, it can occur as a seral stage of mixed conifer forests. Revegetation following disturbances begins with a dense shrubby stage dominated by taller broad-leaved species. The stand gradually increases in height, simultaneously developing into two canopy strata with faster growing conifers above and broad-leaved species below. On moist sites, the conifer component overtakes the hardwood component more rapidly than on drier sites where the hardwood component is dominant longer (Meyer and Laudenslayer Jr., 1988).

Montane Hardwood (including the blue oak-gray pine community

In the upper watershed above the Clear Creek road crossing, this habitat type has a pronounced hardwood tree layer, with an infrequent and poorly developed shrub layer, and a sparse herbaceous layer. On favorable sites, individual or groups of trees may be only 10 to 13 feet apart and crowns may close but seldom overlap. On poorer sites, spacing doubles or triples. Steep canyon slopes and rocky ridge tops are areas where pure stands of canyon live oak can be found. Knobcone pine, gray pine, Oregon white oak, and canyon live oak are abundant at lower elevations. Understory vegetation is mostly scattered woody shrubs (manzanita, mountain-mahogany, poison-oak) and a few forbs. Mature oaks range between 56-98 feet tall and up to 59 inches diameter (breast high). Snags and downed woody material generally are sparse throughout the montane hardwood habitat.

Initial establishment of canyon live oak and California black oak is by acorns, most of which do not move far from beneath tree crowns. Wider dissemination of acorns and seeds of associated species comes about by birds and mammals. After disturbances, canyon live oak sprouts vigorously from the root crown. Most hardwood associates also sprout prolifically. Rapid sprout growth enables these hardwoods to capture most of the favorable micro sites, forcing the conifers to invade harsher sites, or those made harsh by hardwood roots below ground and shade above. Delayed establishment, slow growth, and sparse or clumped distribution of conifers often results.

In the lower watershed below the Clear Creek road crossing, the blue oak-gray pine habitat has a pronounced hardwood tree layer with a developed shrub layer, and where there is a more open canopy, a herbaceous understory is prevalent. On favorable sites, individual or groups of trees may be only 10 to 13 feet apart and crowns may close but seldom overlap. On poorer sites, spacing doubles or triples. Blue oak, interior live oak, and gray pine are the dominant species. Understory vegetation is mostly scattered woody shrubs consisting of manzanita, buck brush, coffee berry, poison-oak and a few forbs. Mature oaks range between 56-98 feet tall and up to 59 inch dbh. A 1993 study by Allen-Diaz and Holzman found an increase in basal area as well as mean number of trees per plot over a 60-year period on blue oak study plots in the Redding area, indicating good regeneration. Urban development, however, did have a substantial effect on oak regeneration.

Initial establishment of blue oak and interior live oak is by acorns, most of which do not move far from beneath tree crowns. Wider dissemination of acorns and seeds of associated species comes about by birds and mammals. After disturbances, interior live oak sprouts vigorously from the root crown, blue oak sprouts sporadically. Most hardwood associates also sprout prolifically. Rapid sprout growth enables these hardwoods to capture most of the favorable micro sites. Delayed establishment, slow growth, and sparse or clumped distribution of gray pine often results.

Ponderosa Pine

Ponderosa pine stands vary from open patchy to extremely dense. Typical canopy closure of all layers may exceed 100%. Other conifers, when present, provide denser crowns than do the pine, thus creating habitat diversity. Grasses, shrubs, and deciduous trees may be present or absent. Typical coverage of shrubs is 10-30% and of grasses and forbs is 5-10%.

In the lower Clear Creek watershed, ponderosa pine habitat is usually a mix of species in which at least 50% of the canopy area is ponderosa pine. Other associated species include white fir, incense-cedar, Douglas-fir, canyon live oak, California black oak, and tan oak. Associated shrubs include manzanita, ceanothus, California buckthorn and poison-oak.

Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic surface fires. In many of these stands, crown fires can occur when there is a dense montane chaparral understory. Sites disturbed by fire or logging sometimes are converted to dense montane chaparral or mixed chaparral. Moist chaparral areas of higher site quality tend to develop gradually into mixed conifer stands.

In our analysis area, ponderosa pine stands occur in elevations above the blue oak and blue oak-gray pine woodlands and below mixed conifer habitat on drier sites.

Shrub Dominated

The upper watershed above Clear Creek road is characterized by evergreen and deciduous species. The herbaceous understory in the mature stand is largely absent. Conifer and oak trees may occur in sparse stands or as scattered individuals. Shrub species consist of whitethorn ceanothus, bitter cherry, mountain mahogany, and green leaf manzanita. Tree species associated are ponderosa pine and canyon live oak. Mature plants sprout back from the root crown after fire. Some species require scarification of the seed for germination. Following fire it will usually take 7-9 years for the brush overstory to re-establish. This vegetative type may persist up to 50 years or longer before conifer development begins to reduce the shrub growth.

The lower watershed below the Clear Creek road is dominated by evergreen species. Herbaceous cover exists depending upon the amount of canopy present. Shrub species consist of white leaf manzanita, wedgeleaf ceanothus, coffee berry, toyon, and yerba santa. Gray pine and blue oak species are scattered throughout the area. This community is dependent on fire for regeneration, which occurs through sprouting and seed scarification. Overall, this shrub community is in the latter stage of development and is decadent due to fire suppression over many years.

Herbaceous Dominated

This habitat type is defined as having a herbaceous cover that exceeds 2 percent, while trees and shrubs do not exceed 10 percent cover. If less than 2 percent of the site is covered with herbaceous species, the site is considered barren. This community consists primarily of annual grasses and forbs, including soft chess, wild oats, annual rye grass, filaree, and yellow star thistle. In small portions of the upper watershed, native perennial grasses still exist. These include needlegrass, wild rye species, mountain brome and mountain fescue.

Barren

Barren is defined as sparsely vegetated lands measured by canopy closure. Habitats are considered barren at different levels of canopy closure. Tree and shrub habitats are considered barren if they support less than 10% crown closure.

Water Dominated

Land is considered water dominated if open water comprises more than 98 percent of the surface, resulting in less than 2 percent vegetative cover.

TABLE 3-5
WILDLIFE HABITAT TYPES AND ACRES FOUND IN CLEAR CREEK

WHR TYPE	ACRES
Knobcone Pine	1135
Douglas Fir	2669
Klamath Mixed Conifer	3612
Montane Mixed Conifer	9713
Montane Hardwood	9209
Ponderosa Pine	2582
Shrub Dominated	1636
Barren	1098
Herbaceous Dominated	146
Water	59
Undefined	124

VEGETATION - REFERENCE CONDITIONS

Past conditions can be estimated and described in terms of what currently exists and what the likely differences were from current conditions. Spatial distribution of land in the watershed which supported trees and other vegetation at the time of the first land surveys is estimated to be similar to the current distribution, but the subject should be researched further.

Some of the estimated differences between current and reference conditions are:

1. The boundaries of the current habitat types have shifted. The composition of the vegetative communities have not changed drastically. Although the same species are still present, they currently occur in different densities and age classes.

2. The Douglas-fir, KMC, ponderosa pine, and MHC habitat types, exhibited characteristics of later seral stages such as more large-stemmed trees and dense herbaceous understory than what appears currently.

   Canyon live oak that occurs as a major component of the montane hardwood habitat type was less abundant in the lower watershed than what currently exists. Canyon live oak succession is slow. Seldom is canyon live oak a pioneer species, but occasionally it invades and becomes established on alluvial soils. Canyon live oak has loose, dead, flaky bark that catches fire readily and burns intensely. With the frequent fire regime of the past, stands of canyon live oak changed to live oak chaparral. During times of frequent fires, canyon live oak becomes scarce or even drops from the montane hardwood community (Meyer and Laudenslayer Jr., 1988).

3. Due to the historical fire regime, overall plant densities were probably lower. Frequent fires would have kept the floor of the watershed more open and park-like.

4. The herbaceous habitat type was probably more plentiful with recurrent fire. Without natural, recurrent fire, grasslands tend to decrease in abundance as a community. It is estimated that grasses native to California were more abundant in each of the habitat types. The major grasses that currently occur in the watershed are all introduced species, either annual or perennial.

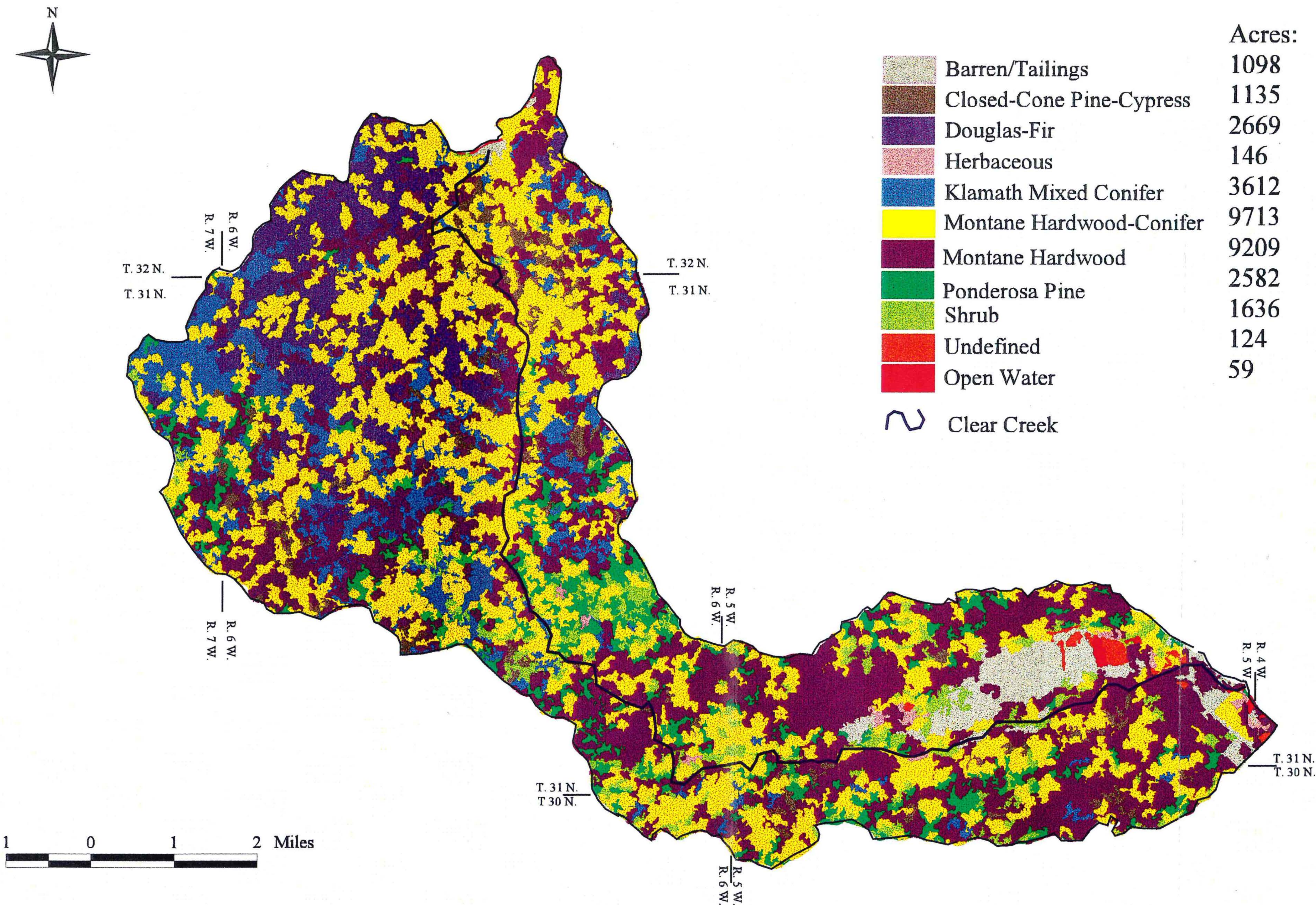
FACTORS INVOLVED IN CHANGE

Suppression of the natural fire regime has had a great effect upon altering reference conditions and establishing the current vegetative conditions seen in the watershed. Logging and other disturbance activities have had equally powerful effects on altering vegetative composition. The introduction of non-native species to the watershed has also played a role.

Through suppression of the natural fire regime, fire-adapted plant species, which naturally would have thrived in a fire-recurrent environment, have been out-competed in some cases by non-fire dependent species, and have therefore declined in abundance. Other species, such as manzanita, which would have been maintained in an arrested state of development in the presence of fire, have increased in abundance and grown to dangerously flammable proportions.

Historical logging, mining, and other high-disturbance activities have also altered vegetative composition in the watershed, primarily through direct removal of upland vegetation and secondarily, through destruction of habitat. Placer mining and dredging resulted in the removal of riparian vegetation as well as the destruction of riparian habitat. Similarly, unrestricted logging resulted in the initial removal of mature trees, and secondarily, the destruction of riparian habitat due to high sediment yields from improper road and landing construction.

Land disturbing activities, the alteration of the natural fire regime, and the introduction of non-native species to the watershed has severely reduced some native species from areas in the watershed. The replacement of native grasses by exotic grasses and forbs is the prime example.



Map 3-2: Vegetation Communities in the Lower Clear Creek Watershed

USDA Natural Resources Conservation Service
Redding Field Office 1995

Adapted from the 1993 California Timberland Task Force Vegetation Coverage

PLANT SPECIES OF CONCERN

SPECIAL STATUS PLANTS

The term "special status plants" includes all of the following: 1) Federally-listed and proposed species, 2) Federal candidate species; 3) State-listed species; and 4) sensitive species. Sensitive species are those species that do not meet any of the first three criteria, but which are designated by the State Director for special management consideration. Plants on List 1b (*Plants Rare, Threatened, or Endangered in California and Elsewhere*) of the California Native Plant Society (CNPS) *Inventory* that do not meet any of the first three criteria are considered sensitive by BLM in California. Sensitive plants receive the same level of protection as Federal Candidate species. Site inspections by qualified botanists should occur during site specific restoration planning.

Silky Cryptantha - (*Cryptantha crinita*)

Silky cryptantha is a member of the family commonly called the Forget-me-nots (*Boraginaceae*). It ranges in height from six to twelve inches. The silky cryptantha is restricted to Shasta and Tehama counties in gravel stream-beds below 1000 feet elevation in valley and foothill grasslands and cismontane woodlands. Although silky cryptantha have not been recorded in lower Clear Creek, they do inhabit similar nearby habitats and may exist within the drainage. It is a CNPS 1b species.

Red Bluff Dwarf Rush - (***Juncus leiospermus* var. *leiospermus***)

Red Bluff dwarf rush is a small (1" to 4-1/2") annual which occurs within the margins of vernal pools and other wet places. Surrounding habitat is usually woodland or chaparral. It occurs below 1500 feet elevation in Shasta, Tehama and Butte counties only. Although dwarf rush has not been recorded in lower Clear Creek, they do inhabit similar nearby habitats and may exist within the drainage. Site inspections by qualified botanists should occur during site specific restoration planning. This species is Federally listed as 3c and CNPL 1b.

Dimorphic snapdragon - (***Antirrhinum subcordatum***)

The dimorphic snapdragon is a small to medium height annual member of the snapdragon family (*Scrophulariaceae*). The plants are erect but may cling to adjacent shrubs with tendril-like branches. The flowers have a typical snapdragon appearance and are off-white in color. Habitat is gentle to steep slopes of serpentine or Lodo Shale, primarily south and west-facing. It is restricted to areas below 2500 feet elevation in the central portions of the north Coast Range. Special habitat types (serpentine or Lodo Shale) could be revealed through analysis of existing soils and geology maps. Site inspections required for any restoration project could also reveal the presence of these special habitat types. Although dimorphic snapdragon have not been recorded from lower Clear Creek, they do inhabit similar nearby habitats and may exist within the drainage. Site inspections by qualified botanists should occur during site specific restoration planning. This species is Federally listed as 3c and CNPL 1b.

Slender orcut grass - (***Oructtia tenuis***)

The habitat this species favors is vernal pools. It is a federally proposed threatened species as well as State endangered and has a 1b status with the California Native Plant Society. Although no sitings for this plant have been recorded for the lower Clear Creek watershed there is a potential for them to exist in the area.

Canyon Creek stonecrop - (***Sedum paradisum***)

The habitat this species favors is rock outcrops of higher elevations. It has a 1B status with the California Native Plant Society. Although no sitings for this plant have been recorded for the lower Clear Creek watershed there is potential for them to exist in the area.

NOXIOUS WEEDS AND EXOTIC PEST PLANTS

The development which has occurred in the lower reach of the watershed since the Gold Rush has led to the introduction of many exotic plant species. Now that these plants have escaped into the watershed, the threat exists that they could replace some native plants.

One vegetative change which occurred in the area was the introduction of Mediterranean annual grasses and forbs as livestock forage in the area. The grassland component in the watershed is not large but it was definitely impacted by the invasion of these annuals. Almost none of the grasses in savanna landscapes on the watershed are native to California. In addition, some researchers have suggested that these aggressive annuals may be limiting the establishment of blue oaks in their vicinity by competing for moisture. One exotic grass that does particularly well on the watershed is medusa-head grass.

Another plant which was introduced to the watershed is yellow star thistle. A Eurasian species introduced with exotic grasses, this plant thrives on open areas where grasses might naturally grow. It grows particularly well on the barren lands common in the mine tailings areas of the watershed. Yellow star thistle reproduces rapidly and, over time, can form nearly pure stands.

Himalayan blackberries were introduced to the watershed as an agricultural species some time during the latter half of the nineteenth century. An Asian species, these exotic plants may be the most problematic in the watershed. While native blackberries are a small, unobtrusive plant, Himalayan blackberries send out long runners and grow rapidly, spreading over large areas. Over time, this species can grow over and out-compete existing vegetation by shading it. Few species become established under Himalayan blackberry, but the blackberry is both sun and shade tolerant. Since it prefers moist areas, many riparian areas, particularly on the lower part of the watershed, are gradually being completely covered. This species provides cover for birds and small mammals but restricts access by larger animals to some portions of the creek. Following wildfire, it re-sprouts instantly, sometimes forming pure, dense stands.

Non-native tree species which do well on the watershed include black locust, native to the eastern U.S.; and Chinese tree-of-heaven, an Asian species. These species reproduce more slowly than the Himalayan blackberry, but their high fecundity means that they will become more common on the watershed over time. Both species were introduced by early gold miners, the tree-of-heaven by the Chinese for medicinal purposes; the black locust by eastern miners for its durable wood. The tree-of-heaven spreads much more rapidly than the black locust due to its ability to produce thousands of seeds as well as its ability to reproduce by runners. Currently, these species are most common on the lower part of the watershed, particularly adjacent to mined areas.

WILDLIFE - CURRENT AND REFERENCE CONDITIONS

Wildlife habitat in the lower Clear Creek Watershed has undergone dramatic changes since the beginning of non-native settlement. Gold mining, logging, gravel mining, development and fire suppression began so long ago, attempts to reconstruct reference conditions for wildlife are highly speculative. Diaries and accounts of early white settlers in the Northern Central Valley of California tend to focus upon the numerous game or predatory species such as bear, deer, elk, pronghorn, otter, beaver, wolf, and salmon. These species likely inhabited the watershed in the past. While historical records do contain occasional references to habitat types (vast monotypic stands such as grassland, riparian forest, valley oak, California juniper or ponderosa pine), they rarely specify locations or vegetative details required for a watershed analysis.

One can assume that pre-settlement wildlife habitats included the following:

1. later seral stages than current conditions, especially in areas with commercial timber;
2. fewer shrubs and undergrowth in forest associations because of the natural fire regime;
3. more extensive riparian and valley oak woodland associations, especially in the lowest reaches.

Current wildlife habitat types in the lower Clear Creek watershed are listed in the previous section. Montane hardwood- conifer forest, montane hardwood, and mixed chaparral dominate much of the upper watershed and blue oak-gray pine woodland dominates the lower watershed.

The Wildlife Habitat Relationships (WHR) Program can be used to estimate the species that may have inhabited lower Clear Creek before white settlement by making the following assumptions:

1. include a wider range of seral stages and levels of canopy closure to be inclusive of more possible habitat types. This will produce an artificially higher number of species using the watershed than probably occurred.
2. that overall, the WHR habitat types in the watershed have not changed. This approach allows for conversion between habitat types which surely has occurred.
3. that the amount, spatial distribution, and connectivity of habitat types, and the presence of special habitat types is sufficient to maintain the species. This assumption is assuredly false. These important landscape-level factors are central to use of the WHR and cannot in this case be reconstructed.

Therefore the reference condition species list generated by WHR should be seen as a list of species that may have had suitable habitat in lower Clear Creek in the past (see Appendix D). This list cannot be compared to present or future conditions. The following extant vegetation types were not used to generate the species list: pasture, cropland, orchard-vineyard or urban.

ANIMAL SPECIES OF CONCERN

Table 3-6 is based upon species occurrences in the Rarefind database (an application of the California Natural Heritage Database), the California Native Plant Society database, the records of the Shasta Trinity National Forest, the National Park Service, Whiskeytown Unit, and the California Department of Fish and Game. Please see Appendix E "Endangered Species Act And Other Species Considerations" for more information on Threatened, Endangered and Sensitive species.

TABLE 3-6
LIST OF THREATENED & ENDANGERED SPECIES AND CURRENT STATUS WHICH MAY OCCUR IN THE LOWER CLEAR CREEK WATERSHED

COMMON NAME	SCIENTIFIC NAME	STATUS/LISTING
Southern bald eagle	*Haliaeetus leucocephalus*	F-T, C-E
Osprey	*Pandion haliaeetus*	SPC
Peregrine Falcon	*Falco peregrinus*	F-E, C-E
Bank swallow	*Riparia riparia*	C-T
Long-eared owl	*Asio otus*	SPC
Spotted Owl	*Strix occidentalis*	F-E, C-E
Willow flycatcher	*Empidonax trailldi*	F-CAT 1, C-E
Yellow warbler	*Dendroica petechia*	SPC
Yellow-breasted chat	*Icteria virens*	SPC
Red-legged frog	*Rana aurora*	F-T (proposed)
Northwestern pond turtle	*Clemmys marmorata*	SPC
Pale big-eared bat	*Plecotus townsendii*	SPC
Pacific fisher	*Martes pennanti pacifica*	SPC
Chinook salmon spring run	*Oncorhynchus tshawytscha*	SPC
Silky cryptantha	*Cryptantha crinita*	CNPS 1b
Red Bluff dwarf rush	*Juncus leiospermus*	F-3c, CNPS 1b
Diamorphic snapdragon	*Antirrhinum subcordatum*	F-3c, CNPS 1b

F=Federal C=California CNPS=California Native Plant Society
E-Endangered T=Threatened CAT 1=Candidate Species
SPC= State Species of Special Concern

Bald Eagle

The bald eagle is a permanent resident and common winter migrant in Shasta County. Prior to 1977 it has been restricted to breeding primarily in Butte, Lake, Lassen, Modoc, Plumas, Shasta, Siskiyou and Trinity counties. Approximately half of the winter population is concentrated in the Klamath Basin. It is principally found at lower elevations. Whiskeytown Reservoir has two nesting pairs of bald eagles, one within the lower Clear Creek watershed (T32N R6W sections 28 and 33). The other is within one mile of the watershed boundary (T32N R6W section 20). Bald eagles are regularly observed throughout Whiskeytown Reservoir, and are occasionally seen fishing along Clear Creek south of Whiskeytown Dam near the N.E.E.D Camp.

Bald eagles generally require large bodies of water which provide an abundant source of fish or waterfowl and are seldom found far from the ocean, rivers or large lakes. They nest in large, dominant trees which are usually located near a permanent water source. Large ponderosa pine are used extensively for nesting in Shasta County.

Eagles feed on waterfowl, fish, and mammal carcasses. Groups of eagles may feed gregariously.

The bald eagle is federally listed as threatened and state listed as endangered. These birds are highly vulnerable to eggshell thinning induced by ingestion of DDT (dichloro-diphenyl trichloro-ethane) and its primary metabolite DDE (dichloro-diphenyl dichloro-ethylene). Human disturbance such as logging, recreational development and nest site disturbance has also caused loss of productivity and territory abandonment.

Potential restoration projects driving this watershed analysis could impact bald eagles in the following ways:

1. by increasing the food base. Increased salmon spawning should provide wintering bald eagles with additional forage. Both spawned carcasses and live spawners will be taken. Increased pool to riffle ratio should increase the biomass of non-game fish in the project area. These non-game species are heavily utilized by foraging eagles.
2. by direct disturbance during restoration activities.
3. Increased turbidity during dredging or project construction may impact foraging eagles who visually search for prey items in the stream. This localized and minor impact could be reduced or mitigated by:
    a. diverting water around instream restoration sites or dredging at McCormick-Saeltzer Dam;
    b. pre-washing gravel before placement, and
    c. using a short time frame for instream construction activities.

Osprey

The osprey breeds in northern California from the Cascade Range south to Lake Tahoe and along the coast south to Marin County. Populations of osprey nest at Shasta Lake, Eagle Lake, Lake Almanor and other inland lakes and reservoirs. California's breeding population is estimated at 350-400 pairs in Northern California. Although osprey have not nested recently in lower Clear Creek, they have successfully nested in the Carr Powerhouse area at Whiskeytown Reservoir for a number of years. This site is approximately 5 miles NW of the watershed boundary. There is also one nest that has been inactive for several years in the Oak Bottom area approximately 4 miles NW of the watershed boundary. Ospreys are regularly observed throughout Whiskeytown Reservoir and along Clear Creek south of Whiskeytown Dam to the N.E.E.D Camp. An estimated 6 to 8 ospreys were living on Whiskeytown Reservoir this year.

The osprey is listed by the DFG as a species of special concern. A cause of their decline can be linked to the use of DDT (dichloro-diphenyl trichloro-ethane) which causes eggshell thinning.

Ospreys use large trees, snags, and man-made structures in canopy forest for nesting and cover. Nest locations are associated with large bodies of water that contain abundant sources of fish. Osprey feed primarily on fish, but on occasion take mammals, birds, reptiles, amphibians, and invertebrates.

Potential restoration projects driving this watershed analysis could have impacts on ospreys in the following ways:

1. by increasing the food base. Increased salmon spawning should provide osprey with additional forage. Increased pool to riffle ratio should increase the biomass of non-game fish in the project area.
2. by direct disturbance during restoration activities.
3. Increased turbidity during dredging or project construction may impact foraging osprey which visually search for prey items in the stream. This localized and minor impact could be reduced or mitigated by:
   a. by diverting water around instream restoration sites or dredging at McCormick-Saeltzer Dam;
   b. pre-washing gravel before placement, and
   c. using a short time frame for instream construction activities.

Peregrine falcon

The peregrine falcon is an uncommon resident or migrant in Northern California. Peregrine falcons have occasionally been sighted near the N.E.E.D. Camp.

The peregrine falcon is both a federal and state listed endangered species. Drastic declines in abundance were associated with DDT contamination which caused eggshell thinning. Populations of this raptor are increasing to the point where some authorities are considering Federal down-listing.

This species breeds near wetlands, lakes, rivers or other water on high cliffs, banks, dunes or mounds. Peregrines also nest on man-made structures, and occasionally tree or snag cavities or nests of other raptors. The peregrine usually breeds and feeds near water.

Bank Swallow

The bank swallow is a migratory species found in riparian areas spring and fall in interior California. During the summer bank swallows inhabit areas with silty cliffs and banks that form the nesting colony. Formerly bank swallows were a common breeding species in California. Currently, only a few breeding colonies remain within the state. The bank swallow has had recorded colonies along the upper Sacramento River near the mouth of Clear Creek.

Currently, the bank swallow is listed as Threatened by the DFG. Channelization and stabilization of nesting banks and other destruction and disturbance of nesting areas are major factors causing the marked decline in numbers . Bank swallows use cliffs and banks for nesting that are almost vertical to reduce access by predators. Stabilization of these banks encourages plant growth and tallus formation which in turn increases access to nests by land based predators. Bank material is usually silty, with a clay content that helps to stabilize their burrows.

Bank swallows use open riparian, grassland, and agricultural areas for foraging. The swallow feeds by catching insects during long gliding flights. The riparian areas along Clear Creek would be suitable for insect hunting.

Although vertical cliffs and banks are found near the Clear Creek floodplain, some of these banks contain a distinct and compacted clay layer. Furthermore, sandy, gravelly soils found along lower clear Creek are generally not suitable for bank swallow nesting. Bank swallows prefer silty soils rather than sand, gravel, or clay. The proposed restoration projects would not include modifications to banks.

Long-eared Owl

The long-eared owl is an uncommon permanent resident throughout most of the northeastern part of the state. Dense riparian habitat and live oak thickets are heavily used for roosting and nesting. Resident populations have declined in recent years.

The long-eared owl is listed by the DFG as a species of special concern. It is believed that loss of habitat and habitat fragmentation are the cause of its decline.

Nest sites are located in abandoned crow, magpie, hawk, heron, or squirrel nests in a wide variety of trees. Nests are rarely located in tree cavities or on the ground. Owls feed utilizing low gliding flights and pounce on their prey while on the ground. They usually feed in open fields and on occasion in woodland and forest habitats. They require riparian thickets with small densely canopied trees for roosting and nesting.

Restoration projects may impact long-eared owl roosting and nesting habitat by disrupting the live oak thickets and riparian habitat preferred for roosting and nesting. Restoration plans should avoid constructing roads and access ramps through live oak thickets as well as other riparian vegetation.

Willow Flycatcher

The willow flycatcher is a rare to uncommon summer resident in wet meadow and montane riparian habitats at 2000 to 8000 feet in the Sierra Nevada and Cascades. It is a common spring and fall migrant in lower elevation riparian habitats throughout the state excluding the north coast. Willow flycatchers are not known to nest along Clear Creek. The extent of its use of lower Clear Creek is unknown. However, suitable habitat for willow flycatcher exists along Clear Creek. Restoration projects should minimize impacts to riparian vegetation.

Willow flycatchers require dense willow thickets for roosting and nesting purposes. The largest populations of flycatchers have been found in dense low thickets of willows along water or meadow edges. The flycatcher feeds by making short sallies for flying insects from perches in willows.
The willow flycatcher is listed as a California endangered species and has a Federal category 1 listing.

Yellow Warbler

The yellow warbler was a common resident in northern California. They breed in montane chaparral, open ponderosa pine and mixed conifer habitats. In recent years the number of breeding pairs has declined in lowland areas such as the Sacramento Valley and are now rare where it once was common. Currently the yellow warbler is listed as by the DFG as a species of special concern.

The yellow warbler is usually found in riparian deciduous habitats in summer: cottonwoods, willows, alders, and other small trees and shrubs typical of low open canopy riparian woodland. During other times of the year they utilize woodland, forest, and shrub habitats. Areas adjacent to lower Clear Creek contain riparian and woodland habitat that would be suitable for the yellow warbler. Restoration projects should minimize impacts to deciduous riparian habitats. Existing roads should be used in upland areas.

Yellow-breasted Chat

The yellow-breasted chat is both an uncommon summer resident and migrant in coastal California and the foothills of the Sierra Nevada. During migration they are found in lower elevation mountains in riparian habitat.

The yellow-breasted chat eats insects, fruits, and berries picked from the foliage of small shrubs and trees along riparian thickets and brushy tangles near water courses. Restoration projects should minimize impacts to riparian vegetation. Surveys for yellow-breasted chat should be completed between April 15 and August 1, before any removal of blackberry thickets.
Currently, the yellow-breasted chat is listed as a DFG-species of special concern due loss of habitat.

Red-legged Frog

The California red-legged frog occurs west of the Sierra-Cascade crest and scattered throughout the coast ranges the entire length of the state, usually below 3900 feet. Their habitat consists of quiet, permanent pools of streams, marshes, and occasionally ponds, preferably with shorelines with extensive vegetation. Red-legged frogs have not been recorded recently within the lower Clear Creek drainage.

The red-legged frog is a candidate species proposed for listing by the USFWS. The red-legged frog is also designated as a species of special concern by DFG. This species has declined due to habitat destruction and introduction of non-native competitors and predators (bullfrogs, sunfish, and bass).

This is a highly aquatic species with little movement away from stream-side habitats. The frogs have periods of inactivity from late summer to early winter. Breeding takes place from January to July with a peak in February in the south and March to July in the north. Females lay 750 to 4,000 eggs in clusters up to 10 inches across attached to vegetation 2 to 6 inches below the surface of permanent pools. Tadpoles require 11 to 20 weeks to reach metamorphosis.

Stream restoration projects could impact red-legged frogs if they exist within the project area. However, red-legged frogs have probably been extirpated from the lower Clear Creek watershed. Restoration of the red-legged frog to lower Clear Creek would require elimination of non-native predators and competitors, a difficult task because of the high risk of non-native reintroduction.

Northwestern Pond Turtle

The northwestern pond turtle is distributed from Washington south to Baja California. Many populations have been reduced or extirpated, especially where aquatic habitats have been modified or eliminated.

The northwestern pond turtle is a State species of concern. The USFWS declined to list the northwestern pond turtle as threatened because sufficient status and population trend data were not available at the time of proposal. As the human population continues to grow in California, riparian corridors and the water in many of the creeks will come under increasing demand for urban and agricultural uses. Without some protection of the creeks, associated uplands areas, and riparian corridors, the long-term survival of pond turtle populations in California cannot be assured.

Pond turtle nesting occurs in sand banks along the courses of large rivers or sandy hillsides in foothill regions. Nesting can occur up to 400 meters from, and 60 to 90 meters above, stream-beds. Along the central California coast, mating occurs in April and May, and eggs are laid from June through August. Hatchlings over-winter in nests and emerge in March and April. Incubation in captivity takes 73 to 80 days, and hatchlings may over winter in nests.

Restoration projects have limited potential to improve northwestern pond turtle habitat. The shallow, wide riffle areas of lower Clear Creek currently provide little suitable turtle habitat. Increased pool/riffle ratio and the introduction of structure (logs, boulders, root masses etc.) to the creek should improve foraging habitat and cover. Removal of shoreline cover and emergent structure could adversely impact northwestern pond turtle habitat at McCormick-Saeltzer Reservoir. However, the placement of root masses and logs along the waterline in McCormick-Saeltzer Dam after sediment removal could help mitigate any short-term loss of shoreline or submerged aquatic cover.

Fisher

The fisher once inhabited the coniferous and mixed forested regions of Canada and the Northern United States, including the Boreal forests, the Northeastern mixed forest, and the Pacific Coastal Forest. In California, the fisher is an uncommon permanent resident of the Sierra Nevada, Cascade and Klamath mountains and a few areas in the North Coast Ranges. It occurs in intermediate to large-tree stages of coniferous forests and deciduous-riparian habitats with a high percent canopy closure (Zeiner et al, 1990). This house cat- sized member of the weasel family eats small to medium-sized mammals, birds, fruits, and carrion, including: snowshoe hares, squirrels, mice, shrews, mountain beavers and porcupines. Fishers have been sighted recently within the lower Clear Creek drainage on National Park Service lands. Fishers are more commonly sighted in the Clear Creek drainage upstream of the Whiskeytown Reservoir, near French Gulch.

This species was recently petitioned for listing in California, Oregon, Washington, Idaho, Montana, and Wyoming, under the Endangered Species Act. According to the Biodiversity Legal Foundation (BLF, 1994) "In the western United States, fisher populations declined or became extirpated throughout most of the United States and Canada between 1800 and 1940 due to over-trapping, habitat destruction caused by logging, and settlement (Douglas and Strickland 1987, Powell and Zielinski 1994)." The fisher is considered a sensitive species by the BLM.

Foothill yellow-legged frog

The foothill yellow-legged frog (FYLF) occurs in western Oregon, south in California coastal mountains and Sierra Nevada foothills to Los Angeles and San Bernardino Counties. The FYLF is found in or near rocky streams in a variety of habitats, including valley-foothill hardwood, valley-foothill hardwood conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow types. Surveys supervised by Gary Fellers of the National Biological Survey on National Park Service lands of the Whiskeytown Unit documented the occurrence of foothill yellow-legged frog at three sites within the lower Clear Creek drainage within 2 miles of Whiskeytown Dam.

The BLM considers the FYLF a sensitive species. Decline may be due to habitat modification and introduction of non-native predators and competitors (bullfrogs, bass and sunfish).

The FYLF is rarely found far from permanent streams. Adults often bask on exposed rocks near streams. When disturbed, they dive into the water and take refuge among stone, silt and vegetation. Eggs are deposited in moving water near stream margins from mid March to early June, after spring flows have diminished. Tadpoles metamorphose within 3 to 4 months. Adult FYLF eat aquatic and terrestrial insects.

Instream restoration projects in the foothill region of lower Clear Creek may disturb adults year-round, and tadpoles from March through September. The restoration site may need to be surveyed prior to work to identify any measures necessary to mitigate impacts.

Shasta Salamander

The Shasta salamander is an uncommon endemic of isolated limestone outcrops in the vicinity of Shasta Reservoir. Populations are known from within 12 miles of Clear Creek watershed boundary. This salamander is included in this section for the following reasons:

1. It has been speculated that populations may exist in the lower Clear Creek drainage. Lower Clear Creek is comprised of wildlife habitats similar to those inhabited in the headwaters of Shasta Reservoir. Small populations occur in limestone areas within valley-foothill hardwood conifer, ponderosa pine and mixed conifer habitats
2. The Shasta salamander is identified in Table C-3 of the Standards and Guidelines (USDA and USDI, 1994b) as a species afforded special consideration under the Forest Plan.

No populations are known within the Clear Creek watershed. The Shasta salamander is categorized as Survey Strategy 1 (manage known sites) and 2 (survey prior to activities and manage sites) under the ROD Table C-3.

Restoration projects are unlikely to adversely impact this amphibian because the Shasta salamander is not likely to inhabit the lower Clear Creek watershed. Special habitat types required (limestone outcrops and caves) were not revealed through analysis of existing soils and geology maps. Site inspections required for any restoration project could also reveal the presence of these special habitat types.

Pale Big-Eared Bat (A Subspecies Of The Townsend's Big-Eared Bat)

Townsend's big-eared bat (*Plecotus townsendii*) occurs throughout much of western North America from British Columbia southward the central Mexican highlands and east to Texas. Scattered populations are known from the Ozarks and Appalachia. Townsend's big-eared bat formerly occurred throughout California in all but sub-alpine and alpine habitats. It is most abundant in mesic habitats.

There are five subspecies of Townsend's big-eared bat, two in California. The Pacific western big-eared bat (*P. t. townsendii*) is found in North coastal California and the pale big-eared bat (*P. t. pallescens*) is found further inland in Shasta and Siskiyou Counties. Pale big-eared bat roosts were recently discovered in old mines on private land in lower Clear Creek.

Townsend's big-eared bat is considered a sensitive species by the BLM and Forest Service, and a Species of Special Concern by the state. Recent declines have been alarming and severe. The Pacific western big-eared bat was a Federal category 2 candidate for listing as threatened. The pale big-eared bat was a Federal category 2 candidate for listing as endangered. The Federal candidate category 2 was recently eliminated. The two eastern subspecies of Townsend's big-eared bat are Federally listed as endangered. The fifth subspecies occurs only in Mexico.

The Townsend's big-eared bat eats moths and beetles which it captures in flight or gleans from foliage.

Caves, mines, tunnels, buildings, or other human-made structures are required for roosting. Roosting sites are the most important limiting resource. This species is extremely sensitive to disturbance of roosting sites. A single visit may result in abandonment of the roost.

The Townsend's big-eared bat has declined due to the following reasons:

1) direct destruction of roosting habitat including recreational vandalism and structural collapse of mine tunnel roosts;
2) human activities disturbing roosting habitat including caving and scientific collecting; and,
3) purposeful and incidental pesticide poisoning.

Any restoration activity in lower Clear Creek should avoid disturbing known roosting sites. A survey of other potential roosting sites is needed. Access to known sites should be restricted.

Black Bear

The National Park Service is concerned because the Whiskeytown National Recreation Area has a substantial population of black bears. Historically, national parks with bear populations have had problems with bears caused by readily available human food. The result is an increase in the bear population in developed areas and alteration of their natural behavior and foraging habits. The major difference between Whiskeytown and other parks is enabling legislation that allows hunting within the Whiskeytown Unit consistent with California state law. This has not significantly lowered the number of bear incidents, however.

The Whiskeytown Unit has installed bear-proof food storage lockers and electrified a dumpster at the N.E.E.D. camp. In the lower Clear Creek watershed, black bear sightings are frequent near the N.E.E.D. camp and in other campground areas. The Whiskeytown Unit tracks bear incidents such as trash disruption and damage to assess damages and identify problem bears. Bears are observed, marked, and trapped for relocation, if necessary. A working group of agency personnel from Shasta County, BLM, DFG, NPS, and FS meets occasionally to discuss bear problems.

The Whiskeytown Unit has proposed to develop and implement a Black Bear Management Plan to reduce the number and severity of bear/human interactions within developed areas. This plan would include six elements to prevent the causes of human/bear conflicts:

1. Public information and education.
2. Employee information and education.
3. Enforcement of regulations regarding food storage, garbage disposal, and feeding of wild animals.
4. Removal of human food sources.
5. Management of problem bears.
6. Bear management oriented research.

Mountain Lion

In the past few years there has been an increase in the number of mountain lion/human encounters in the Whiskeytown Unit. In the lower Clear Creek watershed, mountain lion sightings have been frequent near the N.E.E.D. camp and in some of the west-side subwatersheds, such as Paige Boulder Creek. Park Service has focused their effort on public and employee awareness, by training staff and N.E.E.D. camp students basic anti-lion behaviors . N.E.E.D. camp policy requires students to travel in groups after dark. The Unit has proposed a study to determine mountain lion habitat use in relation to human use areas.

FACTORS INVOLVED IN CHANGE

The main factor impacting terrestrial wildlife populations in the watershed is the destruction or alteration of habitat. Also impacting terrestrial populations of some animals are pollutants introduced in the Clear Creek system since the arrival of non-native people in the area.

Habitat destruction was most extensive in riparian areas (the result of mining) and in old-growth timber areas (the result of logging). Habitat change has also come about as a result of fire suppression policies. Changes in habitat conditions due to mining, logging, and fire suppression policies have favored generalist species. Specialist species that require special habitat types have become less abundant as these special habitat types have declined. Specialists requiring snags and large trees for roosting or large woody debris (such as terrestrial salamanders) have suffered from logging. Loss of large woody debris from streams may have led to the decline of pool loving species such as red-legged frogs. Loss of instream woody debris in turn changes the type and numbers of aquatic invertebrates. Fish eating birds such as kingfisher, bald eagle and osprey declined as fish population declined.

In addition, human impacts have altered the spatial pattern or mosaic of habitat types necessary for some species. For example, nesting bald eagles require large snags near healthy riparian areas and large bodies of water. These combinations of habitat types have been reduced by both logging and mining. Fragmentation of riparian areas which serve as migration or movement corridors for many species can have profound impacts on species distribution and diversity. Failure of riparian regeneration in the upper reaches of lower clear Creek probably limits dispersal of many organisms.

Some pollutants, especially persistent agricultural chemicals such as DDT, have also altered the composition of terrestrial species in the watershed. While the use of these chemicals was not confined to the lower Clear Creek watershed, widespread use of these chemicals contributed to the decline of several species, particularly raptors, in the watershed.

THE KEY ISSUES - TERRESTRIAL DOMAIN

The natural fire regime has been interrupted from years of fire suppression, timber harvest, grazing, the introduction of exotic plant species, and development.

KEY QUESTIONS AND ANSWERS

1. What are the historic and current roles of fire in the Clear creek watershed? What is the effect of the lack of fire?

The lower Clear Creek watershed evolved and historically developed with fire. Prior to human habitation, naturally-occurring fire was the primary disturbance factor which affected the structure and composition of the vegetative communities in the watershed. Under a natural fire regime, the vegetation was somewhat open with an herbaceous understory, a diversity of age classes, relatively high biodiversity, and a low fuel load. Native Americans later used fire as a tool to attain the same conditions established by natural fire. Their survival depended upon a healthy and stable environment.

Virtually all of the vegetative communities (with the exception of the riparian community) are dependent on fire either directly or indirectly. Frequent natural fire tends to invigorate some species and plant communities by cycling minerals trapped in both live, and dead but un-decayed, vegetation, while others have developed specific adaptations to survive low-intensity fires such as thick bark, basal sprouting, serotinous cones, buried seed dormancy, etc.

Today, the historical pattern of natural, low-intensity surface fires has been changed due to a management strategy of fire suppression. The dominant effect of fire suppression is to increase fuel loading. As time progresses without fire, fuel loading increases as both live and dead materials accumulate, thereby increasing the potential for catastrophic wildfire.

2. What wildfire control techniques are effective and compatible with our goal of minimizing sediment delivery into Clear Creek?

While no wildfire control technique will prevent sediment delivery into Clear Creek, some techniques will induce less erosion than others. Those direct techniques which produce less sediment include aerial fire control and manual installation of fire lines. However, with the high fuel loading present on the lower Clear Creek watershed, these control techniques may not be feasible when structures are involved. Techniques to lower fire intensity and size include prescribed burning and installation of fuel breaks. Presently, the National Park Service is conducting prescribed burning on a limited basis to reduce fuel loading within Park Service boundaries. There are also plans to create shaded fuel breaks along some ridgelines to provide control lines and subdivide the watershed into smaller units. Current plans call for a shaded fuel break on the ridge between the lower Clear Creek watershed and the Middle Creek watershed, which is on the eastern boundary of the study area.

3. Where in the watershed will the effects of a high-intensity fire be most severe?

High intensity fire is characterized by a high energy release from burning vegetation, which can cause significant short and long-term damage to vegetation, soils, air and real property. Fire burns more intensely on steeper slopes and in windy conditions. High intensity fires consume larger fuels than low-intensity fires, leading to the death of mature plant species, consumption of organic soil material, release of partially-burned airborne particulate matter, and damage or destruction of personal property.

Areas of the watershed which would suffer the most severe effects are those which are steep (>30% slope), have the highest biomass (tons/acre), or the highest commercial or personal property value. None of these elements are mutually exclusive, but rather are intermixed throughout the watershed.

4. Where are the ignition sources and likely ignition points?

Likely causes of wildfire include lightning and human sources. Human sources include: arson, careless smoking, trash burning, and outdoor cooking, automobile exhaust systems, and use of portable power tools such as chainsaws without spark arresters or outside the tool's designed function. Human ignitions tend to be in accessible places along roadways, trails, and recreation spots, while lightning ignitions tend to be more inaccessible.

5. How would a high-intensity wildfire affect the watershed's hydrological integrity, anadromous fish habitat, sediment yield, and other resource concerns?

A high-intensity fire could increase water yield, erosion, overland flow, and stream flow; establish new sources of erosion; change intermittent to perennial streams; and cause hydrophobicity of some soils. Fire-induced sediment delivery may smother stream bed gravels used by fish to spawn. In addition, ash and fire retardant chemicals delivered directly into the water from the fire or fire-fighting activities could be toxic to fish until diluted or transported through the system. A high-intensity wildfire would also drastically change wildlife communities and greatly impact aesthetic qualities of the area.

6. How long would the affects of a high-intensity wildfire be felt?

Damages to natural resources have potentially the longest-term effects. Air pollution from a wildfire is temporary. Personal property losses, while possibly long-term to the individual, are a shorter-term loss than the period needed to replace a climax forest stand. Erosion of fire damaged and bare soils take years to stabilize.

The impacts of a catastrophic fire are the greatest just after the fire. The time necessary for recovery often depends on the severity of the initial fire and the rate of revegetation following the fire. Revegetation is tied to the moisture regime. Vegetative recovery generally takes longer in areas with drier climates, steeper slopes, or extreme exposures.

7. What kinds of erosion control activities are needed to control accelerated erosion and the sediment such sites generate? What are the long-term affects of these restoration efforts?

There are currently many acceptable and proven erosion control measures that will minimize accelerated erosion and hasten vegetative recovery on disturbed sites. Appendix F lists the erosion control practices taken from the Natural Resource Conservation Service (NRCS) Technical Guide which are suitable for Shasta County. Additional erosion control measures and standards can be found in the County of Shasta "Erosion and Sediment Control Standards Design Manual," Western Shasta Resource Conservation District, 1992.

The key to minimizing erosion is an erosion control plan developed and in place prior to any soil disturbing activities. This plan must address short-term temporary measures as well as long-term practices. In addition, proper operation and maintenance of the installed erosion control measures are required to ensure long-term stability. One element of erosion control planning is defining a desired condition for the site which would minimize erosion to acceptable levels. It is important that these operation and maintenance requirements are detailed in the erosion control plan.

CHAPTER 4 - The Human Domain

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CHAPTER 4 - The Human Domain

INTRODUCTION TO HUMAN DOMAIN

The study of ecosystem processes in the lower Clear Creek watershed would be incomplete without paying due attention to how society interacts with and influences this ecosystem. People live on, work on, visit, own, manage and regulate the land and natural resources in the lower Clear Creek watershed. Local business persons, fishermen, hikers, home owners, public and private land managers, and tourists influence the conditions of these natural resources through their actions, institutions (i.e. laws), and ethics. In turn, these "human dimensions" of the ecosystem are shaped by economic, social and political forces that influence individuals and that have evolved in local, state, federal and international communities.

A primary objective of this chapter is to make natural resource managers and planners aware of the underlying human mechanisms interacting with, and causing, current natural resource conditions in the lower Clear Creek watershed. Efforts to protect, enhance, or sustain the natural resources in lower Clear Creek will have to deal with the "human dimension" and will meet with greater success by addressing these underlying mechanisms.

METHOD

Quantifying all of the interactions between the myriad of socio-economic and ecosystem processes is a complex and potentially limitless task. Table 4-1 and 4-2 trace out a conceptual model that will be used in this analysis to establish and analyze an ecosystem-society link.

Table 4-1 explains that *current conditions* observed in a watershed such as lower Clear Creek derive from a process where:

a) The natural resources in the watershed have attributes. Attributes include the quantity and quality of fish, timber, gravel, recreation sites, wetlands, in-stream flows and others.
b) These attributes provide service flows to humans. Service flows include material inputs used in production, amenities *used* in recreation, amenities *not directly used* by humans, such as ecosystem support functions (i.e. biodiversity), and others.
c) Humans place values on these service flows. These values include both market based values, such as the price of gravel, and non-market based values, such as the value of recreation sites.
d) The values are determined by economic, social and political/legal/governmental forces. For example, if the price of gravel

doubles, pressure will be exerted by this economic incentive to increase gravel production from the watershed.

e) These forces, over time, lead to the current institutional setting. This setting includes a system of property rights, market structures, social structures and political/legal structures.
f) The institutional setting leads to current land uses and natural resource management methods.
g) The land use and natural resource management methods determine the conditions of the natural resource attributes of the watershed.

Table 4-2 explains how changes or *trends* in current conditions in the watershed can be traced to two major sources:

h) Natural changes resulting from extreme environmental events, such as flooding or lightning-caused fire, and long term changes resulting from natural ecological processes.
i) Changes in economic, social and political/legal forces resulting from changes in relative prices, opportunity costs, the public's values and preferences, population pressures, supply and demand, government agency functions and others. For example, this chapter argues that the biggest reason for institutional changes that protect anadromous fisheries is the change in relative price between in-stream water use and irrigation or power.
j) Both sources of change feed into the processes shown in Table 4-1 to result in new institutional settings, land uses, management methods and natural resource conditions.

TABLE 4-1
HUMAN DOMAIN MODEL
CURRENT AND HISTORICAL CONDITIONS

A. ECOSYSTEM ATTRIBUTES Local soil, water, air, vegetation, wildlife, fish Regional *Tehama Terraces (an ecological sub-section) *Sacramento River-Delta-Ocean system	**B. SERVICE FLOWS** Renewable *Material inputs - game fish, water, timber *Amenities - recreational sites, water sports, fishing, *Other - life support; waste assimilation Non renewable *Material inputs - gravel, residential or commercial land *Amenities - views *Other - genetic variation	**C. VALUE OF SERVICE FLOWS** Market Based *Real estate markets *Recreational industry markets *Natural resource based industry markets - gravel, concrete and roads Non-Market Based *Public Ownership - water, land (aspects of public goods such as scenery) *Existence *Bequest	**D. SOCIETAL FORCES** Economic Forces *Competition, relative prices, scarcity, tradeoff, opportunity costs, profit maximizing firms, consumer preferences, market failure Social Forces *norms, environmental values, perceptions, attitudes, education *population changes, demographic patterns Political/Legal/ Governmental forces *public policy setting, political action, rent seeking interest groups
E. INSTITU-TIONAL SETTING Economic Structure *Market Structure-industry, agriculture, timber, mining, jobs, output *Economic incentives (taxes, subsidies) Social Structures *Codes of conduct, classes, status, interest groups; mediation groups ecological Political/Legal/ Governmental Structure	**F. LAND USES AND RESOURCE MANAGEMENT** Land Uses *Commercial - mining, timber, business sites *Residential - housing *Recreation - water sports, hiking, target shooting *Education - NEED Camp and nature preserve Management Systems *Exploitative - over extraction, poor stewardship *Sustainable - sound stewardship	**G. ECOSYSTEM CONDITIONS** Local *fisheries, riparian, forest, woodland, soil, water, air, plants and animals, ecological diversity and variability Higher Hierarchical Level Conditions *Tehama Terraces; Sacramento River system	

TABLE 4-2
HUMAN DOMAIN MODEL
TRENDS AND CHANGES

H. NATURAL CHANGES IN ECOSYSTEM ATTRIBUTES	**I. HUMAN CHANGES**
Natural Disasters, Natural Extreme Events *fire, flooding Long Term Processes *normal ecological variability	Direct Changes *Restoration activities Indirect Changes *Economic Forces - increased consumer preference for leisure; population increases leading to scarcity of recreational sites; relative price changes leading to sector changes; *Social Forces - increased environmental ethics leading to greater demand for environmental protection; increased disenchantment with government leading to smaller government budgets. *Political/Legal/ Governmental Forces - increased environmental regulations leading to increased protection of natural resources (and community conflict); increased enforcement;
J. LEADS TO: *New Institutional Setting *New Resource Flows *New Resource Flow Values *New Land Uses and Management Systems *New Ecosystem Conditions	**K. CHANGES IN VALUATION** Natural Resource Improvements
	*Benefits Natural Resource Degradation *Damages

This model will be used to classify and analyze the main factors, relating to humans, that influence natural resource conditions in the lower Clear Creek watershed.

SCOPE OF ANALYSIS

This watershed analysis focuses on what many planners call the "benchmark" or "baseline" stage of analysis. The purpose of this planning stage is to understand the current conditions and trends that have a heavy influence on the ecosystem processes in lower Clear Creek. Because this analysis does not emphasize the typical project planning phase where "alternatives" are formulated and evaluated, economic or social impact analyses are not done.

The data used in this section is limited to pre-existing socio-economic data for this region. This includes census data, recreation studies, county zoning maps, and county tax assessors maps. This data was supplemented with interviews carried out in the watershed with knowledgeable local people, including county planners, federal recreation specialists, land owners and owners of businesses. When the data available does not permit very good qualitative or quantitative conclusions, the report points out areas where increased data collection and analysis can be used to support natural resource conservation and social goals.

MAJOR ISSUES

The human factors influencing natural resource conditions in a watershed are almost limitless. Human factors can be studied from a myriad of angles ranging from economic to political. Even if the "proper angle" is chosen, and emphasis placed on one approach and discipline, the analysis still must confront questions about the "right factors" to study, the proper methodologies to use, the scale of analysis (i.e. local, national) and the assumptions made.

Planners use critical issues and key questions to put boundaries on the scale of study and to focus the study toward the "proper angles". A danger in relying on the critical issues and key questions developed by any watershed planners is bias. The team can be dominated by one discipline that prefers one approach. Similarly, the team may not have all the disciplines needed to frame the right questions or address the important issues. For these reasons, although the critical issues and key questions identified in this section by this watershed team receive focus in this chapter, they still are placed in broader, disciplinary framework (see Table 4-1 and 4-2). This broader framework, encompassing mostly economics, allows further investigation into the real issues and correct questions.

Critical Issues

The critical issue directly pertaining to the human domain that was given a *high* priority rating was "Land Use". Land use is a broad issue addressing the observation that land uses, such as mining, and the factors influencing land uses, such as zoning laws, play a prominent roll in fisheries and fuel load conditions. As shown in Table 4-1, land uses are derived from institutional settings, which in turn result from social forces.

A number of critical issues were classified as having a *medium* priority. These included regional economic impacts(i.e. jobs, industries), recreation opportunities associated with the creek, and property rights.

CURRENT AND REFERENCE CONDITIONS AND TRENDS

Tables 4-1 and 4-2 display the model that will be used to describe current conditions and trends of interest in this chapter. The analysis will start with the fairly straightforward description of *Land Ownership and Land Uses* (Box F). Next, the *Institutional Setting* (Box E) of the watershed will be described by looking at the property rights regime, environmental regulations, governmental agency policies, stakeholders and economic factors, such as markets, affecting the watershed. Finally, the *Service Flows* and *Value of Service Flows* (Boxes B and C) associated with the natural resources in the watershed will be examined.

Explanations for the *Societal Forces* (Box D), or socioeconomic causes for land uses, managerial methods, and institutions will be included within Sections B and C.

Readers of this report should be wary of the claim made about the analysis of societal forces. That can mean just about anything. For the purpose of this report, the "forces" of interest are those related to the critical issues and key questions identified in this report. Although many of these forces are not exclusive to the watershed, attention will be paid to those that appear more local rather than global.

Note should be made that the use of reference conditions and variability, as described in previous chapters, works differently within the human domain than with the natural resources domains. Natural resource domains use reference conditions as a benchmark to understand a more undisturbed state for natural resources, one that may be desirable to return to. No such claims are made with human reference conditions. Although an understanding of history can shed very important light on what has occurred in the watershed, no claims are made that the economic, social and political structures in place in the past better than current structures. For this reason, history gets some attention in this section, but the use of "reference conditions" less so.

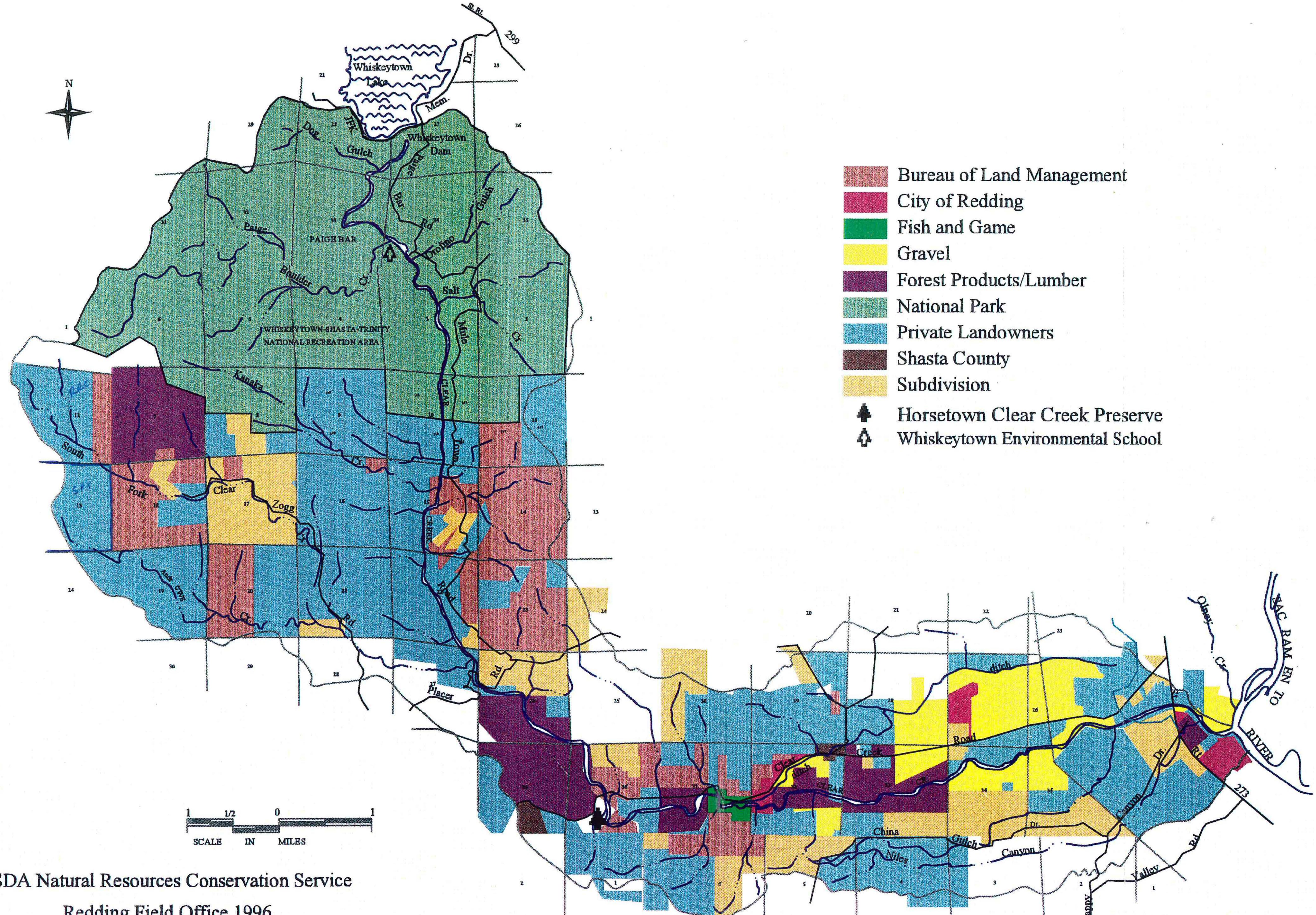
LAND OWNERSHIP AND LAND USES - CURRENT CONDITIONS

This section describes land uses, land ownership and current natural resources management methods that affect the lower Clear Creek watershed. As Table 4-1 shows, land uses and management methods result from "invisible" institutional structures and forces. Sections B and C look at these institutions and attempt to find some causes for current natural resources conditions.

LAND OWNERSHIP

Tax assessor parcel maps and ownership data was used to construct the ownership map for the watershed (see Map 4-1 following). A total of 213 major parcels were mapped out and the owners identified. Small acreage parcels and subdivided housing tracts were combined into larger parcels so that the map is readable. This information was used to classify land owners into the three major categories shown in Table 4-3 following.

Map 4-1: Land Ownership in the Lower Clear Creek Watershed



USDA Natural Resources Conservation Service

Redding Field Office 1996

TABLE 4-3 - LAND OWNER CLASSIFICATION (AUGUST-95)

Classification of Land Owner	Numbers of Owners Acres owned	Major land uses
1. *Public or Non-Profit Owners*	USA (*outside boundaries of NPS*) - BLM - 3600 acs. City of Redding - 200 Shasta County - 40 State of California - 74 Horsetown - Clear Creek Preserve - 27 **Total - 3,940 acres (17.5% outside NPS)**	Undeveloped, Mining, Municipal, Recreation and Natural Resources Protection
2. *Major Commercial Owners*	3 timber-related companies - 4,900 acres 1 real estate developer - 600 3 construction related businesses - 1,960 1 income producing trust - 600 **Total - 8,065 acres (36% outside of NPS)**	Gravel mining, Commercial Timber, Potential Residential, Undeveloped
3. *Miscellaneous Private Owners*	Several hundred residential Several dozen businesses **Total - 10,400 acres (47% outside of NPS)**	Commercial, Rural Residential, Residential - High Density.

Source: County Tax Assessor's records were used for land ownership data; aerial photos (USGS, 1994) were used to identify land uses. Acreage was estimated for parcels that had to be combined (smaller lots and acreage).

The first group of landowners in this table, *Public or Non-Profit Owners*, includes land owned by the, BLM, City of Redding, State of California, County of Shasta, and a non-profit organization, the Horsetown-Clear Creek Preserve. These owners manage approximately 3,900 acres, or 17.5% of the land outside the boundaries of the National Recreation Area. An additional 8,000 acres of land in the watershed is managed by the National Park Service as part of the Whiskeytown-Shasta-Trinity National Recreation Area.

The second category of landowner, *Major Commercial Owners*, includes those businesses and individuals who own major amounts of land (>500 acres) and generally use this land for commercial or income producing purposes. Less than ten landowners fit into this category. Included are two timber companies and one private individual who in total own over 4,900 acres of land and appear mainly interested in the timber resources of their land, three construction-related companies who mine gravel and own 1,960 acres of land, one real estate developer who owns over 600 acres of undeveloped land, and one trust that owns 600 acres and uses the property for irrigated pasture and cattle grazing.

Together these owners account for about 36% of the land outside the boundaries of the National Recreation Area.

The last category of landowner, *Miscellaneous Private Land Owners*, includes those landowners who own smaller acreage and use this land for miscellaneous purposes. Owners include several hundred residential property owners, a few dozen commercial business owners, and miscellaneous other users such as mine owners and ranches. These landowners account for the balance of the land.

LAND USES AND NATURAL RESOURCE MANAGEMENT

The three major owner classifications manage their lands for different purposes and will be examined separately. Map 4-2 (following) highlights the major land uses found in the watershed.

Public and Non Profit Land Owners

The lands owned by public agencies in the park are managed for multiple uses with multiple purposes. The more prominent land uses and land management purposes employed by these agencies include recreation, natural resource protection, education and physical infrastructure and are described below.

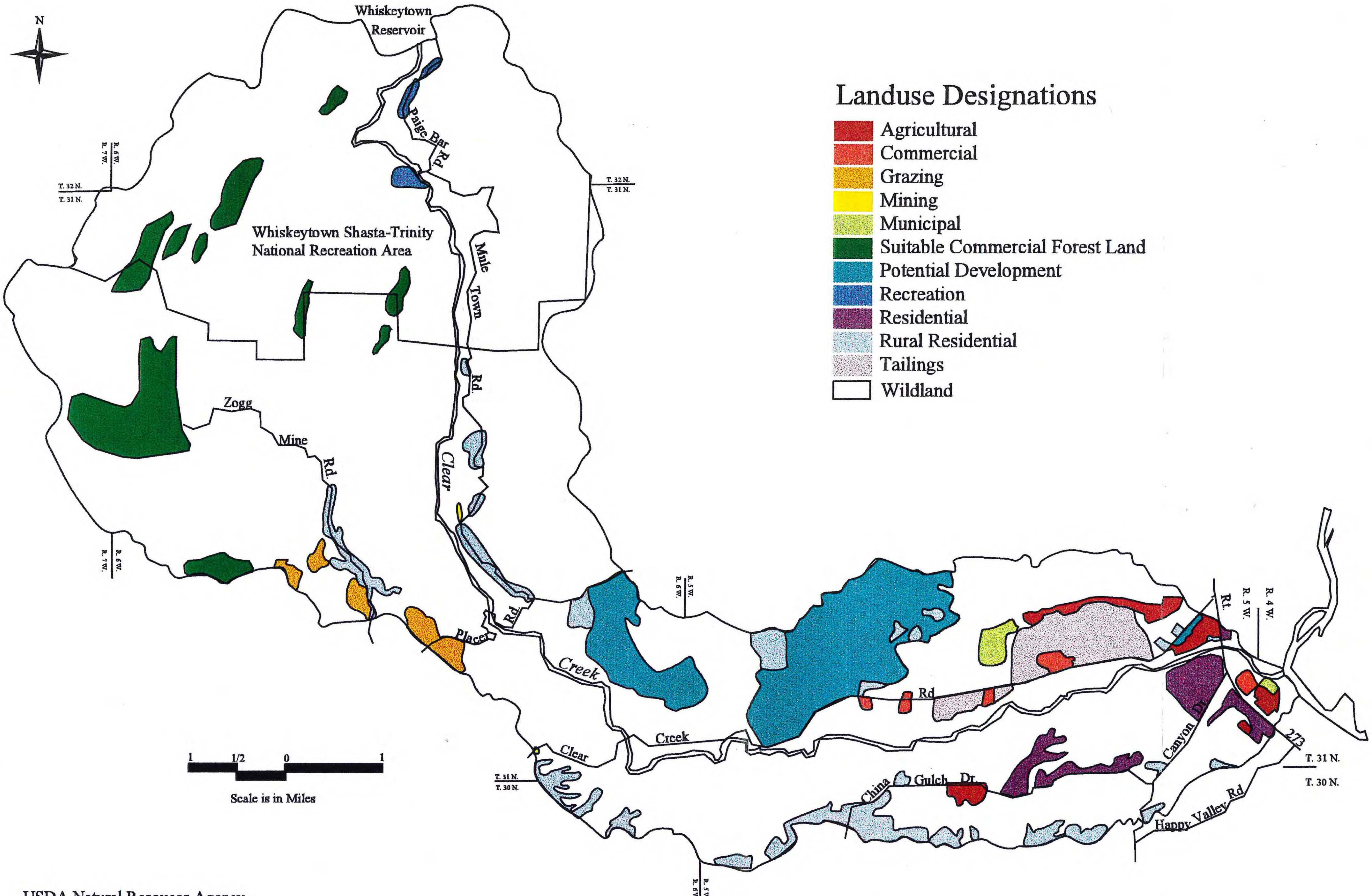
- **Recreation and Natural Resources Protection:** The prominent recreation and natural resources protection sites in the watershed include the following.

National Park Service Land: In the National Recreation Area, the National Park Service has 9 primitive campsites, one cleared campsite for equestrian use, and several miles of hiking trails in the upper watershed (with spectacular views of Clear Creek canyon). Much of the creek area is inaccessible due to steep canyons. They also have a one half mile scenic view easement that extends south from the park boundaries, along Clear Creek. In their final master plan, NPS classified the upper canyon area of Clear Creek as an "outstanding natural area" (BLM, 1992), and planned further improvement efforts (i.e, hiking trails, land acquisitions).

Bureau of Land Management Land - The BLM has classified the upper creek as Scenic and manages this area in accordance with the National Wild and Scenic Rivers program. They do not allow any use that would be inconsistent with this purpose. BLM has a proposal pending that would declare this area part of the National Wild and Scenic Rivers program.

BLM land in the valley area is managed for various recreation purposes. Reports of drug dealing, drinking, squatting and using the ground for dumping trash, have given this area a negative reputation. Under their "No Action" management alternative for this area, they would continue to maintain the existing scenic quality of their lands that have a view of the National Recreation Area (BLM, 1992).

Map 4-2: Land Use in the Lower Clear Creek Watershed



USDA Natural Resouces Agency

Redding Field Office 1995

California Department of Fish and Game - The DFG owns the land surrounding McCormick-Saeltzer Dam (except for an irrigation canal owned by the Townsend Flat Water Ditch Company). They do not fence off or prohibit access to this property and the public uses the reservoir on this property for swimming and fishing. This area also provides access to Clear Creek upstream and downstream from the claim. A Department of Water Resources 1980 recreation survey found this area to be the most heavily used recreation area of lower Clear Creek (and that was when the property was privately owned).

Other Recreation Sites: The Department of Water Resources 1980 recreation survey mentioned two additional recreation sites on the creek that are mainly used for swimming and fishing. The first is the one mile reach from the mouth of the creek to above Highway 273. This area is accessible from the bridge over Highway 273 and from a Redding recreational access easement (DWR, 1980). The second is a small site owned by a private recreation club located above the old Placer Road bridge.

- **Environmental Education.**

National Park Service - The NPS operates a National Environmental Education Camp (N.E.E.D.) on Clear Creek, approximately 1.5 miles below Whiskeytown Dam. The facilities of this camp include a parking area, picnic area, and several buildings. These facilities are used for environmental education purposes and are mainly used by area schoolchildren.

Horsetown-Clear Creek Preserve - This is a non-profit environmental education organization formed in 1989 by local residents. The purpose of this organization is to " save, rehabilitate, and restore approximately 1,000 acres of public land and to create, organize and operate it as a preserve with many broad and overlapping benefits for residents of, and visitors to, the community" (BLM, 1994). The preserve acquired approximately 27 acres of ground in 1992, located directly north of the Clear Creek Bridge and south of Clear Creek Road. On August 2, 1994 they entered into an agreement with the BLM to manage an additional 400 acres of land in this area.

The Preserve plays a very active role in attempting to improve the type of recreational use found in this area. More specifically, they promote changing uses from target shooting, drinking, trash dumping and squatting to uses that enhance the local fishery, promote development of a green-way from the Sacramento River to the National Recreation Area, and expand environmental education and other low-impact recreation activities, such as hiking, fishing and picnicking.

- **Physical Infrastructure**: Map 4-1 shows that the watershed is accessible by several paved roads: from the east by Clear Creek Road, Happy Canyon Drive and China Gulch Road; from the west by Placer Road; from the north by Texas Springs Road. Access from the Whiskeytown Reservoir area is Muletown Road, a gravel road. The main access road into the watershed is Clear Creek Road, which connects with Highway 273. This road also provides access to the county landfill (not located within the boundaries of the watershed) and is heavily used by large trucks.

The watershed does not have formal parking or walking areas that would allow for new recreation uses of the area (outside of a small area at McCormick-Saeltzer Dam). Recreation users of BLM lands park on the side of the road or just off of dirt access roads.

A 45 inch water conduit, managed by the Bureau of Reclamation, goes through the watershed in the Mule Town Road area. Two local water districts have contracts to take water from this conduit. The Centerville Community Water District has three distribution systems around the Mule Town Road area. Because of the slopes in this area, they do not project significant development in this area (Phil Brown, personal communication). They do expect development to occur south of Texas Springs Road, but are not sure when this will take place.

The Clear Creek Water District distributes water from this conduit to an area around China Gulch road. They do expect continued development in this area.

Major Commercial Land Owners

The major land uses taking place by the major commercial landowners include gravel mining, timber production, and residential real estate development.

- **Residential Real Estate:** A major real estate development group owns approximately 600 acres within the watershed. This area (i.e. around Texas Springs Rd.) has a strong potential to be developed in the near future for residential purposes. In 1994 the owner of this property attempted to have the residential density reduced to 3 acres, but was not successful.

- **Resource Use:** Three major construction-related companies own more than 1,950 acres within the watershed. Two of these companies have extracted large gravel deposits from the watershed and continue to do so. The third company plans to begin extraction activities (if the BLM does not acquire their property). Most of their activities occur along Clear Creek Road, in the valley floor area of the watershed. An extensive amount of this land has already been gravel mined

  Two prominent commercial timber companies own more than 4,100 acres within the watershed. At least one of these companies extracted substantial stands of timber after the Kanaka fire in 1990. There is little commercial timber harvesting activities currently in the watershed.

One prominent landowner carries out cattle ranching activities within the watershed; this includes irrigated pasture for feed.

Miscellaneous Land Owners

The several hundred land owners in this category mostly use the land as residential property. Several mining operations own land in the upper portions of the watershed. These mines appear to be restricted to small scale activities and do not appear to be extracting large quantities of minerals or disturbing surface lands.

The China Gulch Road area has one subdivision (about 50 lots) under development and another planned for the future. This area receives water from the Clear Creek Community Services District (personal communication - Bill Suppa, 1995).

TRENDS

Public Lands

Recreation and Natural Resources Protection: The Bureau of Land Management's proposed management alternative (see BLM, 1992) for Lower Clear Creek *(Resource Use with Natural Values Consideration Alternative*) calls for: 1) enhancing anadromous salmonid habitat, 2) restoring the quality and quantity of riparian vegetation to Class I and Class II, 3) enhancing non-motorized recreation opportunities by developing a green-way from the Sacramento River to the National Recreation Area, 4) maintain the scenic quality of the canyon above the Clear Creek Road Bridge, 5) protect the native plant communities and associated fauna of the area and 6) protect the historic values of the area. BLM proposes to transfer land in the upper watershed to other organizations as part of the Recreation and Public Purposes Act.

To accomplish these goals, the Bureau of Land Management is negotiating to acquire more than 1,800 acres of land from two large land owners in the lower watershed. They also propose transferring 280 acres to purposes condoned by the Horsetown-Clear Creek Preserve. The BLM is negotiating land acquisitions with a third major land owner.

The most significant trend in public land use has been agency efforts to enhance the recreation value of this watershed The BLM and Horsetown-Clear Creek Preserve plan for a green-way from the Sacramento River to the National Recreation Area is particularly ambitious and could result in substantial recreation and land use changes in the watershed.

Environmental Education: *Horsetown Preserve* is attempting to expand onto 280 acres of BLM ground under the Recreation and Public Purposes Act. A proposal has been submitted to BLM and is being considered. The Preserve intends to expand their system of hiking trails and environmental education opportunities. In the long run, members of this group envision a bicycle trail that connects the Sacramento River Trail in Redding to Clear Creek, via Old Shasta (personal communication, Gene Clark, 1995).

Physical Infrastructure: Currently, no major planning is underway for installing the physical infrastructure needed to enhance the recreation value of the area (i.e. roads, parking areas, bridge crossings). This situation may change if the BLM and DFG acquire more property and if the Horsetown-Clear Creek Preserve expands their property. A land use and transportation plan may need to be developed that addresses current concerns about incompatible recreation and other illegal uses (target shooting, squatting, drug dealing) in addition to the large number of trucks hauling trash through the area.

Large Commercial Land Owners

Residential Real Estate: The real estate developers who own more than 600 acres of Sections 29 and 30 (north of Clear Creek Road and south of Texas Springs Road) can be expected to develop this area for residential housing within the next ten years. Currently, high quality and high value houses are being built in this area. Although construction activities appear to generate high sediment loads, once construction is completed the erosion should be controlled by the homeowners.

Resource Use: One major construction-elated business has reported plans for expanding their business in this watershed. They just completed the purchase of 40 acres of tailings for this purpose. Two other aggregate businesses can be expected to continue or begin new gravel mining activities if the BLM or DFG do not acquire their properties.

Timber companies should be expected to harvest timber on their parcels when the trees meet their criteria for harvest.

Landowners carrying out ranching activities expect the development of their land in the long term (greater than 7 years), but made clear they are interested in development that is sensitive to the environment and to the community.

Miscellaneous Land Owners

Development can be anticipated in the Texas Springs and China Gulch areas. Pat Cecil, of the County Planning Department, believes that much of the rest of the lower watershed will not undergo extensive development in the near future, because of four significant constraints to development. The four main constraints to real estate development in the watershed are 1) limited water availability, 2) excessive slopes, 3) poor conditions for septic systems and 4) limited access to many parcels. Current zoning laws require that land with slopes greater than 30% have a minimum of an 80 acre site in the Rural Residential B General Plan land use designation and the Limited Residential zone district. However, the maximum density for land exceeding a 30% slope is one dwelling unit per 10 acres in the Rural Residential A General Plan land use designation and the Rural Residential zone district. The maximum development in other land use designations and zone districts is not determined by the percent slope of the land. Additional access roads are required when more than 1000 feet of road are needed to reach a developed site.

The China Gulch Road area has a high probability of continued real estate development because water is available from the Clear Creek Community Service District (personal communication, Bill Suppa). Mule Town Road has three water distribution systems managed by the Centerville Community District, but the slopes in this area will likely limit development to low-density housing.

INSTITUTIONAL SETTING - CURRENT CONDITIONS

Table 4-1 indicates that the institutional setting found in the watershed contributes to natural resource conditions. Natural resource plans often do not define what is meant by institutions. Institutions will be defined here because they are not always understood, and a definition may add clarity to this section.

Institutions include the formal and informal laws, rules, and organizational settings which are important in governing the behavior of a community or society.

Four broad categories will be used to describe the formal and informal institutions affecting the watershed:

1. Political/Legal/Governmental: property rights, environmental laws, government policy
2. Economic: markets, incentives, provision of public goods
3. Social: characteristics of stakeholders; norms
4. Cultural Resources: archaeological sites

Most of the critical issues identified by the watershed planning team are found in categories 1 and 2.

POLITICAL/LEGAL/GOVERNMENTAL SETTING

The main political, legal, and governmental institutions of concern in the watershed relate to the property rights regime and the laws regarding use and management of the natural resources in the watershed. In addition, the policies followed by governmental agencies also play a big role in this watershed because of the large amount of publicly owned land and water. The following section first examines existing property rights, then summarizes several key environmental laws, and finishes with a summary of current public agency environmental policy.

Property Rights

Property rights are a "bundle" of rights that owners of a resource (i.e. capital, land, water, fish) acquire when they purchase the resource. These rights dictate how the resource can be improved, used, managed and sold. Many environmental problems involve resource allocation problems (i.e. over exploitation, generation of externalities) thought to be based, in part, on poorly developed property rights. "Clear" or "well developed" property rights are well defined, exclusive, transferable and enforceable. The development of clear property rights is thought to be a precursor needed for developing private market solutions to natural resource problems (i.e. they lead to better information about correct prices and therefore better resource allocation decisions)(OECD, 1994).

This section examines aspects of these rights that influence natural resource conditions in the lower Clear Creek watershed. These aspects will include: i) Zoning Laws, ii) Water Rights and iii) General Property Rights.

i) Zoning Laws

The lower Clear Creek watershed is located in Shasta County. The County General Plan indicates the type of development approved by local officials in the future. The General Plan drives the zoning that regulates real property use and development in this area. A small portion of the watershed lies within the boundary of the City of Redding. Land use in this small area is covered by the City's General Plan and zoning laws.

Zoning laws show the land uses and developments permitted by the County in the past and planned for the county in the future. Examining these helps to explain how current natural resource conditions arose and how they might change in the future.

Current Conditions

Table 4-4 summarizes land zoning in the lower Clear Creek watershed. The acreage shown in this table were derived by looking at zoning maps and approximating the acreage for each section (640 acres) of the watershed. Some of the zoning maps covering the perimeter of the watershed were not available. The zoning for these areas was estimated from nearby zoning (usually zoned "U"-Unclassified).

TABLE 4-4. ZONING

Zoning Codes	Description	Acres	% of Area
A A-1-BSM	Limited Agriculture	20	.07
City	City of Redding Zoning	1880	6.2
CM	Commercial Light Industrial	40	.13
EA-AP	Exclusive Agriculture - Agriculture Preserve	760	2.5
M M-DR, M-L	General or Light Industrial	710	2.34
NRA NRA-WI, NRA-WII, NRA-WI-R-R-B-6, C-R-NRA-WI	National Recreation Area	8000	26.3
OS	Open Space	125	.4
PD	Planned Development	100	.33
RL R-L-BA-10, R-L-BA-20	Limited Residential	1055	3.47
RR R-R-BA-5, R-R-BA-10, R-R-BA-20, R-R-BA-40, R-R-BA-60, R-R-BA-100, R-R-BSM, R-R-SP, R-R-T-BSM	Rural Residential	2560	8.4
U	Unclassified	15,155	49.8
Total		30,405	99.94%

Source: Shasta County Planning Department zoning maps; data was extrapolated from the maps.

Table 4-4 shows approximately 50% of the watershed is zoned Unclassified, 26% National Recreation Area, 12% Rural Residential, and the remaining 12% City, Commercial, Agriculture, or Industrial.

The zoning that has had the largest impact on watershed conditions in the recent past is the last category - Commercial and Industrial. This zoning permits the gravel mining operations that dredged the creek beds and surrounding areas. Most of the gravel has been mined from the creek bed and operations have moved outside the riparian zones. There is no zoning prohibition or other restriction on development based on the distance of the development site form the middle of the creek. However, the siting of potential development in relationship to the creek would depend on the findings of a site-specific environmental review, which could require a setback from the creek to mitigate potential impacts on the fish, wildlife and /or riparian vegetation. The zone district, in which the development site is located, prescribes which uses do not require permits, which uses require use permits, and which uses are prohibited. The county may require an

Environmental Impact Report (EIR) depending upon the results of the initial study phase of environmental review under CEQA.

Residential zoning on slopes greater than 30% requires at least 80 acres per site in the Rural Residential General Plan land use designation and the Limited Residential zone district. There is a maximum of 10 acres per dwelling unit in the Rural Residential A General Plan land use designation and the Rural Residential zone district for land exceeding 30% slope. Because much of the upper watershed has slopes that exceed 30%, housing density should remain low in most of this area.

Trends

The Shasta County Planning Department noted that zoning codes are fairly malleable. They can and do change. Although this could lead to substantial changes in land uses, the Shasta County Planning Department doubts that this change will occur (development is constrained by lack of water, poor septic conditions, poor accessibility, and excessive slopes).

The next update to the County General Plan will take place shortly. Interest groups, including natural resource conservation groups, will have the opportunity to participate in the public process accompanying the plan. This represents a good opportunity to become involved in County planning activities that will play a large role in future development in the watershed.

ii) Water Rights

The most significant human impact on the creek and riparian habitat has been the construction of Whiskeytown Reservoir and the dam constructed to hold back the waters of Clear Creek. Whiskeytown Dam was built in 1963 as part of the Central Valley Project. It resulted in 87% of Clear Creek's natural flow being diverted to the Spring Creek powerhouse at Keswick Reservoir (DFG, 1993). The ability to control the amount of water released from this dam year round offers planners a chance to balance the benefits and costs of such releases.

McCormick-Saeltzer Dam is the only other major dam on the creek. It is a 15 foot high concrete dam built to divert water for irrigation. This dam effectively bars all fish passage to the upper reaches of the creek.

Current Conditions

The Bureau of Reclamation controls the right to almost all of the in-stream water flow in the creek. The major exception is 55 cfs of flow owned by the Townsend Flat Water Company and diverted at McCormick-Saeltzer Dam. An unlined canal (which was recently cleaned out and expanded) carries the water to livestock pastures located several miles east of McCormick-Saeltzer Dam. In addition, a Department of Water Resources study completed in 1986 (DWR, 1986) found that the only other significant consumptive uses of water were by the Renshaw ranch who pumped up to 1 cfs in the summer and at the B& S gravel plant where water was used to wash gravel. Neither company is currently listed as a property owner in this area. The report also mentioned that some property owners on the lower 2 miles of creek diverted small quantities of water for garden irrigation.

Bureau of Reclamation (BOR): Table 4-5 shows the current typical water releases made by the BOR into Clear Creek. These releases are managed by BOR as part of the Trinity River Division of the Central Valley Project. The Trinity River Division was authorized by Congress in 1955 and completed in 1964 (BOR, 1983).

TABLE 4-5. AVERAGE ANNUAL FLOW AT MCCORMICK-SAELTZER DAM (CFS)

(this table is taken from DWR, 1986)

	Jan	Feb	Mar	Ap	Ma	Ju	Jul	Au	Se	Oc	Nov	Dec	Total AF
Release from Whiskey-town Dam	50*	50	50	50	50	50	50	50	50	50	100	100	42,000
Average Normal Year Tributary Inflow	120	140	145	95	35	10	3	3	3	5	30	65	39,000
Total Flow at Mc Cormick-Saeltzer Dam	170	190	195	145	85	65	53	53	53	55	130	165	81,000

Source: Department of Water Resources, 1986

*The schedule and rates have fluctuated over the last few years up to 70 cfs to accommodate the Redding Power Plant.

The major purposes of the Central Valley Project are to provide water for irrigation, power, recreation, fish, and wildlife conservation (BOR fact sheet, 1980). The major features of the Trinity River Division, as described by BOR are:

"Trinity River water is stored in the 2,448,000 acre-foot Clair Engle Lake behind Trinity Dam. Releases from this reservoir are utilized by a 105,556 kW powerplant and are again regulated in Lewiston Lake about 7 miles downstream. Lewistown Dam, with the 350 kW Lewiston power plant regulates flows to meet downstream requirements of the Trinity River Basin, including the Trinity River Fish Hatchery and downstream fishery.

Water not released to the Trinity River Basin is diverted from Lewiston Dam through the Clear Creek Tunnel to the 141,444 kW Judge Francis Carr Powerhouse and then into the 241,000 acre-foot Whiskeytown Reservoir behind Whiskeytown Dam on Clear Creek, a tributary of the Sacramento River. From Whiskeytown Lake, the Trinity River water, and any surplus from Clear Creek, is diverted into the Spring Creek power conduit to the 150,000 kW Spring Creek Powerplant and discharged into Keswick Reservoir on the Sacramento River. The imported Trinity water supplements the Sacramento River flows for irrigation, municipal, industrial, water quality, and navigation uses in the Central Valley basin (BOR, 1980)."

Additional features of this system include the Clear Creek South Unit which furnishes irrigation water and domestic water, through a 11.7 mile conduit, to approximately 5,000 acres of land southeast of Redding and west of Redding (BOR, 1983). In addition, the City of Redding operates a power plant at the point where water is released from Whiskeytown Dam into Clear Creek (Serge Birk, personal communication, 1995).

Tradeoffs are an obvious feature of the Trinity Division. Water releases can be changed to any point in the system, but only by trading off releases in another part. These tradeoffs have major implications for irrigation, power generation, recreation and natural resource conservation. The Bureau of Reclamation is still attempting to balance these tradeoffs. Final decisions have not yet been made on how provisions of CVPIA will be implemented (Serge Birk, personal communication).

Townsend Flat Water Company: This irrigation company is entitled to 55 cfs of instream flow as a result of pre-1914 water rights (personal communication, Lee Salter). The principal owner of the irrigation company is a local landowner, the McConnell Trust. The irrigation company recently did maintenance which brought the carrying capacity of the ditch to original condition.

Other owners: No other major water diversions were identified for this report.

Trends

The pricing and use of Central Valley Project water continues to be a major source of controversy in California. The Bureau of Reclamation has traditionally established contracts with irrigation districts that spell out prices and quantities of irrigation water to be delivered. Many people claim that these prices fall well below the marginal cost of the water, or the price that a free water market in California would establish. Others claim that instream water uses have greater value to society than irrigation water. Farming interests counter with the claim, among others, that the benefits of these water prices have already been capitalized into farmland real estate values. Any changes in these prices will affect a major source of rural wealth.

The Central Valley Improvement Act (CVPIA) requires that the Bureau of Reclamation place fish and wildlife protection on an equal priority with other water uses such as irrigation and power. Details about this law are covered in the next section of the report. The US Fish and Wildlife Service developed a working paper addressing the restoration needs for Clear Creek as part of this Act. The paper called for the specific actions to take for improving Clear Creek fisheries that would improve habitat for fall, late fall, and spring run Chinook salmon and steelhead. These included increasing instream flows, maintaining water temperatures at prescribed levels, restricting gravel mining from the creek bed, providing fish passage at McCormick-Saeltzer Dam, preventing sediment deposition, and restoring gravel and spawning habitat. The Bureau of Reclamation is still formulating final actions to take in order to implement this law.

iii) General Property Rights

Current Conditions

At least two additional aspects of property rights are important in this watershed analysis. The first, Anadromous Fisheries, involve the *open access* nature of fishing stocks. *Open access* refers to a property right characteristic where no one individual or group owns the resource stock. In the case of anadromous fisheries, the stock of Chinook salmon and steelhead in the ocean-river-stream system are not owned by any one person or group. Because the stock of fishes is not owned, recreation and commercial fishermen have an incentive to take as many fish as possible without accounting for the subsequent effects.

Economists see this over-fishing and resource depletion as a type of market failure (normal markets for goods and services fail to allocate these goods properly) that may justify government intervention. In the case of anadromous fish in California, the government has definitely intervened to protect fishery stocks through a series of laws limiting catches. The large list of laws pertaining to fisheries detailed in the next section of this chapter have a large basis in the *open access* nature of the fishery.

The second important property rights issues deal with *externalities*. Externalities arise when the actions of one economic agent, such as a property owner, affect (beneficially or harmfully) other economic agents, such as fishermen, but no penalties are paid, or rewards received, for the effects. Externalities that somehow damage other economic agents are referred to as *negative externalities*, those that provide benefits are referred to as *positive externalities*. Externalities that appear to be present in lower Clear Creek include excess fuel loading in forests, sediment that leaves real estate through erosion processes, and negative fishery impacts resulting from gravel mining.

The high fuel load conditions found in the watershed represent a negative externality because owners of forests and woodlands that allow high amounts of fuel to accumulate on their properties increase the risk of serious fire. A negative externality is present when these fires occur because they damage neighboring property. In addition the owner of the high fuel load property is not liable for the damages.

Properties subject to soil erosion generate negative externalites when the eroded soil enters Clear Creek and somehow damages fish stocks. In lower Clear Creek, this appears to occur after timber harvests, on abandoned timber roads, on construction sites, and on land that is not well maintained.

Gravel mining appears to generate a mix of positive and negative externalities. The negative externalites include the generation of sediment that enters spawning areas, the direct alteration of the stream bed, and the digging of deep pits that allow entrapment of young fish after flood events. Positive externalities are also generated because the digging of pits has generated more wetlands (Harry Rectenwald, personal communication).

The last important property rights issue involves the large amount of publicly-owned land in the watershed and the continued acquisition of land by the BLM. The three agencies that own land in the watershed - NPS, BLM and DFG are mandated by law to protect valuable natural resources by purchasing and managing real estate. They respond to a type of market failure - the belief that the private sector would not supply enough of this pristine and scenic land on its own (scenic views and other aspects of environmental quality are seen as public goods to be protected and maintained by government).

Trends

Current political trends in the United States appear to favor existing property rights structures over new alternatives that favor environmental resources, or that would deal more effectively with negative externalities. Several pieces of federal legislation are pending that would enhance existing property rights, such as giving property owners compensation for "takings" that had not been compensated in the past. A full analysis of the major national and state trends that will affect the property rights regime in the watershed goes beyond the scope of this study

Private sector solutions to property rights may have a greater possibility of being effective than in the past. Media reports and anecdotal information suggest that fire insurance companies are beginning to enact risk management policies that recognize differences in fire risk. The heavy losses experienced by these companies as a result of recent natural disasters in California explain the change.

ENVIRONMENTAL REGULATIONS

A wide number of federal, state, and local laws and regulations are in effect for protecting or enhancing the natural resources in lower Clear Creek. Many of these laws pertain, in particular, to anadromous fisheries. These laws have originated for dealing with the variety of market failures mentioned in the last section. Their major impact is to realign property rights in ways that deal with the common access nature of anadromous fish and the externalities found in the watershed. The following section summarizes the major laws and identifies the public agency responsible for administration.

Many of the laws highlighted in this section work at broader ecosystem scales (i.e. the Sacramento River). The anadromous fishery issue in Clear Creek is part of this larger scale natural resource issue.

Current Conditions

i) General Laws and Regulations (USFWS, 1995; DFG, 1993; Central Valley Improvement Act, 1994)

- **National Environmental Policy Act (NEPA)** - requires federal agencies to prepare detailed environmental impact statements when considering major federal actions which could significantly affect the quality of the environment. Federal agencies who own major amounts of land in the watershed are the BLM and NPS.
- **California Environmental Quality Act (CEQA)** - requires the preparation of environmental impact reports for projects proposed or permitted by State or local agencies with the potential to significantly affect the environment. Negative impacts must be mitigated to a safe level and there must be a mitigation monitoring plan to ensure the effectiveness of mitigation measures. Requires county to analyze the environmental impacts of new development. Highly site specific - depends on features of site (i.e. wetlands, important environmental features ...)

- **Federal Endangered Species Act (ESA) and California Endangered Species Act-** limits how the habitats of federally listed threatened or endangered species can be managed and used.

- **Section 404 (Clean Water Act) and Section 10 (Rivers and Harbors Act)** - prohibits the discharge of dredged or fill material into waters of the United States, or alteration or obstruction of navigable waters without a permit. EPA gives authority to State Water Resources Control Board and Regional Water Quality Control Boards (RWQCB) for carrying out provisions. Requires Army Corps of Engineers permit for dredge and fill activities, i.e. gravel mining.

- **Section 208 (Clean Water Act)** - mandates the control of "non-point source" pollution. Administered by the State Water Resources Control Board. This agency, along with the RWQCB, review proposals for permits to ensure water quality is maintained. RWQCB is also in charge of issuing permits for water discharges under provisions of Clean Water Act

- **Porter Colgne Water Quality Act** - Designates Clear Creek as a cold water fish production and immigration creek; establishes standards for stream temperature, dissolved oxygen, pH ...

- **General Mining Law of 1872; Surface Resources Act of 1955; 43 CFR 3809 Regulations:** These federal laws permit mining claims to be made on federal lands (for nominal sums) but also require that large scale mining activities or mining activities in areas with Wild and Scenic Rivers include mitigation efforts and reclamation bonding.

- **County Grading Ordinance** - Supervised by the County's Department of Public Works, Building Division. Requires erosion control plans for certain types of building construction.

ii. Fisheries Laws (USF&WS, 1995; DFG, 1993; Central Valley Improvement Act, 1994)

- **Central Valley Project Improvement Act (CVPIA) -** "amends the authorization of CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancements as a purpose equal to power generation." The section of the act known as Anadromous Fish Restoration Program was established to develop and implement "a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period 1967-1991.".

- **Section 3406(b)(12) of Central Valley Improvement Act (Clear Creek provisions)** - "develop and implement a comprehensive program to provide flow and allow sufficient spawning, incubation, rearing, and out-migration of salmon and steelhead from Whiskeytown Dam as determined by instream flow studies conducted by the California Department of Fish and Game after Clear Creek has been restored and a new fish ladder has been constructed at the McCormick-Saeltzer Dam. Costs associated with channel restoration, passage improvements, and fish ladder construction required by this paragraph shall be allocated 50 percent to the US as a non-reimbursable expenditure and 50% to the State of California. Costs associated with providing the flows required by this paragraph shall be allocated among project purposes."

- **Fish and Wildlife Conservation Act** - provides that wildlife conservation shall receive equal consideration, and be coordinated with, other features of water development programs. USFWS reviews Section 404 and 10 permit applications.

- **Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988** - Provisions include: a) it is the policy of the state to significantly increase the natural production of salmon and steelhead trout by the end of this century. The DFG shall develop a plan and program that strives to increase the current natural production of salmon and steelhead trout resources b) it is the policy of the state to recognize and encourage the participation of the public in these efforts.

- **State of California Public Resources Code Sections** - *Section 1603*: requires a streambed alteration agreement with DFG for projects affecting flow bed and channel or bank of any river, stream or lake. The Keene - Nielsen Fisheries Restoration Act of 1985 states that "California intends to make reasonable efforts to prevent further declines in fish and wildlife, intends to restore fish and wildlife to historic levels where possible and intends to enhance fish and wildlife resources where possible". *Section 5931*: requires that an owner of a dam provide sufficient passage facilities to allow fish over the dam to satisfy Department of Fish and Game and Fish and Game Commission. *Section 5936*: requires that an owner of a dam release sufficient water to keep below stream fish in good condition. *Section 5650*: prevents the release of substances hazardous to fish life.

- **County Ordinances:** a) Mining: an ordinance was passed in 1977 prohibiting gravel mining in Clear Creek floodplain (requires EIR prior to obtaining county consent);

iii. Fire Protection Laws

- **AB 337 - Bates Bill** - a California assembly bill requiring CDF to review and identify all areas in the state that fall within a very high fire hazard severity rating.

If counties accept findings, they are required to adopt ordinances such as contained in PRC 4291 (see below)

- **Public Resources Code 4290** - Fire safe measures required by law for new construction in State Responsibility areas, including: road construction, emergency access, emergency water supply, etc.

- **Public Resources Code 4291** - Fire safe measures required by law for homeowners living in a SRA, which include the following: clearing debris from roof, maintaining 30 feet of defensible space around the house, etc.

- **SRA, LRA, FRA** - state, local or federal responsibility areas. Primary responsibility for fire protection belongs to an agency of local, state or federal government.

- **Board of Forestry** - mandated to determine, establish, and maintain an adequate forest policy for the state.

- **Forest Practice Act of 1973**- state law that regulates the harvest of timber from private and state land in California; guides use of timber harvesting plans (THPs); licensing requirements for Professional Foresters and timber operators.

- **Forest Improvement Act of 1978** - includes provisions for cost-sharing and forest planning for private landowners

- **California Department of Forestry and Fire Protection** - directly responsible for wildland fire protection of privately owned land in the state

- **Fire Safe, California! Advisory Council** - an assemblage of private and public/government sector entities that share a common vested interest in fire prevention education.

- **County Ordinances** - the county has local ordinances requiring that commercial properties have sufficient water for fire prevention and fire fighting; this also includes requirements for fire access roads.

Trends

An adequate coverage of trends in environmental rules and regulations, one that includes federal, state and local actions, goes beyond the scope of this analysis. Several major trends that have the potential to impact the watershed include pending environmental legislation in Congress. The media has reported extensively about efforts of Congress to roll back or weaken environmental laws, such as the Endangered Species Act and the Clean Water Act. In addition, a group of Central Valley agricultural interests are combining with municipal interest groups to challenge the Central Valley Improvement Act. Actual implementation of these changes is uncertain, especially given the roles played by the President and Supreme Court, but they portend lesser environmental legislation in the future.

GOVERNMENTAL POLICIES

Current Conditions

Federal natural resource management agencies, such as the Forest Service, Bureau of Land Management, National Park Service, Bureau of Reclamation, Fish and Wildlife Services and National Resources Conservation Service, have begun promoting ecosystem planning. While total agreement does not yet exist about exactly how this should be done, all these agencies are promoting ways to increase the sustainability of healthy ecosystems (National Environmental Education and Training Foundation, 1995). The State of California, Department of Water Resources water management policy "includes a balanced interest in ... water use for recreation and fish and wildlife ..." (DWR, 1986). Shasta County has shown a keen interest in protecting important, local natural resources.

Trends

Federal, state, and local public agency policies appear to show a trend toward more comprehensive natural resource planning and implementation. If this watershed report is any indicator, this trend appears to be strengthening. This should result in better natural resource management plans and better natural resource management policies and activities being carried out in watersheds and localized regions throughout the state.

ECONOMIC SETTING

This section describes economic institutions that relate to the critical issues and key questions raised in this report (anadromous fisheries, high fuel loads, land uses and property rights). The formal economic institutions identified here include: a) Markets for land, inputs, goods and services produced from the watershed, b) Economic incentives associated with using or managing natural resources in the watershed, and c) Methods for dealing with market failures and providing public goods.

Understanding the economic setting assists both in explaining why natural resources are managed and used in particular ways and in providing benchmark indicators about the economic impacts of any changes in these uses and management.

COMPETITIVE MARKETS AND THE REGIONAL ECONOMY

Current Conditions

The markets that bring buyers and sellers together, under what appear to be open and competitive conditions, include the material input, real estate and parts of the recreation-based markets. Each of these markets will be discussed below.

Note should be made of the role of regional economic impacts in natural resource analysis. Economists do not count economic impacts associated with natural resource enhancement, such as increased expenditures by tourists or greater numbers of jobs due to gravel extraction, as *direct benefits* from the natural resource improvement. The measurement of direct benefits is explained later in this chapter. Regional economic impacts are considered *indirect benefits* from environmental improvement. They do not play a direct role in determining whether the benefits or a project exceed the costs. This is not to say regional economic impacts are not important. They are often an important criteria for judging project alternatives, but they should remain a separate criteria from the benefit cost criteria used to analyze projects.

Material Input Markets (factor markets) - Material input, or factor, markets, consist of sales and purchases of inputs used by companies to produce their output. The alluvial gravel produced in the watershed is a regionally important source of aggregate used in construction. The major construction-related businesses in the watershed generate several hundred local jobs and contribute substantial tax revenue to the county and state.

Timber production appears relatively unimportant in the watershed. No evidence can be found of large scale timber harvests in the recent past (except for salvage activities after the Kanaka fire in 1990). The remnants of two clear cuts are visible in the north-east section of the lower watershed, but these are on small acreage and took place some time ago. Very little watershed land is used for grazing or agriculture.

The water released into Clear Creek from Whiskeytown Reservoir is a critical input into agricultural and power-generation businesses and for municipal drinking water. It is also a critical input in the production of anadromous fisheries. Anadromous fisheries generate substantial economic activity in the form of recreation and commercial fisheries. Like water use, most of these economic activities benefit areas outside the local region (the power generation plant at Whiskeytown is owned by the city of Redding and is an exception).

Real Estate markets - Current levels of real estate development in the watershed are not high. Two smaller subdivisions are being built - one on China Gulch Road and another south of Texas Springs Road. As the population of Redding expands, more pressure will be exerted to develop land in this area.

Recreation-based markets - The Department of Water Resources conducted a recreation survey of the entire creek below Whiskeytown Dam from July through September of 1980 (DWR, 1982). The survey concluded that the recreation use of this area during the period May through September is approximately 15,000 user days. They found that 72% of the use was on weekends and 85% of the use was by local residents. Major activities include relaxing (42%), beach use (26%), and swimming (23%). In addition, camping, fishing, hiking and tubing accounted for about 7%.

These survey results are 15 years old and use along the creek has changed appreciably. In 1980 most of the land bordering Clear Creek was privately owned and access to the creek was limited (DWR, 1982). Since that date, the BLM and DFG have acquired substantial amounts of land near Clear Creek (see section A of this chapter). This land acquisition now makes recreation much more accessible to the public. More recent information was collected from the National Park Service, Horsetown-Clear Creek Preserve and the California Department of Trade and Commerce, in order to better understand the amount of recreation activity taking place in this area and the potential economic impacts of this activity.

The Whiskeytown Unit of the Shasta-Trinity National Recreation Area keeps track of the number of visitors at several locations in this NRA. Table 4-6 below shows the total number of visitors to the NRA. This number was extrapolated to estimate the number visitors to the lower Clear Creek watershed portion of the NRA. Most of the lower Clear Creek visits were to the N.E.E.D. camp that is about 1 mile below the dam. A small proportion of these visitors were hikers, backpackers and campers. If the drought years of 1992 to 1994 are left out, this data suggests that about **63,000** annual visits are made to just the National Recreation Area portion of the watershed.

TABLE 4-6. NATIONAL PARK SERVICE VISITS IN CLEAR CREEK WATERSHED

Year	Numbers of Visitors - Recreational	Numbers of Visitors - Non - Recreational	Visitors to Clear Creek Watershed Area within Park*
1985	1,246,675	6,712	50,135
1986	1,678,712	6,927	67,426
1987	1,742,251	8,317	70,023
1988	1,352,456	6,926	54,375
1989	1,550,783	6,941	62,309
1990	1,717,064	5,109	68,887
1991	1,537,073	7,098	71,676
1992	785,975	6,645	31,705
1993	446,180	6,925	18,124
1994	950,586	6,592	38,287
Average			**53,861**
Standard Deviation			**17,655**
Average excluding Drought years			**63,547**

Source: National Park Service, *Visitor Statistics for Whiskeytown*.

* Number of Visitors to Clear Creek watershed area was calculated by estimating that 10% of the monthly visitors who traveled over the Whiskeytown dam during the period 5-93 to 4-94 were traveling to the Clear Creek area (the other 90% were mainly traveling to two popular beach areas on the reservoir). National Park Service park rangers judged that 10% was a fair approximation. This came to 4% of the total visitors to the park which was then extrapolated to 10 years of visitor information available for the park.

Records kept by the managers of the Horsetown-Clear Creek Preserve show that more than 1,000 school children visited the preserve during the period between February and May of 1995 (Gene Clark, 1995). The visits were part of the Preserve's "Adopt a Watershed" program.

Census data presented in Table 4-10 of this chapter shows that the population in Shasta County increased by 27% from 1980 to 1990 and the population is expected to more than double during the period 1990 to 2030. Data collected by the California Department of Trade and Commerce indicates that the money spent on "Total Destination Spending" (expenditures on hotels, private campgrounds, public campgrounds, day travel, private homes, vacation homes) has more than doubled in the state during the period 1983 to 1993 (source: California Trade and Commerce Agency, *California Travel - Its Economic Impact*, 1995). If these trends in population and recreation spending are carried over to lower Clear Creek and combined with the NPS and Horsetown Clear Creek Preserve visits, the Department of Water Resources estimates would increase by several multiples.

Table 4-7 shows the total economic impacts from travel expenditures in Shasta County during 1993. Spending by travelers generates jobs, payroll and state and local tax revenue. Although there is no reliable method (at present) for determining to what extent lower Clear Creek contributed to this number, the recreation industry and its impact in Shasta county are pronounced. The large number of total visitor days to Clear creek suggest that even in its present undeveloped state, Clear Creek represents an important recreation asset in the county.

TABLE 4-7. 1993 TRAVEL IMPACTS

	Expenditures ($000)	Payroll ($000)	Employ (jobs)	Local Taxes ($000)	State Taxes ($000)
Type					
Accommoda-tions	39,486	8,099	860		
Eating, Drinking	58,747	14,075	1,862		
Food Stores	14,879	1,519	87		
Air Transport.	7,044	2,158	89		
Ground Transport	60,932	3,404	268		
Recreation	31,411	7,333	736		
Retail Sales	54,742	6,044	444		
Travel Arrangement	541	732	45		
Total	267,781	43,394	4,392	4,477	17,460

Source: Dean Runyon Associates, prepared for California Trade and Commerce Agency, Division of Tourism. January, 1995. California Travel Impacts by County 1993.

The sportfishing for salmon and steelhead that occurs in the Sacramento River-Delta-Ocean also generates substantial economic activity that impacts other parts of California.

Trends

As long as the demand for alluvial gravel remains high in the area, businesses based on gravel extraction can be expected to continue and expand (unless public agencies purchase the property). These companies will remain an important source of jobs and tax revenue in the local region. Unless land ownership changes, timber businesses will continue to harvest timber in the upper watershed.

Real estate development will likely take place in the Texas Springs Road and China Gulch Road area. In addition, as Redding continues to expand, those areas in the northeastern portion of the lower watershed will undergo development pressure.

The City of Redding conducted a Recreation Needs Assessment survey (City of Redding, 1991). This study concluded that the four recreation activities most preferred by city residents were: #1 - walking for pleasure, #2 - bicycling for pleasure, #3 - nature walks, and #4 - fishing (freshwater). The study concluded that another 25 miles of recreation trails would be needed for city residents by the year 2010.
The activities and plans of the BLM and Horsetown - Clear Creek Preserve are consistent with the recreation needs identified by the city. The recreation value of this area will continue to increase, but will not be expanded unless some coordinated recreation planning takes place in the watershed. The current lack of parking, hiking trails and access points limits the recreation potential of the area. The 'greenbelt" idea being fashioned by the BLM could substantially change this.

INCENTIVES, CONTRACTS, AND ENFORCEMENT

Current Conditions

Incentives, and the policies that provide these incentives, govern behavior. The incentives of concern in this watershed include any subsidies, relative price changes, fines or penalties that affect how businesses, land users, homeowners and other entities manage the land and natural resources in the watershed.

An argument can be made that the most substantial source of institutional change (changes in rules, constraints) in recent years that has affected the watershed has been the change in values that Californians, in general, have made between in-stream water uses and irrigation water. An increase in environmental awareness in the past two decades may have caused citizens to put greater value on the ecosystem benefits, such as improved anadromous fishery habitat, relative to production benefits, such as more crop production, from water use.

This relative price change (the price of anadromous fish habitat increased relative to the price of crop production to voters), is an economic incentive that leads consumers (voters) to demand more and better anadromous fishery benefits. Among the important outcomes resulting from this economic incentive has been new legislation, such as the Central Valley Project Improvement Act.

The main economic incentives governing natural resource use and management in the watershed are related to the wide assortment of rules and regulations outlined earlier in this chapter. The main economic incentives are the fines and penalties that would be incurred if these rules and regulations are violated. Local officials in charge of enforcing these laws have indicated that, for the most part, local businesses do a good job of keeping within the borders of the law. But these officials also point out that many of the provisions of these laws have never been enforced to the degree actually required by the law.

Trends

The State of California is responsible for implementing the provisions of the Clean Water Act by the year 1996. The Regional Water Quality Control Board established several technical advisory committees to make recommendations on how the provisions of this law should be carried out in the state. These committees were set up along the lines of major land uses (i.e.: urban, range, irrigated crop, mining) and representatives came from the private sector, public agencies and special interest groups. The general recommendation to come from these committees was to establish a two tier system of enforcement. The first tier would be a voluntary participation program aimed at the major industries contributing non-point sources of pollution. The second tier would be a system of monetary penalties for non-compliance.

The enforcement of monetary penalties for activities that violate the provisions of certain key items of environmental legislation would appear to represent the major trend in the economic incentives that will be faced by many land users in the watershed. This may be tempered by recent congressional efforts to reduce the provisions of these laws.

MARKET FAILURES

Current Conditions

Aspects of environmental quality can be considered *public goods* when they have the characteristics of non-exclusivity and, in more restricted instances, when they are non-rival. Non-exclusivity means that once a good or service is produced or provided, people can't be excluded from using it (i.e. scenic views). Non-rivalry means that the consumption of a good or service by one person does not increase the cost of providing the service (i.e. one more car passing over a bridge). An argument for government provision of public goods is that the private sector can not capture all the benefits of providing these goods and services and, as a result, will not provide sufficient quantities.

Environmental quality is an important public good in this watershed. A great deal of the natural resources in the lower Clear Creek watershed have been purchased or acquired by the federal government to protect their natural resource value and increase their recreation value. The provisions of the CVPIA, that provide additional instream flow to support fisheries, also suggest that water is an important public good found in the watershed.

Trends

Two federal agencies are negotiating the purchase of additional lands along the Clear Creek corridor. Their purpose is to enhance the fisheries and related recreation opportunities found in the watershed. In effect, the agencies have decided to purchase this land because of the public goods aspects of the watershed. Regardless of whether or not these sales are finalized, it appears that several public agencies will continue efforts to improve the environmental quality and public goods aspects of this watershed.

SOCIAL SETTING

The social setting found in the watershed has not been investigated beyond collection of secondary data. This lack of sufficient information fails to fully identify stakeholders, and characteristics of these stakeholders, who may have an interest in what happens in the watershed. It also fails to develop an understanding of the informal constraints (norms, codes of conduct) governing how people use the watershed. The limited scope of this study, which does not require studying the social or economic impacts of project alternatives, explains this current approach.

CURRENT CONDITIONS

Knowledge of land uses, land ownership and the economic setting of the watershed point to several potential stakeholders in the watershed. Table 4-8 below summarizes the more obvious stakeholders.

TABLE 4-8. POTENTIAL STAKEHOLDERS

Stakeholder Interest	Local (Redding - Shasta county)	Non-local
Business	Commercial property owners within watershed, gravel operations within watershed. Realtors working within watershed	Central valley farming groups; commercial salmon fishing industry; urban water districts
Recreation oriented	freshwater fishing groups, hiking and camping groups, hunters, and Horsetown - Clear Creek Preserve.	Sacramento River - Delta - Pacific Ocean sportsfishing;
Education	Horsetown - Clear Creek Nature, schools, N.E.E.D. camp	N/A
Residential property	homeowners w/in watershed	N/A
Natural Resource	Western Shasta RCD; various local environmental groups	Sacramento River groups; various state and national environmental groups
Government	Shasta County Planning and Building Departments; City of Redding Parks and Recreation; various state and federal agencies	various state and federal agencies

Table 4-9 below lists demographic characteristics of people in this area. The three census tracts included in this table overlap the boundaries of lower Clear Creek, but include substantial areas beyond these boundaries. For that reason, the data has to be interpreted as the characteristics of residents in the much larger three census tract region.

TABLE 4-9. DEMOGRAPHIC CHARACTERISTICS AROUND THE CLEAR CREEK AREA.

Demographic Variable	County	Census Tract 110	Census Tract 123	Census Tract 124	Total Census Tract
Number of Persons	147,036	6,044	11,061	3,659	20,764
Median HH Income	25,581	30,662	25,984	27,853	28,166
Persons below Pov. Line	19,840	566	1,324	486	2,376
Persons w/ Income more than 2x Poverty level	91,609	4,155	6,988	2,253	13,396
Household w/ Public Assistance	8,083	293	552	131	976
Household without P.A.	47,857	1,881	3,437	1,116	6,434
Median Home Value	91,000	91,800	84,400	120,900	99,033
Households - Owner Occupied	94,635	4,322	8,633	2,825	15,780
Households - Renter Occ.	49,734	1,722	2,399	748	4,869
Race					
White	138,344	5,528	10,503	3,565	19,596
Black	1,120	31	80	0	111
Asian, PI	2,655	172	393	12	577
Native American	3,895	213	351	82	646
Hispanic	5,401	172	469	missed	
Education					
Less than 9th	5,931	209	520	83	
9th to 12th	14,573	592	1,206	394	
High school grad.	27,971	1,043	2,455	645	
some college	24,716	914	1,739	573	
College degree	17,786	911	1,130	462	
Grad. or Prof. degree	3,867	147	60	203	
Occupation					
Manager and Prof.	14,015	715	822	320	
Techn., Sales, Admin.	18,223	897	1,184	397	
Service	8,769	348	410	191	
Farm, Forestry , Other	1,781	53	120	56	
Precision, Craft, Prod.	7,374	278	780	137	
Operator, Laborer	8,416	366	881	172	
Unemployment Rate	12.0				

Sources: Department of Commerce, 1990 and 1980 Census of Population; Employment Development Department, Labor Market Information Division, Annual Planning Information, Redding, 1994.

Table 4-9 suggests that the population of lower Clear Creek is fairly homogeneous, mostly white, has a median household income above the county's average, has a lower percentage of people below the poverty line than the county (11% to 13%), has median home values that vary from slightly under the county average to substantially greater than the county average, and has an equal percentage of people who have a high school education or greater (78% to 79%) as the county average.

Table 4-10 below shows the population of the three census tracts that encompass the watersheds, as well as data for the nearby cities and Shasta county.

TABLE 4-10. POPULATION

Area	1980 Census	1990 Census	Percent Change	1994	1990 to 1994
Census Tract 110 - Southwest Redding - Centerville	5,496	6,054	10		
Census Tract 123 - West Cottonwood - Happy Valley	9,925	11,063	11		
Census Tract 124 - French Gulch - West Upland	3,101	3,702	19		
City of Redding	41,995	66,462	58.3	76,800	15.6
City of Anderson	7,381	8,299	12.4	8,775	5.7
Unincorporarted area - Shasta county	66,339	72,275	8.9	77,600	7.4
Total (Redding, Anderson and Unincorp.)	115,715	147,036	27.1	163,175	11.0

Source: Department of Commerce, 1990 Census of Population, 1980 Census of Population; Department of Finance -

This table shows that the population in these census tracts increased between 10% and 19% from 1980 to 1990. This is substantially below the City of Redding's 58% increase in population, similar to Anderson's 12.9% growth and above the rate of growth for the rural areas of the county.

TRENDS

Table 4-11 and 4-12 show population and employment projections for this area. The population of Shasta County is projected to double by the year 2030. Much of this growth will be in Redding. The population growth will be accompanied by substantial real estate development and the expansion of jobs and industry.

TABLE 4-11. POPULATION PROJECTIONS

	1990	2000	2010	2020	2030
Shasta County	148,800	196,800	231,600	267,200	302,500

TABLE 4-12 EMPLOYMENT PROJECTIONS

Redding Metropolitan Statistical Area (Shasta county)	1990	1997	Percent Change
Total - all industries	52,425	59,400	13.3
Total agriculture, forestry and fishery	1,225	1,350	10.2
Total non-agricultural	51,200	58,050	13.4

Source: State of California, Department of Finance, Demographic Research Unit, Official Population Projections; Report 93 P-1, 4/93; Employment Development Department, Labor Market Information Division, Annual Planning Information, Redding, 1994.

SERVICE FLOWS, VALUES, BENEFITS AND ECONOMIC FORCES - CURRENT CONDITIONS

This section analyzes the concepts introduced in Table 4-1, Boxes B, C and D. This table shows that the natural resource attributes of the lower Clear Creek watershed can be seen as assets that generate several types of service flows that people value. The values are based on the demand that these people have for the service flows. This demand is an underlying economic force driving land uses and natural resource conditions. The higher the demand and the more scarce the resource, the greater the value of the natural resource asset.

The valuation of natural resources is important for a number of reasons. First, this valuation can be used to justify natural resource improvement activities. One important criteria for spending public funds on environmental improvement activities is that the benefits from the improvement exceed the cost. Second, failure to conserve the natural resource assets in lower Clear Creek will impose costs on the rest of the economy. Valuations help to make these costs transparent. Third, they allow planners to consider policy alternatives from various social science fields that can be used to enhance the alternatives being considered for improving natural resources. Fourth, people can be expected to manage natural resources in accord with the value they place on these resources. An understanding of the basis for these values (i.e. property rights regimes) may allow planners to more fully understand the causes for current natural resource conditions.

Although actual valuations for the natural resources in lower Clear Creek will not be made at this stage of planning, data was used from previous studies on lower Clear Creek to demonstrate how such studies may be completed. This report recommends that formal valuation studies be completed, and that funding be allocated for this purpose, if planning moves to the stage where alternatives are formulated and evaluated.

NATURAL RESOURCES AND SERVICE FLOWS

If the natural resources in lower Clear Creek are seen as assets, two prominent services of these assets, in particular, give the assets value. The first are the material inputs used by private industry and residents. These include land for residential and commercial development, water used for irrigation and hydropower, gravel for construction, anadromous fish for commercial or recreational fishing, and timber for the lumber industry. Most of these inputs are used by local industry, but water, a very important resource, is used by businesses and municipalities that are not local (i.e. who receive Central Valley Project water).

The second are amenities, those features of the watershed that people value for reasons other than the business value of material inputs used in business production. Amenities found in lower Clear Creek include recreational opportunities associated with fishing, water sports, hiking or relaxing; educational opportunities, especially those associated with the Horsetown-Clear Creek Preserve and the N.E.E.D. camp; and other amenities that might be broadly associated with the "quality of life". Quality of life amenities include the scenic views and rural lifestyle provided by the forests and mountainous landscape.

Some of the amenities and material inputs found in this area, such as anadromous fish stocks, may not be directly used by many Shasta County or California residents (i.e. they may not fish for salmon), yet these residents may desire that these fish stocks not disappear. The same is true for high quality woodland and forests, especially on the extensive public lands found in the watershed. Many California and United States residents may prefer that these forests not degrade, even though they may never actually visit this area. The public that derives value from these service flows extend well beyond the boundaries of the watershed.

LOWER CLEAR CREEK VALUES

Besides providing a reasonable natural resource basis for taking improvement actions, planners may be interested in having a reasonable economic rationale for undertaking improvement efforts. The economic basis will largely be determined by the values associated with the natural resources and natural resource processes found in the watershed. The first stage in determining the value of the two environmental features of particular interest in the watershed, anadromous fish and forest lands, is to determine how they are used by humans. The two prominent uses, or service flows, mentioned in the last section are material inputs and amenities. In the case of material inputs, anadromous fish have supported an important Pacific Ocean commercial fishery. For forested lands, timber has been used for lumber and firewood.
In the case of amenities, anadromous fish provide recreational opportunities for sport fishing in the Sacramento River, Sacramento Delta, and Pacific Ocean. Forest lands provide amenities in terms of enhancements to residential property (i.e. a rural lifestyle) and opportunities for recreation, such as hiking or the enjoyment of nice scenery.

In addition to direct human uses, anadromous fish and forest lands provide value to people who do not directly fish for salmon or steelhead or visit these forests and woods. These non-use values are often know as "existence" value - a value people derive from knowing that natural resources exist in a protected state. Tables 4-13 and 4-14 show the main components of value that are addressed in this watershed study.

TABLE 4-13. ANADROMOUS FISH/CLEAR CREEK SYSTEM VALUE

Components of Anadromous Fishery - Clear Creek System Value		
	Material Input	**Amenity**
Market based (use value)	Commercial salmon and steelhead used in Ocean fishery	Recreation: fishing carried out in Clear Creek, Sacramento River, Delta and Pacific Ocean
Non market based (non-use)	N/A	Existence: knowing that anadromous fish exist in a protected state
Who are the primary groups determining these values:	commercial fishermen, buyers and consumers of Chinook salmon or steelhead	• Recreation sportfishers; • citizens who value anadromous fish stocks
Method of Valuation	Market model for demand and supply in commercial steelhead and Chinook commercial markets.	• Travel Cost models for recreation • Contingent Valuation for existence
Relative magnitude of value	small	large

TABLE 4-14. FORESTLANDS / WILDLANDS SYSTEM VALUE

Components of Forestlands and Wildlands Value		
	Material Input	**Amenity**
Market based (use value)	Timber or firewood	Quality of life: rural lifestyles, open space, scenic views
Non market based (non-use)	N/A	Existence: knowing that forests exist in this spot and are protected
Who are the primary groups determining these values:	Commercial producers of lumber or firewood (but not consumers - no marginal price changes)	• Recreational hikers, tourists and residential property owners who enjoy the use of forests and woods • People who value the existence of protected forests in this area
Method of Valuation	Increases in profits or measures of producer surplus	• Risk Aversion models for fire hazard reduction • contingent valuation for existence
Relative magnitude of value	small	large

As the amount or quality of anadromous fish stocks or forest lands change, their associated human activities, and the value of these activities, also change. Changes in these activities can be measured by changes in the level of well being, or welfare, of the persons identified in Tables 4-9 and 4-10 who attach value to the natural resources of the watershed. As Freeman notes "changes in environmental quality can affect individuals' welfare though any of four channels: 1) changes in the prices they receive for goods bought in markets, 2) changes in prices they receive for their factors of production, 3) changes in the quantities or qualities of non-marketed goods and 4) changes in the risks faced by individuals" (Freeman, 1993). Changes in well being, or welfare, can then be measured by the amount individuals are *willing to pay* to avoid price increases *or willingness to accept compensation* to obtain price decreases (note: this is an incomplete definition of the economic term, *compensating variation*).

Changes that improve welfare are known as *benefits* while changes that decrease welfare are called *costs.* An important criteria for judging the merits of resource improvement or policy alternatives is whether or not the benefits exceed the costs. In addition, two popular criteria for using these valuations to compare policy alternatives are 1) can the gainers of an environmental improvement fully compensate the losers? and 2) is the resultant income distribution fair? (Freeman, 1993). How can such welfare changes be measured in practice?

Four economic models (out of many) can be used to measure the welfare changes associated with the main components of value being analyzed in this report. These models would need to be associated with physical resource models. A brief description of the model and a graph of how measurement would be made is shown below. Each of these components of value affect a fairly distinct consumer group and so can be measured separately using the four models.

1. The value of commercial anadromous fish: Typical supply and demand models that show how Pacific Ocean fish prices are related to fish quantities can be used to measure the welfare changes associated with changes in numbers of anadromous fish. Because Clear Creek has the potential to support an additional 4% of the anadromous fish stock in the Sacramento River system (DWR, 1986), price changes appear likely. This implies that welfare measures need to account for the effects on both fishermen (producers) and fish buyers (consumers). Typical supply and demand models can be used to capture these two distinct effects.

Previous welfare measurements of the commercial value of salmon have derived values between $14 to $53 per fish (a summary of valuations can be found in Boyle, 1992). The current price in commercial salmon contracts is under $2.00 per pound.

2. The recreation value of sportfishing for anadromous fish: A travel cost model can be used to measure the welfare changes associated with recreation. This type of model relates expenditures on travel with the number of travel trips or visits made. The number of travel trips is directly related (complementary) to a key natural resource or natural resource service flow (i.e. number of fish that can be caught). The resultant demand curve (relating price per trip to number of trips) shifts out when key improvements occur in environmental quality, such as restoration actions that increase the quantity of fish that can be caught. Values can then be determined from changes in these demand curves.

Previous welfare measurements of the recreation value of salmon have derived values between $11 to $900 per fish (a summary of valuations can be found in Boyle, 1992). Some authors have applied the values strictly to sport fishers, while others have applied the value of all California residents. Better efforts are needed in reaching a consensus value and consensus market segment.

3. The fire hazard associated with improperly maintained stands of forests: This watershed analysis has identified fire as the most substantial source of risk to forest stands. The potential damages that might accompany an unplanned, major fire could be severe. These potential damages include the loss of property and life, the disruption of Clear Creek instream flows and substrate conditions (which in turn will harm the fishery), and the amenity loss experienced by persons who enjoy forested slopes.

Because fire can be classified as an environmental risk, economic models that incorporate risk can be used to measure the value of reducing the risk of fire. These models measure changes in benefits and costs (i.e. welfare changes) that would accompany the change in the risk of fire occurring. Two types of models, in particular, can be fruitfully employed. The first, Risk Aversion models, measure an individual's willingness to pay to avert the risk of fire (this could include their willingness to pay for an increase in government spending that reduces the risk of fire). This type of model requires data about the amount of money residents in the area pay to reduce the risk of fire (i.e. extra fire insurance premiums, higher tax bills to pay for extra fire fighting, differences in property values, or defensive expenditures on their properties).

The second type of model that can be used to value the risk of fire involve the concept of "adequate margin of safety" (Freeman, 1993). In this case, public officials desire some minimum level of safety for the residents that could be affected by a fire. The minimum level of safety has some probability of failure occurring because the exact relation between forestry conditions (i.e. amount of fuel load) and the risk of fire (and subsequent damages from the fire) is uncertain. Public officials can then attempt to reduce the probability of failure by setting stricter standards (less fuel load permitted). The decision criteria for setting this standard, from an economic perspective, is at the level where the additional benefits people assign to reducing the probability of failure are close to the additional costs needed to implement the standard.

4. The non-use, or existence values associated with better fisheries and forests - Contingent valuation models can be used to measure the value that people place on knowing that fish and forests exist in a protected state in this watershed. This method derives estimations of value by asking people their willingness to pay to gain an increase in some environmental quality variable (such as fish stocks or pristine forests). The hypothetical nature of the responses makes this technique somewhat controversial in the economics discipline.

As an example the Forest Service surveyed recreation users of Trinity and Shasta Lakes, using Contingent Valuation, to determine the impacts of lake level on customer "satisfaction" (USDA Forest Service, 1994). The study concluded that the net household economic benefit for recreation at the two lakes ranged from \$48 to \$210 per year. On a per day, per individual, basis these benefits ranged from \$.88 to \$3.32. They then used these numbers, along with an estimated increase in visitor days from changing lake levels, to determine the benefits of project alternatives.

5. Other service flows and values - Just about any environmental quality variable that provides service to humans can be measured. However, these surveys are costly to complete and are not believed to be critical to this particular watershed study. The four models identified above should satisfactorily capture the major critical issues identified in this report.

6. Damage-dose models - If monetary damages could be attached to the anadromous fish-natural resource conditions and fire-forest conditions explained in Chapters Two and Three, models could be developed showing how damages change as certain key environmental variables change (i.e. changes in instream flow, fire hazard index, etc.).

These type of models do not account for important economic relations, like how recreational sport fishers respond to changes in the quantity of "catchable" fish, or how the cost of production ($ per pound fish caught) changes for commercial fishermen when the stock of fish changes. For these reasons, these models are not preferred for valuation studies.

COSTS

Selected service flows in the watershed, such as sport fishing recreation, can be increased, with resultant benefits to environmentalists, commercial fishermen and recreational sport fishers. However, many of these increased service flows can only be achieved by reducing some other service flow (i.e. irrigation water that produces crops). The benefits gained by increasing one service flow (i.e. recreation from fisheries) is offset by the benefits foregone (opportunity costs) of the next best use of this resource (i.e. irrigation water for crops).

The opportunity costs associated with the tradeoffs in service flows can be measured using the concepts and models described above. Many of the major decisions regarding which tradeoffs to make and evaluating the benefits and costs of these tradeoffs, have already taken place. Restoration activities are already being planned for the fishery at Clear Creek as a result of the Central Valley Improvement Act. Even so, the models mentioned in this section can provide sound criteria for judging project alternatives and formulating and evaluating project alternatives.

TRENDS

The natural resource assets found in the lower Clear Creek watershed will continue to grow in value as populations increase and economic activity expands. Scarcity of residential land and quality of life factors should result in a greater appreciation in value of the amenity aspects of the watershed compared to the material input factors. This should mean that fisheries and forestlands will continue to experience a higher relative price compared to resource extracting industries, such as gravel, timber and mining.

The effect that these relative price and value differences will have on the natural resources in the watershed depend on how public agencies provide the public goods associated with fisheries and forests and how property rights, social norms, economic incentives, markets, laws and other institutions evolve.

THE KEY ISSUES - HUMAN DOMAIN

Human habitation and use of the watershed has resulted in drastic changes of the resources.

KEY QUESTIONS AND ANSWERS

1. What are the trends of land uses that impact erosion and sediment delivery in the watershed? What is the potential for accelerated erosion and sediment from potential land uses?

Negative Externalities: Historic and ongoing logging and construction activities have led to accelerated soil erosion and deposited sediment into the creek, resulting in degraded fish habitat. In past years, land users responsible for accelerated erosion have not been forced to pay compensation for this damage. Current county building and grading ordinances have reduced these types of damages, but have not eliminated them. One example of an exception is that harvesters of non-commercial species are not required to submit a timber harvest plan for their activities.

Government Policies: Many individuals argue that past government fire policies may have placed too much emphasis on fighting fires, rather than preventing fires. With aggressive fire fighting usually comes an extensive road and firebreak network designed to provide for equipment access and fire control on the burn area. However, with this network often comes soil erosion. Foresters and recent media reports indicate that public forest management agencies have begun to gradually alter these policies to stress preventative fire management in addition to fire protection. In the mean time, fire control roads must be designed and decommissioned properly to reduce erosion.

Population: From 1980 to 1990, the population of Redding increased 58% and population in the lower Clear Creek watershed increased 10-19%. Shasta County population will double its current level by 2030. On the positive side, with population increase comes increased demand for recreation and improved environmental quality. On other hand, it also increases pressure to develop the watershed. In general, residential and commercial development has the potential to harm local fisheries.

Factor Markets: Continued strong markets for residential real estate, construction aggregate, and timber will support jobs and economic activity in the local economy but could also lead to negative impacts on natural resource conditions. The present emphasis by natural resource-oriented public agencies to carry out ecosystem planning and management presents a major opportunity to achieve better natural resources planning and more effective results.

2. What level of recreation would be consistent with restoration goals? Which type of physical infrastructure improvements would be needed to enhance the recreation value of the watershed?

In general, low-impact land uses are most consistent with our goals of protecting/ preserving anadromous fisheries and reducing erosion and sedimentation in the watershed. Due to the highly erosive nature of much of the soils on the watershed, the area is best suited to types of recreation which do not disturb substantial amounts of soil. These activities include fishing, hiking, swimming, hunting, picnicking, skiing, and bird watching. All of these activities could be improved through infrastructure improvements, but fundamentally, require little infrastructure to take place, other than public access improvements. A formal recreation study would be needed to more fully answer this question.

3. What transportation network is necessary for resource management and fire control?

A series of interconnecting roads, trails, and fire breaks would be necessary to fully protect the homes and property of landowners in the watershed. Forestry operations typically also require a similar road network. However, the highly erodible soil and geologic types on the watershed warrant a high degree of care in laying out this road network. In addition, the utmost care should be exercised, particularly on decomposed granite soils to design roads and trails with sufficient runoff engineering to provide for adequate drainage and to minimize concentrated flows.

4. What type of parking should be provided along Clear Creek Road to provide access to the creek? What is the best way for pedestrians, equestrians, etc. to cross Clear Creek considering that the Clear Creek Bridge is narrow and traffic is heavy?

Land on the Horsetown-Clear Creek Preserve has little potential to be developed for increased parking. BLM land near Clear Creek could also be developed for parking, as some of these lands should be, if BLM is to acquire the string of lands along the lower half of the creek as they plan to. On the upper half of the creek, private ownership restricts much of the parking potential, but more parking areas could certainly be developed, maintained, and policed by the National Park Service.

Pedestrian access across the Clear Creek Road bridge is a difficult issue. When the funds are made available, development of a protected, covered footbridge could be developed on the side of the existing vehicular bridge. Improved pedestrian access across the bridge is currently needed for the functioning of the Horsetown-Clear Creek Preserve, and would prove particularly valuable once the public greenbelt corridor has been acquired and promoted.

5. How does Whiskeytown Dam affect the lower watershed related to human use and water rights issues?

Property Rights and Environmental Regulation Reforms: Current water rights laws cause wastefulness in the use and management of natural resources (i.e. "use it or lose it" water rights laws). These negative incentives could be reformed partly through water marketing: developing private water markets that balance recreation and amenity values with factor input and municipal use values. The water rights issues involving the CVP and CVPIA are state and federal level issues that need to be clarified and implemented prior to effective local efforts.

6. How will planned watershed restoration and fishery improvement activities impact current social conditions?

An economic or social impact analysis would be needed to answer this question. The scope of this report does not include such an analysis. This is an area where additional follow up support is needed.

7. What values does society place on improved fishery habitat, safer fuel conditions, or public uses of land in the watershed?

Section C, part b, lower *Clear Creek Values* summarizes the major values that different market segments place on the natural resources found in lower Clear Creek. The two tables in this section show that anadromous fisheries and forest lands/wild lands are valued for both their material outputs and amenities. Values include both market-based and non-market-based components. The people valuing these resources extend well outside the boundaries of the watershed. The magnitude of these values are believed to be high, but were not quantified for this analysis.

8. What interest groups would support or oppose actions to improve natural resource conditions in the watershed? What are their main interests?

Table 4-8 of this chapter summarizes the major stake holders who should have an interest in the natural resources of the watershed.

9. What changes would be needed in laws, policies, incentives, funding, social norms or other institutions in order to improve fishery habitat and decrease fuel loading? Would these changes be acceptable, equitable, and efficient?

Chapter 6 of this report includes several recommendations based on economic, policy or social bases that could result in improved fisheries and reduced fire hazards.

CHAPTER 5 - Conclusions

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CHAPTER 5 - Conclusions

ISSUES

1. Disruption of instream flow
Clear Creek's natural instream flow has been disrupted due to damming and diversion at McCormick-Saeltzer Dam and Whiskeytown Dam. Anadromous fisheries in lower Clear Creek have declined due to disruption of instream flow and other impacts.

2. Disruption of the natural fire regime
The natural fire regime has been interrupted from years of fire suppression, timber harvest, grazing, the introduction of exotic plant species and development.

3. Land use practices
Consumptive land use practices in the watershed have led to several resource problems such as sedimentation, habitat loss, and disrupted the natural channels of the creek.

INTRODUCTION/INTERRELATIONSHIPS

The condition of anadromous fisheries, fuel loads and other natural resources in the lower Clear Creek watershed are directly related to and caused by human intervention. Anadromous fish stocks in Clear Creek have been reduced by the construction of two dams and subsequent policy regarding water releases from the Whiskeytown Dam. Fish stocks have been affected by gravel mining operations in the stream bed and surrounding areas. Some foresters argue that higher quantities of fuel, which increase the risk of serious fire, have resulted from policies that react to fires rather than prevent them.

The land uses and natural resource management methods that can be observed in the watershed explain a great deal about the current state of natural resources. National Park Service land has not been developed to any significant degree and many impressive views can be found hiking along the creek in the upper watershed. Conversely, gravel pits have altered much of the flood plain in the lower watershed. What are less obvious are the causes for these land uses and management methods. These causes involve political, economic and social forces and structures that are invisible to many watershed users. The best places to look for explanations of why natural resources are in a particular condition are in the systems of property rights, markets, social norms, government policies, and other institutions that underlie the uses of the watershed.

The institutions in the watershed lead people to assign values to the natural resource attributes of the watershed. The value of the natural resources in the watershed derive from how people use these resources (e.g. the gravel that goes into concrete aggregate) but also include non-use values (e.g. the importance Californians assign to in-stream water flows that improve anadromous fishery habitat).

The natural resource values found in the watershed fall into two broad categories. These categories point to interest groups that have a stake in what happens in the area. The first category deals with the municipal/commercial or consumptive value of natural resources in the watershed. Gravel mined from the flood plain continues to be an important input into several local construction-related businesses. Water is used to generate electricity for Redding and to irrigate farmland in the Central Valley. Land is developed for sewage treatment facilities. Clear Creek presently supports an estimated 2% of the anadromous fisheries in the Sacramento River. The watershed has supported some timber activities in the past. The proximity of the watershed to Redding has resulted in the gradual development of commercial and residential real estate.

Interest groups that might have a stake in the commercial aspects of lower Clear Creek's natural resources include local construction businesses, Realtors and commercial land owners. In addition, agricultural businesses and urban areas also have a stake in Clear Creek water because of the Central Valley Project water and anadromous fish.

The second broad category of values relate to non-consumptive or ecosystem framework and functional uses of the watershed. Public agencies own 42% of land in the watershed. Multiple use management is practiced on this land with some differences in emphasis between NPS land and BLM land. Recreational use of the watershed appears to be on an upward trend, especially as public agencies such as BLM begin implementing long range plans for recreational development in the watershed. The ecosystem functions (i.e. wetlands, riparian areas) of the watershed also appear to represent substantial value to citizens, especially those concerned about improving fishery habitat. Not all of these latter values come from direct use of features of the watershed; they include values that people who will never use the resources of the creek assign to protecting these natural resources.

The interest groups that have a stake in the non-consumptive aspect of the watershed include outdoor recreation groups, educational groups, local residential property owners, natural resource protection groups and environmental groups. As with the groups interested in the commercial value of lower Clear Creek's natural resources, members of these groups extend outside the boundaries of the watershed.

Balancing the use and protection of the natural resources in this watershed with the interests of businesses and citizens remains a complicated matter involving individual values, which is outside the scope of this watershed analysis.

However, there are certain common factors which have effected change in all the resource areas examined in this watershed analysis. These factors fall into two broad categories; land uses, and management policies. Studying the effects of these factors and developing recommendations to reduce their effect is an important goal of this analysis.

LAND USES

When considering a watershed from an ecosystem perspective, it is important to consider the interactions between ecosystem components. Humans, sometimes ignored when discussing watershed processes, have an important role in maintaining or disturbing the stability and sustainability of a watershed. Human land use can be the overriding influence on how a watershed functions. The manner in which this land use is carried out determines whether the impacts are negative or positive. Land use varies from very low impact activities such as photography or wildlife viewing, to high impact activities such as logging and housing development. These land uses will have a varying degree of influence on the resources and processes in the watershed. The intent of this section is to identify the different land use activities which are occurring on the lower Clear Creek watershed and to discuss how they influence and interact with key ecosystem components. The impacts of land uses covered in this section are outlined in Table 5-1.

MINING

Soil

Historically, one of the most injurious land uses in terms of erosion was gold mining. While currently not a major land use on the watershed, historically, gold mining resulted in tremendous amounts of soil erosion on areas of the watershed through the use of hydraulic methods to remove massive amounts of topsoil. Currently, lands which were mined during the placer mining period are mostly re-vegetated and exhibit minimal soil erosion. A few areas of recent surface and deep gold and silver mining activity exist on the watershed. These sites are on BLM and private lands on the upper part of the watershed. While most of these are not in active use, many are actively eroding.

Riparian Vegetation and Wildlife

Past gold and recent gravel mining has decimated riparian vegetation through the direct removal of stream side plants; through the removal of the substrate upon which they grow; and, through the destabilization of the banks at creek crossings for heavy machinery, particularly below Horsetown-Clear Creek Preserve. Current stream side conditions on many parts of the watershed exhibit bare bedrock or bare gravel, upon which little vegetation grows.

Most of the wildlife species of concern in the watershed have declined both range-wide and in lower Clear Creek, due to the loss of riparian habitat associated with mining. A few generalist species have benefited as specialist species decline. Many species have suffered direct loss of habitat including the red-legged frog, long-eared owl, willow flycatcher, and yellow warbler. Loss of riparian vegetation also negatively impacts fish and invertebrate populations, which in turn impacts species such as black bear, raccoon, otter, kingfisher, bald eagle and osprey. Some species which use the riparian corridor for movement or migration such as fisher, black bear, mountain lion, may have been impacted by reductions and fragmentation of riparian habitat. Pale big-eared bats may have gained roosting habitat from the creation of mine shafts and tunnels, however, they were probably driven out of their original roosts by the intrusion of miners.

Stream Channel Habitat/Aquatic Wildlife

Tailing material in the stream channel combined with the loss of stream bank material causes the stream to change course in some areas, especially during periods of high rainfall, resulting in a shallower, more braided morphology where a deeper, meandering stream formerly flowed. The pattern and location of this braiding varies with precipitation regime. Compounding the problem of stream bed meandering is the almost complete destruction of upper floodplain terraces through gravel dredging. This shallow, braided morphology can cause fish passage problems during periods of low water level.

This problem is exacerbated by continued gravel mining on the watershed. Current gravel mining has resulted in the development of deep holes and low areas in some portions of the stream channel. Migrating and resident fish can become stranded in these areas during periods of low flow, resulting in fish deaths when these areas become isolated from the main stream course and water and oxygen levels drop. Gravel mining also alters stream habitat through sediment delivery and streambank failures, occurring during the fording of Clear Creek by heavy machinery.

LOGGING

Soil

The most intensive logging on the watershed occurred from the 1950s through the early 1960s. The extensive road and landing network which has accompanied logging on the watershed combined with soil types, the use of heavy machinery, steep topography, and relatively high rainfall amounts, is still resulting in accelerated soil erosion on the watershed. Sub-watersheds 2, 3, 6, 8, and 10 exhibit accelerated erosion from past logging activities. The combination of intensive logging and highly erodable granitic soil types on these sub-watersheds proved to be the most damaging factors. While logging has slowed on the watershed in recent years, some logging continues, and presently occurs with state mandated restrictions.

Upland Vegetation

Logging has had a significant influence on the vegetative composition of the upper watershed. 1950s logging practices were often shortsighted. Only highly valued species and merchantable logs were harvested, leaving small, poor quality or damaged trees. In areas, these trees survived to re-establish a forest which lacks species diversity. In some areas, past logging of conifer stands resulted in conversion to brush, particularly when large areas were heavily logged and no trees were replanted. In other areas, selective logging or high-grading has resulted in the domination of certain sites by less valuable species such as gray pine, knobcone pine, and manzanita where more valuable species such as ponderosa pine and Douglas-fir formerly grew. Often, these less valuable species are the more flammable, fire dependent species, creating a scenario for more intense fires.

Wildlife

Logging has, and still does adversely affect terrestrial wildlife on the watershed. This occurs through habitat fragmentation; conversion of old-growth habitat types to field and edge types (early successional); reduction of potential den and nest habitats; removal of mature tree food resources; conversion of habitat types, and, transformation of habitats to favor select species. Overall, seral stage succession has been set back, and most of the forested lands on the watershed are in various stages of second or third growth. Snags and large downed logs probably do not exist in sufficient quantity to provide habitat for species dependent on this habitat element. Species which prefer old growth forests, such as spotted owls, flying squirrels, fishers, hairy woodpeckers, and goshawks, have experienced a major reduction in habitat. The logged areas provide an increase in habitat for species that require early to mid-successional stages of forest vegetation. Species which benefit from logging include black-tailed deer (summer range), black bear, gray squirrel, and mountain quail, among others.

ROADS

Soils

Many of the roads in use are poorly graded and located on highly erosive material. In-sloped roads concentrate runoff on the inside edge of the road surface. In addition, culverts accompanying this in-sloping are spaced too far apart, resulting in overloading of the drainage system. This combination of factors has resulted in substantial sheet, rill, and gully erosion on the road surfaces and surrounding areas, mainly through the down-cutting of drainage ditches and the gullying of runoff zones below culverts. In addition, many cut banks in granitic soil are extremely unstable, forming eroded banks fifteen to twenty feet high, exposing tree roots, and resulting in considerable erosion and sedimentation. In many areas, old roads are located on such highly erosive materials, they completely wash out in high rainfall events sending sediment and road materials down hillsides and into streams. The extensive network of abandoned or seldom-used logging roads and trails on the watershed are in various states of re-vegetation and thus, are contributing varying amounts of sediment to the creek, ranging from extensive to relatively little.

Stream Channel Habitat/Aquatic Wildlife

The increase in sedimentation on the watershed from numerous sources greatly degrades Clear Creek as anadromous fish spawning habitat. Sediment is a by-product of agriculture, forestry, or industrial and residential development mainly from the road network on which these industries depend. Fish populations in small tributary streams are most vulnerable to sedimentation because of decreased stream sediment transport capability. Sediment in streams can fill in spaces between gravels. In substantial amounts, sediment in-filling can smother fish eggs and keep them from hatching and emerging. In addition, because these fishes require clean, well-aerated gravels to reproduce, they will avoid gravels which are buried by sediment, thereby resulting in reduced spawning habitat (Burns, 1970).

HOUSING/POPULATION

Soils

Areas utilized for housing on the watershed often have areas that are not well-vegetated and have drainage problems, resulting in accelerated soil erosion. Estimated erosion rates from house pad surfaces are shown in Table 3-3.

Water Quality

Clear Creek is not currently affected by major water quality problems. The low population density allows any minor problems to remain minor problems. The trend of increasing growth in the lower Clear Creek watershed means that concerns which are insignificant today may mature into major water quality issues in the coming years. Planners and resource managers need to consider the cumulative effects of future population growth and industrial activity on water quality in the watershed.

While septic systems are not problematic now, future systems could be. The soils upon which future development is likely to take place are all poor candidates for septic systems. The Shasta County Soil Survey rates all but one of the 13 different soils as poor for septic tank filter field development. Bedrock in these areas proposed for development ranges from one-half foot to four feet from the surface and slopes range from 5 to 70%. Slow permeability and hardpans also present problems in some soils. Inappropriately located septic systems can result in the contamination of surface and groundwater by human waste. Transient populations camping for extended periods of time without safe human waste disposal systems also pose a threat to the water quality of Clear Creek

At this time, there are no industrial or wastewater discharges directly into Clear Creek. In accordance with waste discharge requirements, gravel mining operations must allow sediment-laden water to settle out in gravel wash water ponds.

TABLE 5-1
NEGATIVE IMPACTS OF LAND USE ACTIVITIES UPON MAJOR RESOURCES OF THE LOWER CLEAR CREEK WATERSHED

LAND USES (CURRENT STATUS)	NEGATIVE RESOURCE IMPACTS								
	Soil erosion	Water quality	Water quantity	Air quality	Riparian vegetation	Upland vegetation	Stream channel habitat	Terrestria l wildlife	Aquatic wildlife
Gravel mining	M	M	L	L	H	L	H	M	H
Gold mining	M	L	L	L	H	M	H	M	M
Housing	H	M	L	L	L	M	L	M	M
Roads	H	M	L	L	L	M	L	M	H
Trails: (ORV/ horse/ foot travel)	M	M	L	L	L	M	L	M	L
Camping	L	M	L	L	L	L	L	L	L
Logging	H	M	M	L	L	H	H	H	H
Grazing	M	M	L	L	L	L	L	M	L
Orchards	L	M	L	L	L	L	L	L	L
Recreational fishing	L	L	L	L	L	L	L	L	L
Hydroelectric power generation	L	M	H	L	M	L	H	M	H
Irrigation water impoundment	L	L	M	L	L	L	M	L	H
Ecosystem preservation	L	L	L	L	L	L	L	L	L

H=High M=Medium L=Low

MANAGEMENT POLICIES

WHISKEYTOWN DAM

Riparian Vegetation

On various sections of lower Clear Creek, riparian vegetation has changed due to Whiskeytown Dam altering the natural flow regime. U.S. Fish and Wildlife Service sources indicate that the alteration of normal flow regime through the Whiskeytown hydroelectric project has adversely affected riparian conditions by encouraging vegetative growth in areas which would normally be swept free of vegetation by annual high flows. This effect is probably more serious in the upper part of the watershed, where less gravel and gold mining have occurred, and more potential for riparian growth exists. This excess riparian growth in the upper watershed has the potential, if sustained long enough, to increase stream depth and reduce stream bed width in the upper watershed, thereby reducing the area of shallow stream edge habitat available to juvenile fishes

Terrestrial Wildlife

Hydroelectric power generation can indirectly affect terrestrial wildlife by altering the species composition of stream fauna and flora upon which terrestrial animals feed.

Water Quantity

The Whiskeytown Dam has influenced the water regime on Clear Creek more than any other element on the watershed. Whereas high water flows formerly occurred during the late winter and spring months of the year and during particularly intense storms at other times of the year, the water flow regime is now remarkably constant throughout the year. Overall, this reduction of natural flow has had a disastrous effect on fish. Since water equals fish habitat, reduced flow equals reduced habitat. With less stream flow, spawning gravels which might normally be covered by water are left dry. In addition, reduced flow reduces stream depth, raising stream temperature. Higher stream temperatures impact Clear Creek's potential to provide suitable habitat for spring-run Chinook and steelhead. One final externality resulting from the alteration of stream flow is its effect on fish migrations. Since migrating fish respond to higher flows by swimming in that direction, the desirability of Clear Creek to migrating fish is reduced by its controlled flow regime.

Stream Channel Habitat/Aquatic Wildlife

Coarse particulate organic matter, the basis of the aquatic food chain, is greatly decreased in the lower watershed, being trapped behind the dam. The aquatic insects and other organisms that feed upon this material are also diminished, thereby reducing food resources for trout and salmon which feed upon these organisms.

McCORMICK-SAELTZER DAM

The use of Clear Creek to impound irrigation water at McCormick-Saeltzer Dam effectively shuts off the upper reaches of the stream to anadromous fish and other migratory aquatic organisms. Although a fish ladder exists at McCormick-Saeltzer Dam, it is ineffective and fish are still unable to pass. This exclusion effectively shuts off the upper reaches of Clear Creek as spawning habitat for anadromous salmonids.

FIRE SUPPRESSION

Fire suppression has effectively eliminated the frequent surface fires that characterized the lower Clear Creek fire regime. Fire suppression has increased fire-intolerant, shade-tolerant conifers, stand densities, forest insect outbreaks, and fuel loads. Habitat diversity and forage production have decreased. These elements provide the vehicle to carry severe stand replacing fires. When a high-intensity fire occurs, it will have a major effect on the aquatic, terrestrial, and human resources of the lower Clear Creek ecosystem.

It is estimated that the historical fire recurrence interval was approximately once every 13 years. Only a fraction of the watershed has burned since 1950, leaving a fuel load of 3-4 times that of a natural fire regime. Current fuel loads are estimated at 20-30 tons per acre in the upper watershed.

Public Costs

Fires may ultimately cost millions of dollars for suppression and result in loss of human life and property, losses in forest products, and long-term damage to the ecosystem. The greatest of these concerns is loss of life and property. The 1992 Fountain Fire in western Shasta County demonstrated how a high-intensity fire affects an area. The majority of homes in the communities of Montgomery Creek and Round Mountain were destroyed. Many lives were disrupted due to the high costs of clean up and rebuilding.

Many people who live in these high fire hazard conditions are aware of the dangers involved in wildfire yet choose to face the risks associated with living in the conditions. Given these situations, landowners are beginning to face difficulties in obtaining insurance from U.S. insurance companies. The insurance companies are encouraging homeowners to protect themselves by clearing dense vegetation away from structures. The recent trend of insurance companies is to offer discounts to people who perform the type of vegetation clearing required to be safe. However, current fuel conditions in the lower Clear Creek watershed will affect the fire fighting techniques the CDF will use. The increased fuel load increases the intensity of the fire. Based on fire intensity, methods of fire suppression would more likely be chosen which decrease direct protection of individual property. The watershed can be protected from accidental fires by establishing clearance laws enforced by the city, county and state. Debris burning regulation and fire clearance limits should be backed up with substantial fines and potential loss of insurance coverage.

Vegetation

A direct effect of a very hot, stand-replacing fire will be the loss of vegetation. Many of the existing vegetation species are adapted to survive low-intensity fires. These adaptations can be broadly generalized to include those traits which facilitate survival of the individual, and those traits which facilitate reproduction and perpetuation of the species. Examples of fire survival traits include thick bark to protect living tissues. Bark can also protect dormant buds on trunks and main branches in epicormic sprouting species. Thick bark is an adaptation for survival in regimes of low-intensity surface fires, but of little value in severe, stand-replacement fires, which are expected to happen in the lower Clear Creek watershed. Other adaptations are listed in Table 5-2 below.

TABLE 5-2
ADAPTATIONS OF VEGETATION TO FIRE

Trait	Function	Example
Thick bark	protects cambiam tissues from heat damage	ponderosa pine, other conifer trees
Epicormic sprouting	re-growth from dormant buds protected by bark on branches and stems	oaks, tanoak
Basal sprouting	re-growth from subterranean buds located on roots, rhizomes, or lignotubers	oaks, tanoak
Refractory seed buried in soils	dormant seeds with a capacity to survive for hundreds of years until scarified by fire	manzanita, ceanothus
Fire-stimulated flowering	increased reproductive effort the years following fire	forbs, grasses
Serotinous cones	long-term seed storage on parent plant released by fire	knobcone pine

Soil

Erosion has occurred naturally in the lower Clear Creek watershed over time and is the product of complex interactions among geomorphic processes including: climate, vegetation, soils, topography, and time. However, disturbance accelerates the erosion process, altering the transport and storage of sediment with the watershed, and increasing export of material from the watersheds. The frequency and severity of wildfire, a major disturbance, affects the magnitude of erosion. The effects are primarily seen on vegetation and soil. As fire increases in severity, more vegetation is killed and litter, duff and soil organic matter is consumed causing the physical properties of the soil to change. The potential for erosion increases with fire severity, soil erodibility, steepness of slope, and intensity or amount of precipitation. Coarse-textured soils which are low in organic matter are very susceptible to surface erosion. Since much of the area in the upper watershed is composed of decomposed granitic soils, this is an area highly susceptible to erosion after a fire.

Soil Hydrophobicity

A catastrophic wildfire will increase water yield from burned watersheds due to the loss of vegetation and associated lack of vegetative water uptake. Streams which were once intermittent may become perennial until re-vegetation occurs. Catastrophic fire and site conditions can combine to cause hydrophobicity of soils. This process results in a water-repellent soil layer resulting from fire-induced coating of mineral soil particles with organic matter (USDA FS, 1981). Should hydrophobicity be induced, water yield from a watershed might be greatly increased. DeBano (USDA FS, 1981) states that if a non-wetable soil layer forms, soil above it may become saturated during a rainfall event, thereby causing water to flow laterally, over and through the surface layers of soil, and thus, increasing runoff. Soil hydrophobicity is usually caused by high-temperature fires (over 572 degrees F) (USDA FS, 1980) burning on sites with coarse-textured soils covered by heavy litter or containing substantial amounts of decomposing roots or organic matter. Hydrophobicity has been especially prevalent on sites following the burning of brush species (USDA FS, 1981). Current conditions on the Clear Creek watershed, including heavy brush loading, soil organic matter, heavy fuel loading, and coarse-textured soils are conducive to the formation of hydrophobic soils, should a catastrophic wildfire occur.

Sediment yield

One of the most serious impacts associated with a possible wildfire on Clear Creek would be an increase in erosion on the watershed. This increase would largely result from the lack of surface vegetation, canopy cover, and litter layer following a burn. Without these protective layers, soils are exposed to greater impact from raindrops, thereby loosening the surface layers of soil (Tiedemann, 1981). Consequently, substantial increases in sheet and rill erosion or dry ravel are likely to occur following a catastrophic wildfire (USDA FS, 1980).

Overland flow may also increase following a wildfire due to decreased infiltration and possible hydrophobic soils problems (Tiedemann, 1981). Thus, increased up-slope runoff and erosion could cause an associated increase in sedimentation and sediment delivery within Clear Creek. This in-stream sediment could be derived from both up-slope sediment removal and from the down cutting of stream channels due to increased flows (Tiedemann, 1981).

Hydrophobicity of soils would also increase sediment yield to areas below these soils. As before mentioned, a non-wetable layer near the surface can cause saturation of the surface layers of soil. The lack of vegetative water uptake following fire can exacerbate this effect (Tiedemann, 1981). In addition to increasing overland flow above these saturated soils, this saturation can accelerate the erosion of these layers and their transport down slope.

One final consideration is the disturbances caused by fire fighting activities. The use of bulldozers and hand implements to create fire breaks and fire lines can greatly exacerbate erosion problems on mountainous watersheds. The disturbance of soil on these steep areas, often at the tops of ridges, can pose significant sedimentation hazards to areas down slope. In addition, increased road and landing use by trucks and heavy machinery during fire control puts added stress on these roads and landings, thereby further increasing post-fire erosion. Although sediment delivery measurements were not taken following the fire, the degree of visible erosion on the persistent fire breaks after Clear Creek's 1990 Kanaka fire serves as an example of how fire control measures can affect erosion in a mountainous watershed. In addition, the increased heavy truck traffic on the watershed's already stressed road system almost certainly degraded road surfaces, and consequently, increased sedimentation into the stream.

Overall, the extent of erosion and sedimentation depends largely upon soil types and varying levels of rainfall in the sub-watersheds. While mountain granitic soils pose the most substantial threat for erosion, they are not, strictly speaking, the most erodable soils on the watershed in terms of 'k' value (see Table 3-1). Their high erosive potential largely results from the comparatively high rainfall levels present in the zones where these soils occur combined with their low available water content and their associated slow re-vegetation period.

Duration of increased sedimentation on Clear Creek will be tied to the rate of re-vegetation on the watershed following the wildfire. This rate depends upon the species of plants on the watershed prior to burning and their means of reproduction in addition to climate and soil conditions (USDA FS, 1980). As before stated, the granitic (mountain) soils in the upper part of the watershed are particularly drought-prone, and would therefore re-vegetate more slowly following wildfire. Unfortunately, no sediment delivery measurements were taken on Clear Creek following the Kanaka fire.

Duration of increased sedimentation will also be tied to climatological conditions. If rainfall levels on the burned watershed are slightly low to normal following the fire, accelerated erosion might be minimized. If however, the hypothetical fire is followed by a season of intense rainfall, like that seen in 1995, erosion might accelerate to levels which may impede re-vegetation, thereby causing prolonged sediment removal and delivery (USDA FS, 1980).

The area burned in 1990 by the Kanaka fire seems to have re-vegetated well following the burn. As of summer 1995, the area had reverted to a dense grass understory with

Hydrophobicity of soils (if water-repellent soils form) may occur for from a few months to up to fifteen years, depending upon the soil characteristics, fire intensity, fire duration, plant litter type, climate (freezing and thawing), and possibly depending on microbial activity (USDA FS, 1980).

Air Quality

The Clean Air Act is the primary legal instrument for air resource management. It establishes a strategy of managing widespread air pollution to maintain standards for ambient air quality. Particulate matter (visible smoke) is the material regulated by the Clean Air Act. Over 90% of smoke particles are less than 10 microns in size. The particles in this size range (called Pm-10) can be inhaled and therefore are the focus of most regulations. Pm-10 particles are considered to be a respiratory irritant by OSHA.

Local and State air quality standards attempt to control the amount of PM-10 generated by all sources. controlled burns are included with other agricultural and industrial sources in air quality planning for a given day. Wildfires are unplanned events which can cause air basins to exceed specified limits and contribute to potentially unhealthy situations.

Wildlife

Shrub dominated (Chaparral) vegetation found in the watershed provides good habitat for black-tailed deer, black bear, gray fox, valley quail and many species of birds in its early successional stages. However, as chaparral becomes mature, it loses much of its nutritional value and grows out-of-reach and unavailable as suitable food. Chaparral is a fire maintained ecosystem which, under natural conditions, would maintain a mosaic of various age classes within the watershed or landscape area. Current State and Federal policies have dictated that all unplanned fires be extinguished, resulting in numerous climax or old growth brush fields in the watershed. In these brush fields, some type of vegetation manipulation must take place (burning, brush crushing, etc.), to restore the vigor and nutritional value of this habitat type. Wildfire typically burned during the hot summer months, creating a very hot and clean burn. These burns had sufficient soil temperatures to scarify the seed from plants that regenerate from seed sources. The result was an increase in primary browse plants that germinate from seed sources. Low and moderate-intensity fires produced root crown sprouting from adaptive species. These sprouts yield high quality forage. This positive value lasts approximately seven years.

In the lower Clear Creek ecosystem, fire is an important disturbance which influences both input and disappearance of coarse woody debris. With frequent surface fires, the input was relatively continuous, with small quantities added with each fire. In regimes characterized by stand replacing fires, huge inputs of coarse woody debris occurred following fire, but no large trees were left for recruitment sources once these were consumed by a subsequent fire. Optimal wildlife habitat diversity results when fire creates a mosaic of different age classes of vegetation. This leads to a higher spatial diversity of food and habitat types and creates a maximum area of ecotone or edge. Fire is presumed to improve the quality of foods by release of such nutrients as nitrogen, calcium, and phosphorus, but other factors related to fire, such as greater exposure of plants to sunlight, and removal of litter, may also influence forage quality.

Chapter 3 describes vegetation changes for each habitat type as a result of fire or other disturbances. Although this is very general, it is the best available information for the analysis area. Wildlife changes resulting from changes in vegetation is related to site conditions, including climate, soil, and water. The Clear Creek habitat types provide for a variety of wildlife species (see Appendix D). Tree species composition, size, canopy cover, and understory vegetation types are variable which makes the habitat suitable for numerous species, ranging from those dependent on early to late-seral stages or more generalist species. Due to geographic variation in components of each habitat type, caution must be exercised when predicting wildlife species use. For site specific analysis of how fire affects wildlife species in each habitat type, a more intense study would need to be conducted.

Aquatic Habitat

Fire can modify the quantity, quality, and use of salmonid habitat by altering water temperatures, sedimentation rates, riparian vegetation, nutrient availability and food resources, and woody debris in the stream.

Sediment and turbidity are the most significant water-quality responses associated with fire. Usually, where terrain is steep and a hot burn occurs, substantial increases in sediment yields can occur, affecting successful reproduction of trout and salmon. Sediment forms a physical barrier to fry emergence by blocking the route of movement from the gravel. Survival of fry after emergence can be affected since sediment fills the crevices and spaces between the gravel, thus eliminating escape cover and fills in deep pools utilized as resting areas. Accumulation of sediment in the gravel reduces the number of aquatic insects available for fish food. The more desirable fish food organisms, such as mayflies, stone flies, and caddis flies require a clean, firm, rocky bottom for existence.

DATA GAPS

The following list includes known data gaps identified by this watershed analysis.

1. A watershed sediment budget is needed, including the location of sources of severe erosion and information such as how much erosion is coming from each site.
2. An inventory of site-specific erosion control projects and a erosion control plan for each site.
3. Maps of landslide and unstable areas and a description of their condition should be completed.
4. In-place studies on erosion and sedimentation from prescribed burning should be conducted.

5. Site specific inventories of the composition and extent of vegetative communities within the watershed.
6. Better local information on vegetative successional processes in the watershed is needed.
7. An assessment of riparian vegetation in the upper portion of the analysis area is needed.
8. An inventory of fuel loading and size classes is needed.
9. A weather monitoring program is needed to obtain precipitation and temperature data from the upper portion of lower Clear Creek watershed.
10. It has been suggested that much of the Northern spotted owl (NSO) nesting, roosting and foraging habitat identified in the watershed is too hot for the NSO. Although not evaluated in this report, temperature suitability should be determined through consultation with NSO experts and examination of air temperature records for the watershed.
11. A more complete assessment of Peregrine falcon habitat and occupancy may be warranted if suitable cliffs are identified in the watershed.
12. A survey for vernal pools (aerial or photo) or consultation with vernal pool experts may be needed prior to projects in the lower portion of Clear Creek. Some potential restoration sites have already been surveyed for vernal pools.
13. More information is needed to determine the presence of potential bat roosting sites.

CONCLUSIONS

The land uses and management policies which have the greatest potential to disturb the functions and natural resource values of the lower Clear Creek watershed from an ecosystem perspective include the following:

- gold and gravel mining
- logging
- roads
- housing
- water impoundment, diversion and flow alteration
- fire suppression

Immediate and unilateral cessation of these activities would be unrealistic and undesirable. Long term solutions to reverse the changes brought about by past land use activities will require a number of actions to occur. In order to effectively deal with past resource damages, current land uses need to be mitigated by such measures as: stronger land use ordinances, regulations, incentives for restoration activities, and greater cooperation among resource agencies.

Until such political solutions begin to take effect, projects recommended in Chapter 6 can begin to address the causal factors affecting the aquatic, terrestrial, and human concerns expressed previously. Additional study, inventory, planning, and monitoring are important to fill in some of the resource data gaps apparent after the analysis was started.

CHAPTER 6 - Projects and Recommendations

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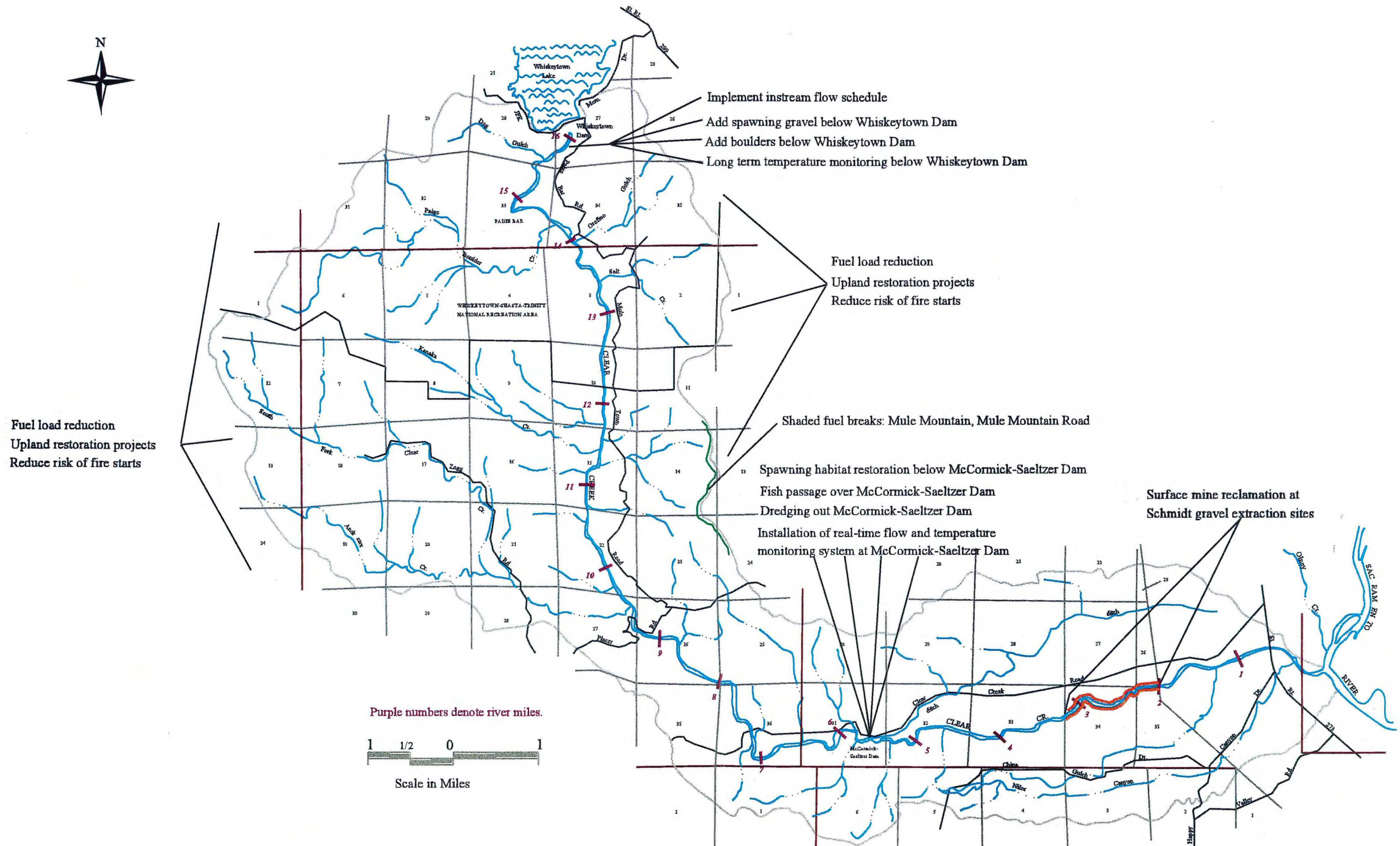

USDA Natural Resources Conservation Service
Redding Field Office 1996

CHAPTER 6 - Projects and Recommendations

The following project recommendations and monitoring needs are not an exhaustive list of activities which could be implemented in the lower Clear Creek watershed. However, the projects listed are some of the higher priority ones discussed as part of the analysis process. (See Map 6-1)

These projects could happen sequentially or simultaneously, as several agencies are involved in the funding and implementation. Much of the descriptive information is taken from "Working Paper on Restoration Needs" Volume 3 (USDI USFWS 1995).

RESTORATION FOR CLEAR CREEK

Management objectives

1. Improve anadromous fisheries and ecosystem processes upon which fisheries are reliant, in ways that are acceptable, efficient and equitable to the interest groups and future generations that have a stake in this watershed.

2. Double long term natural reproduction of salmon in Clear Creek.

3. Reduce chance of accidental fire occurrence.

Six major actions

1. Implement an integrated instream flow schedule for the various stream life stages of salmon and steelhead.
2. Compensate for gravel recruitment and salmon and steelhead spawning areas blocked by Whiskeytown Dam.
3. Control water temperatures in Clear Creek to make them suitable for spring-run Chinook salmon and steelhead trout.
4. Restrict gravel mining and restore the degraded Clear Creek stream channel.
5. Provide effective fish passage over McCormick-Saeltzer Dam.
6. Develop and implement land use practices in the Clear Creek watershed compatible with fishery restoration.

RESTORATION MEASURES FOR CLEAR CREEK
(IN APPROXIMATE DESCENDING ORDER OF PRIORITY)

1. ***Project Name:*** Implement instream flow schedule

Project Description: Implement an instream flow schedule to provide adequate flows and suitable temperatures for all life stages of salmon and steel head in Clear Creek. The intent is to provide sufficient spawning, incubation, and rearing habitats, adequate outmigration flows for salmon and steelhead, together with suitable temperatures and channel maintenance (prevention of riparian vegetation encroachment).

The current schedule of flow releases from Whiskeytown Dam provides 100 cfs during November and December and 50 cfs during the remainder of the year. Restoring the spawning and rearing habitat in Clear Creek and doubling the salmon and steelhead populations will require higher flows.

The recommended releases from Whiskeytown Dam to Clear Creek are 200 cfs from October to April and 150 cfs for the remainder of the year with variable spring-time releases depending on water year type. Annually, this flow regime represents an amount of water that is equaled or exceeded by the natural runoff of the creek at the dam site during 25 - 30% of the water years. During drought conditions, these recommended releases are reduced by 25%. The recommended drought used to trigger a flow reduction is an amount of natural runoff within the driest ten percent of the record. These recommendations are based on attainable temperature objectives and habitat requirements that were determined by an instream flow study and the Clear Creek hydrologic data at Whiskeytown Dam for 1923 to 1994.

The recommended flows provide habitat and temperature requirements for fall-run and late fall-run Chinook salmon and steelhead and to a lesser extent, for spring-run salmon, which are presently extirpated from the stream. If the spring-run Chinook salmon population becomes successfully reintroduced, it may require an even lower summer water temperature regime, necessitating increased flows. The releases are measured at Whiskeytown Dam to provide more precise temperature regulation and prevent harmful flow fluctuations.

A springtime flushing flow recommendation will be developed empirically to accomplish sediment removal, prevent vegetation encroachment, maintain the proper channel configuration, distribute new spawning gravel, facilitate timely juvenile outmigration, and attract adult spring-run salmon and steelhead into the stream. The schedule and amount of flow would be determined by a series of experiments designed to intensify and augment a storm flow at strategic times. The flushing flow releases would not exceed the natural inflow into Whiskeytown Reservoir during the storm.

Implementing the recommended flows can be accomplished via a re-operation of the Keswick and Whiskeytown dams in a manner that does not affect the water supply of the Shasta-Trinity unit of the CVP. Because Clear Creek enters the Sacramento River a short distance below Keswick Dam, it can be used to convey a small portion of the large irrigation supply needed in the river.

Clear Creek flows recommended during the wet season approximate the annual amount of natural runoff that is present or exceeded in 90% of the years of record (1923-1994 in USBR Central Valley Project Operations Hydrologic Data). Drought years within the 10% of the driest years on record require flow reductions that approximate the natural runoff. During the dry season, the Clear Creek releases will be subtracted from the Keswick Dam releases, requiring no net change in release from storage, only a change in delivery route. The flow reductions at Keswick Dam during May through September are minor relative to the average river flow (approximately 1%) and will not affect the habitat or temperature regime of the Sacramento River. Specifically, the Keswick Dam releases would be reduced to approximately 85 cfs (the flow increment above the water right requirements).

The recommended flow schedule should be implemented as soon as possible because there is a significant amount of usable habitat, presently taken out of service, that can significantly contribute to the doubling goals.

1. Related Actions That May Impede or Augment the Action: The water rights permit for the project allows implementation of a new release schedule for Whiskeytown Dam at any time on mutual consent between the USBR and DFG (CVPIA does not affect water right permits). the re-operation of Whiskeytown Dam may require preparation of a Fish and Wildlife Coordination Act Report; however, it may not be needed prior to operational changes based on past practice.

2. Agency and Organization Roles and Responsibilities: The U.S. Department of the Interior is responsible for providing the stream flows that ensure preservation of fish and wildlife and compensate for lost spawning areas above Whiskeytown Dam. DFG should recommend flow releases, and the fishery agencies must monitor the habitat restoration effort. The USBR and DFG must update the water right for the project by submitting a revised MOU to SWRCB.

A detailed operational plan describing the recommended flow regime, consisting of natural runoff from Clear Creek into Whiskeytown Reservoir, should be prepared by DFG, the USBR, and USFWS. It should include flow release adjustment procedures at Keswick and Whiskeytown dams and dry year flow regimes to ensure that Clear Creek flows do not exceed its annual natural unimpaired runoff.

3. Potential Obstacles to Implementation: A consequence of providing additional releases down Clear Creek is the trans-location of power production from Spring Creek and Keswick power plants to the City of Redding power plant located at Whiskeytown

Dam where there is less power potential (head). A timely resolution of this power production loss may not be possible.

4. Predicted Benefits: By increasing the flows below Whiskeytown Dam, it is possible to add back approximately 5 miles of spring-run habitat and 10 miles of steelhead habitat and to reintroduce spring-run Chinook salmon. If successful, another distinct and genetically viable population of spring-run Chinook salmon and steelhead could become established in the Central Valley, which would reduce the probability of these species going extinct. In addition, the recommended flow releases can nearly double available fall-run and late fall-run Chinook salmon habitat over that provided by the present releases. Clear Creek is one of two tributaries in the upper Sacramento River that can provide habitat for three races of salmon and steelhead.

Clear Creek's estimated production is 6,190 salmon and 13,052 steelhead.

Project Cost: The project costs are being quantified by the western Area Power Administration (WAPA). There will be substantial losses in power generation at the Spring Creek Power Plant, reducing the power available for marketing by WAPA. In addition, there will be substantial increases in power generation at the City of Redding Whiskeytown Power Plant; however, the amount of power gain will not equal power loss. The CVPIA requires that the power losses will be reimbursed by allocation among authorized project purposes.

*2. **Project Name:*** Fish passage over McCormick-Saeltzer Dam

Project Description: Modify or remove McCormick-Saeltzer Dam to allow effective fish passage including improving fish passage in degraded channel below dam, and prepare environmental documentation.

The McCormick-Saeltzer Dam was completed in 1903 and is located approximately 10 miles downstream from Whiskeytown Dam at river mile 6.2. This dam diverts up to 25 cfs into the Townsend Flat water ditch for irrigation use.

DFG has made a number of attempts to provide effective fish passage over McCormick-Saeltzer Dam that have been largely unsuccessful to date. This is compounded by a difficult passage situation in the bedrock channel below the dam that could be improved by modifying the channel to improve fish passage (project scheduled for 1996).

The most effective method of passing fish would be removal of the dam. The land at the dam site is now under the ownership of DFG. Although the dam can be used to segregate fall-run from spring-run salmon, that service is not relevant and can be provided by alternate means if necessary. To protect water quality and substrate, dredging of sediment behind the dam is needed. A project design and environmental documentation is already completed for this action.

The dam and diversion appear to be greatly oversized for the current water use serviced by the canal (i.e., much of the irrigation district lands serviced by this diversion have been urbanized and mined for gravel). There are alternate methods of supplying water, including groundwater pumping, contracting water from the ACID's canal, or piping water from Clear Creek using a smaller diversion. The proposal to exchange the dam for an alternate water supply was discussed with the owner-operators and in public meetings; the evaluation process is continuing.

1. Related Actions That May Impede or Augment the Action: The program could be augmented by the CVPIA water purchasing program by offering to purchase its pre-1914 water right and the USBR water contract. The landowners in the district may request the NRCS to develop a water conservation plan for farm use and this program could identify alternate water supplies.

2. Agency and Organization Roles and Responsibilities: DFG is responsible for documenting the fish passage problem. The SWRCB is responsible for responding to any complaints that the water right is not being exercised according to the rules for reasonable use and/or preventing environmental damage.

3. Potential Obstacles to Implementation: The water district serviced by the dam may choose not to enter into a water conservation program or not accept any alternate water supply.

4. Predicted Benefits: Fish passage provides access to the only reach of the stream where water temperatures can be controlled by releases from Whiskeytown Dam during the dry season. Without access to this reach there would not be suitable habitat available for yearling steelhead or spring-run Chinook salmon. There are educational benefits to allowing salmon and steelhead access to the upper reach where they could be observed at the Whiskeytown Environmental Camp. This facility is operated by the Shasta County Department of Education and the National Park Service to accommodate thousands of elementary school students annually with programs that include fishery issues.

Project Cost: $500,000

3. Project Name: Surface mine reclamation at Schmidt gravel extraction sites

Project Location: North State Aggregate and Sunrise Excavation Pits

Project Description: Surface mine reclamation will take place at Schmidt gravel extraction sites, including arranging land exchange and environmental clearances. This project includes construction of deflection walls, stabilizing banks, consolidating braided channels, and restoring spawning gravels.

The adverse effects of instream gravel mining have been well documented. Specific problems on Clear Creek include formation of a highly unstable braided and pitted channel harmful to anadromous fish and lacking sufficient supplies of spawning gravel. Purchase of the mined stream channel along with that proposed for mining would eliminate this problem.

Currently the US Bureau of Land Management (BLM) is in the process of exchanging some of their lands for 900 acres of land bordering Clear Creek between McCormick-Saeltzer Dam and the confluence with the Sacramento River consistent with the Record of Decision for the Redding Resource Areas Land. Completion of the land exchange will place approximately 96% of the lands along the valley reach of the stream in public ownership, while in the foothill reach of the stream all the adjoining lands are in public ownership.

After mined areas transfer to public ownership, channel restoration projects such as the placement of a berm to deflect water away from pits (estimated cost $1,000,000), consolidation of braided channels, and installation of spawning riffles can begin. Plans and environmental documentation are competed for some of the initial channel restoration work.

1. Related Actions That May Impede or Augment the Action: The approved Surface Mine Reclamation Plan for the mined section of the creek is compatible with projects that restore the site for fish and wildlife uses. Restoration activities may be augmented by the Federal Forest Plan Option 9 program that includes Clear Creek watershed. Restoration proposals for labor-intensive projects have been submitted to this program for funding.

2. Agency Roles and Organization Roles: BLM is implementing the land exchange with the assistance of the DFG. Shasta County and the City of Redding are administering the Surface Mine Reclamation Plans that have requirement consistent with restoration of fish and wildlife habitat. Plans for public recreation in the watershed are the responsibility of the City of Redding, National Park Service and BLM. The County of Shasta and the Corps of Engineers are responsible for establishing conditions for any future proposed gravel mining activity in the lands near Clear Creek.

3. Potential Obstacles: None, if the land exchange process proceeds as planned.

4. Predicted benefits: Approximately 12% of the anadromous fish habitat has been heavily mined for gravel but this can be restored for spawning and rearing. An additional 10% of the stream can be exempted from gravel mining. Approximately 95% of the juvenile and adult salmon and steelhead in Clear Creek are subjected to the unsafe passage conditions as they travel to and from the river and the spawning areas of the creek. Public ownership and restoration will provide recreation benefits with the creation of green belt between the Sacramento River and Whiskeytown National Recreation Area.

Project Cost: $1,030,000

4. Project Name: Spawning Habitat Restoration

Project Location: Below McCormick-Saeltzer Dam

Project Objective: Compensate for spawning gravel recruitment and spawning areas blocked by Whiskeytown Dam.

Project Description: Spawning habitat restoration will involve the placement of approximately 6,000 cubic yards of cleaned, graded, spawning-sized gravel at several locations below McCormick-Saeltzer Dam. Work will include improving existing gravel roads, and constructing short sections of new roads with truck turn around areas for equipment access to Clear Creek. Access routes will be chosen to minimize disturbing existing vegetation.

The recruitment of spawning gravel to the creek is halted by Whiskeytown Dam, resulting in a 90% reduction in spawning habitat in the first 10 miles below the dam as indicated by a comparison of pre- and post-project spawning gravel surveys. This loss can be compensated for by artificially introducing quantities of spawning-sized gravel on a continuous basis.

During construction of Whiskeytown Dam, the stream below the dam site was mined for dam building materials, including boulders and rubble, reducing the quality of the habitat in this reach. Boulders can be placed in this section to restore habitat diversity.

The construction of Whiskeytown Dam also resulted in the blockage and inundation of approximately 12 miles of stream suitable for salmon spawning. The early surveys of the stream reach above Whiskeytown indicated that less than 1% of the stream bed was suitable for spawning, yielding an estimated capacity to support a run of approximately 700 salmon. These surveys did note that the stream was affected by mining wastes. There are historical records of a salmon run above the town of Whiskeytown prior to blockage by McCormick-Saeltzer Dam at the turn of the century.

The blockage of the salmon and steelhead habitat by Saeltzer Dam was not legally sanctioned and DFG funded mitigation was never successful. It is appropriate to mitigate for the Whiskeytown Dam's permanent blockage and inundation of historical anadromous fish habitat, especially considering the authorized purpose of the project included protection of fish and wildlife values in the stream. The Central Valley Project Improvement Act recognizes that, "..in the course of developing and implementing this program the Secretary shall make all reasonable efforts consistent with the requirements of this section to address other identified adverse environmental impacts of the Central Valley Project not specifically enumerated in this section (b)". The Act also specifies that "The mitigation for fish and wildlife losses incurred as a result of construction, operation, or maintenance of the Central Valley Project shall be based on the replacement of ecologically equivalent habitat ...".

1. Related Actions That May Impede or Augment the Action: Reintroduction of salmon and steelhead above Whiskeytown Dam is impossible because of unsolvable fish passage issues for adults and juveniles. The preferred mitigation method when mitigation cannot be accomplished onsite, according to DFG and USFWS policies, is to compensate for those lost resources by creating new ecologically equivalent habitat as close to the site as possible. Mitigation could be achieved on the remaining 16 miles of stream below Whiskeytown Dam by managing flows, temperature, and spawning gravel so that the stream has the habitat with the capacity to support the same type and population size of anadromous fish as the historical habitat prior to blockage by dams.

2. Agency and Organization Roles and Responsibilities: DWR, DFG, and USFWS need to formulate and implement a habitat restoration plan for Clear Creek below Whiskeytown Dam.

3. Potential Obstacles to Implementation: None are anticipated if all land management agencies follow current plans.

4. Predicted benefits: The replacement of a portion of the spawning gravel will restore and increase available habitat. Attainable increases in habitat using many years of gravel addition could range between 25% and 50%. This restoration action, along with the other actions proposed for Clear Creek, are expected to nearly double existing populations of salmon and steelhead.

Project Units: 2,050 feet of winter-run spawning habitat restored

Project Cost: $227,500

*5. **Project Name:*** Upland Restoration projects

Project Description: This project will involve implementing erosion control on high priority sites that are producing high amounts of sediment. Specific sites are in sub-watershed 8 (Stony Gulch and 4 adjacent tributaries draining from east into Clear Creek) and in sub-watershed 6 (South Fork Clear Creek). Project design will be developed to address erosion on roads, trails, skid trails, gullies, fire breaks, driveways, house pads, landings and mined areas.

The soils in the upper portion of the watershed are highly erodible decomposed granite that is capable of degrading water quality and spawning substrate. A review of land management practices in the Clear Creek watershed is being conducted through the Coordinated Resource Management process. The Western Shasta Resource Conservation District formed a group of interested parties from private and government sectors and held several public meeting discussing fishery restoration plans. This is a collaborative process is directed at developing the land use practices for timber harvest, residential development, agriculture, mining and road building that prevent sedimentation of the stream. The Resource Conservation District initiated this watershed analysis in the spring of 1995 that identifies the scope and scale of watershed problems. The Natural Resource Conservation Service could, if funded, inventory and prioritize problem sites then design and implement treatment measures.

As urbanization of the lands in continues in the Clear Creek watershed there is a need to preserve a wide unfragmented corridor of riparian vegetation for fish and wildlife. The land exchange process being completed by BLM will produce a greenbelt along over 98% of the stream. The stream corridor along the remaining private land should be protected under the Stream Corridor Protection Program adopted as an interim policy by both the city and the county. Part of the documentation for this program includes a complete mapping of Clear Creek with its riparian habitat and wetlands in a geographic information system format.

1. Related Actions that May Impede or Augment the Action:
Almost all the land adjacent to the creek will be owned by public agencies that presently have land management objectives consistent with fishery restoration, wildlife conservation and public recreation. The land use activities on the remaining private lands should be consistent with the recently revised Shasta County General Plan that specifies special development and erosion control practices in the erodible Clear Creek watershed and protection of salmon spawning gravel in the creek.

2. Agency and Organization Roles: The land use activities on public lands must be managed in a manner that prevents degrading the quality of either the water or the spawning substrate consistent with state and federal water quality laws. The land use activities on private land are conditioned in permits issued by Shasta County consistent with the provisions of the General Plan. The Department of Fish and Game, Central Valley Regional Water Quality Control Board and the Western Shasta Resource Conservation District review the proposed land use activities and advise the county of appropriate measures to conserve natural resources through the California Environmental Quality Act process.

3. Potential Obstacles to Implementation: None anticipated if all land management agencies follow current plans.

4. Predicted benefits: By establishing land use practices that decrease rather than increase the discharge of sediment to the stream, the restored sections of habitat will not be degraded by future land use practices. Effective source control of sediment discharge will also eliminate the need to operate sediment basins that interfere with fish passage and water quality protection. The decreased sediment loads will also increase the effectiveness of spring-time flushing flow releases from Whiskeytown Dam. Fish and wildlife values associated with the stream and its riparian vegetation will be preserved with the implementation of the Stream Corridor Protection Program.

Solution possibilities include:

a) Drainage improvements

1) road out-sloping
2) rock lined channels
3) gully head-cut structures

b)Decommission/Re-route

c) Re-plant critical area with native species

To define these projects and future long term projects, it is strongly recommended that an erosion inventory of the watershed be performed before any more projects are implemented.

Project Cost: $125,000 for erosion control (estimate for demonstration projects on portions of these sites)
$60,000 for erosion inventory of watershed (public and private lands within the watershed)

6. ***Project Name:*** Mule Mountain Shaded Fuel Break

Project Description: The project area separates lower Clear Creek watershed and Middle Creek watershed, an adjacent highly populated area. It consists of the construction of a shaded break for the purpose of reducing fuel loading and serve as a defense mechanism for protecting wild and urban interface properties. The shaded fuel break will provide a fire control line from which to work if needed in the future and be used in future prescribed burning projects. The project area is approximately 4.5 miles long and 120 feet wide. It will connect an existing interagency (NPS, CDF) fuel break system. Partnerships will develop with Shasta County Jobs in the Woods program to train dislocated workers in hazard reduction principles and techniques. The Clear Creek watershed analysis recommended this project as high priority.

Expected Environmental Benefits: The expected benefits include reduction in the rate of spread by any wild fire in the area while providing adequate cover of the soil to minimize erosion. This reduced rate of spread will allow fire fighters time to manipulate the direction or intensity of wild fires to protect lives and property. It will provide recreational access and create a visual, park-like setting. Training opportunities for Shasta County PIC Crew will be available.

Project Cost: $50,000 estimate

7. ***Project Name:*** Fuel-load reduction

Project Description: Reduce fuel-loads in the watershed by the following methods:

a) Prescribe burns

b) Biomass harvest

A Fuel loading/vegetation inventory should be conducted for the watershed.

Project Cost: Prescribe burns: brush areas $350 per acre; timber areas $600 per acre; conditional costs based on location
Biomass harvest: $1000 per acre, conditional on access
Fuel loading/vegetation inventory: $25,000

8. ***Project Name:*** Dredging out McCormick-Saeltzer Dam

Project Description: Removal of sediment will be accomplished by dredging with a hydraulic excavator (backhoe) and will need to be repeated periodically. This dredged material will be evaluated for its potential as a source for spawning gravel material. A bypass channel will be constructed on the adjacent gravel bar. This channel will divert flows around the dredging work to reduce downstream turbidity. It's alignment would be chosen to minimize impacts to existing vegetation.

Dredging activities may result in the temporary loss of some stream side vegetation (1/8 to 1/4 acre) at equipment access ramps. The work will be designed to keep these losses to a minimum by constructing single paths 15-30 feet wide through existing riparian corridors in areas where vegetation cannot be avoided. Disturbed areas will be re-vegetated with appropriate native grass species to prevent erosion.

Presently, there is scattered aquatic vegetation in McCormick-Saeltzer reservoir. Dredging will remove these plants in the area excavated. Pool design will retain shallow benches of existing bottom material at the edges of the reservoir for safety in entering and exiting the pool. Aquatic vegetation will remain on these benches. As the pool fills with sediment, changes in depths will favor re-establishment of some of the vegetation, until the reservoir again requires dredging. The interval between dredging projects is unknown because of unpredictable runoff patterns.

Project Units: removal of approximately 10,000 cubic yards of material

Project Cost: Up to $220,000 (May elect to partially dredge out reservoir and contribute more funds to Project 5 below.)

9. ***Project Name:*** Installation of real-time flow and temperature monitoring system (California Data Exchange Center) at McCormick-Saeltzer Dam.

Project Location: USGS Housing at Placer Road Bridge

Project Objective: Operate Whiskeytown Dam to control temperatures primarily for steelhead or spring-run Chinook if re-establishment is successful.

Project Description: Whiskeytown Dam has several outlets at different elevations that allow lower temperature water releases. The installation of the Oak Bottom temperature control curtain further assists in regulating temperature for Clear Creek. A remote sensing temperature monitoring device is needed at the USGS gauge station at Placer

Road Bridge to help project operators to actively control the creek temperatures. Temperature monitoring during several experimental releases demonstrate that temperature control within appropriate reaches of the stream is attainable at objectives for juvenile rearing (65° F), holding of pre-spawning adult (60° F) and egg incubation (56° F).

1. Related Actions that May Impede or Augment the Action: This action is primarily implemented by providing the recommended stream flows.

In a related action, the Department of Fish and Game has proposed an amendment to the Water Quality Control Plan for the Central Valley Basin that establishes an objective of maintaining temperatures suitable for spring-run Chinook and steelhead in the foothill reaches of Clear Creek. The Central Valley Regional Water Quality Control Board staff is considering the recommended amendment pending further analysis.

2. Agency Responsibilities: Same as that described for the stream flow action. In addition, the Central Valley Regional Water Quality Control Board will continue to analyze the temperature objectives for Clear Creek proposed by the Department of Fish and Game.

3. Potential Obstacles: Same as described for the stream flow action.

4. Predicted benefits: Temperature control makes the habitat usable for salmon and steelhead and recreates habitat similar to what is now blocked by Whiskeytown Dam. The expected temperature regime provided by the recommended flows will provide the following:
a) Within the first ten miles of stream below the dam steelhead are provided with habitat suitable for over-summer rearing of juveniles and spawning and incubation;
b) Within the first five miles below the dam any reintroduced spring-run Chinook would be provided with habitat suitable for over summer-holding of adults and spawning and incubation, and
c) Within the first eight miles of the stream above the confluence with the Sacramento River, suitable habitat would be provided for spawning, incubation and juvenile rearing of fall-run and late fall-run Chinook.

Project Cost: $100,000

10. Project Name: Add spawning gravel below Whiskeytown Dam and throughout the lower Clear Creek watershed.

Project Description: Add spawning gravel throughout the lower Clear Creek watershed and move gravel near Carr Powerhouse to below Whiskeytown Dam.

It is not possible to reintroduce salmon and steelhead above Whiskeytown Dam, due to unsolvable fish passage issues for adults and juveniles. The preferred mitigation method when it cannot be accomplished on-site, according DFG and USFWS policies, is to compensate for those lost resources by creating new ecologically equivalent habitat as close to the site as possible. Mitigation could be achieved on the remaining 16 miles of stream below Whiskeytown Dam by managing flows, temperature and spawning gravel so that the stream has the habitat with the capacity to support the same type and population size of anadromous fish as the historical habitat prior to blockage by dams.

1. Predicted benefits: Establishing habitat conditions for anadromous fish below Whiskeytown Dam that are ecologically equivalent to that permanently blocked by the dam and having the capacity to replace the increment of lost production the action meets a mitigation obligation for the CVP. The restoration activity are expected to more than double existing populations of salmon and steelhead (as discussed in the section on flows).

The loss of gravel recruitment to Clear Creek due to blockage by Whiskeytown Dam has greatly reduced spawning habitat in the reach above McCormick-Saeltzer Dam. Gravel mining operations in the stream channel below the dam have made spawning conditions even worse in the lower reach of Clear Creek. Spawning-sized gravel needs to be introduced to the stream channel and replaced on an annual basis. These actions would not be effective with continued instream gravel mining operations, so the stream channel should be protected by State or federal acquisition, currently underway.

2. Agency and Organization Roles and Responsibilities: DWR, DFG, and USFWS need to formulate and implement a habitat restoration plan for Clear Creek below Whiskeytown Dam.

3. Potential Obstacles to Implementation: None are anticipated if all land management agencies follow current plans.

4. Predicted Benefits: The replacement of a portion of the spawning gravel will restore and increase available habitat. Attainable increases in habitat using many years of gravel addition could range between 25% and 50%. This restoration action, along with the other actions proposed for Clear Creek, are expected to nearly double existing populations of salmon and steelhead.

Project Cost: $350,000

11. Project Name: Add boulders to Clear Creek below Whiskeytown Dam

Project Description: Add boulders to first 1/2 mile of Clear Creek below Whiskeytown Dam to replace habitat diversity lost during dam construction.

During construction of Whiskeytown Dam, the stream channel immediately below the dam site was mined for boulders and rubble, thus reducing the quality of the habitat in this reach. Boulders should be placed in this reach to restore habitat diversity.

Project Cost: $25,000

12. Project Name: Long term temperature monitoring in Clear Creek below Whiskeytown Dam

Project Cost: $80,000

13. Project Name: Proposal to conduct applied research on selecting riparian communities for restoration.

Project Description: This proposal directly addresses two areas of research emphasis for the Integrated Hardwood Range Management Program: conservation and management of riparian ecosystems and development and testing of new monitoring techniques.

Project Cost: $75,000 over 2 year period, includes cost-sharing

OTHER MANAGEMENT RECOMMENDATIONS

Private land restoration could be accomplished by outreach programs to promote public awareness and involvement. Priorities should be based on resource impacts and willing landowners. A system should be established for disseminating information on building, maintaining and retiring private roads and trails as well as conservation-minded mining practices.

WILDLIFE

1. The site specific bald eagle protection and management assessment under development by the National Park Service Whiskeytown Unit should be completed. An overall assessment should be made of potential and capable bald eagle activity areas in the watershed. Enhancement projects could then be proposed that could help develop the sites into "potential" or "occupied " sites. Historical occurrence in the watershed, other than nesting, should also be researched.

2. Survey public lands in lower Clear Creek for Northern spotted owl and Peregrine falcon habitats.

3. Continue contracting studies for species of concern such as foothills yellow-legged frog, red-legged frog, and Northwestern pond turtle. Continue compiling occurrence data on species such as osprey, Peregrine falcon, Pacific fisher, black bear, mountain lion and pale big-eared bat.

4. Improve riparian vegetation and stream channel conditions.

5. Continue moratorium on instream mining, as specified in the Shasta County General Plan, 6.7.13.

6. Full adoption of the Stream Corridor Protection Plan by the City of Redding and Shasta County is recommended to protect riparian reserves.

7. Determine appropriate riparian reserves for upper portion of lower Clear Creek not covered by Stream Corridor Protection Plan.

8. Investigate methods to reduce vegetation encroaching on stream in lower reaches.

9. Encourage riparian growth and retention of large woody debris in upper reaches.

10. Continue public acquisition and protection of sensitive riparian areas.

ECONOMIC

The following recommendations are separated into the main categories used in Chapter 4 - economic, social, political/legal/governmental.

Natural resources need to be valued at least at their private marginal cost, but more preferably, at their social marginal costs. Obstacles to achieving this, such as externalites and open access resources, can be dealt with by such measures as the following:

Market based incentives

- Deal with negative externalities by imposing enforced fines. Fine the fire hazard condition and fine the gravel mining hazard.
- Deal with negative externalities by subsidizing fire hazard reduction or gravel mining reduction. Depends on nature of public good.
- Common access problem needs coordinated action for the catch from the Pacific commercial and recreation industries, to Delta and Sacramento river sports fisheries to Clear Creek sports fisheries
- Rationalize fire insurance policies
- Rationalize real estate markets - externalities such as fire hazard risk should be incorporated in market value
- Deal with absence of risk market for fire insurance bonds kept in escrow pending damage
- complete economic valuation and impact analysis studies to understand benefits and costs of changes in environmental conditions - separate local from broader scale needs (fish at the national level, not local level).

Property right based incentives

Which property rights should be realigned?

SOCIAL

- gain support of interest groups; don't antagonize, find ways to involve concerned parties in flexible ways that promote cooperation and compromise.
- Provide information and develop support
- Build consensus and local organizations for taking improvement actions
- complete a social impact assessment for major changes in watershed (i.e. full implementation of stream corridor)

POLITICAL/LEGAL/GOVERNMENTAL

work with private industry on sound remediation plans that allow resource extracting activities but also promote sound reclamation.

- enforce existing laws and regulations - or make them more useable
- coordinate the sixty laws into one plan or one document that an owner or businessperson could readily understand and use
- Reform water laws that require owners of water rights to use it or lose it

MONITORING

Monitoring programs will be needed to assess the performance of the watershed analysis and the restoration projects at three levels: 1) Sacramento River basin. Basin wide monitoring currently being carried out by various agencies includes annual salmon spawning estimates, water temperature monitoring, juvenile salmonid abundance and outmigration timing, inland angler harvest surveys, ocean harvest estimates and habitat assessment. The CVPIA establishes "a comprehensive assessment program [CAMP] to monitor fish and wildlife resources in the Central Valley" (Sec. 3406(b)(16)) which is currently under development for implementation by October 1997; 2) lower Clear Creek watershed. The Conceptual Plan being developed for the CAMP, has acknowledged the importance of a watershed level monitoring program for Clear Creek; and 3) individual project. Any restoration actions in Clear Creek should include a project level assessment.

1. Within the lower Clear Creek watershed biological monitoring has focused on Chinook salmon and bald eagles. DFG may continue to provide spawning estimates within Clear Creek dependent on budget constraints. Continued counts of fish passing Saeltzer Dam and maintenance of the fish screen will be essential for evaluating efforts to restore spring-run to Clear Creek. Baseline stream morphology data should be collected from surveyed transects and aerial photos before any instream restoration begins. An erosion

inventory should be conducted and reference sub-drainages should be monitored to estimate the benefits of restoration projects. Integration of project and watershed monitoring data could take place through a reiteration of this watershed analysis process. Post-project monitoring plans should be developed through interagency consultation for each project.

2. The time scale for measuring the success of the CVPIA doubling plan is 6 years. While changes in stream flow and water temperature can be measured fairly quickly, the overall benefit of restoration projects will take 20 to 50 years to assess. Many hillslope and riparian restoration projects require the establishment of vegetation that can take decades to grow. For instance, stream channel restoration may require additional gravel below Whiskeytown, which depends stream channel movement or the artificial placement of gravels. Gravel restoration will also require removal of fine sediments and sediment reduction through upland restoration. Stream channel restoration will require both channel maintenance flows and accumulation of instream woody debris which in turn relies on the growth of riparian and upland vegetation.

3. Develop and implement a watershed scale fisheries monitoring program for lower Clear Creek compatible with the comprehensive assessment program (Sec. 3406 (b) (16)) of CVPIA.

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Redding, CA	7 1/2 minute
Olinda, CA	7 1/2 minute
Igo, CA	7 1/2 minute
Enterprise, CA	7 1/2 minute
Ono, CA	7 1/2 minute
Cottonwood, CA	7 1/2 minute

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Red Bluff, CA	1: 100,000
Redding, CA	1: 100,000

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APPENDIX A

CENTRAL VALLEY PROJECT IMPROVEMENT ACT
AS IT RELATES TO
LOWER CLEAR CREEK WATERSHED

The CVPIA (Title 34 of Public Law 102-575) amends the authorization of the Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancements as a purpose equal to power generation. Whiskeytown Dam and the Trinity River reservoirs are CVP features. Section 3406(b)(12) of the act specifically singles out Clear Creek for restoration

"develop and implement a comprehensive program to provide flows to allow sufficient spawning, incubation, rearing and outmigration for salmon and steelhead from Whiskeytown Dam as determined by flow studies conducted by the California Department of Fish and Game after Clear Creek has been restored and a new fish ladder has been constructed at the McCormick-Saeltzer Dam."

Other pertinent sections of the act include:

3406(b)(1): create the anadromous fisheries restoration program (AFRP) to double the natural production of anadromous fish in Central Valley rivers and streams.

3406(b)(2) dedicated 800,000 acre feet of CVP yield for fish, wildlife and habitat restoration purposes and measures.

3406(b)(2)(A) the 800,00 acre feet shall be supplemented by all water that comes under the Secretary's control pursuant to subsections:

3406(b)(3) acquisition and supplementation
3408(h) land retirement
3408(i) conservation

and through other measures consistent with subparagraph 3406(b)(1)(B) which authorizes and directs the modification of CVP operations to provide flows of suitable quality, quantity and timing, "from other sources which do not conflict with fulfillment of the Secretary's remaining contractual obligations to provide Central Valley Project water for other authorized purposes"

3406(b)(3) acquire supplemental water for fish and wildlife

3406(b)(7) meet CVP flow standards that apply to CVP

3406(b)(8) use pulse flows to increase migratory fish survival

3406(b)(16) comprehensive assessment and monitoring of actions taken under 3406(b)

3406(b)(21) develop measures to avoid fish losses resulting from un-screwed or inadequately screened diversions

APPENDIX B

SOIL MAPPING UNITS AND MISCELLANEOUS LAND TYPES OF LOWER CLEAR CREEK WATERSHED

SOIL SERIES	MAP UNITS	PARENT MATERIALS	SOILS GROUP
CHAIX	CbF, CbE, CaE3, DbD2, CaF3	Granite	Mountain Soils
NEUNS	NdE, NdG	Greenstone	Foothills
BOOMER	B1F, BkE, BkD	Greenstone	Foothills
GOULDING	GeE2, GeF2, GdD	Greenstone	Foothills
REIFF	RfB, RgB, RkA, RhA, RmA	Recent Alluvium	Bottom land
KANAKA	KcF2, KcE, KcD	Granite	Mountain
CORBETT	CxG	Granite	Mountain
HOLLAND	HcF, HcE	Granite	Mountain
KIDD	KgF2	Volcanic Phylite	Foothill
DIAMOND SPRINGS	DfD2	Metadacite	Foothill
AUBERRY	A1F, A1D	Granite	Mountain
SIERRA	SmD, SmE, SmC	Granite	Mountain
AUBURN	AnD, AtE2, AuF2, AsD2, ArD	Volcanic	Foothill
RED BLUFF	RcB, RcA, RbA	Old Alluvium	High Terrace
NEWTOWN	NeD, NeE2, NeC	Old Alluvium	High Terrace
CHURN	CcB, CeB, CeA, CcA, CfA, CfB	Recent Alluvium	Low Terrace
ANDERSON	Ae, Ad	Recent Alluvium	Low Terrace
HONCUT	He, Hd	Recent Alluvium	Low Terrace
MILLSHOLM	MeD, MfE2	Sandstone	High Terrace
MODA	MgA	Old Alluvium	High Terrace
REDDING	RbB, RbA	Old Alluvium	High Terrace
PERKINS	PmA, PmB, Pob, PmC	Mixed Alluvium	Low Terrace
TEHAMA	TbA	Mixed Alluvium	Low Terrace

MISCELLANEOUS LAND TYPES

COLLUVIAL	CfS
LANDSLIDES	LaE
RIVERWASH	Rw
TAILINGS	TaD
COBBLY ALLUVIUM	Ck, Ch
ROCK LAND	RxF
GRAVEL PITS	Gp

APPENDIX C

PLANT LIST FOR LOWER CLEAR CREEK WATERSHED

COMMON NAME	SCIENTIFIC NAME
annual ryegrass	*Lolium multiflorum*
bigleaf maple	*Acer macrophyllum*
black locust	*Robinia pseudoacacia*
blue oak	*Quercus douglasii*
brome grasses	*Bromus spp.*
California black oak	*Quercus kelloggii*
California buckthorn, coffeeberry	*Rhamnus californica*
canyon live oak	*Quercus chrysoepis*
Ceanothus	*Ceanothus spp.*
chinquapin	*Castanopsis sempervirens*
Douglas-fir	*Pseudotsuga menziesii*
fescue grasses	*Festuca spp.*
green-leaf manzanita	*Arctostaphylos patula*
gray (Digger) pine	*Pinus sabiniana*
himalayaberry	*Rubus procerus*
incense-cedar	*Calocedrus decurrens*
interior live oak	*Quercus wislizenii*
knobcone pine	*Pinus attenuata*
leather oak	*Quercus durata*
manzanita	*Arctostaphylos spp.*
medusahead	*Taeniatherum asperum*
mountain mahogany	*Cercocarpus betuloides*
native black berries	*Rubus spp.*
needle grasses	*Stipa (Nassella) spp.*
Oregon white oak	*Quercus garryana*
pacific madrone	*Arbutus menziesii*
pine mat manzanita	*Arctostaphylos nevadensis*
poison oak	*Toxicodendron diversilobum*
ponderosa pine	*Pinus ponderosa*
scrub oak	*Quercus dumosa*
soft chess	*Bromus mollis*
squaw carpet	*Ceanothus prostratus*
sugar pine	*Pinus lambertiana*
tan oak	*Lithocarpus densiflora*
tree of heaven	*Ailanthus altissima*
wedge-leaf ceanothus	*Ceanothus cuneatus*
white fir	*Abies concolor*
white-leaf manzanita	*Arctostaphylos viscida*
wild ryes	*Elymus (leymus) spp.*
wild oats	*Avena fatua*
yellow star thistle	*Centaurea solstitalis*

APPENDIX D

TERRESTRIAL ANIMAL SPECIES THAT MAY HAVE HAD SUITABLE HABITAT IN LOWER CLEAR CREEK

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SINGLE HABITAT SPECIES DETAIL LIST

SELECTION CRITERIA:

Reference Conditions-
Terrestrial animal species that may have had suitable habitat in lower Clear Creek before white settlement

ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
A003	LONG TOED SALAMANDER			Yearlong		
A004	PACIFIC GIANT SALAMANDER			Yearlong		
A006	ROUGH-SKINNED NEWT			Yearlong		
A007	CALIFORNIA NEWT			Yearlong		
A012	ENSATINA			Yearlong		
A014	CALIFORNIA SLENDER SALAMANDER			Yearlong		
A020	BLACK SALAMANDER			Yearlong		
A024	SHASTA SALAMANDER	4 7		Yearlong		
A026	TAILED FROG			Yearlong		
A028	WESTERN SPADEFOOT			Yearlong		
A032	WESTERN TOAD			Yearlong		
A039	PACIFIC TREEFROG			Yearlong		
A040	RED-LEGGED FROG			Yearlong		
A042	CASCADES FROG			Yearlong		
A043	FOOTHILL YELLOW-LEGGED FROG			Yearlong		
A046	BULLFROG	9		Yearlong		
B006	PIED-BILLED GREBE			Yearlong		
B009	EARED GREBE			Yearlong		
B010	WESTERN GREBE / CLARK'S GREBE			Yearlong		
B042	AMERICAN WHITE PELICAN	6		Summer		
B044	DOUBLE-CRESTED CORMORANT	6		Yearlong		
B049	AMERICAN BITTERN			Yearlong		
B051	GREAT BLUE HERON			Yearlong		
B052	GREAT EGRET			Yearlong		
B058	GREEN-BACKED HERON			Yearlong		
B059	BLACK-CROWNED NIGHT HERON			Yearlong		
B067	TUNDRA SWAN			Winter		
B075	CANADA GOOSE	9		Yearlong		
B076	WOOD DUCK	9		Yearlong		
B077	GREEN-WINGED TEAL	9		Winter		
B079	MALLARD	9		Yearlong		
B080	NORTHERN PINTAIL	9		Yearlong		

Status Definitions:

1. FE: Federally Endangered
2. FT: Federally Threatened
3. CE: California Endangered
4. CT: California Threatened
5. CP: California Protected
6. CS: California Special Concern
7. FS: Forest Service Sensitive
8. BS: BLM Sensitive
9. H : Harvest

CPS: Candidate or Proposed Candidate Species

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B082	BLUE-WINGED TEAL	9		Summer		
B083	CINNAMON TEAL	9		Summer		
B084	NORTHERN SHOVELER	9		Yearlong		
B085	GADWALL	9		Yearlong		
B087	AMERICAN WIGEON	9		Yearlong		
B089	CANVASBACK			Winter		
B090	REDHEAD	9		Yearlong		
B091	RING-NECKED DUCK	9		Yearlong		
B094	LESSER SCAUP	9		Yearlong		
B101	COMMON GOLDENEYE	9		Winter		
B102	BARROW'S GOLDENEYE	6 9		Winter		
B103	BUFFLEHEAD	9		Yearlong		
B104	HOODED MERGANSER	9		Winter		
B105	COMMON MERGANSER	9		Yearlong		
B107	RUDDY DUCK	9		Yearlong		
B108	TURKEY VULTURE			Yearlong		
B110	OSPREY	67		Summer		
B111	BLACK-SHOULDERED KITE	5		Yearlong		
B113	BALD EAGLE	1 3 5		Yearlong		
B114	NORTHERN HARRIER	6		Yearlong		
B115	SHARP-SHINNED HAWK	6		Yearlong		
B116	COOPER'S HAWK	6		Yearlong		
B117	NORTHERN GOSHAWK	678		Yearlong		
B119	RED-SHOULDERED HAWK			Yearlong		
B121	SWAINSON'S HAWK	4		Summer		
B123	RED-TAILED HAWK			Yearlong		
B124	FERRUGINOUS HAWK	6		Winter		
B125	ROUGH-LEGGED HAWK			Winter		
B126	GOLDEN EAGLE	567		Yearlong		
B127	AMERICAN KESTREL			Yearlong		
B128	MERLIN	6		Winter		
B129	PEREGRINE FALCON	1 3 5		Yearlong		
B131	PRAIRIE FALCON	7		Yearlong		
B133	RING-NECKED PHEASANT	9		Yearlong		
B134	BLUE GROUSE	7 9		Yearlong		
B136	RUFFED GROUSE	9		Yearlong		
B138	TURKEY	9		Yearlong		
B140	CALIFORNIA QUAIL	9		Yearlong		

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B141	MOUNTAIN QUAIL	9		Yearlong		
B145	VIRGINIA RAIL			Yearlong		
B146	SORA			Yearlong		
B148	COMMON MOORHEN	9		Yearlong		
B149	AMERICAN COOT	9		Yearlong		
B150	SANDHILL CRANE	5		Yearlong		
B158	KILLDEER			Yearlong		
B163	BLACK-NECKED STILT			Summer		
B164	AMERICAN AVOCET			Summer		
B165	GREATER YELLOWLEGS			Winter		
B168	WILLET			Summer		
B170	SPOTTED SANDPIPER			Yearlong		
B185	LEAST SANDPIPER			Winter		
B191	DUNLIN			Winter		
B197	LONG-BILLED DOWITCHER			Winter		
B199	COMMON SNIPE			Yearlong		
B200	WILSON'S PHALAROPE			Summer		
B214	RING-BILLED GULL			Yearlong		
B215	CALIFORNIA GULL			Yearlong		
B216	HERRING GULL			Winter		
B227	CASPIAN TERN			Summer		
B233	FORSTER'S TERN			Summer		
B235	BLACK TERN			Summer		
B250	ROCK DOVE	9		Yearlong		
B251	BAND-TAILED PIGEON	9		Yearlong		
B255	MOURNING DOVE	9		Yearlong		
B260	GREATER ROADRUNNER			Yearlong		
B262	COMMON BARN OWL			Yearlong		
B263	FLAMMULATED OWL			Summer		
B264	WESTERN SCREECH OWL			Yearlong		
B265	GREAT HORNED OWL			Yearlong		
B267	NORTHERN PYGMY OWL			Yearlong		
B269	BURROWING OWL	6		Summer		
B270	SPOTTED OWL	2 6		Yearlong		
B272	LONG-EARED OWL	6		Yearlong		
B274	NORTHERN SAW-WHET OWL			Yearlong		
B275	LESSER NIGHTHAWK			Summer		
B276	COMMON NIGHTHAWK			Summer		
B277	COMMON POORWILL			Summer		

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B279	BLACK SWIFT	6		Summer		
B281	VAUX'S SWIFT			Summer		
B286	BLACK-CHINNED HUMMINGBIRD			Summer		
B287	ANNA'S HUMMINGBIRD			Yearlong		
B289	CALLIOPE HUMMINGBIRD			Summer		
B291	RUFOUS HUMMINGBIRD			Summer		
B293	BELTED KINGFISHER			Yearlong		
B294	LEWIS' WOODPECKER			Yearlong		
B296	ACORN WOODPECKER			Yearlong		
B299	RED-BREASTED SAPSUCKER			Yearlong		
B300	WILLIAMSON'S SAPSUCKER			Yearlong		
B302	NUTTALL'S WOODPECKER			Yearlong		
B303	DOWNY WOODPECKER			Yearlong		
B304	HAIRY WOODPECKER			Yearlong		
B305	WHITE-HEADED WOODPECKER			Yearlong		
B307	NORTHERN FLICKER			Yearlong		
B308	PILEATED WOODPECKER			Yearlong		
B309	OLIVE-SIDED FLYCATCHER			Summer		
B311	WESTERN WOOD-PEWEE			Summer		
B315	WILLOW FLYCATCHER	6		Summer		
B317	HAMMONDS' FLYCATCHER			Summer		
B318	DUSKY FLYCATCHER			Summer		
B320	WESTERN FLYCATCHER			Summer		
B321	BLACK PHOEBE			Yearlong		
B323	SAY'S PHOEBE			Winter		
B326	ASH-THROATED FLYCATCHER			Summer		
B333	WESTERN KINGBIRD			Summer		
B337	HORNED LARK			Yearlong		
B338	PURPLE MARTIN	6		Summer		
B339	TREE SWALLOW			Summer		
B340	VIOLET-GREEN SWALLOW			Summer		
B341	NORTHERN ROUGH-WINGED SWALLOW			Summer		
B342	BANK SWALLOW	4		Summer		
B343	CLIFF SWALLOW			Summer		
B344	BARN SWALLOW			Summer		
B345	GRAY JAY			Yearlong		
B346	STELLER'S JAY			Yearlong		
B348	SCRUB JAY			Yearlong		

SINGLE HABITAT SPECIES DETAIL LIST

ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B349	PINYON JAY			Yearlong		
B350	CLARK'S NUTCRACKER			Yearlong		
B351	BLACK-BILLED MAGPIE			Yearlong		
B352	YELLOW-BILLED MAGPIE			Yearlong		
B353	AMERICAN CROW	9		Yearlong		
B354	COMMON RAVEN			Yearlong		
B356	MOUNTAIN CHICKADEE			Yearlong		
B357	CHESTNUT-BACKED CHICKADEE			Yearlong		
B358	PLAIN TITMOUSE			Yearlong		
B360	BUSHTIT			Yearlong		
B361	RED-BREASTED NUTHATCH			Yearlong		
B362	WHITE-BREASTED NUTHATCH			Yearlong		
B363	PYGMY NUTHATCH			Yearlong		
B364	BROWN CREEPER			Yearlong		
B366	ROCK WREN			Yearlong		
B367	CANYON WREN			Yearlong		
B368	BEWICK'S WREN			Yearlong		
B369	HOUSE WREN			Yearlong		
B370	WINTER WREN			Yearlong		
B372	MARSH WREN			Yearlong		
B373	AMERICAN DIPPER			Yearlong		
B375	GOLDEN-CROWNED KINGLET			Yearlong		
B376	RUBY-CROWNED KINGLET			Yearlong		
B377	BLUE-GRAY GNATCATCHER			Summer		
B380	WESTERN BLUEBIRD			Yearlong		
B381	MOUNTAIN BLUEBIRD			Yearlong		
B382	TOWNSEND'S SOLITAIRE			Yearlong		
B385	SWAINSON'S THRUSH			Summer		
B386	HERMIT THRUSH			Yearlong		
B389	AMERICAN ROBIN			Yearlong		
B390	VARIED THRUSH			Winter		
B391	WRENTIT			Yearlong		
B393	NORTHERN MOCKINGBIRD			Yearlong		
B398	CALIFORNIA THRASHER			Yearlong		
B404	WATER PIPIT			Winter		
B407	CEDAR WAXWING			Winter		
B408	PHAINOPEPLA			Yearlong		
B409	NORTHERN SHRIKE			Winter		
B410	LOGGERHEAD SHRIKE			Yearlong		

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B411	EUROPEAN STARLING			Yearlong		
B415	SOLITARY VIREO			Summer		
B417	HUTTON'S VIREO			Yearlong		
B418	WARBLING VIREO			Summer		
B425	ORANGE-CROWNED WARBLER			Yearlong		
B426	NASHVILLE WARBLER			Summer		
B430	YELLOW WARBLER	6		Summer		
B435	YELLOW-RUMPED WARBLER			Yearlong		
B436	BLACK-THROATED GRAY WARBLER			Summer		
B438	HERMIT WARBLER			Summer		
B460	MACGILLIVRAY'S WARBLER			Summer		
B461	COMMON YELLOWTHROAT	6		Summer		
B463	WILSON'S WARBLER			Summer		
B467	YELLOW-BREASTED CHAT	6		Summer		
B471	WESTERN TANAGER			Summer		
B475	BLACK-HEADED GROSBEAK			Summer		
B476	BLUE GROSBEAK			Summer		
B477	LAZULI BUNTING			Summer		
B482	GREEN-TAILED TOWHEE			Summer		
B483	RUFOUS-SIDED TOWHEE			Yearlong		
B484	BROWN TOWHEE			Yearlong		
B489	CHIPPING SPARROW			Summer		
B491	BREWER'S SPARROW			Summer		
B493	BLACK-CHINNED SPARROW			Summer		
B494	VESPER SPARROW			Summer		
B495	LARK SPARROW			Yearlong		
B497	SAGE SPARROW			Yearlong		
B499	SAVANNAH SPARROW	3 6		Yearlong		
B501	GRASSHOPPER SPARROW			Summer		
B504	FOX SPARROW			Yearlong		
B505	SONG SPARROW	6		Yearlong		
B506	LINCOLN'S SPARROW			Yearlong		
B509	GOLDEN-CROWNED SPARROW			Winter		
B510	WHITE-CROWNED SPARROW			Yearlong		
B512	DARK-EYED JUNCO			Yearlong		
B519	RED-WINGED BLACKBIRD			Yearlong		
B520	TRICOLORED BLACKBIRD	6		Summer		
B521	WESTERN MEADOWLARK			Yearlong		
B522	YELLOW-HEADED BLACKBIRD			Yearlong		
B524	BREWER'S BLACKBIRD			Yearlong		

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
B528	BROWN-HEADED COWBIRD			Summer		
B532	NORTHERN ORIOLE			Summer		
B536	PURPLE FINCH			Yearlong		
B537	CASSIN'S FINCH			Yearlong		
B538	HOUSE FINCH			Yearlong		
B539	RED CROSSBILL			Yearlong		
B542	PINE SISKIN			Yearlong		
B543	LESSER GOLDFINCH			Yearlong		
B544	LAWRENCE'S GOLDFINCH			Summer		
B545	AMERICAN GOLDFINCH			Yearlong		
B546	EVENING GROSBEAK			Yearlong		
B547	HOUSE SPARROW			Yearlong		
M001	VIRGINIA OPOSSUM			Yearlong		
M003	VAGRANT SHREW	6		Yearlong		
M010	WATER SHREW			Yearlong		
M012	TROWBRIDGE'S SHREW			Yearlong		
M015	SHREW-MOLE			Yearlong		
M018	BROAD-FOOTED MOLE			Yearlong		
M021	LITTLE BROWN MYOTIS	6		Yearlong		
M023	YUMA MYOTIS			Yearlong		
M025	LONG-EARED MYOTIS			Yearlong		
M026	FRINGED MYOTIS			Yearlong		
M027	LONG-LEGGED MYOTIS			Yearlong		
M028	CALIFORNIA MYOTIS			Yearlong		
M029	SMALL-FOOTED MYOTIS			Yearlong		
M030	SILVER-HAIRED BAT			Yearlong		
M032	BIG BROWN BAT			Yearlong		
M033	RED BAT			Yearlong		
M034	HOARY BAT			Yearlong		
M037	TOWNSEND'S BIG-EARED BAT	6		Yearlong		
M038	PALLID BAT	6		Yearlong		
M039	BRAZILIAN FREE-TAILED BAT			Yearlong		
M043	PIKA			Yearlong		
M045	BRUSH RABBIT	6 9		Yearlong		
M046	NUTTALL'S COTTONTAIL	9		Yearlong		
M047	DESERT COTTONTAIL	9		Yearlong		
M049	SNOWSHOE HARE	6 9		Yearlong		
M050	WHITE-TAILED HARE	6 9		Yearlong		
M051	BLACK-TAILED HARE	9		Yearlong		

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ID	SPECIES NAME	STATUS 123456789 FFCCCCFBH ETETPSSS	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO COVER FEED INDEX
M052	MOUNTAIN BEAVER	6		Yearlong		
M055	YELLOW-PINE CHIPMUNK			Yearlong		
M057	ALLEN'S CHIPMUNK			Yearlong		
M059	SONOMA CHIPMUNK			Yearlong		
M063	LODGEPOLE CHIPMUNK			Yearlong		
M066	YELLOW-BELLIED MARMOT			Yearlong		
M070	BELDING'S GROUND SQUIRREL			Yearlong		
M072	CALIFORNIA GROUND SQUIRREL			Yearlong		
M075	GOLDEN-MANTLED GROUND SQUIRREL			Yearlong		
M077	WESTERN GRAY SQUIRREL	9		Yearlong		
M078	FOX SQUIRREL	9		Yearlong		
M079	DOUGLAS' SQUIRREL	9		Yearlong		
M080	NORTHERN FLYING SQUIRREL	6		Yearlong		
M081	BOTTA'S POCKET GOPHER			Yearlong		
M084	WESTERN POCKET GOPHER			Yearlong		
M085	MOUNTAIN POCKET GOPHER			Yearlong		
M088	GREAT BASIN POCKET MOUSE			Yearlong		
M105	CALIFORNIA KANGAROO RAT	6		Yearlong		
M112	BEAVER			Yearlong		
M113	WESTERN HARVEST MOUSE			Yearlong		
M117	DEER MOUSE	6		Yearlong		
M119	BRUSH MOUSE			Yearlong		
M120	PINYON MOUSE			Yearlong		
M127	DUSKY-FOOTED WOODRAT	6		Yearlong		
M128	BUSHY-TAILED WOODRAT			Yearlong		
M129	WESTERN RED-BACKED VOLE			Yearlong		
M133	MONTANE VOLE			Yearlong		
M134	CALIFORNIA VOLE	1 3 6		Yearlong		
M136	LONG-TAILED VOLE			Yearlong		
M137	CREEPING VOLE			Yearlong		
M139	MUSKRAT	9		Yearlong		
M140	BLACK RAT			Yearlong		
M142	HOUSE MOUSE			Yearlong		
M143	WESTERN JUMPING MOUSE			Yearlong		
M145	PORCUPINE			Yearlong		
M146	COYOTE	9		Yearlong		
M147	RED FOX	4 78		Yearlong		
M149	GRAY FOX	9		Yearlong		
M151	BLACK BEAR	9		Yearlong		
M152	RINGTAIL	5		Yearlong		

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CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
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CALIFORNIA DEPARMENT OF FISH AND GAME
Database Version: 5.0

SINGLE HABITAT SPECIES DETAIL LIST

ID	SPECIES NAME	STATUS 1 F E	2 F T	3 C E	4 C T	5 C P	6 C S	7 F S	8 B S	9 H	C P S	SEASON IN LOCATION	SEASON IN HABITAT	IMPORTANCE TO......... REPRO	COVER	FEED	INDEX
M153	RACCOON									9		Yearlong					
M154	MARTEN											Yearlong					
M155	FISHER						6					Yearlong					
M156	ERMINE									9		Yearlong					
M157	LONG-TAILED WEASEL									9		Yearlong					
M158	MINK									9		Yearlong					
M159	WOLVERINE				4	5						Yearlong					
M160	BADGER						6			9		Yearlong					
M161	WESTERN SPOTTED SKUNK						6			9		Yearlong					
M162	STRIPED SKUNK									9		Yearlong					
M163	RIVER OTTER						6					Yearlong					
M165	MOUNTAIN LION						6					Yearlong					
M166	BOBCAT									9		Yearlong					
M176	WILD PIG									9		Yearlong					
M177	ELK									9		Yearlong					
M181	MULE DEER									9		Yearlong					
M182	PRONGHORN									9		Yearlong					
R004	WESTERN POND TURTLE											Yearlong					
R022	WESTERN FENCE LIZARD											Yearlong					
R023	SAGEBRUSH LIZARD											Yearlong					
R024	SIDE-BLOTCHED LIZARD											Yearlong					
R036	WESTERN SKINK											Yearlong					
R039	WESTERN WHIPTAIL											Yearlong					
R040	SOUTHERN ALLIGATOR LIZARD											Yearlong					
R042	NORTHERN ALLIGATOR LIZARD											Yearlong					
R046	RUBBER BOA											Yearlong					
R048	RINGNECK SNAKE											Yearlong					
R049	SHARP-TAILED SNAKE											Yearlong					
R051	RACER											Yearlong					
R053	CALIFORNIA WHIPSNAKE											Yearlong					
R057	GOPHER SNAKE											Yearlong					
R058	COMMON KINGSNAKE											Yearlong					
R059	CALIFORNIA MOUNTAIN KINGSNAKE											Yearlong					
R061	COMMON GARTER SNAKE											Yearlong					
R062	WESTERN TERRESTRIAL GARTER SNAKE											Yearlong					
R063	WESTERN AQUATIC GARTER SNAKE											Yearlong					
R071	NIGHT SNAKE											Yearlong					
R076	WESTERN RATTLESNAKE											Yearlong					

TOTAL SPECIES: 343

APPENDIX E

ENDANGERED SPECIES ACT
AND
OTHER SPECIES CONSIDERATIONS

Endangered Species Act and Other Species Considerations.

This information refers to questions asked in Appendix C pages 7 through 12 of the FY 1994-96 Watershed Analysis Guidelines. This information should assist in project planning and Endangered Species Act Section 7 consultations for these species.

Northern Spotted Owl

1. Are spotted owl activity centers located within the watershed? If so, how many and in what ROD land allocations are they located? Which of these are currently above "take thresholds and which are below? When were the activity centers located? Describe the reproductive history.

No spotted owl activity centers are located in the lower Clear Creek watershed.

2. Has a 100 acre core activity area been designated around each activity center located in matrix lands?

Not applicable.

3. How many acres of nesting, roosting and foraging habitat (NRF) are there in the watershed?

The potential NRF habitat is 7.6% of the watershed. None of the stands have been surveyed to protocol. There are 2,371 acres of habitat that could potentially serve as NRF. This habitat was identified using the Timberland Task Force Klamath Province habitat database, which was created from satellite imagery from 1991. Conifer habitats with canopy closure greater than 60% and QMB greater than 36 " were designated as NRF. The conifer habitats suitable for NSO found in the watershed were Douglas fir (1,066 acres), Klamath Mixed Conifer (171 acres), and Ponderosa Pine (68 acres). This habitat is located in the Northwestern part of the watershed as a mosaic interspersed primarily with coniferous habitats with greater than 40% canopy cover and 11" QMB (potentially dispersal habitat).

It has been suggested that much of habitat is too warm for NSO. This statement was not evaluated for this report. Wildlife biologists associated with the Whiskeytown Unit do not consider this habitat suitable for NSO (Bud Ivey, pers. comm., NPS, 1995).

4. What is the amount of nesting, rearing and foraging habitat in each ROD land allocation within the watershed?

Approximately 2/3rds of the NRF is within the congressional reserved area of the Whiskeytown National Recreational Area (NRA).

5. Does any portion of the watershed contain late successional reserves (LSR)?

No late successional reserves are located within the watershed.

6. What is the amount of dispersal habitat (11-40 and above) in each ROD land allocation within the watershed?

The amount of dispersal habitat within the watershed, defined as coniferous habitats of types habitable by NSO, with greater than 40% canopy cover and 11" QMB is large. However, there are no LSR's or activity areas nearby that would be connected by the dispersal habitat. Much of this habitat consists of gray pine / blue oak which provides only low quality NSO habitat.

7. Is distance between LSRs (those LSRs over 10,000 acres in size) greater than 4 miles? (This determination may require analysis beyond the watershed). If so, then what is the amount of dispersal habitat on Federal lands for all 1/4 townships between the LSRs? Is this total greater than 50%? Describe , if present, the natural barriers to dispersal. Is connectivity, or dispersal habitat sufficient to allow movement?

No LSR's are located within the watershed or within 4 miles of the watershed. The watershed does not lie between any LSRs. Therefore Northern spotted owl habitat connectivity and dispersal are not issues in the watershed.

8. How much critical habitat has been designated within the watershed? How much of this total overlaps with LSRs? For areas that do not overlap, how much is currently NRF habitat, how much is capable? How many activity centers are located in this "non-overlap" area of CHU [critical habitat unit]? How many are currently above "take". how many below? What role does this "non-overlap" critical habitat play in this watershed (and/or larger scale). in relation to the reasons for the designation of the CHU?

Not applicable because no critical habitat nor LSRs have been designated within the watershed.

Bald Eagle

1. Are occupied bald eagle activity areas (nesting, foraging, winter roosts, or concentration areas) located within the watershed? If so, what type, how many and in what ROD land allocations are they located? Describe the reproductive history based on monitoring data. Has a final site-specific protection/management assessment been developed for each site? Does this watershed analysis corroborate the findings of the management assessment?

Whiskeytown NRA (a congressional reserved land allocation) has two nesting pairs of bald eagles, only one of which nests within the lower Clear Creek watershed (T32N R6W sections 28 and 33). The other nest is within one mile of the watershed boundary (T32N R6W section 20). Bald eagles are regularly observed near Whiskeytown Reservoir, and are occasionally seen fishing along Clear Creek south of Whiskeytown Dam downstream to the N.E.E.D Camp. Information on reproductive history based on monitoring data is not available. A site specific protection / management assessment is under development by the National Park Service Whiskeytown Unit.

The single nesting pair of bald eagles within lower Clear Creek and the bald eagles observed foraging downstream of Whiskeytown Dam are found within the Whiskeytown NRA a congressional reserved area land allocation. Although many bald eagles forage at Whiskeytown Reservoir, this area is not within the portion of the Clear Creek watershed under assessment.

2. Has an assessment been made as to whether there are "potential" bald eagle activity areas (nesting, foraging, winter roosts or concentration areas) located within the watershed? ("Potential would mean the habitat components appear sufficient, but the area is unoccupied, or has not been surveyed.) If yes, what type, how many, and in what ROD land allocations are they located? Have these areas been surveyed to protocol to determine they are unoccupied?

No overall assessment has been made as to whether there are "potential" bald eagle activity areas in the watershed.

3. Describe historical bald eagle occurrence and nesting within the watershed.

Historical occurrence in the watershed, other than nesting, is unknown. Historically nesting records in the watershed indicate that nesting 50% of the time.

4. What is the status of the watershed as it relates to the Recovery Plan? (Target Recovery territories, etc. Analysis may need to extend beyond the watershed boundaries.) Does the watershed and the surrounding area meet the objectives of the Recovery Plan? If not then:

Are there "capable" bald eagle activity areas located within the watershed? ("Capable" would mean that many but not all of the habitat components are present, yet site could become "potential" through enhancement, restoration, or time.) If "capable" activity areas are present, what type are they, how many, and in what ROD land allocations are they located? What type of project or enhancement could be proposed that could help develop the sites into "potential" or "occupied " sites?

Lower Clear Creek is included in Zone 24 (Shasta / Trinity) of the Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service, 1986) [insert into references: U.S. Fish and Wildlife Service, 1986. Recovery Plan for the Pacific Bald Eagle. U.S. Fish and Wildlife Service, Portland, Oregon. 160 pp.] The most urgent site-specific tasks for Zone 24 identified in the recovery plan are (numbers are given to aid locating tasks in recovery plan):

1.3211 Prohibit logging of known nest trees, perch trees, and winter roost trees;

1.331 Establish buffer zones around nest sites;
1.332 Exclude logging, construction, habitat improvement, and other activities during critical periods of eagle use;
1.334 Prohibit vehicle traffic at sensitive key areas during periods of eagle use;
4.11 Reduce bald eagle mortality associated with shooting and trapping;
4.121 Restrict use of poisons detrimental to eagles in predator and rodent control programs within important bald eagle nesting and wintering habitat;

Zone 24 includes three key areas: Shasta Reservoir, Whiskeytown Reservoir and Trinity Reservoir/Lewiston Reservoir. The habitat management goal for Whiskeytown Reservoir is 3 bald eagle territories, 2 of which were in existence when the plan was written. The Whiskeytown Reservoir key area still requires another territory to meet Recovery Plan goals.

Capable and potential activity areas in the Whiskeytown Reservoir key area have yet to be determined.

5. If present, describe the significant habitat within the watershed that is currently not under Federal ownership.

Significant habitats within the watershed have not been determined.

Amphibians

1. Have any amphibian inventories been done on a project or watershed level?

Inventories have been performed in the Whiskeytown Unit for yellow-legged frog by Dr. Gary Fellers of the National Biological Service. Foothill yellow-legged frogs were found at three sites within the lower Clear Creek drainage within 2 miles of Whiskeytown Dam.

What species does literature suggest may be present in the watershed?

The California Wildlife Habitat Relationships System indicates that the following amphibians may be found within the watershed: ensatina, western spadefoot toad, western toad, Pacific tree frog, California red-legged frog, and foothill yellow-legged frog. While the range of the long toed salamander, Pacific giant salamander, and black salamander includes a small portion of the lower Clear Creek watershed, specific habitat requirements for these species are probably lacking in the watershed.

2. Are sensitive species (including those listed in Table C-3 of the ROD) present or is there a possibility they can occur in the watershed?

No C-3 species are known to occur in the watershed. There is a remote possibility that the Shasta salamander (a C-3 species) could occur in the watershed if limestone outcrops are found in the watershed (Peter Lewendahl, personal communication). No limestone outcrops were identified on either soil or geological maps of the watershed.

Yellow-legged frogs are the only sensitive amphibians known to inhabit the watershed and are discussed within the wildlife section of the watershed analysis.

The tailed frog inhabits colder and higher velocity streams than those found in lower Clear Creek.

The red-legged frog has probably been extirpated from the watershed. The absence of red-legged frog is discussed within the wildlife section of the watershed analysis.

The western spadefoot toad has also declined and may not be found in the watershed. The western spadefoot toad inhabits grasslands with shallow temporary pools such as vernal pools. Vernal pools were not found in this watershed analysis.

4. Are endemic species (species limited to a small geographic area) known to occur in the geographic region of the watershed?

The Shasta salamander is known to occur within 12 miles of the watershed in areas with vegetation types also found in Clear Creek watershed. No populations are known within the Clear Creek watershed. The Shasta salamander is an uncommon endemic of isolated limestone outcrops in the vicinity of Shasta Reservoir.

5. Are exotic species known or suspected to occur in the watershed?

Bullfrogs are abundant in lower Clear Creek and would limit the ability to recover populations of native frogs in the watershed.

Peregrine Falcon

Peregrine falcons have occasionally been sighted near the environmental school.

1. Are any cliffs located within the watershed as determined by topographic maps, aerial photographs and ground/air reconnaissance? (A cliff is defined as a rock wall or outcrop which has a total height of 60 feet or more.)

Although no known cliffs are located within the watershed, no attempt was made to systematically consult the above types of resources. Consultation with personnel from the Whiskeytown unit indicated that no suitable cliffs were known in the Recreation area or watershed.

2. Are any cliffs within the area of watershed analysis historic (pre-1975) or traditional (post-1975) Peregrine falcon aeries?

There are no historic or traditional aeries within the watershed.

3. For past projects near historic cliffs, have mitigation measures for surrounding cliffs been considered, and have surveys to protocol (Page l 1992) been accomplished for at least two years prior to the activities?

Not applicable.

4. For traditional cliffs, have surveys/monitoring been conducted to determine nest site occupancy and reproductive success; and has a draft or final site-specific protection / management plan based on site-specific and Pacific Northwest sub-population nesting ecology been created?

Not applicable.

5. Have the cliffs within the watershed been rated/monitored for peregrine falcon potential/ presence?

No cliffs within the watershed have been rated or monitored. No cliffs have been identified within the watershed

6. If cliffs are un-rated, have surveys to protocol (Page l 1992) been accomplished?

No surveys to protocol have been accomplished.

7. Describe site specific habitat variables within a 3-mile radius of historic and traditional nest sites.

Not applicable.

Gray Wolf and **Grizzly Bear**

These species do not occur in the state or province.

Marbled Murrelet.

The watershed is not within Zone 1 or 2 of the marbled murrelet.

APPENDIX F

TYPICAL EROSION CONTROL PRACTICES SUITABLE FOR THE LOWER CLEAR CREEK WATERSHED

PRACTICE	APPLICATION
Stream Bank Protection, Stream Channel Stabilization	Structural Measures To Stabilize Streams
Stream Corridor Improvement, Channel Vegetation	Bio-Engineering And Establishment Of Channel Vegetation
Diversions, Land Grading, Sediment Basins, Cut Bank Stabilization, Water Bars And Rolling Dips, Out Sloping Of Roads	Mechanical And Structural Measures To Reduce And Retain Erosion And Sediment
Critical Area Planting, Tree And Shrub Planting, Fertilization And Mulching, Road And Landing Removal	Re-Establish And Maintain Vegetation On Eroding Areas
Access Roads, Recreation Land Improvement, Logging Skid Trails And Landings	Practices To Reduce The Erosion Potential Through Proper Planning And Designs

Practices taken from Natural Resources Conservation Service, Redding Field Office Technical Guide, Section IV, Standards and Specifications.

Additional Standards and Specifications are listed in the publication "County of Shasta Erosion and Sediment Control Standards Design Manual." Prepared by John McCullah for the Western Shasta Resource Conservation District, 1992.