Preface

This Watershed Analysis is presented as part of the Aquatic Conservation Strategy adopted for the President's Plan (Record of Decision for Amendments to Forest service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, including Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Related Species).

Watershed analysis provides understanding of the watershed context that is essential to guide project planning and decision making. Watershed analysis is not a decision making process, and a watershed analysis report is not a decision document, a planning document requiring NEPA review, or a regulatory prescriptive document. Watershed analysis contributes, however, to efficiently meeting land management and regulatory requirements at the watershed scale.

This document follows the format provided in Part 2 of *Ecosystems Analysis at the Watershed Scale: Federal Guide for Watershed Analysis - Version 2.2* (August, 1995). This format consists of six steps:

1. Characterization of the watershed
2. Identification of issues and key questions
3. Description of current conditions.
4. Description of reference conditions
5. Synthesis and interpretation of information
6. Recommendations

This document is guided by two levels of analysis:

Core Topics: Provide a broad, comprehensive understanding of the watershed. Core topics are provided in the Federal Guide for Watershed Analysis (8/95) to address basic ecological conditions, processes, and interactions at work in the watershed.

Issues: Focus the analysis on the main management questions to be addressed. Issues are those resource problems, concerns, or other factors upon which the analysis will be focused. Some of these issues prompted initiation of the analysis. Other issues were developed from public input in response to scoping or were identified by the team during the analysis process.

Key analysis questions are developed for each issue in Chapter 2. The information needed to address each key question is presented within the core topic discussions for each chapter.

This is the first iteration of the Squaw Creek Watershed Analysis. The issues, key questions, interpretations and recommendations are a result of current conditions in the watershed and current management direction. Watershed analysis is an iterative process. The content and guidance provided in this document is expected to change with shifting management direction, and with the addition of new information. These changes should be incorporated into the document in subsequent iterations.

Public Involvement: Scoping for this Watershed Analysis occurred in January 1998. A news release appeared in the Intermountain News in January 1998. Letters were sent to about 40 individuals and organizations informing them of the analysis and requesting input to the Watershed Analysis process.

Squaw Creek Watershed Analysis

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CHAPTER 1:

WATERSHED CHARACTERIZATION

The purpose of this chapter is to identify the dominant physical, biological, and human processes or features of the watershed that affect ecosystem functions or conditions. The relationship between these processes and features and those occurring in the river basin or province is established. This chapter provides the watershed context for identifying elements that will be addressed in the analysis.

1.1 Location

The Squaw Creek Watershed is located within the Sacramento Headwaters Sub-Basin. The sub-basin is that portion of the Sacramento River Basin above Shasta Dam. The sub-basin includes the Upper Sacramento, McCloud, and Pit River watersheds (see Map 1 - Vicinity Map). The south end of the Squaw Creek Watershed is approximately 15 miles northeast of Redding, California. The entire watershed is located within Shasta County.

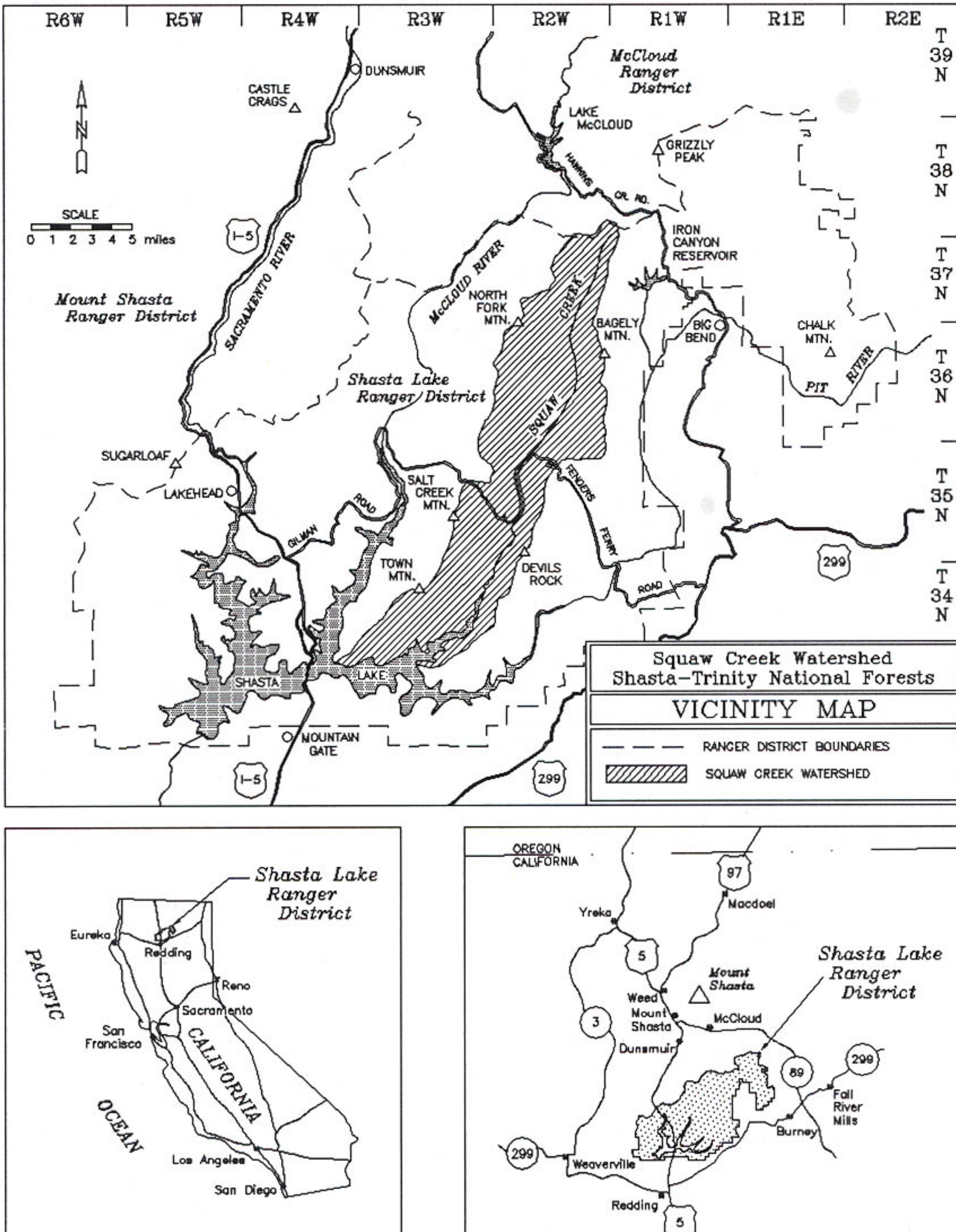
1.2 Relationship to the Sacramento Headwaters Sub-Basin

Many physical, biological and human processes or features span areas much larger than a watershed. To appropriately characterize and analyze specific aspects of the watershed, the watershed should be placed in its logical setting with respect to these larger scales. Squaw Creek is located in the southern portion of the Sacramento Headwaters Basin. Some important characteristics of the sub-basin include the following[1]:

- The sub-basin drains a total area of 6,421 square miles. The majority of the sub-basin area (approximately 78 percent) is drained by the Pit River.
- Prominent physical features in the lower sub-basin include Shasta Dam and Lake, Castle Crags (a granite batholith) and Mount Shasta.
- The terrain in the vicinity of Shasta Lake is generally steep and mountainous.
- All major tributaries to Shasta Lake contain reservoirs in headwaters areas with the exception of Squaw Creek.
- Interstate 5 is the main north/south travel corridor.
- Land ownership in the lower sub-basin is approximately 50/50 between private and Federal.
- Recreation use is high within the Whiskeytown-Shasta-Trinity National Recreation Area and along the Interstate-5 corridor.
- Five Late Successional Reserves and one Managed Late Successional Area are within the sub-basin (see Map 2 - Adjacent Late-Successional Reserves).

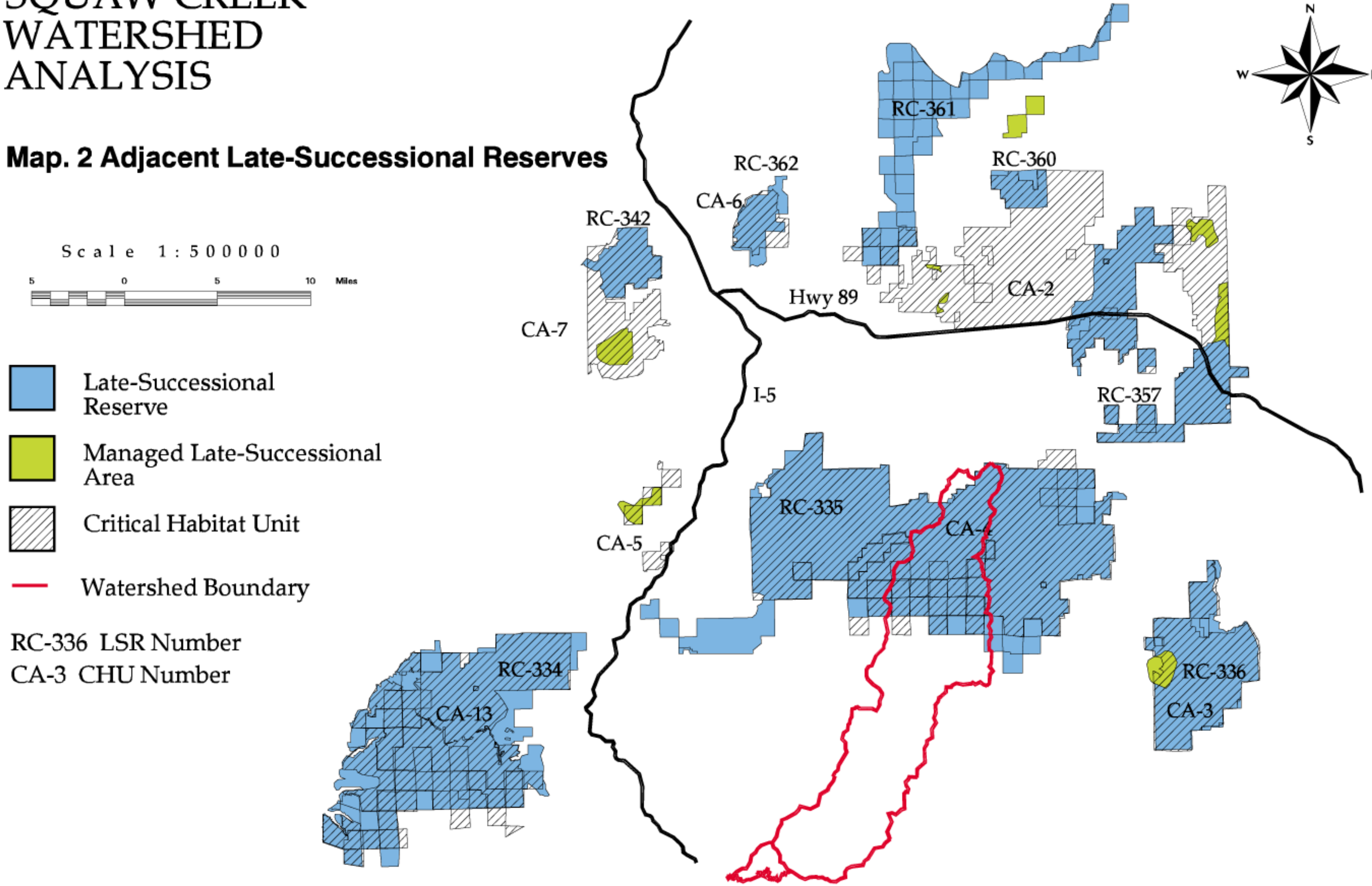
[1] Due to the large size of the basin, basin characteristics are limited to portions of the Sacramento, McCloud, and Pit River drainages located in close proximity to Shasta Lake.

Map 1. Vicinity Map



SQUAW CREEK WATERSHED ANALYSIS

Map. 2 Adjacent Late-Successional Reserves



1.3 Physical, Biological and Human Features and Processes

The ecosystem function and condition in the Squaw Creek Watershed is governed by physical, biological and human features and processes. The dominant features, including major mountains, streams, roads and campgrounds are shown on Map 3 (Dominant Features). The dominant physical, biological and human features and processes in the Squaw Creek Watershed include the following:

1.3.1 Physical Features

- The watershed has a total area of 66,145 acres (103.4 square miles).
- The entire watershed is located in the Klamath Geomorphic Province.
- The terrain is mostly steep and rugged and developed through erosional and mass wasting processes.
- Elevation ranges from 1,065 feet along Shasta Lake to 5,300 feet at Shoeinhorse Mountain.
- The Squaw Creek Arm of Shasta Lake is a part of the watershed (46 miles of reservoir shoreline).
- Limestone outcrops are present throughout the watershed.
- Portions of Salt Creek and its tributaries have been severely impacted by mass wasting activity and peak flow discharges occurring during the 1997 Flood.

1.3.2 Biological Features

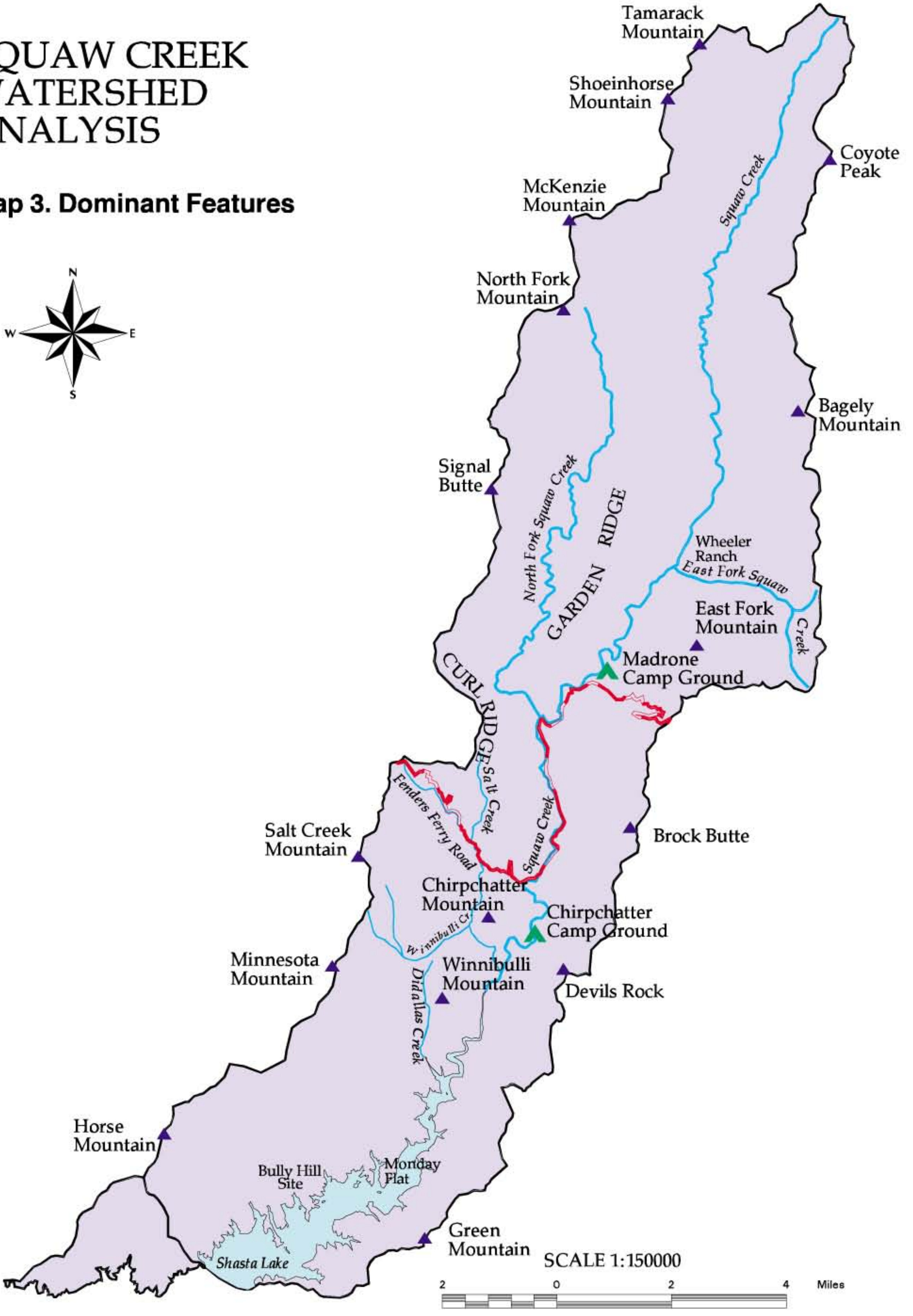
- The northern 1/3 of the watershed has mixed conifer forests on highly productive soils.
- A mix of conifer and hardwoods are found on moderately productive soils in the middle 1/3 of the watershed.
- Mixed conifers with gray pine and canyon live oak are found on moderate to low productive soils at lower elevations in the lower 1/3 of the watershed.
- There are approximately 108 miles of fish bearing streams within the watershed.
- Shasta Salamander are known to inhabit the southern 1/3 of the watershed where limestone outcrops are present.
- Roosevelt Elk are known to inhabit the watershed.
- There is one Peregrine Falcon eyrie within the watershed.
- There are two Bald Eagle Territories within the watershed.
- From the 1920's through the 1950's 33 percent of the watershed was burned to various intensities .
- Prior to the 1900's 75 percent of the watershed was burned to various intensities.
- Fire exclusion in the last fifty years has altered historic fire regimes.
- The lower 1/3 of Squaw Creek is an excellent resident trout fisheries.

1.3.3 Human Features

- All public lands in the watershed are managed by the Shasta-Trinity National Forests.
- Sixty-nine percent of the watershed is located within National Forest.
- The watershed is entirely within Shasta County, California.
- The major private landowner is Sierra Pacific Industries.

SQUAW CREEK WATERSHED ANALYSIS

Map 3. Dominant Features



- A portion of the Whiskeytown-Shasta-Trinity National Recreation Area is within the watershed.
- The Fenders Ferry Road is the main transportation route through the watershed.
- Private residences are scarce and limited to small areas along Squaw Creek.
- A portion of the proposed Hosselkus Research Natural Area is within the watershed.
- Abandoned copper mines in the southern part of the watershed are causing water quality problems in adjacent streams.
- Roads in the watershed are predominately low standard.
- A portion of Late Successional Reserve RC335 is within the watershed.
- There is one Managed Late Successional Area within the watershed.

1.4 Land Allocations, Prescriptions and Management Areas

Management direction for the Squaw Creek Watershed is found in the Shasta-Trinity National Forests Land and Resource Management Plan (LMP) which incorporates direction from the Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. All Federal land within the watershed is managed by the U.S. Forest Service. Federal lands and privately owned lands in the Squaw Creek Watershed are shown on Map 4 (Land Ownership).

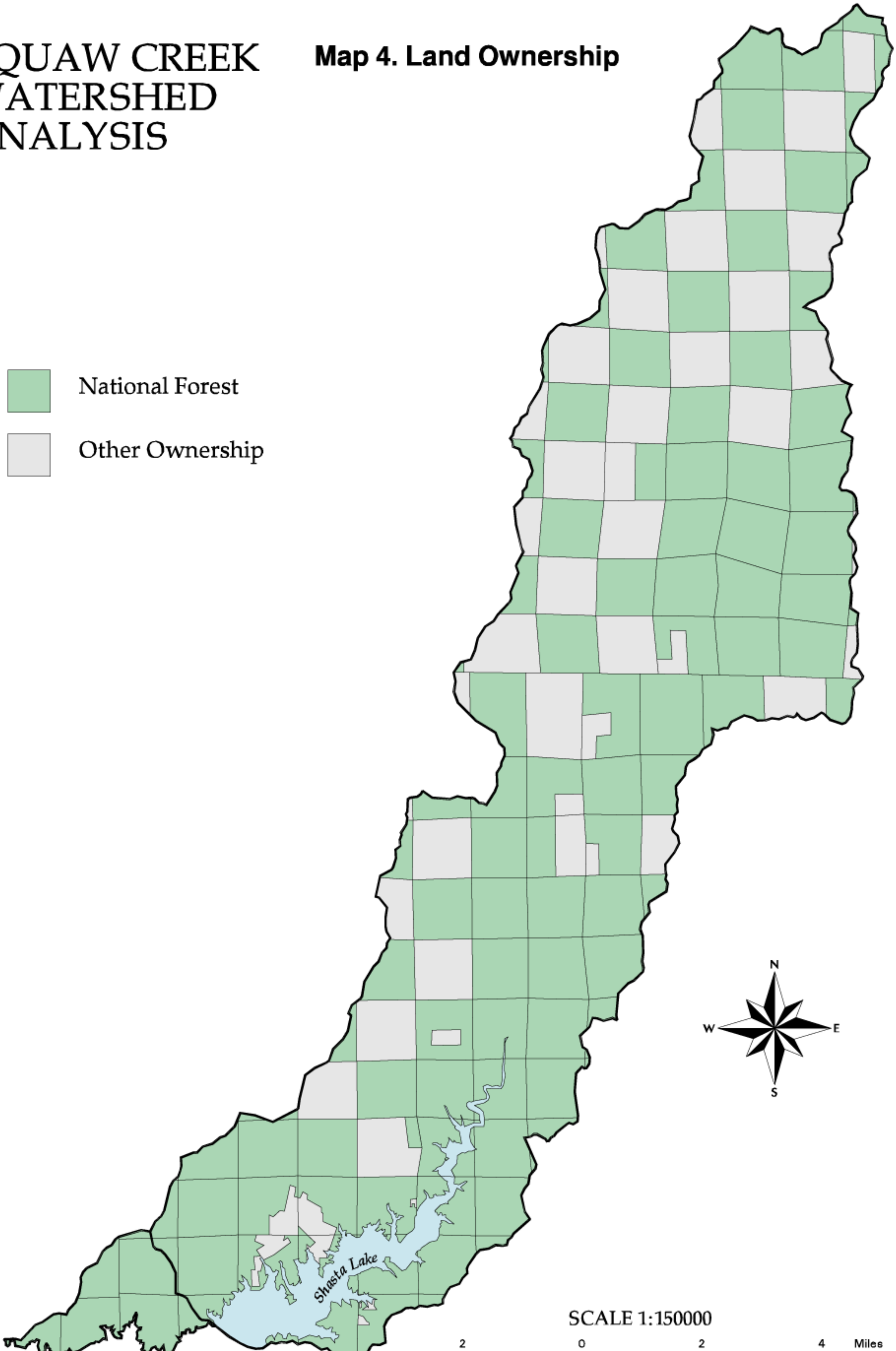
1.4.1 Land Allocations

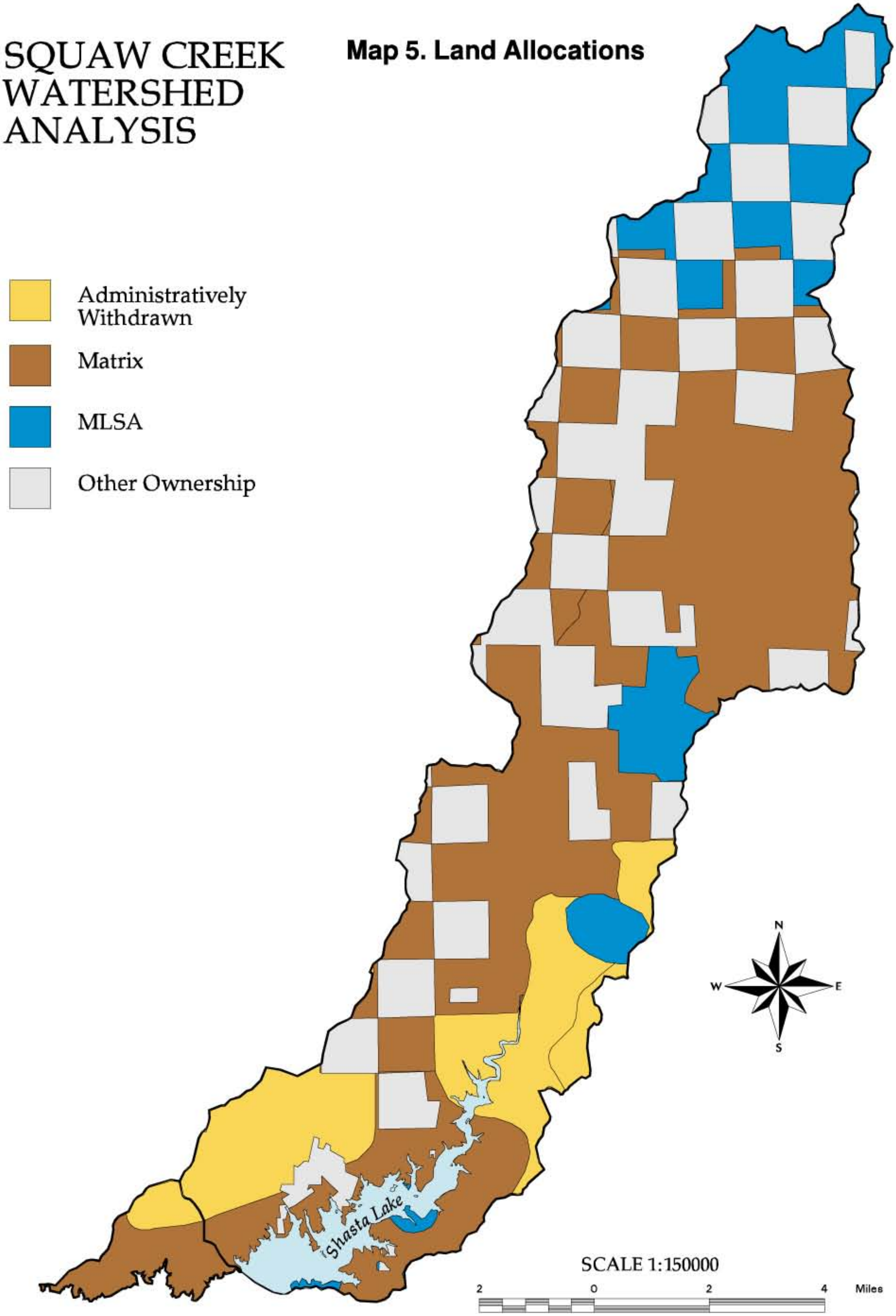
The ROD identifies four land allocations within the Squaw Creek Watershed. They include Late-Successional Reserves, Matrix Lands, Riparian Reserves and Administratively Withdrawn Areas. The locations of Administratively Withdrawn Areas, Matrix Lands and Late-Successional Reserves are shown on Map 5 (Land Allocations). Riparian Reserves include lands associated with stream channels, lakes, reservoirs, springs, wet meadows and unstable areas. Riparian Reserves overlay all other land allocations. Table 1-1 summarizes land allocations and shows the relationship of Riparian Reserves with other allocations. Because Riparian Reserves occur within other land allocations they are shown separately on Map 6 (Riparian Reserves).

Late-Successional Reserves (LSR)	Late-Successional Reserves are areas that have been established to protect and enhance conditions of late-successional and old-growth forest ecosystems and to insure the support of related species, including the northern spotted owl (LMP 4-37). A portion of LSR RC-335 is located within the northern third of the Squaw Creek Watershed (see Map 2 - Adjacent Late-Successional Reserves).
Matrix	The Matrix consists of those federal lands outside the three categories of designated areas listed above (ROD A-5). The Matrix are lands on which most timber harvest will occur and where standards and guidelines are in place to assure for appropriate conservation of ecosystems as well as provide habitat for rare and lesser known species (ROD B-10).

SQUAW CREEK WATERSHED ANALYSIS

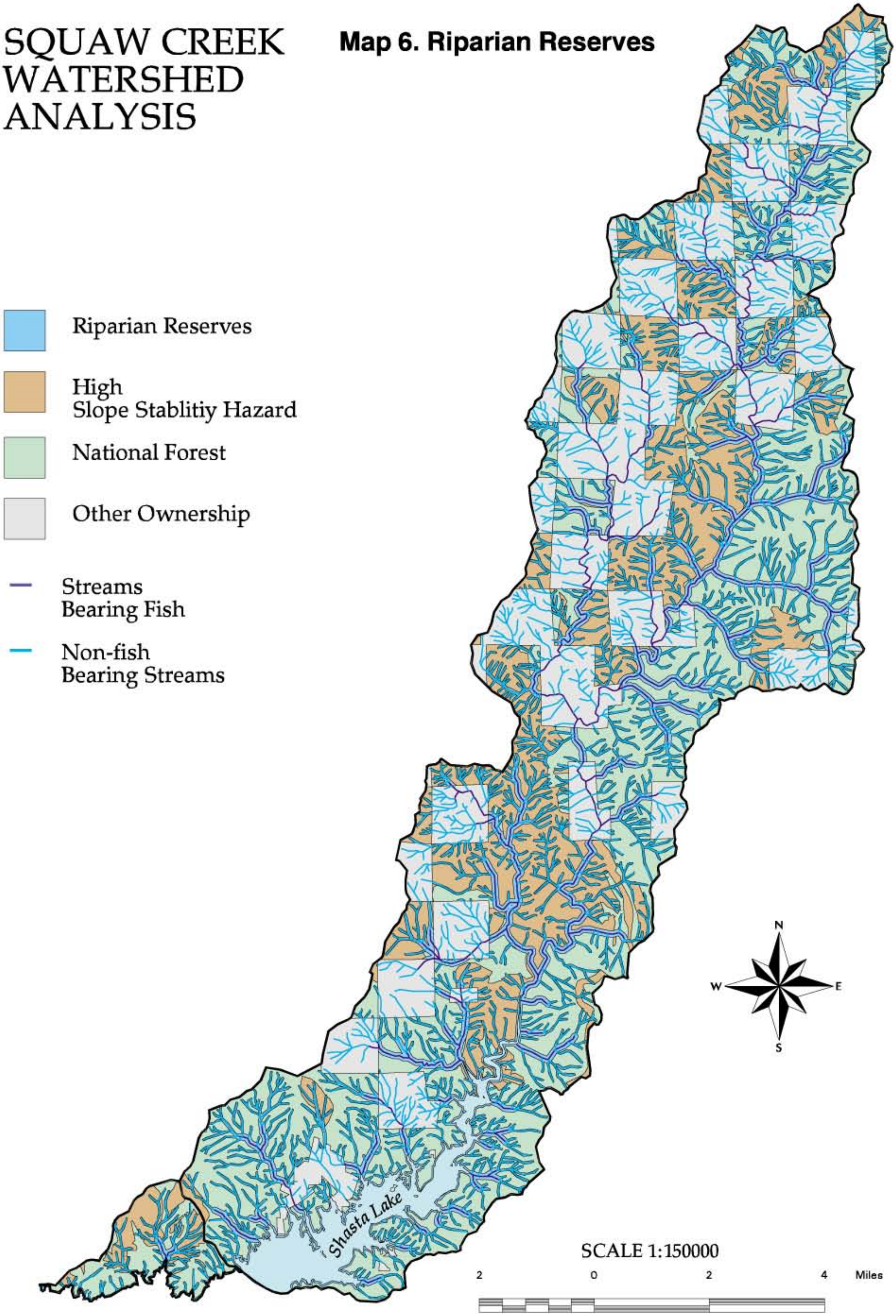
Map 4. Land Ownership




SQUAW CREEK
WATERSHED
ANALYSIS
Map 5. Land Allocations
Administratively Withdrawn
Matrix
MLSA
Other Ownership
N
W
E
S
Shasta Lake
SCALE 1:150000
2
0
2
4
Miles

SQUAW CREEK WATERSHED ANALYSIS

Map 6. Riparian Reserves



Riparian Reserves

Riparian Reserves provide an area along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are important to the terrestrial ecosystems as well, serving, for example, as dispersal habitat for certain terrestrial species (ROD A-5).

Administratively Withdrawn Areas

Administratively Withdrawn Areas are identified in current Forest and District Plans or draft plan preferred alternatives and include recreation and visual areas, back country, and other areas where management emphasis precludes scheduled timber harvest (ROD A-4).

Land Allocation or Management Prescription	Area outside Riparian Reserves		Area within Riparian Reserves		Percent National Forest	Total acres
	%	acres	%	acres	%	acres
Late-Successional Reserves						
Rx7F T&E Species (Peregrine Falcon)	65.24	518	34.76	276	1.73	794
Rx7E T&E Species (Bald Eagle)	55.24	116	44.76	94	0.46	210
Rx7L Late-Successional Reserve	64.82	3271	35.18	1775	11.00	5046
Rx7M MLSR	65.26	1086	34.74	578	3.63	1664
Total Late-Successional Reserve	64.70	4991	35.30	2723	16.82	7714
Administratively Withdrawn Areas						
Rx2 Limited Roaded Motorized Recreation	69.74	5249	30.26	2278	16.41	7527
Rx10 Special Area Management	76.45	893	23.54	275	2.55	1168
Rx9 Heritage Resource Mngt.*	*	*	*	*	*	*
Total Administratively Withdrawn	70.64	6142	29.36	2553	18.95	8695
Matrix						
Rx6 Roaded Recreation	65.41	6268	34.59	3314	20.89	9582
Rx3 Wildlife Habitat Management	61.59	3553	38.41	2216	12.58	5769
Rx8 Commercial Wood Products Emphasis	65.78	9286	34.21	4830	30.77	14116
Total Matrix	64.84	19107	35.16	10360	64.23	29467
Total Riparian Reserves**				13336	29.07	
Total All National Forest Land	65.92	30240	34.08	15636	69.36	45876
Total Private Land	NA	NA	NA	NA	30.64	20269
Total Watershed Area					100.00	66145

Table 1-1: Acreage summary by land allocation and management prescription within the Squaw Creek Watershed on National Forest lands.

* The Heritage Resource Management prescription occurs as minor unmapped inclusions within other prescriptions. Actual acreage in the watershed is small and is not displayed in this table.

** Unstable areas are not included within Riparian Reserve totals but are shown on Map 6.

1.4.2 Prescriptions

In addition to the four land allocations identified in the ROD, the LMP identifies eight Management Prescriptions in the Squaw Creek Watershed. These are:

- II - Limited Roaded Motorized Recreation (LMP 4-46)
- III - Roaded Recreation (LMP 4-64)
- VI - Wildlife Habitat Management (LMP 4-66)
- VII - Late-Successional Reserves (LMP 4-43)
- VIII - Commercial Wood Products Emphasis (LMP 4-67)
- IX - Riparian Management (LMP 4-59) *
- X - Special Area Management (LMP 4-49)
- XI - Heritage Resource Management (LMP 4-50) **

* *mapped separately due to complexity. See Map 6 - Riparian Reserves.*
** *unmapped - occurs as minor inclusions within other prescriptions*

Management prescriptions for the Squaw Creek Watershed are shown on Map 7 (Management Areas and Prescriptions).

1.4.3 Management Areas

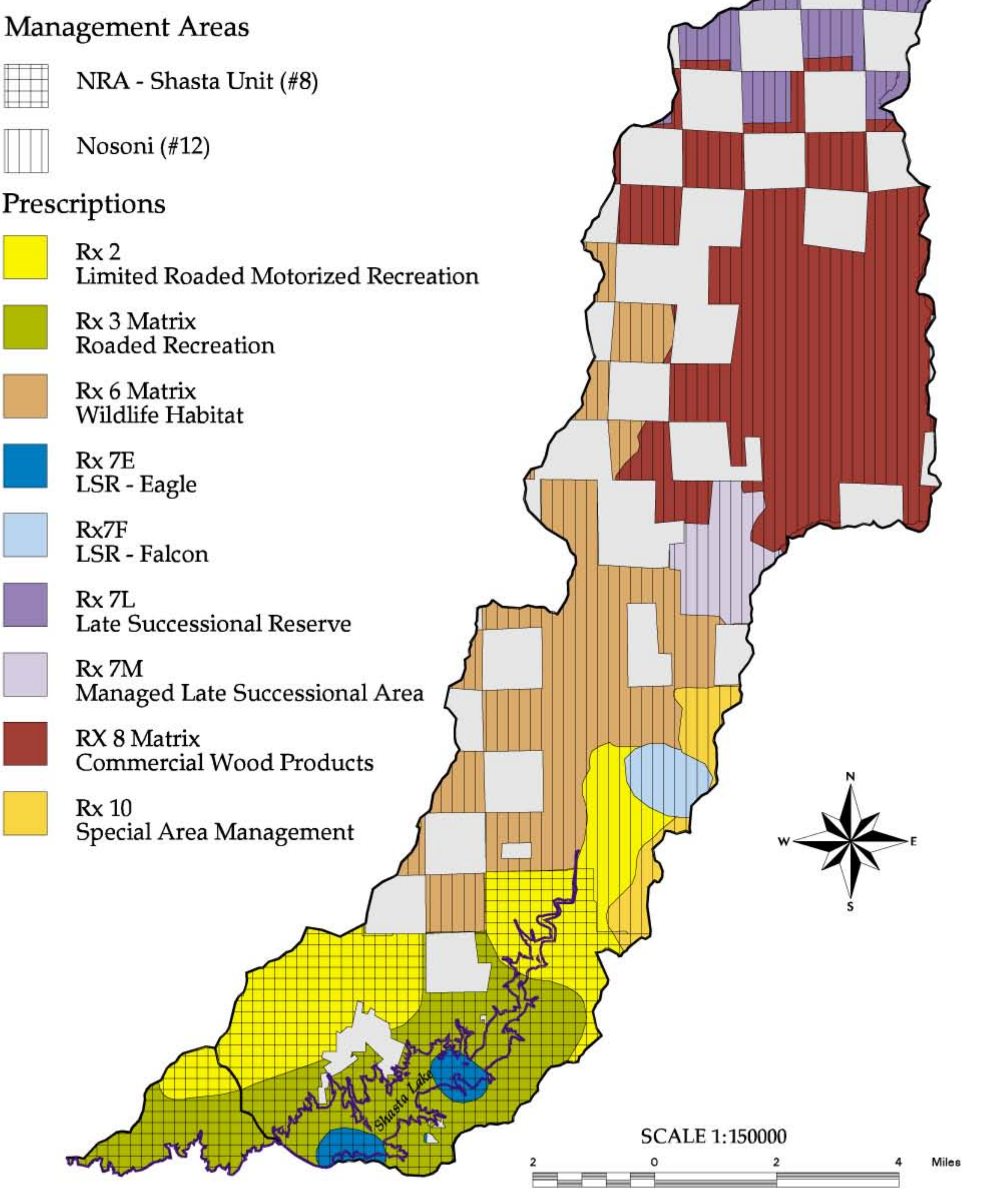
Supplemental management direction for specific units of land is provided in the LMP under Management Area Direction (LMP - Chapter 4 - Section G). The LMP identifies two Management Areas in the Squaw Creek Watershed. They are:

Nosoni (#12) (LMP 4-129)
NRA - Shasta Unit (#8) (LMP 4-111)

Management Areas for the Squaw Creek Watershed are shown on Map 7 (Management Areas and Prescriptions).

SQUAW CREEK WATERSHED ANALYSIS

Map 7. Management Areas and Prescriptions



CHAPTER 2:

ISSUES AND KEY QUESTIONS

The purpose of this chapter is to focus the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values, or resource conditions in the watershed. Issues and key questions for the Squaw Creek Watershed were identified by the line officer responsible for the watershed and the Squaw Creek Watershed Analysis Interdisciplinary Team. The issues and key questions described in this chapter represent specific concerns unique to the Squaw Creek Watershed.

All information needed to address the issues and key questions is presented within the context of the watershed analysis core topics. The core topics and core questions that accompany each topic address the basic ecological conditions, processes, and interactions (elements) at work in the watershed. Core topics and core questions are presented in part 2 of *Ecosystem Analysis at the Watershed Scale, Federal Guide for Watershed Analysis, Version 2.2* (August 1995). Core topics that should be covered in all watershed analyses include erosion processes, hydrology, vegetation, stream channels, water quality, species and habitats and human uses.

- Human Uses
- Vegetation
- Species and Habitats
- Erosion Processes
- Hydrology
- Stream Channels
- Water Quality

All issues and key questions will be discussed in Chapters 3 and 4 within the context of the core topics described above. The major issues identified in this analysis are:

- Threatened, Endangered and Sensitive Species (TES) Habitat Management
- Management of Pure and Mixed Black Oak Stands
- Fire and Fuels Management
- Erosion and Mass Wasting Processes
- Aquatic Habitats

2.1 Issue: TES Species Habitat Management

Old growth habitat within the watershed is scarce. True old growth stands occur over less than 10 percent of the total watershed area. Old growth stands are scarce in both the LSR to the north and in the MLSA in the center of the watershed. There are nine known Northern Spotted Owl (NSO) activity centers in the watershed. No breeding pairs are known to exist. There are also two bald eagle territories on the Squaw Arm of Shasta Lake. Habitat is inadequate to support these species over the long term. Habitat is not well-distributed and dispersal corridors are not present across the landscape. A peregrine falcon eyrie exists near Low Pass Creek. Human activity is believed to have resulted in abandonment of the eyrie. Rock climbing is popular in the limestone near the eyrie. Shasta salamanders are present in the southern third of the watershed near limestone outcrops. Surveys have not yet been conducted to protocol and may impact implementation of identified project opportunities. Many species use riparian corridors to travel across the landscape. The distribution and condition of riparian corridors needs to be assessed in order to determine whether they are functioning as travel corridors.

Key Questions:

1. What TES species inhabit the watershed?

2. Does the existing late-successional habitat in the watershed exceed 15 percent for public lands? What is the percentage of old growth habitat in the watershed on public lands?

3. How could management activities impact TES species?

4. Are there adequate travel corridors for TES species in the watershed?

5. Are riparian reserve widths adequate for riparian travel corridors?

2.2 Issue: Management of Pure and Mixed Black Oak Stands

Portions of this watershed contains some of the largest and last remaining pure/mixed black oak stands in the Shasta Lake area. Many game species are dependent upon hardwoods for nesting and feeding. Prescription 8 lands within the watershed contain the majority of the pure/mixed black oak stands. The potential for commercial harvest of oak stands has never been thoroughly evaluated. Prescribed burning in combination with thinning could enhance wildlife habitats and reduce fuels while provide some commercial output from Prescription 8 lands.

Key Questions:

1. How can the landscape be managed to benefit elk, deer, bear and other oak-dependent species?

2. Is the current land allocation (Prescription 8 - Commercial wood product emphasis) appropriate for management of pure and mixed black oak stands?

2.3 Issue: Fire and Fuels Management

There is historical evidence of large catastrophic wildfires occurring within and adjacent to the Squaw Creek Watershed. Over the past 50 years effective fire suppression has largely excluded fires from burning within the watershed. Dense understory vegetation has developed and accumulations of dead and down fuels have created fuel profiles that put resources within the watershed at risk to loss from fire.

Key Questions:

1. What are the current and historic fire regimes in the watershed?
2. What is the potential for catastrophic wildfire in the watershed ?
3. What resources in the watershed are currently at risk to catastrophic fire?
4. Under current management, what are the future trends for fire in the watershed?
5. What is the desired role of fire in the watershed?
6. How can fire be incorporated as an ecological process?

2.4 Issue: Erosion and Mass Wasting Processes

Much of the current topography of the watershed has been formed by erosion processes. These processes have and will continue to play a major role in shaping the landscape of the watershed. The ability of erosion and mass wasting processes to alter hillslope and channel morphologies was illustrated during the 1997 Flood when multiple debris flows reshaped hillslope topography and scoured stream channels. The full extent of flood impacts in the watershed are still unknown. There is a need to determine the distribution, causes and impacts associated with erosion and mass wasting processes in the watershed.

Key Questions:

1. What erosion and mass wasting processes are dominant within the watershed?
2. Where are these features located?
3. What is the slope stability hazard associated with these features?
4. What are the natural and human causes of changes between historical and current erosion processes in the watershed?
5. What are the influences and relationships between erosion processes and other ecosystem processes?

2.5 Issue: Aquatic Habitats

The storm of January 1997 resulted in an increase in accumulated sediments within lower Squaw Creek and some tributaries. This has resulted in significant changes to stream channels and the associated fish and riparian habitats.

Key Questions:

1. How have stream channel processes and functions that govern the formation of fish habitat been affected by the recent increase in bedload?

2. How have aquatic and riparian dependent species and their habitats been affected by the recent channel changes?

3. How will future floods of different magnitudes affect the distribution of bedload and fish habitat?

CHAPTER 3:

CURRENT CONDITIONS

The purpose of this chapter is to develop information relevant to the issues and key questions identified in Chapter 2. The current range, distribution, and condition of the relevant ecosystem elements are discussed.

3.1 Human Uses

The Squaw Creek Watershed has an extensive history of human uses. The overall amount of human use occurring in the watershed today is comparable to that which occurred during the early 1900's, however the types of human uses have changed. Evidence of earlier human activities is scattered throughout the watershed at sites like Squaw Creek Guard Station, Bully Hill Mine and Wheeler Ranch. The past 100 years have also seen changes in the types of land-use activities occurring in the watershed. Grazing and mining activities have given way to boating, camping and other recreational pursuits. The current human uses occurring in the Squaw Creek Watershed include timber harvest, off highway vehicle use, fishing, hunting, camping, boating, rock climbing and spelunking. The scope of these activities in the watershed is described below.

3.1.1 Recreation

The amount of recreation activity in the Squaw Creek Watershed at present has increased from that of the early 1900's due to the presence of Shasta Lake. The watershed is lightly roaded, particularly on public lands, and difficult to access. Due to these two factors, recreation activities in the watershed above Shasta Lake are limited. The two dominant recreation activities are hunting and fishing. These activities peak in April during turkey season, the opening week of the fishing season and in the fall during deer season.

The Forest Service manages two campgrounds within the watershed. Both are located adjacent to Squaw Creek and provide a high quality recreation experience for those seeking refuge from populated areas. Madrone Campground is the only developed campground in the watershed. Use figures for Madrone Campground were calculated to be 2720 recreation visitor days (RVDs) in 1997 and 3092 RVDs in 1996. Chirpchatter Campground is managed as a dispersed recreation site. The Chirpchatter Campground is in a degraded condition do to past floods and encroachment of non-native vegetation. Both campgrounds are small and can only accommodate limited parties (approximately 5-10 groups each).

A possible future opportunity for overnight use in the watershed involves a plan to renovate the Squaw Creek Guard Station located at the Fenders Ferry Bridge on the east bank of Squaw Creek. The station has been abandoned for 13 years. During this period the station has been repeatedly vandalized and has fallen into a state of disrepair. Renovation plans would involve the restoration of the main building (Squaw Creek Station) and the obliteration of the Squaw Creek Barracks. The renovation plans have not been completed due to lack of available restoration funds.

The majority of recreation use in the watershed is focused in the Squaw Creek Arm of Shasta Lake. Fishing and boating are the two major recreational activities. During the summer months considerable overnight camping occurs throughout the Squaw Creek Arm. Some camping also occurs on areas of flat ground located adjacent to Shasta Lake. Areas used by boaters for camping include Monday Flat, French Gulch and Bully Hill. Lower Squaw Creek is occasionally boated by kayakers.

The Forest Service administers special use permits for 8 recreation residences located in the vicinity of Didallas Creek (T34N, R3W, Section 1). All of these residences are located on the perimeter of Shasta Lake and are only accessible by boat.

Off road vehicle use occurs during the spring, summer and fall throughout the watershed. The Green's Creek Trail, accessed via Bully Hill is used by hikers and mountain bikers. Road 36N40, locally known as the Garden Ridge Road, has recently been designated as a managed OHV trail. The trail will be signed during the 1999 field season. A segment of the California Backcountry Discovery Trail (comparable to the Pacific Crest Trail for hikers) may also be located in the watershed. The current proposal would route this OHV trail through the watershed on the Roads 34N17 (Fender's Ferry Road) and 35N46 (Bagley Jeep Trail). At the time that this document was prepared the location of the trail had not been finalized.

Spelunking and rock climbing are popular uses within the Hosselkus Research Natural Area. The RNA is located in the vicinity of the Devils Rock and is known for its limestone outcrops, fossils and caves.

3.1.2 Transportation System

The Squaw Creek Watershed has approximately 157 miles of road (see Map 8: Transportation System). Most roads were originally constructed in support of mining and timber harvest activities and are of relatively low standard. Some road construction is still occurring in conjunction with timber harvest on private land within the watershed (example: private parcels in sections 8, 16, & 17, T35N, R2W, near Smith, Ash, and Squaw Creeks, January 1998). Currently, rights-of-way or cost share agreements exist with Sierra Pacific Industries on approximately 15 miles or roughly 10 percent of the road system within the watershed[1].

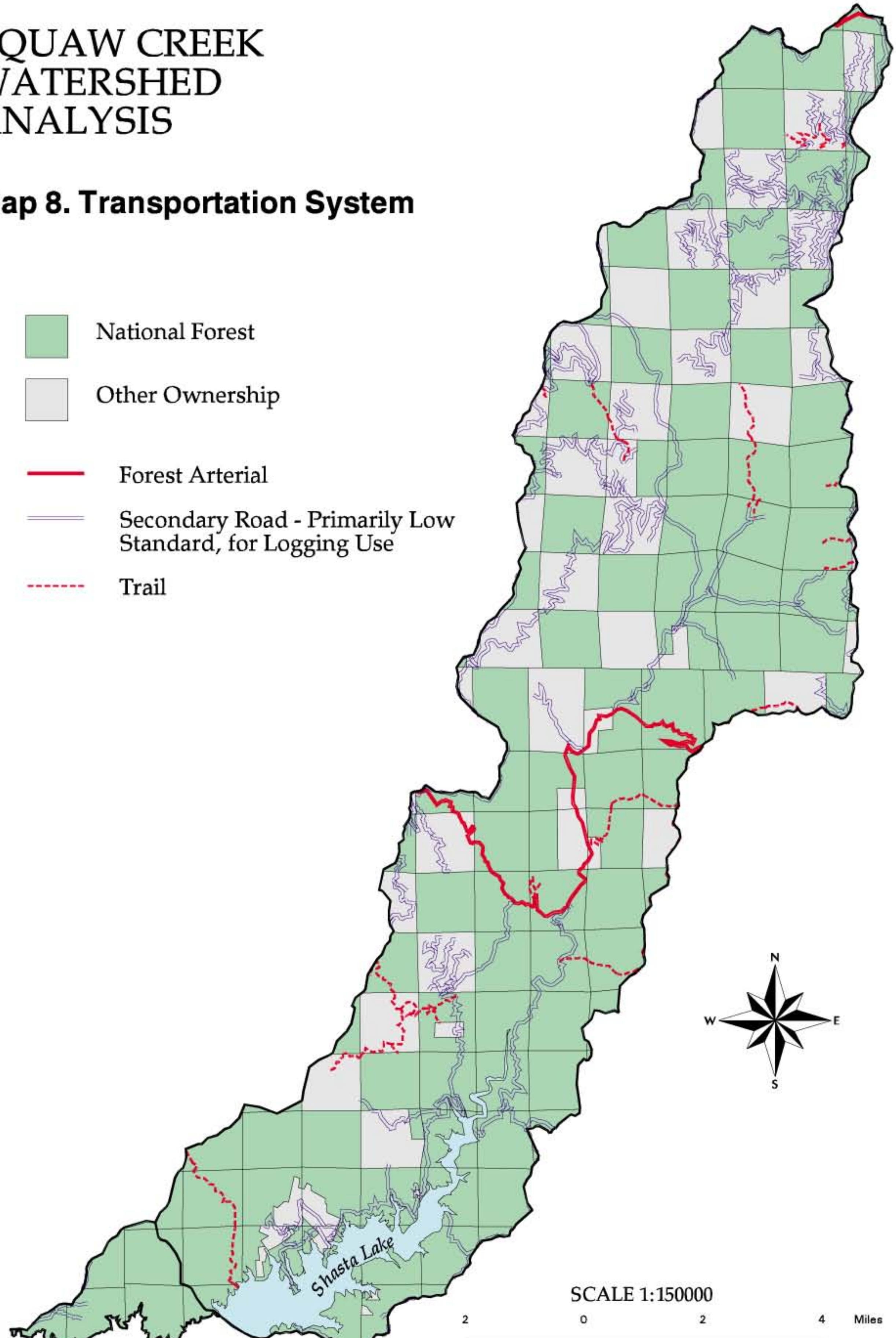
The Fender Ferry Road 34N17 (FA 27) is the primary road traversing the watershed and connects the Sacramento, McCloud, and Pit River drainages north of Shasta Lake. Because of its relatively low elevation it is usually open year-round, although the heaviest use occurs during the spring, summer and fall season when commercial and public use is at its peak. Most of this road is composed of native surface, although there are several rocked and hard-surface segments. Several summer and year-round residences along Squaw Creek are accessed by this road system.

Roads in this watershed also access a variety of seasonal recreation opportunities such as hunting, fishing, camping and off-highway vehicle use. The Madrone and Chirpchatter Campgrounds are two developed sites along Squaw Creek. The Squaw Creek Road 35N07, which crosses Hoffmeister, Crooks, and the East Fork of Squaw Creek north of Madrone Campground, accesses a popular dispersed camping, fishing and hunting area.

[1] ROW information should be verified with a current ROW Atlas.

SQUAW CREEK WATERSHED ANALYSIS

Map 8. Transportation System



The road system includes several engineered bridges, including those over Squaw and Salt Creeks. There are also several "flatcar" bridges over various streams on private land which provide timber haul and tie-through routes, but which are not up to Forest Service safety standards (cost share agreements do not include these structures).

In recent years, the Fender Ferry Road and related transportation system has required increased maintenance and repair due to higher than normal precipitation and storm damage, resulting in damaged drainage crossings, multiple slumps and slides, and erosion along segments of this road system. Some problems are road-related or exacerbated, but many are the result of ongoing natural processes.

In 1996 several road restoration projects were completed in the watershed, primarily on the Bully Hill, Brock Mountain, Monday Flat, and Squaw Creek roads, including culvert cleaning and replacement, slide repair, rip-rap and spot-rocking. These were intended to alleviate road erosion and reduce sedimentation. Unfortunately, the January 1997 storm destroyed many of these improvements. Although some temporary repairs have been made and the roads are passable, as of January 1999 there was still significant road damage along the Fender Ferry Road and the Bully Hill Mine 35N03 road, particularly within the Salt Creek drainage. Some roads in the north end of the watershed tributary to the Van Sicklin and Iron Canyon systems also are in poor condition due to past winter storm damage.

Current road density in the watershed is approximately 1.6 miles per square mile of land. The road density on private timberland is generally higher than that on National Forest land due to more intensive past management practices in the Salt Creek Mountain, Garden Ridge (N. Fork Squaw Creek), and the Little Bagley Mountain/Coyote Peak areas. The "checkerboard" property ownership limits road management options to some extent.

While some physical road closure methods have been used in the past on both public and private land, results have been mixed. The remote nature of the area has resulted in high risk of vandalism and reduced maintenance of signs, gates, and barricades.

3.1.3 Timber Management

The Squaw Creek Watershed contains approximately 24,846 acres of commercial forest lands (CFL) on National Forest System lands. Commercial forest lands are defined as those lands having commercially viable conifer or mixed conifer stands in any forest land allocation. Commercial forest lands account for 51 percent of the public lands within the watershed. Approximately 2,370 acres of commercial forest lands (9.5 percent of the CFL) are within prescriptions that allow intensive timber management (Matrix -Prescriptions 3, 6 and 8).

Intensive timber management has been concentrated on the private lands within the watershed. No information is available concerning the volume of timber removed or types of silvicultural prescriptions used on the private lands. The road system shown on Map 14 (Transportation) provides an indication of where timber harvest activities have been focused, although helicopter logging has also occurred independent of road systems. These areas include private lands in the upper third of the watershed and in the southwestern portion of the watershed in the vicinity of Salt Mountain.

Seral Stage	Description	Acres	Percent of CFL
4c older	Large tree, > 70% canopy closure	1071	4.3%
4b-c	Large tree, 40-70% or > 70% canopy closure	4525	18.2%
4a	Large tree, 10-40% canopy closure	9880	39.8%
3b-c	Pole/medium tree, 40-70% or > 70% canopy closure	1408	5.7%
3a	Pole/medium tree, 10-40% canopy closure	7786	31.4%
Plantations	Small tree	176	0.6%
Total		24846	100%

Table 3-1: Seral Stage Distribution for commercial forest lands (National Forest lands only).

Land Type	Acres	Percent of NFSL
Shrublands	2,950 acres	6% of NFSL
Hardwoods	16,812 acres	36% of NFSL
Digger/Knobcone	861 acres	2% of NFSL
Water	2448 acres	5% of NFSL

Table 3-2: Acres and types of non-commercial forest lands.

Vegetation Class	Description	Acres	Percent of CFL
P	Plantations	176	0%
2G	6-12 feet poles, crown cover ≥ 70%	21	0%
3G	13-24 feet, small to medium timber, crown cover ≥ 70%	285	1%
3N	13-24 feet, small to medium timber, crown cover 40-69%	2490	10%
3P	13-24 feet, small to medium timber, crown cover 20–39%	8382	34%
3S	13-24 feet, small to medium timber, crown cover < 20%	7190	29%
4G	25-40 feet, large saw timber, crown cover ≥ 70 %	1071	4%
4N	25-40 feet, large saw timber, crown cover 40-69%	3138	13%
4P	25-40 feet, large saw timber, crown cover 20-39%	942	4%
4S	25-40 feet, large saw timber, crown cover < 20%	1151	5%

Table 3-3: Vegetation Size/Density Distribution, CFL (National Forest lands only).
(S=sparse, P=poor, N=normal, G=good)

<u>Forest Plan Standard and Guidelines</u>: Timber management activities on National Forest lands adhere to the following standards and guidelines:

- Retain 15% old-growth and late successional forests: Over 62% of the commercial forest lands in the watershed are in seral stage 4, which is mature and older forests meeting the definition of late successional or old-growth. Just over 15% of the seral stage 4 forests are within prescriptions that preclude or limit timber management. Retaining the best late successional forests would mean retaining all 4G, 1071 acres, and 2,652 acres of size class 4N.

- Retain snags at published guidelines or a minimum of 1.5 per acre greater than 15 inches DBH and 20 feet in height: There is no information on snag densities in the watershed.

- Retain coarse woody debris in amounts ranging from 5 to 10 tons per acre on matrix lands with slopes less than 40 percent. There is no information on coarse woody debris within the watershed.

Limited timber management has occurred on the National Forest System lands within this watershed. From 1990 to present, no volume of timber has been removed from this watershed. Between 1970 and 89 approximately 1.0 million board feet were removed from this watershed. An unknown quantity of fuelwood is removed from this area annually.

Timber harvest on public lands has been very limited due to problems associated with limited timber resources and prohibitive road construction costs. During the 1980's the Forest Service made several attempts at planning timber sales. These attempts were focused on what was referred to as the 'Middle Management Area'. This area encompassed the Hoffmeister, Crooks, East Fork, Modin Creek, Shake Creek, and North Fork drainages. Sales that were planned focused on commercial removal of conifers through green tree retention. These sales included the Hoofox (198_), Hoofox 2 (198_), Hoffmeister (198_) and Hoffmeister 2 (1992) sales. These sales were focused on the Bills, East Fork, Hoffmeister and Crooks Creek drainages. All of these sales were dropped from consideration because the cost of road construction exceeded the value of the timber. The only commercially viable timber in the watershed was confined mainly to the streamside riparian areas and even this timber had a cull factor of 50-80 percent (Ron Howard, personal communication). The possibility of commercial oak harvest was also investigated, but the idea was dismissed based on economic considerations.

Timber harvest activities on public land fared better in the northern third of the watershed (now LSR). The Prospect and Little Bagley sales were both sold in the late 1980's. Other sales planned in the vicinity of Happy Hunting Grounds and McKenzie Mountain were economically viable but were dropped following developments preceding the Northwest Forest Plan in 1991.

With the implementation of the Shasta-Trinity National Forests Land Management Plan, new management prescriptions for the Squaw Creek Watershed changed the focus of management activities. Questions remain about why the area formerly known as the Middle Squaw Creek Management area was designated as Matrix Prescription 8 (commercial wood products emphasis) when the area is composed mainly of pure and mixed black oak stands.

3.1.4 Other Uses

The majority of private lands in the watershed are managed by Sierra Pacific Industries for timber production. Numerous private parcels, some of which contain private residences, occur along the Fenders Ferry Road. About half of these residences are occupied seasonally while the other half are used as summer homes.

An undetermined amount of illegal activities also occur in the Squaw Creek Watershed. The warm climate, availability of water and the remoteness of the watershed make it an ideal location for the cultivation of marijuana. During the 1980's a considerable amount of marijuana cultivation was occurring in the watershed. Today marijuana cultivation is still occurring but at lower intensities than the 1980's.

Poaching of wildlife is another illegal activity that is believed to be common place in the watershed. Very little information is available concerning the amount of poaching that occurs and the effects of poaching on wildlife. Due to the remoteness of the watershed and the lack of active Forest Service management, law enforcement presence in the watershed is minimal and little is known about the extent of illegal activities, particularly poaching.

3.2 Vegetation

3.2.1 Overview of Existing Vegetation

The vegetation types and patterns found in the Squaw Creek Watershed today are the result of an active fire history, climate, geology, soils and human activities. Summers are hot, and winters are wet with most precipitation falling in the form of rain. Generally, snow falls only at the higher elevations.

Vegetation types and vegetation size and density in the Squaw Creek Watershed are shown in Maps 9 and 10, respectively. The information provided on these maps should be used with caution since all of the data for vegetation types, size and density was collected in 1975. The following vegetation descriptions were developed from the 1994 Ecological Unit Inventory and provide a more current description of the vegetation types found in the watershed. The vegetation types on Maps 9 and 10 have been cross-referenced to the Ecological Unit Inventory vegetation types, and are in parenthesis next to the Ecological Unit Inventory vegetation type.

Major Vegetation Types in the Squaw Creek Watershed

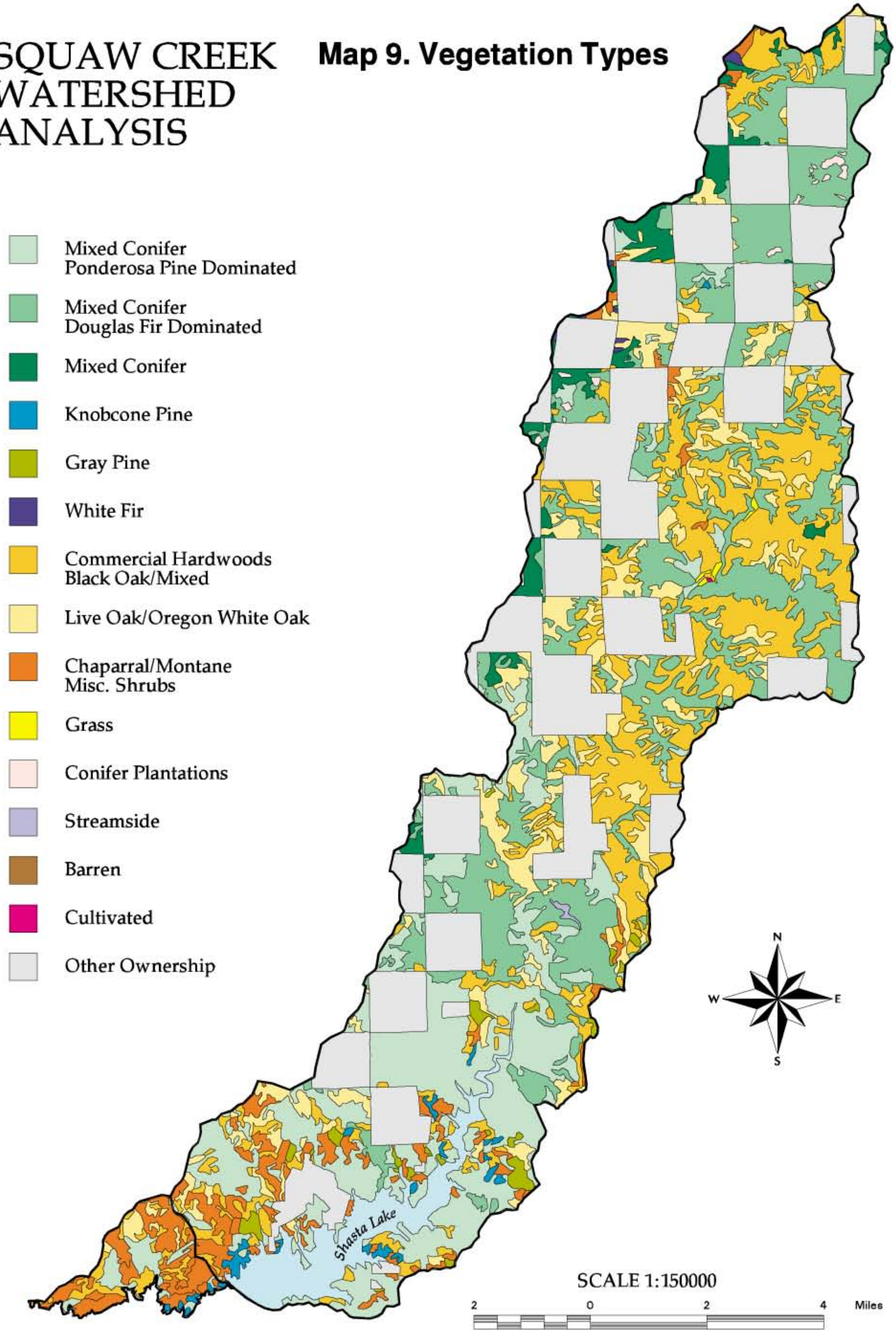
Mixed Conifer - Douglas Fir	Black Oak
Mixed Conifer - Ponderosa Pine	Canyon Live Oak
Mixed Conifer	Low Montane Mixed Chaparral
Gray Pine	Montane Mixed Chaparral
Knobcone Pine	Shrub-Size Hardwoods
Douglas Fir	Dry Meadow
White Fir	

Watershed elevations range from 1065 feet near Shasta Lake in the south end of the watershed to 5300 feet on Shoeinhorse Mountain on the north end of the watershed. Because of the change in elevation from north to south, there are noticeable changes in the vegetation types. The upper third of the assessment area is dominated by Douglas fir mixed conifer with black oak and/or big leaf maple on better soils and canyon live oak on harsher sites. Montane shrubs such as greenleaf manzanita, huckleberry oak, tanoak, bitter cherry and small amounts of chinquapin are found on ridge tops and rocky slopes that have been burned many times. They are also common associates in conifer stands. The only white fir stands in the watershed are found at the far north end between North Fork Mountain, and the Shoeinhorse Mountain/Tamarack Mountain area. In the middle third, ponderosa pine becomes more abundant. Many areas consist of black oak stands with scattered conifers in the overstory. Shrubs are generally dense, and in some areas cover whole hillsides. Common shrubs include the low montane mixed chaparral types such as brewers oak, buck brush, deer brush, sticky whiteleaf manzanita, snow drop bush, California buckeye, mountain mahogany and poison oak.

Riparian areas in the upper two thirds of the watershed tend to be Douglas fir dominated mixed conifer with assorted hardwoods such as big leaf maple, alder, mountain ash, madrone, canyon live oak and black oak. Stream terraces which were once homesteads are now meadows and important habitat for elk. Ponderosa pine, gray pine and knobcone pine are more prevalent in

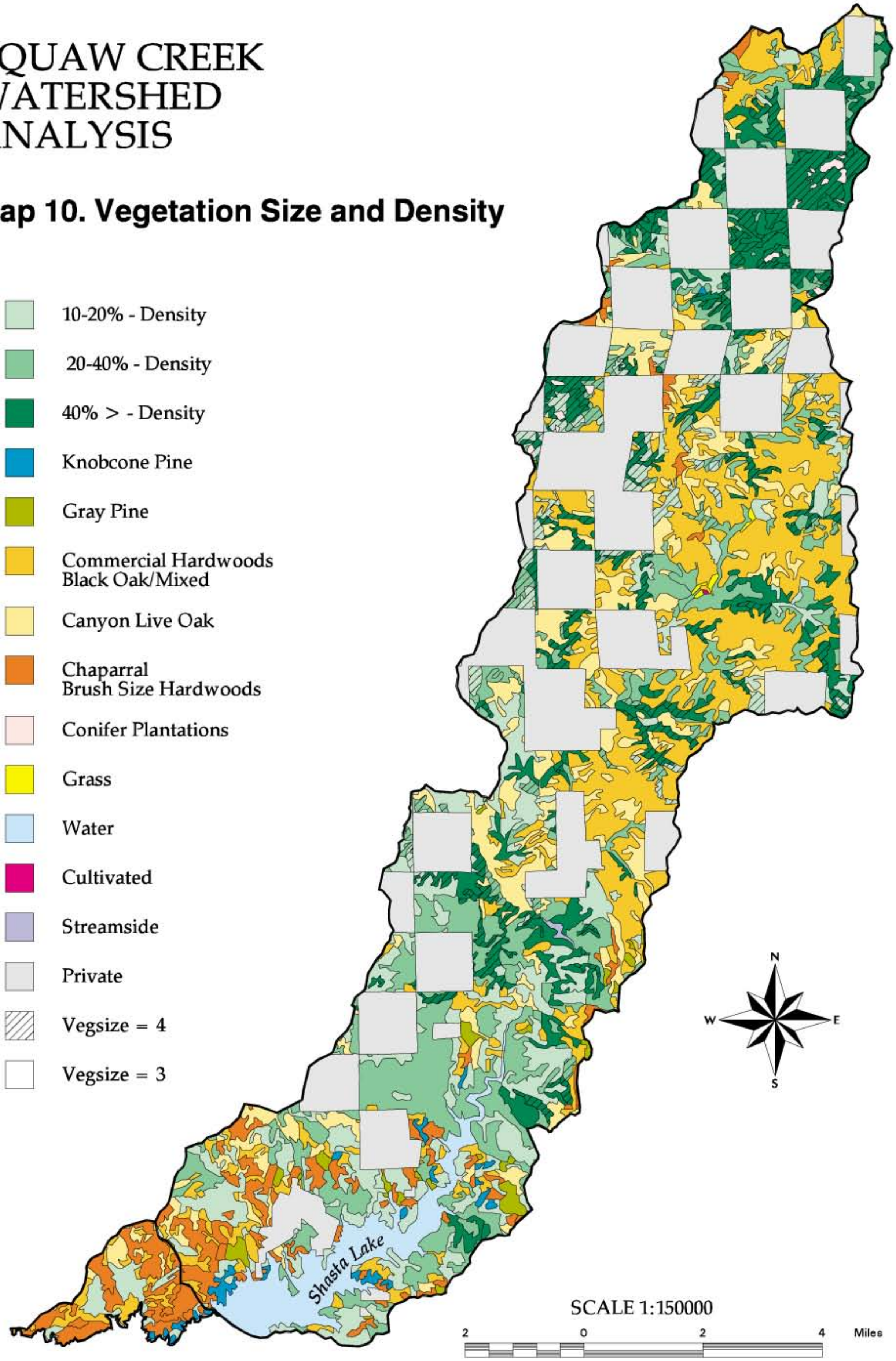
SQUAW CREEK WATERSHED ANALYSIS

Map 9. Vegetation Types



SQUAW CREEK WATERSHED ANALYSIS

Map 10. Vegetation Size and Density



the southern third of the watershed. Gray pine and canyon live oak are important associates in areas with limestone outcrops. Riparian vegetation was scoured from many reaches during the New Years flood in 1997, however it seems to be revegetating riparian areas very quickly. Riparian areas are very diverse and lush. Important riparian associates are elk clover, miners dogwood, California hazel, spice bush, ninebark, western azalea, willows, mock orange, vine maple, wild grape, goats beard, poison oak, Himalayan blackberry, greenbrier, and Indian rhubarb (EUI Survey, 1994; personal observation, Squaw Creek EUI Species List).

Most oaks and conifers are in the early mature (30-60 years) and mid-mature (60-120 years) seral stages. Generally, most trees fall into the 50 to 80 year old category. Old growth is seen in the form of remnant douglas firs, ponderosa pines, sugar pines, black oaks and canyon live oaks scattered along ridge tops, and areas along Squaw Creek and its tributaries. Old growth is not limited to conifers. There are some very nice old growth stands of canyon live oak and black oak scattered throughout the watershed. Large snags and large down woody debris are also rare (EUI Survey, 1994)

3.2.2 General Vegetation Descriptions

Mixed Conifer - Douglas Fir (Mixed Conifer - Douglas Fir Dominated)
The mixed conifer - Douglas fir vegetation type covers approximately 35% of the watershed, and is found primarily in the upper three-quarters of the watershed. It is an important vegetation type in Riparian Reserves even in the southern end of watershed. Douglas fir is the dominate conifer species in this vegetation type. Canopy cover can be as high as 70% for douglas fir and 10% to 15% each for ponderosa pine and sugar pine. Total tree cover can be as high as 95%. Where canopy cover is high, Douglas fir and sugar pine are the only conifers regenerating. Ponderosa pine regeneration can be found in openings, and in areas where canopy closure is less than 40%. On moist sites, big leaf maple and Pacific dogwood are important associates.

Mixed Conifer - Ponderosa Pine (Mixed Conifer - Ponderosa Pine Dominated)
This vegetation type covers approximately 15% of the landscape, and is generally found in the southern quarter of the watershed. Ponderosa pine is the dominant conifer species with gray pine, sugar pine and Douglas fir being important associates. Knobcone pine is an important component along the perimeter of Shasta Lake. Knobcone pine stands are decadent and creating problems with high fuel loads. Mixed conifer - ponderosa pine stands are generally more open than mixed conifer - Douglas fir stands. On less productive sites, conifer cover may be 10% to 20%. On more productive soils, conifer cover is generally 40% to 50% with hardwood cover being at least the same or higher. Low montane chaparral is also an important component.

Mixed Conifer (Mixed Conifer)
True mixed conifer stands cover approximately 3% of the watershed, and are generally found in the northeastern part. Species making up this type are Douglas fir, sugar pine, ponderosa pine, incense cedar and white fir. Black oak and canyon live oak are important hardwood associates. Big leaf maple and Pacific dogwood are found on moist sites.

Gray Pine (Gray Pine)
The current database (LMP90) shows less than 1% of the watershed occupied by the gray pine vegetation type. However, after reviewing 1995 aerial photographs, checking EUI data, and taking observations from a helicopter on March 26, 1998, the percent cover may be closer to 5%. Gray pine is a significant vegetation type in the southern end of the watershed. Tree cover is

generally sparse (10% - 20%), but can be as high as 50%. Black oak and/or canyon live oak are important midstory species, with low montane mixed chaparral in the shrub layer. Another component of this type, although rare, is the gray pine - blue oak type. There are only a couple of areas where this open, grassy type is found, and they are located between Monday Flat and Winston Gulch. Another important vegetation type is the gray pine / sticky whiteleaf manzanita type, and it is found in the southern portion of the watershed. Gray pine is also associated with limestone outcrops.

<u>Knobcone Pine</u> (Knobcone Pine)

Few stands of pure knobcone pine occur in the watershed (<1% of the watershed area). It is most often seen as a component of the mixed conifer - ponderosa pine type. The pure stands are found along the shore of Shasta Lake. This is a fire dependent, short-lived species which has become decadent in the absence of fire. Much of it has fallen down causing a fuels problem, and a high fire risk. The high fire risk comes from its proximity to the lake shore and to recreational activities. Wildfire in such areas could be disastrous to wildlife habitat in the watershed, especially to bald eagle habitat which is already in short supply.

<u>Douglas Fir - Riparian</u> (Mixed Conifer - Douglas Fir Dominated)

Douglas fir stands make up approximately 5% watershed, and are usually found in or near riparian areas. Most old growth (>180 years old) in the watershed is found in riparian zones and belong to this vegetation type. Important hardwood associates on moist sites are big leaf maple, Pacific dogwood, white alder and mountain ash. Hardwood associates on drier sites are black oak and canyon live oak. The shrub layer is generally well developed (10% - 50%), with California hazel, Pacific dogwood, miner's dogwood, poison oak, vine maple, snowdrop bush, creeping snowberry, Oregon grape, mock orange, greenbrier and Oregon boxwood. The forb layer can be well developed (4%-20%) and very diverse. Wild ginger, rattlesnake plantain, trail plant, bleeding hearts, mountain sweet-cicely, western starflower, iris, violets, wintergreen, princess pine, false Solomon's seal, white hawksbeard and fairybells are common forbs. Ferns and grasses are also common. One of the sensitive plants for this forest, Shasta snow-wreath, is found in the Low Pass area (Hosselkus Limestone area) in a riparian area within the Douglas fir vegetation type.

<u>Black Oak</u> (Commercial Hardwoods Black Oak/Mixed)

Oaks are a major vegetation component of the Squaw Creek Watershed. They cover approximately 35% of the area. They are also an important component of all conifer types. Black oak is the most abundant hardwood type. It is found throughout the watershed, and covers approximately 23% of the landscape. This type is generally thought to be a seral community which is transitional to one of the following communities: Mixed conifer-Ponderosa pine; Mixed conifer-Douglas fir or Douglas fir. According to ***"Silvics of North America, Volume 2. Hardwoods"*** published by the USDA Forest Service in 1990 (page 663), "without disturbance, black oak is eventually crowded out of the best sites and remains only as scattered remnants in mixed conifer forests. Here it often exists on "islands" of soil or terrain not favorable to regeneration of conifers. Most of the black oak stands are of one age-class, the result of sprouting after fire." Other hardwood associates in the Squaw Creek Watershed are: Big leaf maple, Pacific dogwood, canyon live oak and occasionally Oregon white oak. Black oak stands are found on all aspects within this watershed. Many stands are very dense (>70% canopy closure). In these stands Douglas fir is the primary regenerating species, and poison oak may be the only shrub. More open stands will have a combination of ponderosa pine, sugar pine Douglas fir and gray pine in the regeneration layer. Oregon white oak is found in the Wheeler Ranch area near old homestead sites. Many of the black oak stands would benefit from light burning and/or thinning.

Canyon Live Oak (Canyon Live Oak)
Canyon live oak covers approximately 12% of the area. Canyon live oak is found throughout the watershed, but is dominant on steep slopes with shallow, rocky, infertile soils. Important associate species are poison oak and sword fern. Other hardwood associates are black oak and big leaf maple. On better sites, conifers are present in the regeneration layer. These better sites will eventually become associated with the Mixed conifer vegetation type.

Shrub-sized Hardwoods/Low Montane Mixed Chaparral/Montane Mixed Chaparral (Chaparral/Brush Sized Hardwoods)
This vegetation type covers approximately 6% of the watershed. Most sites are impenetrable except by small creatures such as birds and rodents, and are located in the southern part of the watershed. Shrub-sized oaks include black oak and canyon live oak less than 15 feet tall. These are generally found at higher elevations on mountain slopes and ridge tops. Low montane chaparral is an important shrub type below 4500 feet. Important low elevation shrubs found in the Squaw Creek watershed include: Sticky whiteleaf manzanita, buckbrush, Brewers oak, poison oak, snowdrop bush, wild grape, lemon ceanothus and deerbrush. The montane mixed chaparral is found at elevations above 4500 feet to 6500 feet on steep, rocky mountain slopes and ridge tops. Overstory tree cover is less than 5%. Shrub cover can be as high as 100%. Shrubs in this group include: Huckleberry oak, greenleaf manzanita, service berry, bittercherry, and silk tassel.

Dry Meadows (Grass)
Dry meadows are located on stream terraces along Squaw Creek (approximately 60 acres) in the area of Wheeler Ranch and the confluence of Squaw Creek and Modin Creek. The condition of these meadows is degraded. Weedy species such as yellow star thistle, soft chess brome, cheatgrass and ripgut brome have replaced most native grasses and forbs. Star thistle can make up 40% to 60% of the vegetative cover on these meadows. These areas are important grazing habitat for the Squaw Creek elk herd. None of these exotic weed species are preferable grazing species. Star thistle is unpalatable and poor in nutrition. Although we don't know how it affects elk, it is toxic to domestic livestock primarily horses, and the stickers can cause physical injury (USDA, 1988). The brome grasses, when mature, have long, barbed awns which make them unpalatable. These awns can also cause physical injury. Ponderosa pine seedlings are also beginning to show up in the meadows. If these meadows are to be maintained for the benefit of wildlife, the problem of exotics will have to be addressed in the near future.

3.2.3 Nonnative Plant Species

Several nonnative plant species have become established throughout the watershed, particularly near riparian areas and open areas.

Himalayan Blackberry
(*Rubus discolor*)
This nonnative blackberry has become established in thickets in many locations. Chirpchatter Campground is an example of an area where these berries are colonizing rapidly, and have already covered large areas of the campground.

Klamath Weed, St. John's Wort
(*Hypericum perforatum)*
This plant is found in open, disturbed areas such as roadsides, log landings and disturbed meadows. Klamath weed was introduced from Europe and Africa. It has many medicinal uses. Menominee Indians mixed it with black raspberry root to make a tea. The tea was used for turberculosis, acted as a diuretic, and was also believed to kill internal worms. The forage value of Klamath weed for livestock and wildlife is poor to worthless, and it is seriously toxic to livestock (Stubbendieck, Hatch, Hirsch, 1986). The active ingredient, hypericin, is now being used as an anti-depressant. It is also added to ointments for use on all types of skin irritations (Moore,1979). Hypericum has been shown to inhibit human immunodeficiency virus (HIV) (Hickman, 1993). More studies are being done, and more medicinal uses are being discovered.

Hedge-Parsley
(Torilis arvensis)
This plant is an annual which produces many prickly seeds which spread easily by hitchhiking on any animal it comes in contact with. It seems to prefer dry, disturbed, open areas.

Yellow Star Thistle
(*Centaurea solstitialis)*
Yellow Star Thistle is a major problem in the lower two-thirds of the watershed wherever there is an opening. It is choking the meadow areas and making them nearly useless as elk grazing habitat. The yellow flowers have large stickers which can cause physical injury to wildlife and humans. Yellow Star Thistle is painful to walk through and its forage value is poor. No information pertaining to start thistle and its toxicity to wildlife was available at the time of this analysis, but Yellow Star Thistle is known to be toxic to horses (USDA, 1988). An aggressive eradication program is needed to reintroduce productive forage to the meadows and to slow down the spread of Yellow Star Thistle.

Other Nonnative Plant Species
Several exotic, annual grasses have become established throughout the area. This may be due to an over use of fire by ranchers and livestock grazing between the 1870's and 1940's. Most of these exotics belong to the genus *Bromus*, and come with sharp awns which make them very unpalatable except for early in the season before the seeds ripen. Many, such as cheat grass (*Bromus tectorum)* and ripgut brome (*Bromus diandrus),* can cause physical injury to humans and wildlife. Hedgehog dogtail (*Cynosurus echinatus*) is another common exotic. Generally, these exotics provide very little forage. They compete aggressively, preventing native grasses from competing for site occupancy.

3.2.4 Current Fire Regime

Fire is a major disturbance factor in most terrestrial ecosystems. The frequency and intensity with which fire occurs in an ecosystem is influenced by the vegetation within it. Fire frequencies vary depending on climate and site characteristics such as weather, aspect, elevation, fuel accumulation and ignition sources. Each ecosystem has a unique combination of responses to fire frequency, intensity and duration. The Squaw Creek watershed is in transition from a low to moderate intensity regime to one of moderate to high intensity. The current regime is typical of landscapes that have Douglas-fir and Ponderosa pine as major species and hardwoods as minor species.

Historically the Squaw watershed was described as a low to moderate severity regime where low intensity surface fires burned at frequencies at 1-25 years. High severity fires also occurred but at long intervals. In these fire regulated ecosystems, fires are frequent but less intense in behavior and effects. Fire occurrence is usually patchy, and age and species diversity are common characteristics. In the absence of fire beyond the normal return interval, these fire adapted species are replaced by late successional species that are predominantly shade tolerant but less fire tolerant. The Squaw Creek watershed is characteristic of such a regime where fire exclusion has changed the species composition and stand structure resulting in fuel profiles that alter fire behavior and effects.

The affect of the fire regimes vary with aspect, placement on slope, shading, soil type, elevation and snow pack. These variables affect moisture content of burnable fuels, exposure to wind and solar heating which in turn regulates fire spread and intensities. Interactions with these variables as well as past fire exclusion accounts for much of the large fire history within the watershed. There have not been any large fires within the watershed since a 550 acre fire in 1944 east of Signal Butte. Large fires before 1944 were generally sparse, covering approximately 33% of the watershed over a 75 year period. The lack of large fires within the past 7-10 decades is a result of advancing suppression technology and reduced human ignition starts.

Generally as the average age of a vegetation series increases, the degree of disturbance from the last event increases.   Similarly as the age of the series increases it can be assumed that the number of years since the last fire disturbance would also increase. These results seem to be consistent with the fact that as fire return interval increases, fire severity or catastrophic fire behavior will increase as well.

3.2.5 Potential for Catastrophic Fire - Hazard and Risk

Fire behavior is a function of fuels, weather and topography. The fuels leg of this triangle relates directly to standing vegetation as well as down and dead surface fuels. Initiation of crown fire behavior is a function of surface fire line intensity and variables of the tree crown layer. Tree crown layer is measured as "Crown Bulk density" to estimate the carrying capacity of a measured stand structure to support crown fires. Residual surface fuel loads of dead and live fuels are indicators do predictable fire intensity levels and are measured in tons of fuel per acre of surface.

An analysis of the watershed shows that approximately 99% of the watershed is at a moderate to high threat to generate or allow crown fire behavior given expected intensities from modeled vegetation and surface fuel conditions. Areas within the watershed at higher threat to catastrophic fire are those that posses all the critical characteristics of fuel, weather and topography that contribute to crown fire or replacement fire behavior.

The Squaw watershed has 11,937 acres that are considered as a "High" threat to produce catastrophic fire behavior.   An additional 31,852 acres are a "Moderate" threat to produce catastrophic fire behavior. The fire effects on vegetation within these high threat areas will likely be replacement in nature.

Fire analysis can identify fire disturbance in a watershed in terms of Risk and Hazard. The risk and hazard for the Squaw Creek Watershed is shown in Map 11 (Fuel Hazard Risk). Risk as it

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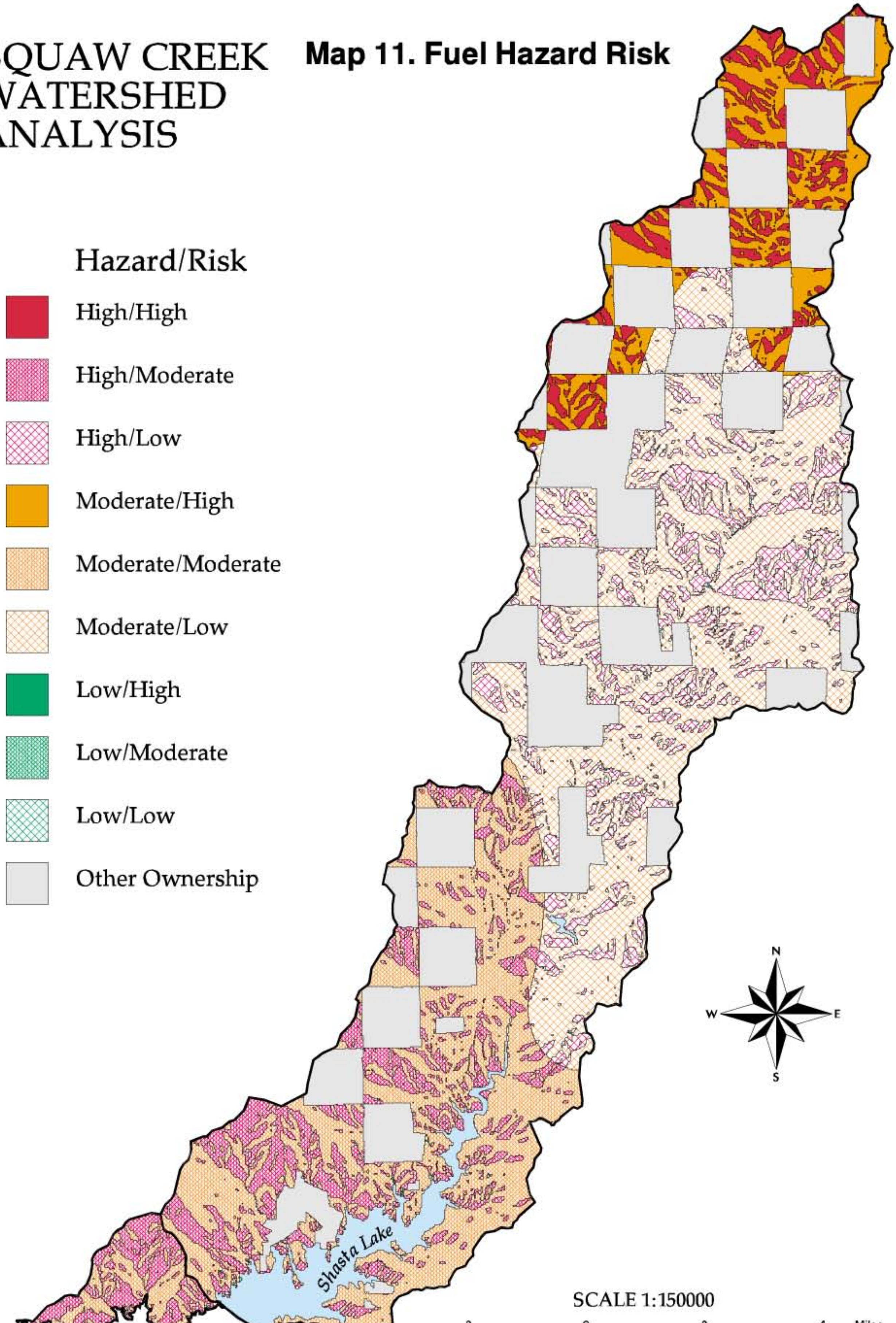
Map 11. Fuel Hazard Risk



relates to this document is identified as a wildfire agent or cause such as lightning, or human caused ignition. Hazard is defined as a rating assigned to a fuel complex to reflect its susceptibility to ignition and the wildfire behavior it would support. Threat refers to all the factors combined. Where high risk coincides with high hazard, the threat of catastrophic fire is more likely. Taking these variables into account the Squaw Creek watershed is characterized in Table 3-4 as follows:

Hazard	Risk	Acres	Potential Catastrophic Fire Threat (Percent Coverage)
H	H	2371	High -------------------------------
H	M	5631	High |----------- 26%
M	H	3935	High -------------------------------
H	L	5223	Moderate ------------------------------
M	L	15852	Moderate |
M	M	12065	Moderate |--------- - 73%
L	H	4	Moderate |
L	M	56	Moderate -------------------------------|
L	L	116	Low ---------------- | --------- 1%

Table 3-4: Hazard and Risk Rating.

3.2.6 Fire Suppression

Suppression responsibility for the 64,000 acres in the Squaw Creek Watershed rests primarily with the U.S. Forest Service. The California Department of Forestry also has suppression responsibility to the east of the watershed, but none in the analysis area. Initial attack response is primarily from the Big Bend area where both the USFS and CDF fire stations are located. Additional response would come from fire stations in McCloud in the northern half of the watershed and stations from Shasta Lake in the southern half of the watershed. Aerial suppression support would come from the Redding Air Attack base. Due to the limited access within the watershed ground based initial attack efforts are at times limited and lengthy. Approximately 25% of the watershed has no access at all from the ground. The remaining 75% has only limited access. In most of the watershed initial response time from the ground is two hours or longer. Due to this delay aerial retardant support is generally on immediate dispatch with a response time of approximately 20 minutes depending on availability. Where access is determined to be limited or delayed smokejumpers are also dispatched from the Redding Air Base with response times generally much faster than ground based forces.

The difficulty of accessing much of the watershed is a concern in fire management planning. Initial detection of ignitions are primarily from lookouts and aerial detection when available. Pre-attack planning is limited although some planning has been accomplished in the past.

The effects of fire suppression on forest stand density are well documented (Agee, 1993) . While the suppression of fires over several decades has been the largest contributor towards altering the historical fire regimes in the watershed, suppressing wildfires during critical summer periods for fire protection of life, property and valuable resources cannot be excluded entirely.

3.2.7 Resources At Risk To Catastrophic Fire

Areas at higher threat to catastrophic fire effects are those noted as "Critical Fire Features" in Table 3-5. Resources within these features will likely experience more fire disturbance activity as well as intense effects from fire events. In general more ignition starts from lightning can be expected at mid to higher elevations. However due to drier moisture zones lower to mid elevations may experience more intense fire effects when fires do occur.

	HIGH THREAT	MODERATE THREAT
LAND BASE DESCRIPTION		
Fuel Model 6	Flame Height - 8 ft.	
Fuel Models 9, 10, 10/6		Flame Height 4-8 ft.
WEATHER		
Season	July-September	June, October
TOPOGRAPHY		
High Elevation	High Lightning Occurrence	
Mid Elevation		Mod-High Fire Occurrence
SLOPE		
0-35% Slope		Moderate Rate/Spread
>35% Slope	High Rate/Spread	
ASPECT		
South/West	High Rate/Spread	
North/East		Low Moderate Rate/Spread

Table 3-5: Critical Fire Features in the Squaw Creek Watershed.

There are several types of resources that are affected by this high potential of catastrophic fire. Physical resources such as vegetation, soils, wildlife, cultural, air and water quality are effected either positively or negatively depending on frequency, duration and intensity of the fire event. The fact that many of these resources are interactive with one another tells us that considerations of potential resources loss and or changes must be considered in effective fire planning. Areas of "High" hazard in the watershed are expected to produce flame lengths of 8 feet plus on a normal summer day. Areas of "moderate " hazard are expected to produce 4-8 ft. flame lengths . Intensity level predictions from these flame lengths range from 143 BTU/ft./sec to as high as 712 BTU/ft./sec. At levels above 100 BTU/ft./sec fires are generally to intense for direct handline construction, and equipment such as dozers and aircraft retardant must be relied upon. Levels above 500 BTU/ft./sec present serious spotting conditions and crown fires are inevitable. With 99% of the watershed in a "high" to "moderate" category the potential for extensive resource loss is probable.

3.3 Species and Habitats

3.3.1 Biodiversity

Documentation from sightings, nest locations and habitat/distribution models (Timossi, 1993) have indicated 228 species of wildlife (13 amphibians, 147 birds, 50 mammals and 18 reptiles) are associated with the habitat and elevations characteristic of the Squaw Creek watershed. This watershed analysis will deal only with the following types of species: Federally listed endangered, threatened or proposed species, Forest Service sensitive species and other species of concern (Survey and Manage, 'protection buffer' species and high profile species - Neotropical Migratory Birds, McCloud Deer Herd, Shasta Lake Elk Herd, etc.).

3.3.2 Wildlife Species of Concern

Wildlife species of concern that may occur within or in close proximity to the Squaw Creek Watershed include the American Peregrine Falcon, Bald Eagle, Spotted Owl, Shasta Salamander, Northern Red-legged Frog, Northern Goshawk, Willow Flycatcher, Pacific Fisher, American Marten and Northwestern Pond Turtle. Current conditions for species abundance and available habitats are summarized below.

	American Peregrine Falcon
Status	Federally Endangered, State Endangered
Presence in Watershed	There is one historical eyrie within the watershed. Recorded sightings of peregrine falcon have occurred in the vicinity of the Hosselkus Limestone formation (NRA) in the vicinity of Low Pass Creek (T35N, R2W, 29) (pers. communication, N. Hutchins 1997, Wildlife Biologist, Shasta-Trinity NF, Shasta Lake RD). As indicated in the table below, the site has a high potential for a peregrine eyrie.
Landscape Overview	The nearest peregrine eyrie outside of the watershed is Pit 6, located 3 miles east of the northeastern edge of the watershed along the Pit River. Another historical eyrie occurs in the vicinity of North Grey Rocks on the McCloud Arm of the lake, approximately 2 miles west of the southern edge of the watershed.
Survey Extents	No surveys are being conducted at present within the watershed boundary. No surveys are being conducted outside of the boundary until Spring, 1998.
Habitat Description	Vertical cliff habitat with large potholes or ledges.
Habitat Condition	Some sites have been identified as possible locations for peregrine eyries (Boyce & White, 1979) Some have very low potential whereas others have higher potential. This data is only informational as the potential rating has been questioned since predictions have not always matched known outcomes. Without current evaluation of these cliff sites, though, each is assumed to have potential for use by peregrines. The following table identifies each location, potential rating, and whether surveys were conducted

Location	T	R	Sec.	Potential	Surveyed
Low Pass	T35N	R2W	SE28	Highly suspected	1993, 1994
Other areas within limestone outcrops.	NA	NA	NA	Potential for habitat is good in adjacent Hosselkus Limestone Formation (SIA).	NA

Table 3-6: Possible eyrie locations, potential, and survey information for peregrine falcon.

*For further information see Boyce and White 1979.
Highly suspected = suitable habitat with signs of peregrine activity
Possible = suitable habitat, no signs of activity
Potential= unsuitable habitat with enhancement potential
Unsuitable = unsuitable habitat without enhancement potential
No rating = cliffs not helicopter surveyed for potential; low priority sites

	Bald Eagle
Status	Federally Threatened
Presence in Watershed	There are incidental sightings of bald eagles along Squaw Creek proper above the lake. There are two known active nest territories on the Squaw Arm of Shasta Lake: Flume Canyon and Frenchman Creek.
Landscape Overview	There are numerous bald eagle nest territories located on the adjacent arms of Shasta Lake. The lake supports a total of 16 nest territories.
Survey Extents	Numerous systematic surveys have been conducted for eagles on all arms of Shasta Lake. No official surveys have been conducted on Squaw Creek above the lake.
Habitat Description	Large ponderosa pine trees near lakes or large streams.
Habitat Condition	The level of occurrence for potential nest trees along Squaw Creek is not known.

	Spotted Owl
Status	Federally Threatened
Presence in Watershed	Federal records show nine spotted owl activity centers (ACs) are located within the Squaw Creek Watershed (location map on file, McCloud Ranger Station). Three ACs are located within LSRRC-335 in the northern portion of the watershed. Five ACs are located within the matrix lands to the south and do not have 100 acre cores. One additional AC (ST-111) is a MLSA in the middle of the watershed. Table 3-7 displays the ACs and the amount of habitat within 1.3 miles of each territory.
Landscape Overview	Virtually all ACs are checkerboard ownership with a combination of National Forest Lands and private lands. Most of the private lands are owned by SPI and have been logged within the last 20 years. Table 3-7 shows the reproductive history of each AC.
Survey Extents	Approximately 30% of the watershed was surveyed to protocol for calling routes, SOHAs, and timber sales, in 1991 (Table 3-8). From 1988 to 1990 District biologists or private individuals conducted unofficial surveys within 45% of the watershed. Since 1991 the survey effort has been limited to historical visits. About 70% of the watershed has not been surveyed to protocol for spotted owls. This area is located in the southern part of the watershed, south of the MLSA all the way to Shasta Lake. Table 3-8 displays a history of surveyed areas within the watershed.

Habitat Description	Mature conifer forests with dense, multi-layered canopies.
Habitat Condition	Northern spotted owl habitat is discussed under the following related headings for the `Vegetation' and `Species and Habitat' sections: `Old Growth Habitat' - for Suitable Nesting/Roosting Habitat `Mature Forested Habitat' - for Forging Habitat `Dispersal Habitat' - for Dispersal Habitat The presence of the LSR, Riparian Reserves, and other late-successional habitats indicate that current and projected management emphases should result in extensive amounts of good quality habitat for the foreseeable future. Catastrophic fire could alter this condition, however. See Map 10 for the distribution of suitable nesting/roosting/foraging habitat and dispersal habitat. Table 3-9 displays the amount of suitable habitat within each AC.

Owl AC#	Status	Status Verified	Reproduction Verified
108	Single	1989 (S)	No reproduction
109	T.Single	1980 (X); 1981 (S); 1989 (S); 1991 (S)	No reproduction
110	T.Single	1990 (TS); 1991 (X)	No reproduction
111	T.Single	1982 (S); 1983 (X); 1986 (S); 1987 (S); 1988 (M/F); 1991 (X)	No reproduction
112	Single	1989 (S)	No reproduction
113	T.Single	1980 (X); 1981 (S); 1989 (S); 1991 (S)	No reproduction
116	Pair	1975 (S); 1976 (S); 1980 (X); 1982 (X); 1985 (X); 1986 (X); 1987 (Y); 1990 (S); 1991 (X); 1992 (X)	1987
117	Pair	1981 (S); 1982 (TS); 1983 (X); 1985 (X); 1986 (TS); 1987 (X); 1989 (S); 1990 (X); 1991 (X); 1992 (P); 1995 (P)	No reproduction
118	Pair	1982 (S); 1983 (S); 1986 (S); 1987 (TS); 1988 (M/F); 1989 (M/F); 1990 (S); 1991 (Y); 1992 (Y); 1994 (S); 1995 (X)	1991, 1992

Table 3-7: Current status and survey history of spotted owl Activity Centers within the Squaw Creek Watershed. Based on data through 1996 field season.

(P) = Pair (TS) = Territorial Single (Y) = Young
(S) = Single (M/F) = Male/Female - no pair (U) = Unknown
(X) = no detection

Survey Area	Type	Years Surveyed	Years Surveyed to 1991 Protocol
Hoffmeister	Green	1991-1997	1991-1997
LSR RC-335	LSR	1991,1995,1996	1991,1995,1996

Table 3-8:   Surveyed areas within the Squaw Creek Watershed. Survey areas with the same name, when listed separately, indicate a change in the survey boundary. Based on data through the 1997 field season.

Owl AC#	Circle Radius 0.7 mile Within watershed	Outside 2/ watershed	Total	1.3 mile Within watershed	Outside 2/ watershed	Total
108	448		448	1670		1670
109	518		518	1611		1611
110	612		612	2260		2260
111	*	*	*	*	*	*
112	425	50	475	1069	202	1271
113		551	551	4	1001	1005
116	860	0	860	2218	5	2223
117	921		921	2704	53	2757
118	882		882	2677		2677

Table 3-9: Acres of suitable nesting, roosting, and foraging habitat for spotted owl Activity Centers within and adjacent to the Squaw Creek Watershed. * Information presently not available.

2/ Actual acres of suitable habitat outside the watershed are probably somewhat higher than shown in this table. Acres outside the watershed are based on 1975 data and adjusted to reflect expected growth over the past two decades, but should be verified at the project level.

	Shasta Salamander
Status	Forest Service Sensitive
Presence in Watershed	Salamanders have been seen in the southern half of the watershed , associated with limestone parent material and outcrops.
Landscape Overview	In the adjacent McCloud Arm, Lower McCloud and Lower Squaw Valley Creek watersheds salamanders are present, though the sighting occurrences are less abundant the further north one travels. This is expected to be a function of the abundance of suitable habitat; less limestone rock exposed, and higher elevations (>3000 feet) where exposure does occur.
Survey Extents	Systematic surveys for the Shasta salamander have occurred in the most southern part of the watershed.
Habitat Description	Cool, moist microclimate around limestone caves or outcrops below 3000 feet elevation.
Habitat Condition	Several limestone outcroppings do occur within the watershed (see Peregrine potential eyrie sites), but these are usually located above 3000', are drier sites and not forested. Caves are also present which may have salamander populations, though past exploration has not detected their presence (see 'Habitat Elements' discussion for Caves). Other sites may occur, but could not be detected at this level of analysis using aerial photos, geological maps and soils maps. Their existence will be determined at the project level.

	Northern Red-Legged Frog
Status	Forest Service Sensitive
Presence in Watershed	No sightings of this species have been reported within the area
Landscape Overview	Red-legged frogs have been found in streams within the adjacent Shasta Lake associated watershed (Bogener and Brouha, 1979).
Survey Extents	While systematic surveys specific to the northern red-legged frog have not been conducted within the watershed, personnel responsible for past stream and wetland surveys looked for this species.

Habitat Description	Cool, deep, still to slow moving water such as lakes, ponds, or slow streams.
Habitat Condition	Red-legged frog habitat may occur in the alluvial uplands or Squaw Creek, if pools are present. Between the pool-riffle and the step-pool reach types, the pool-riffle would have a higher probability of providing suitable habitat as slow moving pools with riparian vegetation and instream vegetation could occur.

	Northern Goshawk
Status	Forest Service Sensitive, Federal Species of Concern, California Species of Concern
Presence in Watershed	Forest records include no nest site within or within close proximity to the watershed. A sighting at Mica Gulch is the only recorded goshawk detection in the vicinity of the watershed. This detection occurred while conducting Northern Spotted Owl surveys. Why there are very limited detections within the watershed is unknown, but could be a function of unsuitable habitat, survey effort, or both.
Landscape Overview	The closest known nest sites are located is 9 miles to the northeast in the Bartle Watershed and in the Squaw Valley Creek Watershed. Immediately outside the watershed, the Nature Conservancy has detected goshawks.
Survey Extents	No information is available concerning past goshawk surveys in the watershed.
Habitat Description	Late seral, conifer forests near early seral openings.
Habitat Condition	Suitable Goshawk habitat is not abundant in the watershed, with the exception of the LSR habitat in the northern quarter.

	Willow Flycatcher
Status	FS Sensitive, California Endangered
Presence in Watershed	This species had not been detected in the watershed, but suitable habitat is present. Overall, wherever suitable habitat occurs, the willow flycatcher has a high probability of being present.
Landscape Overview	Willow flycatcher occurs in the vicinity of Iron Canyon Reservoir to the northeast. Habitat occurs in this and adjacent watersheds.
Survey Extents	Aquatic EUI surveys conducted in 1994 included spot checks for willow flycatcher presence. None were located.
Habitat Description	Large clumps of willow separated by openings.
Habitat Condition	The location of suitable habitat, outside of the areas identified, is unknown as riparian habitat has not been mapped for the watershed.

	Pacific Fisher
Status	Forest Service Sensitive, Federal Species of Concern, California Species of Concern
Presence in Watershed	There are no known records of fisher within the watershed.
Landscape Overview	Habitat is present within the LSR and matrix lands in the northern third of the watershed.
Survey Extents	SPI has also conducted furbearer surveys in the Squaw Creek watershed and elsewhere in the general vicinity. Fishers have been recorded as using this habitat (Steve Self, pers. comm.). PSW is planning additional fisher surveys east of I-5, that may occur within the watershed.
Habitat Description	Large areas of mature, dense forest below 6000 feet.
Habitat Condition	Habitat for the fisher is expected to exist within the LSR, the northern portion of the watershed. Protection and management of the fisher is expected to be provided through management of the LSR.

	American Marten
Status	Forest Service Sensitive, California Species of Concern
Presence in Watershed	There are no recorded detections of marten within the watershed.
Landscape Overview	Habitat is present in the northern third of the watershed within the LSR.
Survey Extents	No information is available concerning past survey activity. PSW is planning to survey American marten. PSW is planning intensive marten surveys east of I-5. The survey extents have yet to be determined but could occur within the watershed.
Habitat Description	Mature mixed conifer forest types above 4000 feet.
Habitat Condition	Habitat for the marten is expected to exist within the LSR, the northern portion of the watershed. If the marten is present, suitable habitat is expected to be provided through management of the LSR.

	Northwestern Pond Turtle
Status	Forest Service Sensitive
Presence in Watershed	Northwestern pond turtles have been found within the watershed.
Landscape Overview	Northwestern pond turtles have been detected within all arms of Shasta Lake.
Survey Extents	Northwestern pond turtle was surveyed during the 1994 Aquatic EUI surveys. In addition turtles were found during historical stream surveys . Surveying for this species at the project level is extremely important as they may travel outside the Riparian Reserves for suitable nesting habitat.
Habitat Description	Deep still water with sunny banks.
Habitat Condition	Suitable habitat may exist along Squaw Creek and its major tributaries and the Squaw Arm of Shasta Lake.

A wolverine (California Threatened) was detected in the Squaw Creek Watershed in 1981 (T. Hesseldenz, 1997, personal communication). The distribution of wolverine within the watershed and adjacent areas is unknown.

3.3.3 Threatened, Endangered and Sensitive Plants

No threatened or endangered plants have been found in the Squaw Creek Watershed. Three Forest sensitive plants have been found. The Shasta snow-wreath *(Neviusia clifftonii)* is a newly discovered species found in cool, moist, shady areas on limestone substrate. There are two locations in this watershed where this shrub is known to exist. One location is in the Low Pass area and the other location is near the confluence of Squaw Creek and Smith Creek. The Shasta eupatory *(Agertina shastense)* is generally found on steep limestone cliffs. However, one population was found on Bagley Mountain in 1994 (Bagley Mountain is not composed of limestone). The are several populations in the Hosselkus limestone formation. Other populations are located on McKenzie Mountain, Shoeinhorse Mountain and Little Shoeinhorse Mountain. The third known sensitive plant is veiny arnica *(Arnica venosa)*. The habitat for this plant is open, often disturbed oak/pine woodland. There are two known locations at this time. One population is located near Dekkas Creek Saddle, and the other is located near Chirpchatter Mountain.

Other sensitive plants which may be in the watershed, but haven't been found are Brandegee's eriastrum (*Eriastrum brandegeae)*, Butte County fritillary (*Fritillaria eastwoodiae*), and Shasta jewelflower (*Strptanthus shastensis).* Brandegee's Eriastrum is found on sites with dry gravelly soils, flat land or benches, on the edges of small openings in chaparral or foothill woodlands between 1000 feet and 2600 feet elevation. Butte County fritillary is found on dry benches and slopes at elevations between 1640 and 4920 feet.   Shasta jewelflower is found in areas of young black oak forest, seral to douglas fir/big leaf maple/Pacific dogwood community, in mesic sites. The species appears to follow disturbance. The elevation range for Shasta jewelflower is 1500 feet to 5500 feet.

3.3.4 Fisheries

The Squaw Creek watershed analysis area originates at the boundary between the Shasta Lake and McCloud Ranger Districts and extends south to the Pit arm of Shasta Lake. Squaw Creek has been designated as a focal watershed by the Shasta-Trinity National Forests Aquatic Conservation Strategy. The goal of this strategy is to "provide for the high probability of maintaining resident and anadromous native fish communities and their habitat in all major forest aquatic ecosystems". Within the Sacramento River basin, Squaw Creek has received the highest priority for the maintenance and improvement of fish habitat.

Within the watershed analysis area there are approximately 108 miles of fish bearing streams and 46 miles of reservoir shoreline. There are 48 streams known to sustain fish life at one life stage or another. The most significant streams include Squaw Creek, North Fork Squaw Creek and Salt Creek. The other streams are of varying importance to fish with the smaller streams providing fish habitat only within their lower reaches. Many of the smaller streams become intermittent during low flow conditions and only provide fish habitat on a seasonal basis. Table 3-10 displays a list of fish bearing streams as well as miles of suitable habitat in the Squaw Creek Watershed.

Squaw Creek and some of the tributaries are examples of properly functioning stream systems where flows, bedload and the delivery of large wood are in dynamic equilibrium. This has resulted in the formation and maintenance of habitat features (deep pools and runs), that are critical to the production of large, mature trout. The relatively large number of trout are indicative of a relatively healthy watershed and stream systems that are properly functioning. Many of the smaller tributaries are also functioning well, but are limited for fish habitat because of their small size and steeper gradients. These streams, though not important for fish habitat, are critical to the maintenance of proper water quality and sediment delivery. The exceptions are Salt and Winnibulli Creeks which sustained major damage as a result of last winters storms. Within these streams, sediment input and bedload movement have resulted in pool filling and lateral channel scour. This has caused a decrease in fish habitat quality within sections of lower Squaw Creek. Unless problems are corrected within these two smaller drainages, fish habitat will continue to be adversely affected within these two streams as well as within a section lower Squaw Creek.

The lower and middle reaches of Squaw Creek contain an excellent resident fishery and fish habitat is in good condition. The upper reach has an abundance of good fish habitat, however fish abundance within this reach is considered low and the fishery is not considered as good as within the other reaches. Fish habitat within the remainder of the watershed is considered fair to good, except for Salt and Winnibulli Creeks where the fish habitat is considered poor. Rainbow trout are common throughout most of the watershed. Lower Squaw Creek also supports a large run of adfluvial rainbow trout from Shasta Lake as well as speckled dace, Sacramento squawfish, riffle sculpin and smallmouth bass. Other fish species that are believed to inhabit lower Squaw Creek at least on a seasonal basis include Sacramento sucker, hardhead minnow and channel catfish.

The Squaw Creek arm of Shasta Lake supports a good warmwater and cold water fishery. Fish habitat within the lake is good, though cover for young-of-the-year bass is considered a limiting factor. This is due to the drawdown nature of the reservoir and the lack of shoreline structure. Habitat improvement projects have been implemented within this area in the past and have resulted in improved fish habitat conditions for warmwater fish species, however additional work is needed. The Squaw Creek arm of the lake contains those fish species already mentioned as well as brown trout, Chinook salmon, spotted bass, largemouth bass, channel catfish, white catfish, brown bullhead, white sturgeon, Sacramento sucker, blackfish, carp, golden shiner, hardhead minnow, bluegill, black crappie, green sunfish, and threadfin shad.

Miles of Fish-Bearing Streams in Squaw Creek Watershed			
Azelle Creek	0.5	Ash Creek	0.9
Unnamed Trib (s-20)	0.7	North Fork Squaw Creek	11.1
Baxter Gulch	0.5	East Fk. N. Fk. Squaw Creek	3.9
Horse Creek	2.1	Jackass Creek	1.4
First Creek	1.2	Bills Creek	2.3
Second Creek	1.8	Hoffmeister Creek	1.4
Didallas Creek	2.1	Bear Trap Creek	1.6
West Fork Didallas Creek	2.5	Crooks Creek	2.1
Winnibulli Creek	2.6	Unnammed Trib (S-14)	1.0
Salt Creek	7.8	East Fork Squaw Creek	4.4
McClure Gulch	0.4	Unnamed Trib (S-27)	0.6
Frenchman Gulch	0.2	Garden Creek	1.0
Flume Canyon	0.4	Modin Creek	2.8
Museum Canyon & Trib	1.0	Shake Creek	1.4
Lick Canyon	1.5	Fish Creek	3.4
Chain Gang Gulch	0.8	Muddy Springs Creek	2.1
Madison Gulch	0.4	West Fork Squaw Creek	2.8
Madison Canyon	1.2	Horse Creek	1.9
Unnamed Trib (S-6)	0.3	Unnamed Trib (S-26)	0.8
Unnamed Trib (S-31)	0.2	Spring Creek	1.1
Hoover Gulch	0.2	Unnamed Trib (S-13)	0.6
Low Pass Creek	1.1	Jessie Creek	1.6
Squaw Creek	24.5	Unnamed Trib (S-24A)	0.6
Smith Creek	1.2	Unnamed Trib (S-24B)	0.4

Table 3-10: Fish Bearing Streams.

3.3.5 Aquatic and Riparian Dependent Species

Approximately 85 species of aquatic or riparian dependent species are believed to occur within the Squaw Creek watershed (Appendix 2). These include, but are not limited to Pacific giant salamander, Pacific treefrog, American dipper, great blue heron, osprey, merlin, many species of ducks, geese and other water birds, tree swallow, purple martin, yellow warbler, downy woodpecker, beaver, river otter and western aquatic garter snake. Species of Federal concern include the Foothill yellow-legged frog, tailed frog, northern red-legged frog, Northwestern pond turtle, American peregrine falcon, bald eagle and willow flycatcher. Habitat requirements include intermittent standing water with varying amounts of vegetation and vegetation types, permanent cool water with instream cover and surrounding dense vegetation, and permanent warm water with little to no vegetation characteristic of the Squaw Arm of Shasta Lake. Management of riparian reserves through implementation of the Aquatic Conservation Strategy and management of the lake through implementation of the NRA Management Guide is expected to minimize adverse impacts to water quality, aquatic and riparian habitats and to those species within the aquatic and riparian guilds. Northwestern pond turtles and bald eagles may be the exception since they range and nest outside of the riparian areas.

The major Squaw Creek tributaries are expected to provide habitat for most aquatic and riparian associated species. Species such as the bald eagle, osprey, many species of waterfowl and beaver are expected to be more common in the larger Squaw Creek and the Squaw arm of Shasta Lake. Based upon surveys conducted in 1994, yellow-legged frogs and western pond turtles were sighted in the watershed (Toroni, R., Wilcox, G. and L. Haley, 1994). Aquatic EUI Survey for Squaw Watershed). The tailed frog was located to the east and west of the watershed but not within the Squaw Creek watershed. Willow flycatchers were not located within the watershed either, but sightings have been recorded to the north in the vicinity of Iron Canyon Reservoir. Since sightings have occurred for all other species in adjacent watersheds, there is high likelihood that these species occur within the Squaw Creek Watershed but were missed during surveys. The difference in survey results may be due to protocol differences, survey season, duration, survey intensity and weather, rather than presence or real absence of the species.

Sudden and prolonged increase in the levels of sedimentation within the step-pool, pool-riffle and alluvial uplands can be detrimental to aquatic and riparian-dependent species. Suspended sediment can kill many aquatic species when their gills become clogged. Where sediment remains settled on rocks and fills in interstitial spaces in the substrate, growth of algae, invertebrates and cover are often reduced if not eliminated. These changes can remove food sources and increase vulnerability to predation and rising temperatures for aquatic wildlife species. As aquatic amphibians and insects are affected, those species which feed on them, such as riparian-associated birds, mammals and reptiles are negatively impacted. The duration and extent of the sedimentation will determine the overall impact to the riparian system as well as the system's recovery capabilities (Bachmann, 1997; Lower McCloud WA).

3.3.6 Early Mid Seral or Multi Guild Species

Approximately 100 species of chaparral, shrub and grassland-associated species could occur within the Squaw Creek watershed (Timossi 1991, Appendix 2). Of the total, eight are Species of Concern and nine are harvest species. Species of Federal Concern include, peregrine falcon, pallid bat, long-eared myotis, fringed myotis, small-footed myotis and Townsend's big-eared bat, all of which use the habitat for foraging and Northwestern pond turtle which uses upland habitat adjacent to open water for nesting. Viability for these species is expected to be provided through special management direction for riparian areas, downed logs, snags, old growth species, green-tree retention, hardwood retention, seral stage diversity management, forest health, management plans for special land allocations (NRA Mngt. Guide, RNA plan) and management plans for deer and elk.

Within hardwood stands, herbaceous forage and acorn production is important to many wildlife species, especially game species such as squirrels, turkey, quail, bear, elk and deer. Additional non-game species which are associated with hardwoods include: Cooper's hawk, acorn woodpecker, downy woodpecker, ash-throated flycatcher, plain titmouse, Hutton's and warbling vireos and house sparrow. Any herbaceous growth and reduction in the acorn crop, then, would be detrimental, especially if these habitat elements are a limiting factor to a species. It is known which species utilize these habitat elements, but it is not known if these elements are limiting to these same species.

Species benefiting from the late seral conditions of the chaparral habitat include those which require large patches of undisturbed habitat, much like the needs of forest interior species. Berry production within these stands would benefit many species able to forage there. These late seral chaparral habitats also provide important thermal and escape cover for birds and larger mammals. Smaller mammals benefit from the lower growing shrubs. Detrimental effects to wildlife species would include the loss of foraging habitat for browsers as senescent chaparral is not palatable. Herbaceous forage is also lost as the chaparral overgrows open, early seral habitat.

3.3.7 Bats

Seventeen bat species may occur within this watershed (Rainey and Pierson, 1996). Five of the bat species are Survey and Manage Species including Long-eared myotis, Fringed myotis, Long-legged myotis, Pallid bat and Silver-haired bat. Two bat species (Yuma myotis and Townsend's big-eared bat) are Federal Species of Concern. Some of these bats require caves, mines, abandoned wooden bridges and buildings for roosting sites, others require snags, still others utilize both types of roost sites. Foraging areas vary from shrub, chaparral and open fields to streams, lakes and or meadows; essentially, anywhere insects can be found, though some bats do favor particular insects.

There are no confirmed sightings of any bat species in the watershed; however, suitable habitat exists. Special habitat needs, though, for the Survey and Manage species expect to be met through snag management, Riparian Reserves, and survey and manage management guidelines. The remaining four species of bats are also expected to be provided for through the above mentioned management.

3.3.8 Neotropical Migratory Birds

Eighty-three (83) neotropical migratory birds (NTMBs) are suspected to occur within the watershed. Examples include:

Riparian guild - Cooper's hawk, sharp-shinned hawk, yellow warbler, yellow-breasted chat.
Open-shrub guild - green-tailed towhee, golden eagle, prairie falcon.
Open-grass guild - killdeer.
Late seral guild - brown creeper, flammulated owl, varied thrush.

Songbird surveys have been conducted by the Point Reyes Bird Observatory at Madrone Campground from 1992-97 (Ballard and Geupel, 1998). Results from the most recent surveys are on file at McCloud Ranger District and summarized in Appendix C.

These species require breeding habitat and migration corridors. Because of alteration to breeding habitat and increased exposure to predation and parasitism many of these populations have undergone significant declines. Habitat preservation and restoration is the backbone of maintaining current populations of NTMBs. Following proper management of breeding habitat, exposure to predation and parasitism is expected to become reduced.

The general Forests standards and guidelines state that habitat is to be managed for NTMBs to maintain viable population levels. Management of Riparian Reserves, fragmented forested habitat, hardwoods, old-growth and late seral habitat, diverse seral stages, visual quality, protection buffers, snags, dispersal habitat, and special lands will help preserve breeding habitat for NTMBs. Deer herd management is also expected to improve the habitat of NTMBs as well as residents which are dependent upon shrub habitats. The creation of edges is beneficial to most of these species. Also of importance is the proximity of water and the size of shrub patches. A preliminary attempt at determining the size of patches needed was conducted (USDA, 1994), but only information about territory size was found. Deer management which maintains large 40+ acre patches of shrub habitat (mostly late seral) is expected to be most beneficial at this time.

3.3.9 Game Species

Black-tailed Deer
A management plan for the Lower McCloud Deer Herd was established in 1983 by the California Dept. of Fish and Game, Region I in cooperation with U.S. Forest Service, U.S. Bureau of Land Management and the U.S. Park Service. This plan indicates the population trends, suitable fawning habitat, and management for winter and summer range. Current information, which will supplement the existing management plan, was provided by CA Dept. of F&G (pers communication, D. Smith 2/97; CA Dept. Fish and Game, Wildlife Biologist)

The Squaw Creek Watershed lies the range of the Shasta Lake deer herd. This herd contains resident and wintering Colombian black-tailed deer. The watershed also contains resident deer, but is noted as providing summer and transitional range. Though there is limited knowledge regarding the area because of access, a number of concerns exist for those resident and seasonal deer populations.

Concerns regarding habitat for deer include the loss of early seral habitat, the loss of herbaceous and young shrub layer in the understory, and the encroachment of hardwoods by conifers. The exclusion of fire has caused the habitat to shift from a mosaic of early seral habitat, to mostly late seral habitat. This shift encroaches upon herbaceous openings as well as limits the amount of foragable shrubs. Fire exclusion has also allowed the understory of forested conifer and oak habitats to mature, to be shaded out and to be replaced by shade tolerant species. Again forage, especially late summer forage important for resident deer, is eliminated with this change in vegetation. Lastly, fire suppression has also allowed hardwoods within mixed hardwood/conifer habitats to be overgrown and shaded out. This is suspected to occur once the conifers reach >60% canopy. The mast produced by these hardwoods is reduced or eliminated, removing another food source for deer and other game species such as elk and turkey.

Specific areas where these changes have occurred is unknown, though they are suspected to have occurred throughout the watershed. Changes can be determined by comparing the 1944 photos to current conditions. Other deer habitat analysis, such as hiding cover, fawning cover, and new brush within the chaparral community was not conducted as such analysis would require a more detailed database than LMP90, which provides no seral stage breakdown for chaparral or hardwoods.

Elk

There are numerous elk sightings within the watershed. The elk are remnants of a herd of Rocky Mountain elk that were introduced into the Squaw Creek Watershed and vicinity in 1913. Approximately 51 elk were transported from Montana and released in the Bully Hill Mine area. After several special hunting seasons occurring between 1968 and 1972 elk use in the watershed and vicinity was observed to decline by 50 percent. A study conducted by Murphy and Smith in the early 1970's concluded that the elk herd had declined steadily since 1966. Factors that were believed to have contributed to the decline of the elk included habitat loss and fragmentation caused by fire suppression, timber harvest and road building. Hunting and poaching may have also played a role in the decline of the elk population. See Smith and Murphy, 1980 for a complete report on the status of the herd and its history.

3.3.10 Survey and Manage Species

The Shasta-Trinity National Forest is required to survey for 17 survey and manage (S&M) species prior to initiating ground disturbing activities (4/99). The Squaw Creek Watershed may have suitable habitat for 14 of these species including 1 aquatic snail, 8 terrestrial snails, 1 bryophyte and 4 vascular plants.

Species Group	Scientific Name	Common Name
Mollusk (aquatic snail)	Fluminicola seminalis	nugget pebblesnail
Mollusk (terrestrial snail)	Helminthoglypta talmadgei	Klamath shoulderband snail
Mollusk (terrestrial snail)	Helminthoglypta hertleini	Oregon shoulderband snail
Mollusk (terrestrial snail)	Monadenia churchi	Church's diebaqnd snail
Mollusk (terrestrial snail)	Monadenia troglodytes	Shasta sideband snail
Mollusk (terrestrial snail)	Monadenia troglodytes wintu	Wintu sideband snail
Mollusk (terrestrial snail)	Trilobopsis tehamana	Tehama chaparral snail
Mollusk (terrestrial snail)	Trilobopsis roperi	Shasta chaparral snail
Mollusk (terrestrial snail)	Prophysaon dubium	Papillose tail-dropper slug
Vascular Plant	Allotropa virgata	sugar stick
Vascular Plant	Botrychium minganense	Mingan moonwort
Vascular Plant	Cypripedium montanum	mountain lady's-slipper
Vascular Plant	Cypripedium fasciculatum	brownie lady's-slipper
Bryophyte	Ptilidium californicum	Pacific fuzzwort

See Appendix D for habitat descriptions of S&M species.

3.3.11 Wildlife Habitats

Late-Successional Habitat
Approximately 24 late-successional associated species are believed to occur within the Squaw Creek watershed: northern goshawk, blue grouse, northern spotted owl, pileated and hairy woodpeckers, varied thrush, solitary vireo, Steller's jay, brown creeper, silver-haired and hoary bats, black bear, American marten and Pacific fisher, to name several species (App. 2). Species of Federal Concern include the northern goshawk, northern spotted owl, silver-haired bat, American marten and Pacific fisher.

Generally, the habitat that these species are keying into includes late-seral, multi-storied forested habitats with >70 percent canopy closure. Northern spotted owls require large snags (>24" DBH) or broken top trees to nest in. Pacific fisher and American marten require large (>20"diameter) dead/down woody material for denning.

Suitable late-successional forest habitat is expected to be provided through the LSR, Managed Late- Successional Area (MLSA) and Riparian Reserve allocations. In addition, the northern portion of this watershed is also Critical Habitat. Northern spotted owl (STOC) suitable habitat categories are incorporated into the following captions to facilitate tracking of the owl's habitat needs.
All species require dispersal habitat between areas of suitable late successional habitat. Generally, dispersal habitat is mid to late-seral forested habitats with 40 percent or greater canopy closure. Riparian reserves containing riparian or forested habitat are also important dispersal corridors. Dispersal habitat is expected to be managed for through LSR , MLSA and Riparian Reserve direction and FWS requirements for STOC dispersal.

Old Growth (Suitable Nesting/Roosting Habitat)
Currently nine percent (4,493 ac.) of the Federal acres within the watershed contain suitable old growth habitat. The northern sixth of the watershed contains the largest blocks of old growth habitat. This portion of the watershed is designated as late-successional Reserve and is a portion of LSR RC-335. Fragments of late successional habitat are scattered in the southern 5/6 of the watershed. This habitat is generally associated with riparian reserves and northerly-facing slopes. In addition, one MLSA is located in the middle of the watershed along the eastern edge. This MLSA supports one STOC activity center and is comprised of stringers of suitable habitat along creeks. This old growth will be protected and additional habitat will be provided for through management of LSR, MLSA and Riparian Reserves and matrix lands.

Old growth habitat within this watershed occurs as larger contiguous checkerboard patches in the north The northern sixth of the watershed contains the largest blocks of old growth habitat. This portion of the watershed is designated as Late Successional Reserve and is a portion of LSR RC-335. Fragments of late successional habitat are scattered in the southern 5/6 of the watershed. This habitat is generally associated with riparian reserves and northerly-facing slopes.

Connectivity between patches in the northern one-sixth of the watershed is present, since this area is within LSR. Connectivity of patches in the southern 5/6 of the watershed is lacking or if present, occurs as a narrow patch of habitat, usually in a riparian reserve or on a ridgetop. The smaller fragmented nature of the old growth patches to the south may be a function of both timber harvest, natural site capability and wildfire.

Potential LS/Old Growth (Foraging Habitat)

Currently, 25 percent of the watershed contains young/mature forested habitat (Suitable foraging habitat). Some of this habitat lies in several patches within the LSR at the northern boundary of the watershed. The remainder of this habitat lies within the matrix, south of the LSR. Several relatively large contiguous patches occur in the vicinity of the MLSA in the center of the watershed and several large patches occur in the southern portion of the watershed. The remaining patches are small and isolated.

Dispersal Habitat

The amount of suitable dispersal habitat in the watershed is currently unknown. Dispersal habitat should be estimated by looking at the vegetation maps and aerial photos. Although conifer-dominated forested dispersal habitat appears to be lacking, the black oak stands and mixed conifer/hardwood forests provide good dispersal habitat for the northern spotted owl and other species during spring, summer and fall months. Riparian corridors also are providing dispersal habitat within bands of conifer-dominated forests located adjacent to intermittent and perennial streams. Dispersal habitat is lacking in the southwestern foot of the watershed on the west slope of Shasta Lake where the habitat is dominated by chaparral (Map 9).

3.3.12 Habitat Elements

Snags

Approximately 27 wildlife species believed to occur within the Squaw Creek Watershed are dependent on snags for nesting, roosting or denning (see Appendix 2). They make up 12% of all the wildlife species within the watershed. Eleven of the snag dependent wildlife species are primary excavators, those species which create cavities. This group includes the white-headed woodpecker and pygmy nuthatch. Forest observation records, breeding bird surveys, and Christmas bird counts have confirmed their distribution in the Shasta Lake Ranger District. Four of the snag dependent wildlife species are bark cavity dwellers, three of which are "survey and manage" bat species. Other wildlife species, besides those considered dependent, will also utilize snags.

Suggested snag densities based on the latest models indicate that the following snag and recruitment densities are needed, per acre (These figures are based on the habitat and the cavity dependent species which are associated with them):

Habitat	Snags/acre	Recruitment/acre
Douglas-fir	1.5	4.5
Hardwoods	2.5	7.5
Riparian habitat	3.0	9.0
Mixed conifer	4.0	12.0
Ponderosa pine	4.0	12.0

Table 3-11: Suggested snag densities for the Squaw Creek Watershed.

Snag densities within National Forest lands within the watershed closely approximate natural potential densities due to lack of recent natural and human disturbance. Snag densities are expected to be lower on private lands due to recent timber harvest. Large snags are not common due to the extensive stand replacing wildfires that occurred at the turn of the century.

Hardwood stands are considered a non-commercial forest product at present, so, except for fuelwood cutting, harvest of hardwoods is expected to have a minimal impact on naturally occurring snag numbers. The snag density needs for wildlife within hardwood habitat are expected to be met. If hardwoods are commercially harvested in this watershed, application of these snag and recruitment tree guidelines is expected to provide for the needs of snag and cavity-dependent species.

Dead/Down Wood

Approximately 24 species of wildlife are dead/down wood dependent species (see Appendix 2). None of the species are Federally listed. Many other species, though not considered dependent, do utilize dead/down wood, like the American marten, small mammals, amphibians, woodpeckers, and bear. Unlike snags densities, suggested dead/down densities are based on the needs of dependent and 'non-dependent' species, mainly those species of high profile. These dead/down densities are expected to meet the needs of most, if not all other wildlife species which utilize dead/down. Areas affected by timber harvest, past wildfire or located in poor growing conditions are expected to have less than the recommended levels of dead/down material.

Caves/Mines/Bridges/Buildings

Twelve wildlife species are known to utilize caves, mines, bridges or buildings for roosting, nesting, or denning. Of these the Shasta salamander, long-legged myotis, long-eared myotis, fringed myotis, pallid bat, and Townsend's big-eared bat are of species of special concern. There is a need to acquire additional information pertaining to caves in the watershed. Due to the abundance of limestone in the Hosselkus Formation the potential for cave habitat is high.

Bridge/Buidling Location	Road ID	Type of Bridge	Surveyed?
Squaw Creek	1W13	Flat Car	No
Squaw Creek	38N95	Flat Car	No
Bill's Creek	34N17	Steel girder and concrete slab	No
Smith Creek	34N17	Steel girder and concrete slab	No
Squaw Creek	34N17	Steel truss and treated timber	No
Salt Creek	35N03	Pre-fab concrete	No
Winnibulli Creek	35N03	Treated timber stringers and treated wood deck	No
Didallas Creek	35N03	Steel girders, timber deck	No
West Fork Didallas Creek	35N03	Steel girders, timber deck	No
Second Creek	35N03	Timber stringers, timber deck	No
Squaw Creek Guard Station and barracks	Various Buildings	NA	No

Table 3-12: Bridges and abandoned buildings which may be utilized by wildlife. Some bridges located on private lands are not shown.

3.4 Erosion Processes

3.4.1 Lithology

The Squaw Creek Watershed is located within the Eastern Klamath Mountain Belt of the Klamath Mountain Geomorphic Province. The lithology of the watershed consists of several distinct rock types arranged in northeast-southwest trending belts (Map 12). From west to east and oldest to youngest the major formations found in the watershed are: the Dekkas Andesite, Pit Formation, Brock Shale, Modin Formation, Arvison Formation, the Bagley Andesite and Potem Formation.

These Mesozoic formations consist of sedimentary and volcanic fragments of tectonically accreted island arcs to the North American continent. Sedimentary rocks composing these formations generally consist of mudstone, shale, sandstone, and conglomerate. Volcanic components generally consist of basalt, andesite, breccia, agglomerate and tuff. Quaternary Alluvium deposits occur within the majority of the Squaw Creek corridor and along portions of the North Fork Squaw Creek and Salt Creek. The Hosselkus Limestone formation is also present in a narrow north-south trending band that bisects the watershed. The southern portion of this formation in the vicinity of Devils Rock is within the proposed Hosselkus Research Natural Area.

3.4.2 Geomorphology

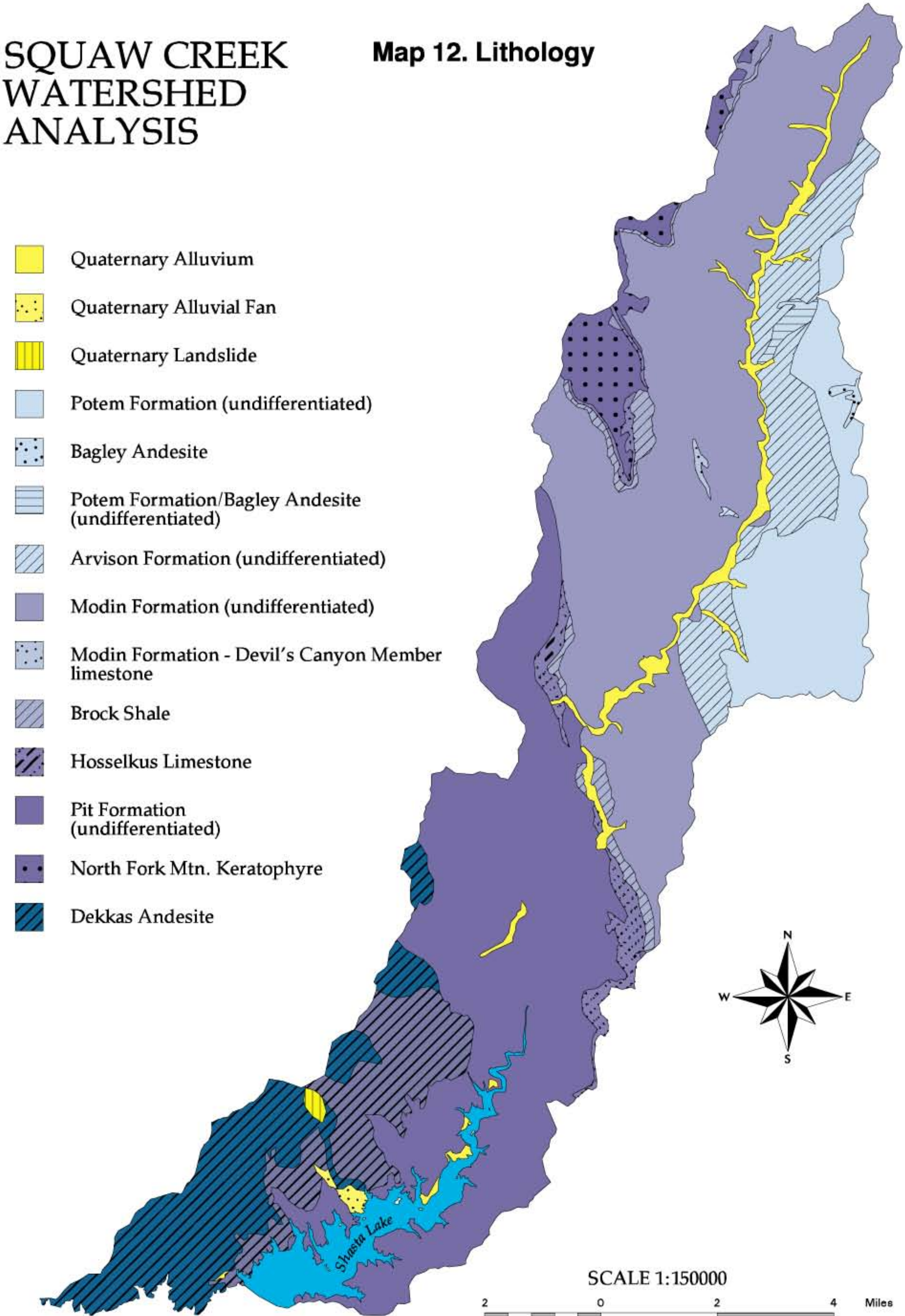
The rugged topography in the watershed has been formed over millions of years by a combination of fluvial and mass-wasting processes which continue to be active in the watershed today. Geomorphic features in the watershed are shown on Map 13.   Some of these features have been generalized in the Figure 1. The majority of the watershed area consists of translational-rotational landslides, debris slides and colluvial hillslope geomorphology. Debris flows and torrents can also be found within some high gradient streams.

Debris slides are generally confined to the shallow soil or colluvium zone. The failure surface generally corresponds to the bedrock/soil interface. A gradation exists from debris slide to debris avalanche depending on water content, cohesion of material and slope steepness. Debris slides and avalanches generally occur in immediate response to significant precipitation events. Within the watershed, the majority of these slides can be found on south or west-facing slopes with gradients greater than sixty-five percent.

Debris flows are also common in the low-order (high gradient) stream channels of the watershed. These consist of rapidly moving water-charged soil, rock and organic material generally initiated during extreme discharge events when a streamside debris avalanche enters a channel and entrains organic debris and sediment through scouring as it moves downstream. The torrent continues to flow and scour until it reaches a lower gradient stream reach or meets a significant obstruction. When its momentum is lost, the slide material is deposited within the channel. The deposit is usually downcut and slowly winnowed of its fine-grained silt, sand, gravel and organic components which are transported further down the channel. The coarser-grained cobbles, boulders, and organic material remain as a lag deposit within and along the channel. This

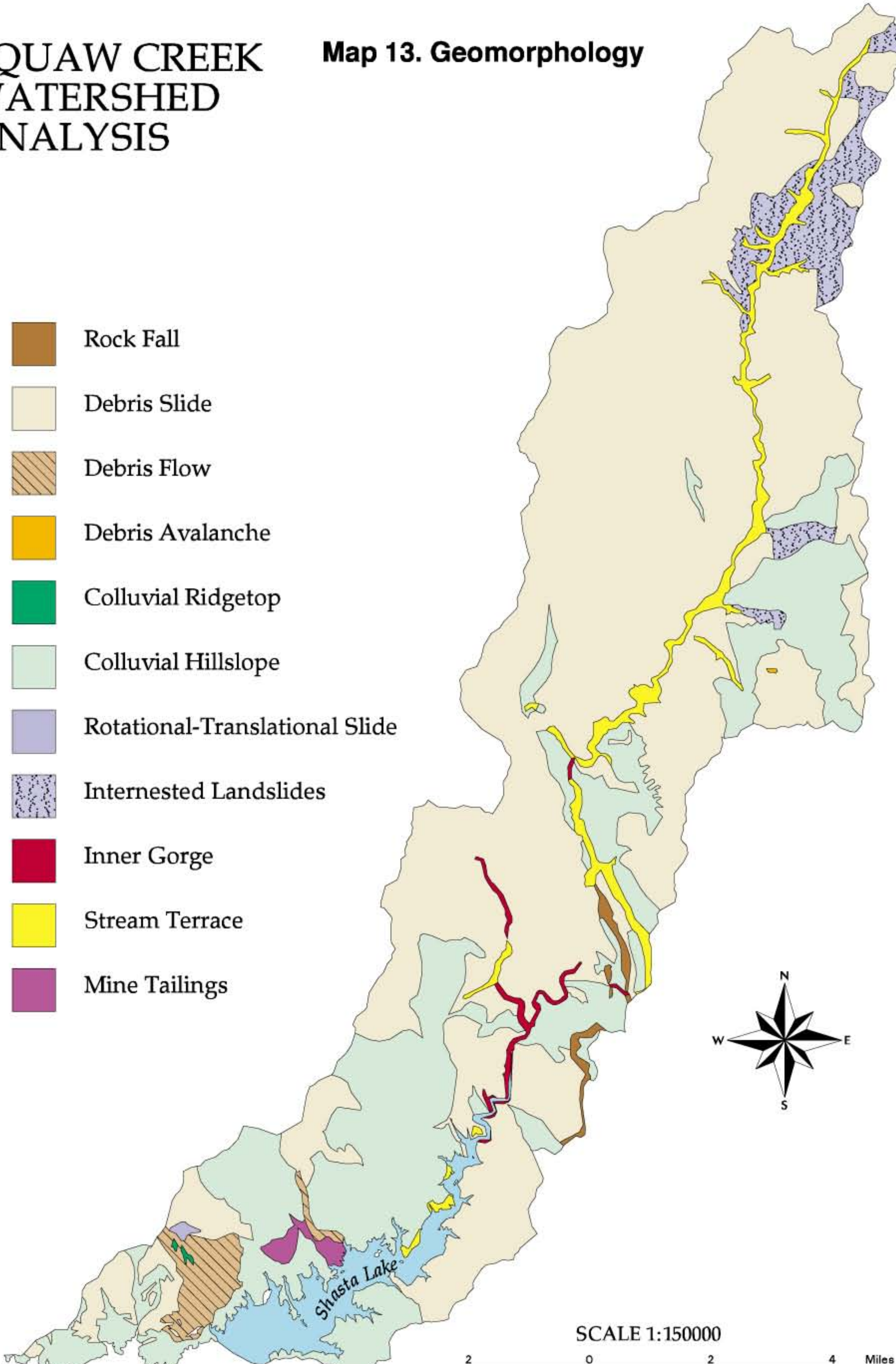
SQUAW CREEK WATERSHED ANALYSIS

Map 12. Lithology



SQUAW CREEK WATERSHED ANALYSIS

Map 13. Geomorphology



material can stabilize, revegetate or be re-entrained by later torrents. Timber harvest or fire activity can have a significant effect on the occurrence of debris torrents through slash and rock accumulations in channels (decreasing stream gradients) increased peak discharges, culvert and fill failures, and disturbance of steep streamside areas through mass-wasting (inner gorge) processes.

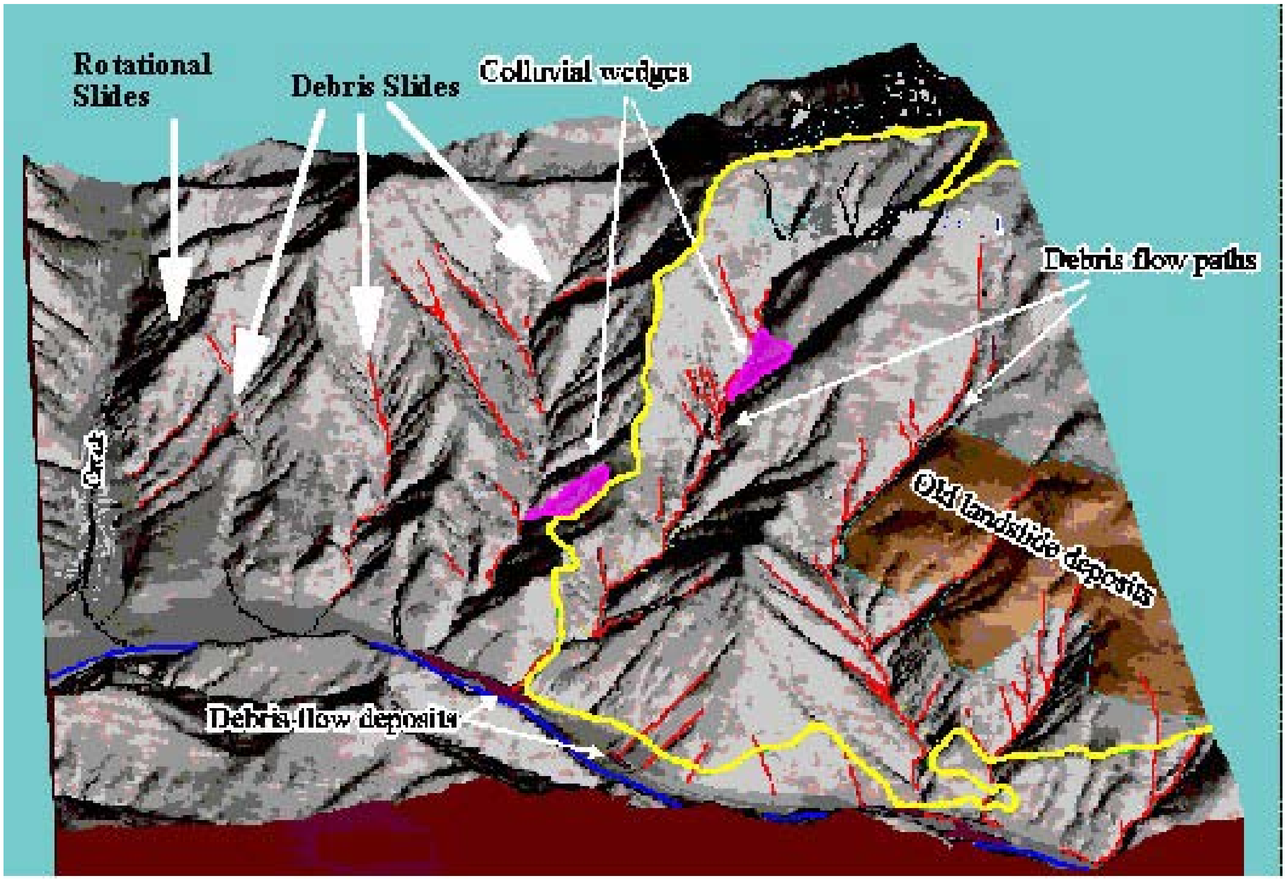


Figure 3-1: Geomorphic features found in the Squaw Creek Watershed.

In contrast, translational-rotational slide planes are moderately to deeply lying with relatively low movement rates. Movement of this type of slide generally occur in the winter and spring when moisture is high. Thusly, this type of morphology dominates aspects with higher moisture content such as north and east facing.

It should be noted here that landslide distribution maps alone are not sufficient for providing information on the causes for instability of a landscape, although they are useful for identifying the distribution patterns that can allow cause to be inferred. Also it should be noted that some types of landslide scars represent areas that are now stable, because previously unstable materials have been rearranged into a stable configuration. **<u>The least stable or potentially hazardous sites can often be those that have not yet failed</u>.** Professional judgement is required in determining the type of instabilities present, their causes, the factors affecting their distribution, and their significance to ecosystem values.

Toward this end, areas viewed as having a high potential for slope failure were delineated for this analysis and are shown on Map 6. High hazard areas occur primarily west of Squaw Creek in the upper two-thirds of the watershed. High hazard areas can include both dormant and active features which are prone to mass failure under current natural conditions or where human activities are likely to increase landslide distribution. The unstable land component of the Interim Riparian Reserves (Map 6) include the following types of land: 1) active landslides (2) inner gorges; (3) those high hazard areas as described above.

3.5 Hydrology

3.5.1 Hydrography

The Squaw Creek Watershed drains mountainous terrain forested primarily by mixed conifer forests, oak woodlands and brushy chaparral. The total drainage area of the watershed, including the Squaw Creek Arm of Shasta Lake, is 103.4 square miles. High points in the watershed include North Fork Mountain (5341 feet), Shoeinhorse Mountain (5256 feet), Little Shoeinhorse Mountain (5253 feet) and Tamarack Mountain (5221 feet), however the majority of the watershed area is between elevations of 1100 and 4000 feet.

The headwaters of Squaw Creek originate at an elevation of approximately 4,000 feet below the watershed divide that separates Squaw Creek from the Hawkins Creek drainage (Lower McCloud Watershed). Squaw Creek flows for a distance of approximately 24.1 miles before reaching the high water line of Shasta Lake (water surface elevation = 1065 feet). The lower 9.2 miles of Squaw Creek have been inundated by Shasta Lake.

Squaw Creek and its tributaries exhibit a dendritic drainage pattern typical of most watersheds in the Klamath Mountains. Because the shape of the watershed is long (north-south orientation) and narrow, most of the tributaries that enter Squaw Creek from the east and the west have small drainage areas of about 2-5 square miles. Examples of tributaries with east or west channel orientations include Crooks Creek, Modin Creek, Shake Creek and the East Fork of Squaw Creek. Tributaries that exhibit more southward stream channel orientations, such as the North Fork of Squaw Creek, Salt Creek and Didallas Creek, tend to drain larger areas.

The drainage density of the Squaw Creek Watershed is approximately 6.9 miles of stream channel per square mile. Drainage densities are very uniform throughout the watershed (Map 13). The watershed contains approximately 110 miles of perennial streams, 190 miles of intermittent streams and 391 miles of ephemeral streams. Ephemeral streams differ from intermittent streams in that they flow only in response to high intensity precipitation events or rapid snowmelt.

3.5.2 Riparian Reserves

Riparian Reserves are applied along all perennial and intermittent streams and along all ephemeral channels that exhibit annual scour. Mapped hydrologic features such as reservoirs, springs, seeps and wetlands are within Riparian Reserves. Unstable or potentially unstable areas are also included within Riparian Reserves (ROD, 1994). Riparian Reserves are intended to provide special protection to areas, where changes likely to occur in the absence of that protection would significantly affect on-site or downstream aquatic and riparian values. This criterion will be used to decide what lands should be considered unstable within a particular and individual project setting (ROD, 1994).

Riparian Reserves in the Squaw Creek Watershed account for approximately 44 percent of public lands (Map 6). Riparian Reserves associated with stream channels and reservoirs account for approximately 29 percent of Riparian Reserve acreage and Riparian Reserves associated with unstable or potentially unstable areas account for approximately 15 percent of Riparian Reserve acreage.

Riparian Reserves are managed according to the Aquatic Conservation Strategy (ROD, 1994; and standards and guidelines for various resource activities described in the Shasta-Trinity National Forest Land Management Plan (Shasta-Trinity LMP, 1995). Additional guidance for Riparian Reserve management is provided in the draft guide for Riparian Reserve Evaluation and Best Management Practices for protection of water quality (Riparian Reserve Evaluation, 1997; Water Quality Management, 1979).

3.5.3 Climate

The climate of the Squaw Creek Watershed is characterized by hot, dry summers and cool, wet winters. Annual precipitation averages approximately 60-80 inches with the majority of precipitation occurring between November and April. Total annual precipitation decreases rapidly to the east of the watershed from 70 inches near Reynolds Basin to 60 inches at Bunchgrass Mountain to 25 inches at Lookout Mountain. The majority of the precipitation falls as rain below 4500 feet. Snow occasionally blankets the entire watershed but rarely accumulates below an elevation of 4000 feet.

3.5.4 Base Flows

The Squaw Creek Watershed is unique among the larger tributaries to Shasta Lake because the entire watershed is located within the Klamath Mountain Geomorphic Province. Unlike the larger McCloud, Pit and Sacramento Rivers, streamflow in Squaw Creek, excluding the portion beneath Shasta Lake, is not affected by water diversion or regulated reservoir releases. The location of Squaw Creek within the Klamath Mountains and the lack of diversions and impoundments create conditions favorable to high base flows in Squaw Creek during the winter months and very low base flows during the summer months.

The location of the Squaw Creek Watershed entirely within the Klamath Mountains also results in different runoff characteristics than surrounding watersheds which are located partly within the Cascade or Great Basin (Basin and Range) Geomorphic Provinces. Streamflow characteristics in the Squaw Creek Watershed are homogeneous due to similar geologic parent material permeabilities, soils and climatic factors. This contrasts significantly with the Sacramento, McCloud and Pit Rivers; all of which have portions of their watersheds located within the Cascade and/or Great Basin Provinces. Runoff characteristics from the Cascade province are typified by lower peak flows due to groundwater storage and relatively constant summer base flows supplied by steady groundwater releases from the volcanic soils. When compared to the Cascade province, the Klamath Mountain Province has a much flashier runoff regime typified by large winter peak flows, limited groundwater storage and low summer base flows (see Figure 3-2).

Very little streamflow data are available for the Squaw Creek Watershed. Streamflow records exist for two gaging stations, both of which have been discontinued (Table 3-13). Station 11366000 was located above the confluence of Squaw Creek with the Pit River near the community of Ydalpom and was only active for two years. Twenty-two years of streamflow data were available for station 11365500. This station was located on Squaw Creek 1.3 miles upstream of the Salt Creek confluence. Daily streamflow measurements ceased in 1966, however winter storm runoff events over base levels were monitored through 1980.

Station Name	Station Number	Area (sq. miles)	Period of Record
1. Squaw Creek above Shasta Lake.	11365500	64.0	1945-1966
2. Squaw Creek at Ydalpom	11366000	99.5	1912-1913

Table 3-13: Discontinued streamflow gaging stations in the Squaw Creek Watershed.

Average monthly base flows for Squaw Creek are presented in Figure 3-2. Base flows are highest from December through April and decrease sharply from July through October in most years. Due to the highly variable nature of winter precipitation in Northern California, considerable variations in average monthly base flows occur from year to year. Considerably less variation occurs from July through September when precipitation is scarce.

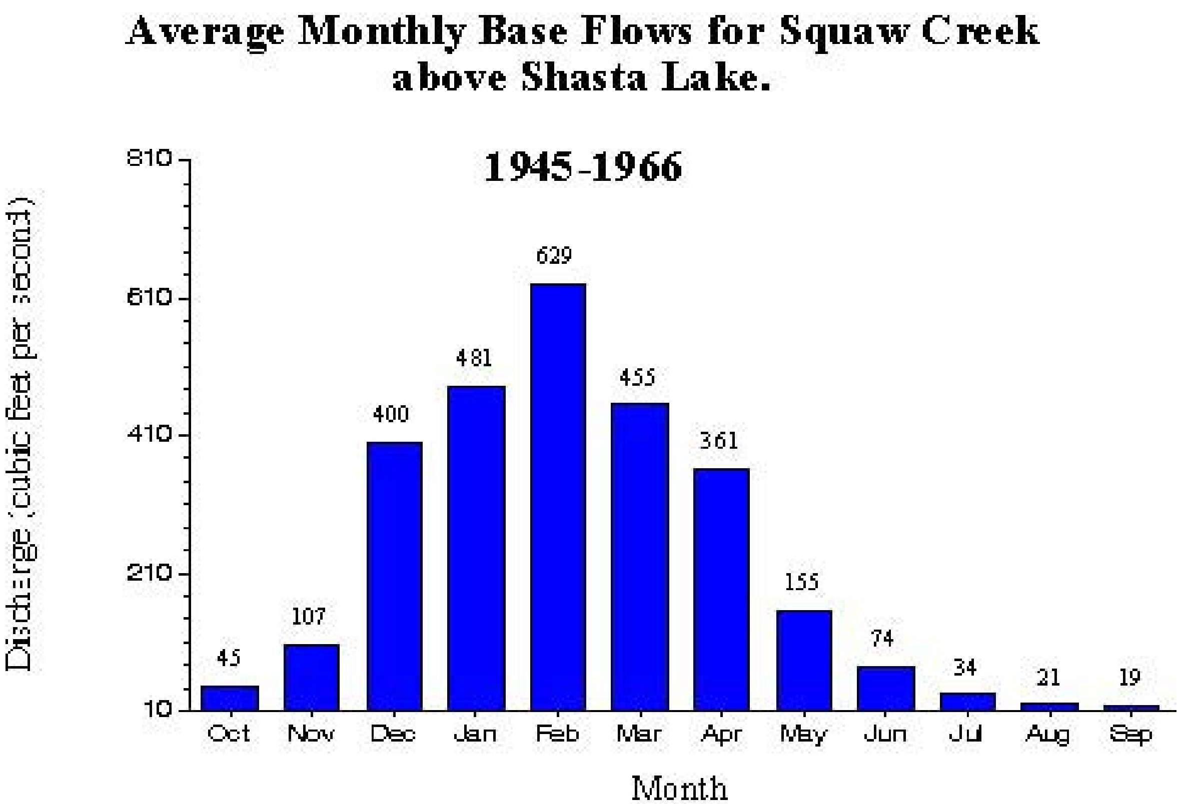


Figure 3-2 Average Monthly Base Flows for Squaw Creek at Station 11365500.

3.5.5 Peak Flows

The peak flow history for Squaw Creek from 1945-66 is shown in Figure 3-3. Peak flows normally occur in the Squaw Creek Watershed from December through March in response to large winter storms originating over the Pacific Ocean. Peak flows are largely a function of bedrock permeability, antecedent soil moisture conditions and the intensity and duration of large

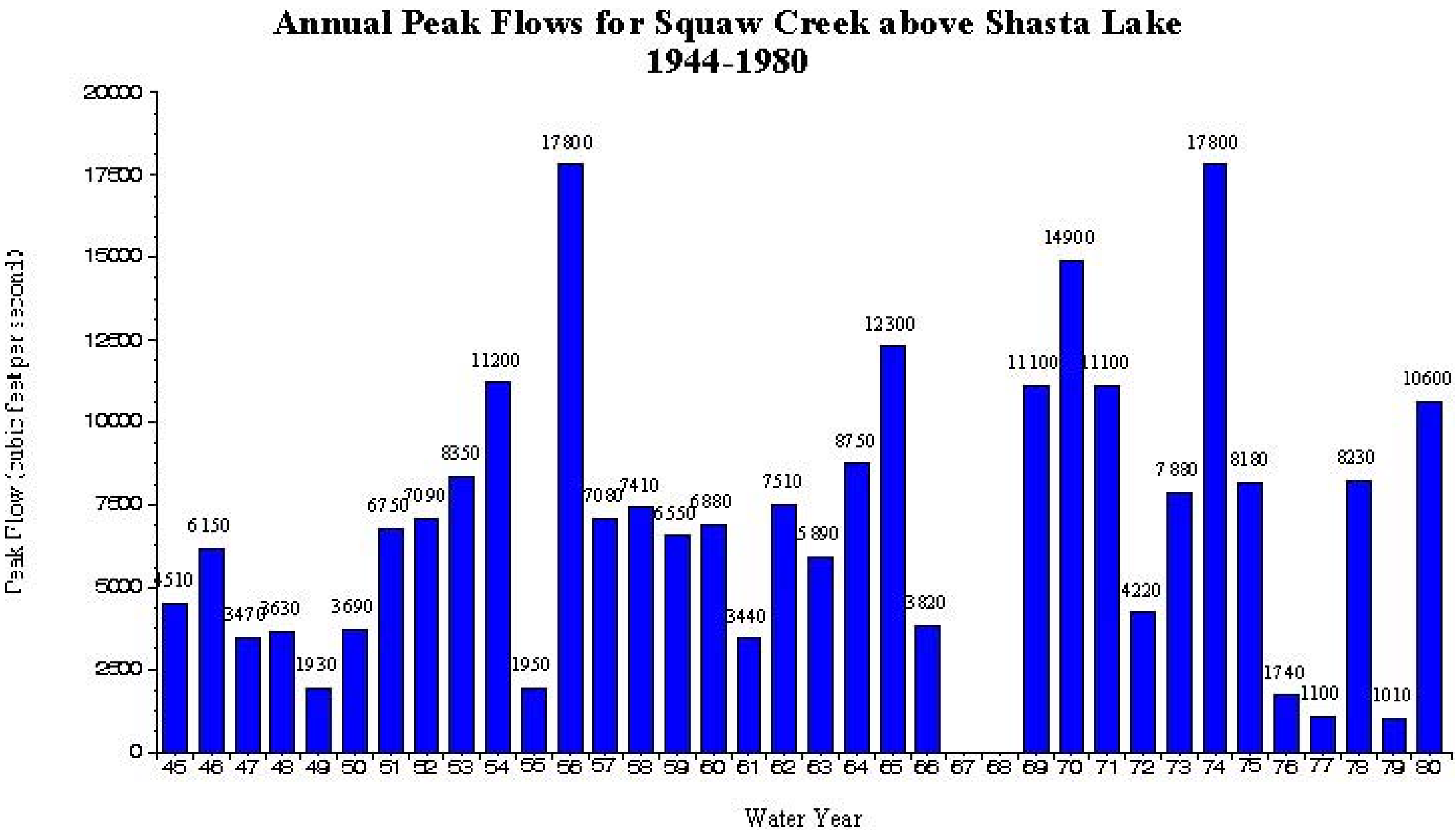


Figure 3-3: Peak flow data for Station 11365500. No data available for 1967-68.

Drainage	Area (mi^2)	Q2	Q5	Q10	Q25	Q50	Q100
Modin Creek	1.9	233	498	667	977	1219	1586
Salt Creek	8.5	886	1733	2249	3245	3989	5110
North Fork Squaw Creek	13.8	1356	2577	3312	4757	5818	7417
Squaw Creek at Fish Creek	15.0	1459	2759	3541	5081	6209	7909
Squaw Creek at Smith Creek	58.2	4810	8387	10473	14826	17875	22462
Squaw Creek Gage 11365500	64.0	5234	9072	11308	15993	19262	24183
Squaw Creek Gage 11365500*	64.0	6540	10700	13800	18200	21700	25600
Squaw Creek Watershed**	103.0	7956	13402	16547	23291	27919	34885

Table 3-14: Predicted peak flows for Squaw Creek Watershed and selected sub-basins (cubic feet per second). *Data from Waananen and Crippen, 1977. **Calculations include Squaw Creek Arm.

winter storms. Because the majority of the watershed is below an elevation of 4,000 feet, rain-on-snow events are uncommon and rarely contribute to peak flow events.

Estimates of instantaneous peak streamflows for 2, 5, 10, 25, 50 and 100 year recurrence intervals were calculated for selected tributaries and for Squaw Creek at several locations according to Waananen and Crippen, 1977 (Table 3-14). Peak flow estimates for station 11365500 include Waananen and Crippen's estimates from their 1977 report and the results obtained from applying the Sierra Region Equation. The largest flow events measured at station 11365500 occurred in both December 1955 and January 1974 when the instantaneous discharge peaked at 17,800 cubic feet per second. According to the flow estimates shown in Table 3-14 the 1955 and 1974 runoff events correspond to a 20-50 year flood for the Squaw Creek Watershed.

3.5.6 Effects of Natural Processes and Land Use Activities

The runoff characteristics in the Squaw Creek Watershed are a consequence of the geologic and climatic influences described previously along with other natural processes and land use activities. Prior to at least the year 1900, large wildfires are believed to have exerted the greatest influence on peak and base flows in the watershed by affecting vegetation and evapotranspiration. Over the past 100 years runoff processes have been affected to a larger extent by timber harvest, road construction, fire suppression, and mine smelter activities localized in the extreme southern portion of the watershed.

A complete review of the literature documenting the impacts of land-use activities on runoff processes is beyond the scope of this analysis. Rather than develop a comprehensive list of all of the known impacts of natural processes and land use activities on runoff processes, this analysis attempts to identify natural processes and land use activities that have the greatest potential to impact runoff processes and to determine the extent of possible impacts.

The impacts of land-use activities such as roads and timber harvest on peak flows are well documented (Reid, 1993; Reid and Dunne, 1984; Harr, 1975 and many others). Timber harvest activities have been found to lead to increased winter peak flows and increased summer base flows due to changes in evapotranspiration brought about by the removal of vegetation. Increases in storm water runoff have also occurred in heavily roaded watersheds. Road systems in the watershed have altered natural runoff processes by intercepting groundwater flows, creating additional runoff pathways on compacted surfaces and accelerating the delivery of water to the channel network.

Road construction and timber harvest have occurred throughout the Squaw Creek Watershed. A complete description of the extent of these activities is complicated by a lack of updated road maps and by the scarcity of information regarding past harvest activities on private and public lands. The impacts of these activities and the extent of the impacts are difficult to assess due to the checkerboard ownership pattern of private and public lands that is prevalent throughout the watershed. Large areas within the drainages surrounding the Squaw Creek Arm of Shasta Lake, are virtually unroaded and have not been subject to timber harvest activities while other areas have experienced varying amounts of timber harvest. The greatest amount of roading and harvest activities have been concentrated on private lands located in the northern third of the watershed (upper North Fork Squaw Creek and upper Squaw Creek) and in the areas to the east of Salt Mountain (Salt Creek drainage). The road systems in these areas are denser than the system shown on the 1992 topographic maps. The full extent of harvest activities and their impacts on runoff processes is unknown at this time, however it can be speculated that increases in both peak and base flows have occurred in the most heavily roaded areas where timber harvest has occurred.

Perhaps the most poorly understood process in the watershed is the role of natural fire, fire suppression and the how fire affects base flows and peak flows. Catastrophic fires have been found to result in increased peak and base flows in many watersheds (Tiedemann, 1979; Kaczynski, 1994). Newspaper accounts from the late 1800's document several large fires that burned throughout the Squaw Creek area catastrophically removing all vegetation with the exception of wetter, riparian areas located within the valley bottoms (see Ch. 4 for fire history). Significant increases in peak flows and base flows would have occurred in response to extensive vegetation removal. With the onset of fire suppression very few large fires have occurred in the watershed since 1920, and vegetation has recolonized the burned over areas. Peak and base flows in the watershed are expected to have decreased in the Squaw Creek Watershed due to the absence of natural wildfires.

3.6 Stream Channels

3.6.1 Channel Characterization

Stream channels in the Squaw Creek Watershed have been formed by mass-wasting and fluvial processes. Land use activities such as Shasta Dam, timber harvest and road construction have also affected channel morphologies by altering sediment transport and depositional processes. In a general sense, stream channels with similar drainage areas exhibit morphological characteristics that are similar to one another because the channels have formed in similar parent materials and under similar climatic conditions.

Data pertaining to channel characteristics were collected in 1994 during the Squaw Creek Aquatic Ecological Unit Inventory (AEUI). A total of 54 channel reaches ranging in size from upland swales to the lower reaches of Squaw Creek were inventoried. Selected characteristics for each reach are presented in Table 3-15 and reach locations are shown in Map 14.

The ability of the AEUI to extrapolate data to unsurveyed reaches was limited due to the low number of reaches surveyed (n=54). Due to the natural variability in measured parameters such as canopy cover, pool distribution and large woody debris function, it was impossible to extrapolate data collected from surveyed reaches to unsurveyed reaches. While some relationships may exist between stream reaches having similar drainage areas, caution should be taken when inferring characteristics from sampled reaches to unsampled reaches with similar drainage areas.

Site ID	Stream Name	Flow Regime	Bankfull Width	Channel Gradient	Bank Erosion Type	Channel and Bed Type	Percent Canopy Cover
600	Tributary to Squaw Creek	EPH	0.0	56	1	3	85
243	Tributary to Squaw Creek	EPH	1.3	42	1	3	84
659	Tributary to Squaw Creek	EPH	1.4	27	1	3	31
286	Tributary to Squaw Creek	INT	2.0	10	1	1	6
563	Tributary to East Fork Squaw Creek	EPH	2.0	34	4	3	89
995	Tributary to Madison Canyon Creek	EPH	2.5	28	1	2	84
423	Tributary to Garden Creek	INT	2.7	22	4	3	90
968	Tributary to Madison Gulch	EPH	2.9	31	1	3	80
660	Tributary to Squaw Creek	EPH	3.0	33	1	3	83
603	Tributary to Squaw Creek	EPH	3.0	19	1	3	83
508	Tributary to East Fork Squaw Creek	INT	4.0	10	2	3	88
874	Bills Creek	INT	4.0	17	1	1	83
553	Tributary to Salt Creek	INT	4.1	18	1	1	79
689	Tributary to Horse Creek	INT	4.1	13	3	3	77
476	Tributary to First Creek	EPH	4.6	53	4	4	26
585	Tributary to Salt Creek	INT	5.0	45	2	2	83
741	Tributary to Crooks Creek	INT	7.5	10	2	2	86
499	First Creek	PER	9.0	29	1	1	56
506	Tributary to East Fork Squaw Creek	EPH	9.2	7	2	3	89
252	Tributary to Modin Creek	INT	9.4	17	2	3	88

Table 3-15: Selected characteristics for stream channels in Squaw Creek Watershed (Squaw Creek Ecological Unit Inventory, 1994).

Site ID	Stream Name	Flow Regime	Bankfull Width	Channel Gradient	Bank Erosion Type	Channel and Bed Type	Percent Canopy
560	Upper East Fork Squaw Creek	PER	9.5	27	3	2	86
84	Low Pass Creek	INT	9.6	6.7	1	2	92
860	Tributary to Bills Creek	PER	10.8	8	2	2	92
228	Tributary to Didallas Creek	INT	12.0	25	1	1	78
149	Tributary to Winnibulli Creek	INT	12.5	49	1	1	92
715	Tributary to Crooks Creek	PER	13.0	10	2	1	92
472	Tributary to East Fork Squaw Creek	INT	13.7	10	3	2	83
359	Shake Creek	INT	14.0	25	2	1	91
126	Winnibulli Creek	PER	15.4	6.7	2	2	94
415	Garden Creek	PER	15.5	15	2	1	89
460	Second Creek	INT	16.2	3.9	2	2	47
358	Tributary to Salt Creek	PER	16.5	2.0	1	1	85
466	Second Creek	INT	17.1	2.0	2	1	41
1252	Beartrap Creek	PER	17.4	2.8	1	1	92
431	Horse Creek	PER	17.5	6.5	1	1	82
288	Salt Creek	PER	19.0	2.0	1	1	67
808	Hoffmeister Creek	PER	20.0	3.8	2	2	82
1419	Jackass Creek	INT	20.0	2.0	3	2	89
608	Prospect Creek	PER	23.0	8.0	2	2	78
24	Tributary to Salt Creek	PER	26.0	6.0	3	2	93
1003	Madison Canyon	PER	26.0	4.7	1	1	90
397	Garden Creek	PER	26.0	4.8	1	1	88
321	West Fork Didallas Creek	PER	29.0	3.9	2	2	96
687	Crooks Creek	PER	29.3	2.2	2	2	82
453	East Fork Squaw Creek	PER	32.8	0.8	3	2	88
76	Salt Creek below Winnibulli Creek	PER	34.1	2.1	1	2	83
65	Salt Creek above Winnibulli Creek	PER	35.5	0.4	3	3	86
607	Squaw Creek above Prospect Creek	PER	37.0	3.1	1	2	79
430	Squaw Creek above Horse Creek	PER	52.2	2.1	2	2	75
807	Squaw Creek above Madrone C.G.	PER	55.4	4.0	1	1	50
1415	North Fork Squaw Creek	PER	56.5	3.0	1	1	78
227	Squaw Creek above Modin Creek	PER	65.0	0.1	1	1	71
961	Squaw Creek below North Fork	PER	71.0	1.1	1	1	48
180	Squaw Creek above Salt Creek	PER	86.0	0.9	1	1	17

Table 3-15 Continuation: Selected characteristics for stream channels in Squaw Creek Watershed (Squaw Creek Ecological Unit Inventory, 1994).

Table Key (Table 3-15)

Flow Regime

PER = Perennial flow
INT = Intermittent flow
EPH = Ephemeral flow
For the purpose of this analysis ephemeral channels are those that only show slight to no evidence of annual scour.

Bank Erosion Type

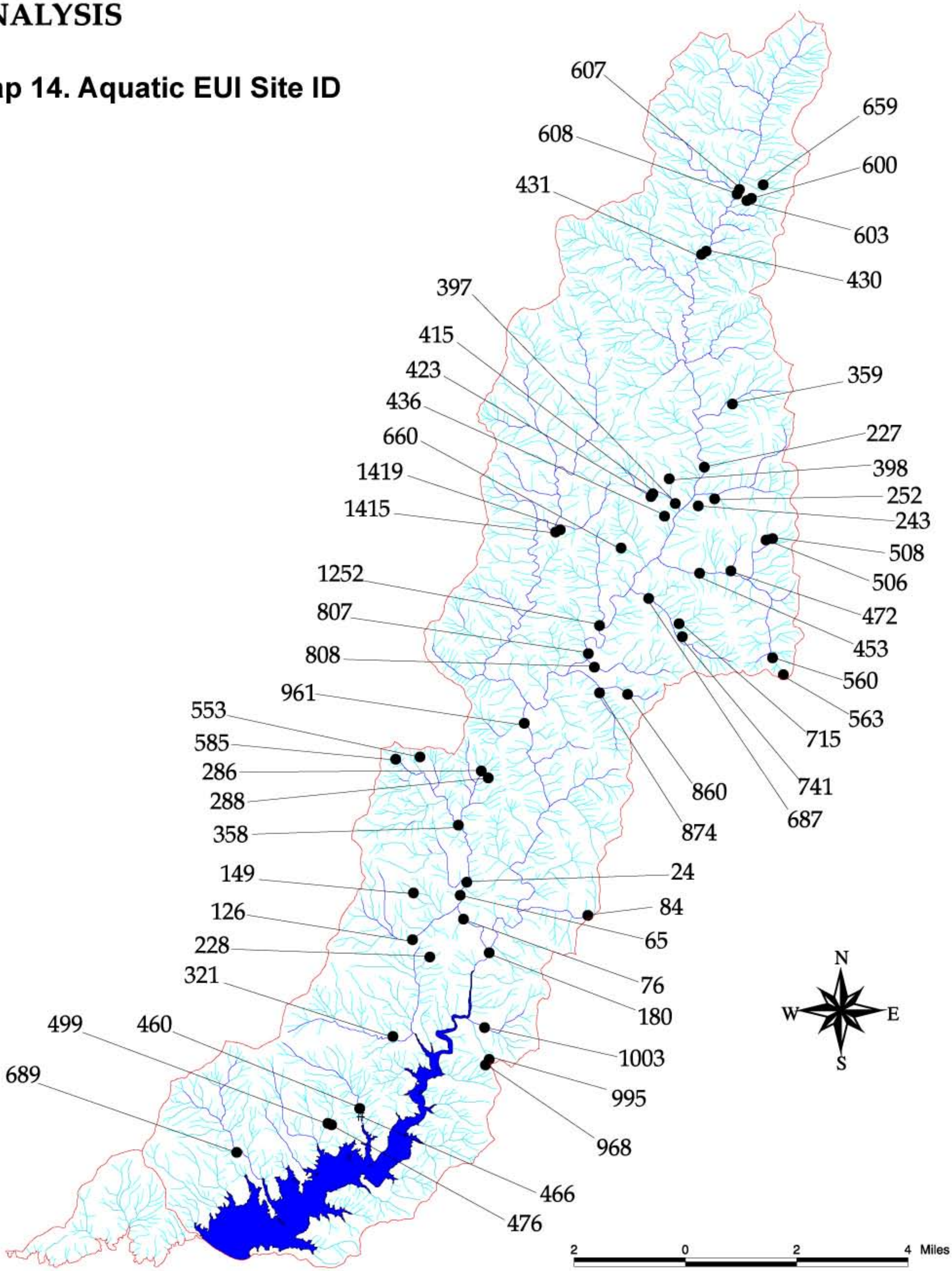
Type 1: The bed is strongly armored. Fine sediment (sand and fine gravel) on the bed surface is rare except in pools, backwaters, and the tops of some bars. Freshly mobilized substrate is evident only over narrow corridors of most channel segments and more widely over the heads of bars or pool tails.
Type 2: The bed is weakly armored. Mobile pebbles are abundant in runs and riffles, and pools are partly filled by small pebbles and sand. Bed displays widespread areas of substrate apparently mobilized by last peak runoff. Some gravel on bar surfaces is not fresh, but bed of channel bounded by bars or stable streambanks shows recent mobilization.
Type 3: The bed is unarmored except for riffles and bars, and appears mobile at relatively low flows. Substrate on the bed surface appears to have been extensively mobilized during last peak runoff.

Channel and Bed Type

Type 1: Noticeable bank erosion occurs only on the outside of alluvial bends and/or in locations where large woody debris has recently shifted or accumulated.
Type 2: Bank erosion is prevalent on the outside bends and on at least one side of some straight reaches.
Type 3: Streambanks show extensive recent erosion except at the inside of bends.

SQUAW CREEK WATERSHED ANALYSIS

Map 14. Aquatic EUI Site ID



3.6.2 Channel Types

In order to present the data the 54 channel segments were stratified into four size classes based on bankfull width. A summary of selected channel characteristics for channels with similar bankfull widths is presented in Tables 3-16 and 3-17. Channels with similar bankfull widths were found to have similar characteristics with respect to measured parameters such as stream order, channel gradient, canopy cover and active channel widths.

Bankfull Width	n	Average Stream Order	Average Percent Channel Gradient	Average Percent Canopy Cover	Average Wetted Channel Width (feet)	Average Active Channel Width (feet)	Averag e Bankful l Channel Width (feet)
0-5 feet	16	1.4	28.6	72	0	1.6	2.9
5-15 feet	12	2.3	18.6	85	1.1	8.0	10.9
15-30 feet	16	3.5	4.8	81	5.3	13.7	20.9
30-90 feet	10	5.1	1.8	67	23.0	37.3	52.6

Table 3-16: Channel characteristics for channels of varying bankfull widths in the Squaw Creek Watershed (Squaw Creek Aquatic Ecological Unit Inventory, 1994).

Bankfull Width	n	LWD contributing to Channel Stability (Percent of all reaches inventoried)	LWD contributing to fish habitat (percent of all reaches inventoried)	LWD contributing to channel gradient control (percent of all reaches inventoried)	LWD contributing to sediment storage (percent of all reaches inventoried)
0-5 feet	16	31	6	38	25
5-15 feet	12	58	0	17	33
15-30 feet	16	69	38	56	63
30-90 feet	10	50	20	10	20

Table 3-17: Large woody debris function in Squaw Creek Watershed (Squaw Creek Aquatic Ecological Unit Inventory, 1994).

Bankfull Widths From 0-5 Feet
Stream channels with bankfull widths of 0-5 feet comprised the majority of channels within the watershed. These channels occurred throughout the watershed but were mostly found in upland areas or in very small residual drainages located immediately adjacent to Squaw Creek. For the purposes of this discussion these channels are hereon referred to as **upland channels**. Upland channels correspond to both **alluvial** and **colluvial** channel types, and **hollows** (both channeled and unchanneled) as described by Montgomery and Buffington, 1993. Most of the upland reaches that were sampled were ephemeral and several of the channels did not display evidence of annual scour. Channels without annual scour were located in swales or within the hollows of

old mass-wasting features. Channel gradients varied but were generally steep, averaging 29 percent.

Large woody debris (LWD) contributed to channel stability, gradient control and sediment storage in less than half of the upland channels surveyed, however LWD was found to play a significant role in slope erosion control in almost all of the sampled reaches. The low values for LWD function are misleading because LWD was only presumed to be functioning if the channel was scoured by annual flows. The lower values for LWD function were due in part to the lack of observed flow in many of the swales that were surveyed. In other words, woody debris present in and adjacent to non-scoured channels (swales) was not viewed as directly contributing to channel stability because no definitive channel with annual scour was present.

Upland channels are important because they serve as source areas for sediment and are most vulnerable to land-use impacts due to their abundance and their position on the steeper portions of hillslopes. The source of many of the changes in channel morphology in larger channels such as Salt Creek can be traced to upland channels, which were the source areas for several large debris flows that occurred in response to heavy precipitation that fell during the 1997 Flood.

Bankfull Widths From 5-15 Feet

Channels with bankfull widths between 5-15 feet do not fit neatly into any one of the classes described by Montgomery and Buffington. In a very general sense they can be described as displaying characteristics similar to **bedrock** and **colluvial** channels and small **cascade** channels. Channels falling in this size class tended to be located on the midslopes of the watershed. Due to their steep gradients (average = 19 percent) these channels were classified as reaches with high sediment transport capabilities.

Large woody debris was observed to be contributing to channel stability in over half of the reaches surveyed, however LWD did not appear to be playing as large of role in storing sediment or controlling channel gradient. The reasons for differing levels of LWD function are unclear. Due to the steep channel gradients it is possible that LWD entering the bankfull channel may have been flushed downstream to lower gradient reaches where LWD was observed to be contributing more to channel gradient control, however the number of channels inventoried is too small to draw any clear conclusions regarding woody debris function.

Bankfull Widths From 15-30 Feet

Channels having bankfull widths between 15 and 30 feet are generally perennial and fall into the category of **step-pool** channels as described by Montgomery and Buffington. These channels were located mostly within inner gorge areas and, in most cases, were perennial streams tributary to Squaw Creek. As their name implies, step-pool channels are characterized by a pattern of alternating steps and pools. Stream channels surveyed generally had low channel gradients averaging 5 percent.

Large woody debris was found to have an important function in these channels with respect to its influence on channel stability, fish habitat, channel grade control and sediment storage. Large woody debris contributed to channel stability in approximately 70 percent of the reaches surveyed and was effective in maintaining channel grade control and storing sediment in over half of the reaches surveyed.

Bankfull Widths From 30-90 Feet
Channels with bankfull widths between 30 and 90 feet included all surveyed reaches of Squaw Creek and the lower reaches of its major tributaries. These channels generally fell into the step-pool or pool-riffle classes as described by Montgomery and Buffington. Measured channel gradients averaged 1.8 percent in all of the sampled reaches. Percent canopy cover along sampled reaches of Squaw Creek ranged between 16 and 79 percent with the lowest measurements occurring in the reaches with the greatest bankfull and active channel widths. Large woody debris contributed to channel stability in half of the channels surveyed, however LWD only functioned in this role in areas where it was located outside of the active channel. The occurrence of large woody debris was low in the larger tributaries. The low occurrence of LWD appears to be due to the scouring effects of large peak flows which are capable of flushing LWD through the lower reaches of Squaw Creek and its tributaries down to Shasta Lake.

The majority of the surveyed reaches of Squaw Creek exhibited pool-riffle channel morphologies. The canyon bottom contains a series of abandoned terraces, the lowest of which function as a floodplain for the river. Well developed terraces were present along the mid to lower reaches of Squaw Creek (i.e. Wheeler Ranch) but were largely absent from the tributaries.

3.6.3 Effects of Natural Processes and Land-Use Activities

Hillslope Processes and Peak Flows
Channel morphologies throughout the Squaw Creek Watershed are controlled primarily by hillslope erosion processes and peak flows. Landslides, debris flows and torrents that are initiated on hillslopes often serve as catalysts for changes in channel morphologies while bankfull flows are responsible for maintaining existing channel morphologies. It is difficult to partition hillslope impacts from peak flow impacts since these processes often operate simultaneously with wide spread impacts to the morphology of both upland channels and larger, low gradient channels. The ability of bankfull and peak flows to maintain or alter channel morphologies increases with increasing watershed area.

As mentioned previously, mass-wasting processes are responsible for much of the existing geomorphology in the Squaw Creek Watershed. Many upland channels have been formed by debris flows and torrents. In other areas slower acting erosion and mass-wasting processes such as soil creep, debris or rotational-translational landslides and earth flows, have gradually formed colluvial channels. While it has taken millions of years for hillslope erosion processes to create the topography visible today, changes to stream channel morphologies often occur suddenly in response to mass-wasting processes and peak flows. Rotational slides and debris torrents occurring during the 1997 Flood were observed to have actually changed hillslope topography in the Salt Creek drainage by creating new depressions on failed hillslopes.

Debris flow and torrent activity occurring in response to the January 1997 storms was particularly intense in the Salt Creek drainage. Numerous catastrophic debris torrents occurred in the headwaters of the west fork of Salt and Winnibulli Creeks. The largest of these began as a rotational landslides and resulted in the displacement of several million cubic yards of sediment. Upon entering the channel network, the slides became torrents and moved quickly through the upland tributaries to Salt Creek where they proceeded to scour riparian and upland vegetation and re-work the channel bed. The impacts continued downstream through the lower reaches of Salt and Winnibulli Creeks. Some of the impacts observed in the field included almost total removal of vegetation within and above the bankfull channel, the creation of new depositional terraces, large increases in inner gorge openings due to loss of canopy cover (particularly in low gradient reaches), channel widening, habitat simplification, entrainment of large woody debris, and the creation of large debris jams. Channel aggradation was prevalent above larger debris jams and in low gradient reaches. The aggraded sediments were subsequently scoured by high stream flows occurring during the final days of the storm. In the aggraded reaches of Salt Creek large debris jams have converted step-pool channels to plane bed channels. Riparian vegetation was observed to be recolonizing many channel banks, floodplains and terraces during the summer of 1997. While riparian vegetation is expected to recover quickly, the changes to channel morphology are expected to be in place for decades.

Effects of Wildfire and Fire Suppression Activities

Fires play an important role in the health of the overall ecosystem by altering hillslope processes and providing "dynamic and biologically critical contributions to ecosystems over long time frames" (Beschta, et al., 1995). Evidence of large wildfires occurring in the watershed in the late 1800's suggest that there is a potential for future similar events, and that some form of fire management other than continuous fire suppression is needed in order to minimize the risk of catastrophic wildfire.

Large wildfires have the potential to affect channel morphologies and water quality by decreasing vegetative cover, increasing hillslope runoff and increasing inputs of sediment and debris to the channel network due to hillslope erosion (Kaczynski, 1994). While the overall effect of fire suppression has resulted in decreased hillslope disturbance, the exclusion of fire has altered the natural disturbance regime of the watershed.

Inspection of 1944 and 1995 aerial photography indicates that impacts to stream channel occurred as a result of the large fires that burned much of the watershed in the late 1800's. Eroded hillslopes and inner gorges are present throughout much of the watershed area. Comparison of the 1944 and 1995 photos indicates that most of these hillslopes and stream channels are recovering from past fire activity. Many of the inner gorges that appeared to be scoured in 1944 are now obscured with a new growth of developing riparian vegetation. While the hillslopes and headwater channel are recovering, many of the larger stream channels in the watershed may still be affected by the large amounts of sediment generated during the late 1800 fires. Aggradation observed to be occurring in the lower reaches of Squaw Creek and its larger tributaries may be largely a consequence of the sediment generated from early fires that is still moving through the drainage network.

Effects of Timber Harvest Activities

Timber harvest activities and road construction are two land-use activities that have had a large opportunity to impact channel morphologies. Both of these activities have the potential to impact channel morphologies by changing the natural sediment regime under which stream channels in the watershed have evolved. The majority of road construction and timber harvest has occurred on private lands in the northern third of the watershed and east of Salt Mountain.

Timber harvest activities were observed to have impacted several of the upland channel segments surveyed during the 1994 AEUI (#659, #563), however timber harvest had not occurred in and adjacent to the majority of the upland channel segments that were surveyed. Impacts from harvest activities were mostly in the form of increased concentrations of slash and debris in and adjacent to ephemeral channels. With respect to public lands in the watershed, the extent of timber harvest impacts appears to be minimal, however it should be noted that the AEUI did not evaluate timber harvest or road impacts to stream channels located on private lands on which the majority of timber harvest has occurred.

Other land-use activities no longer occurring in the watershed have historically affected aquatic environments. Historical land-use activities include grazing, the construction of Shasta Lake, gold mining throughout the watershed, and copper mining in the vicinity of Town, Horse and Zinc Creeks. The effects of these activities will be discussed in Chapter 4.

Effects of Roads

The road network is currently the most damaging, and costly land-use activity influencing channel morphologies on public lands in the Squaw Creek Watershed. Problems with the road system that affect channel morphology include plugged culverts, interception of sub-surface flows (from roadcuts), rilling, gullying, and undercutting of unstable areas due to poor road location. Gullying is often most severe in areas where surface runoff is concentrated on road surfaces (Elliot, et al., 1996). While some of these problems are caused by poor design, the majority of problems with stream crossings can be attributed to lack of maintenance. Stream channels have been aggraded above road crossings due to plugged culverts and drains. In some cases culvert blockage has resulted in catastrophic failure of stream crossings and the introduction of large quantities of fill slope sediments into stream channels. The majority of road drainage and erosion problems are associated with roads located adjacent to and within canyon inner gorges and riparian areas. These problems are mostly noted east of Salt Mountain and in the northern third of the watershed where road densities are greatest.

Recent road construction and timber harvest probably played a role in aggravating mass-wasting processes in the Salt Creek drainage during the 1997 Flood since no other changed conditions are apparent. Landslides associated with forest roads have long been recognized by many researchers as the major source of sediment from managed forests of the Pacific Northwest. Just a few sited here are: Brown and Krygier, 1971; Dyrness , 1967; Swanston and Dyrness, 1973.

3.7 Water Quality

The quality of water in the Squaw Creek Watershed is affected by both natural processes and land-use activities. Beneficial uses dependent on high quality water include fish and aquatic life (including riparian vegetation), domestic drinking water for private land owners along Squaw Creek, aesthetics, and recreation benefits associated with fishing and camping in the upper watershed and fishing and boating in the Squaw Creek Arm of Shasta Lake. Impacts from grazing were not considered since this activity no longer occurs in the watershed. Very little water quality data exists for the Squaw Creek Arm of Shasta Lake. The only known exceptions are water quality data collected by the Water Quality Control Board at the Bully Hill and Rising Star mines and water temperature data collected by the Forest Service. Due to the lack of water quality data only general observations can be made regarding current conditions for water quality in the Squaw Creek Watershed.

3.7.1 Sediment

The cumulative impacts of natural hillslope erosion processes, wildfires, roads and timber harvest control the amounts of suspended sediment and turbidity in Squaw Creek and its tributaries. Changes in some water quality parameters such as suspended sediment only occur during peak flow events when mass-wasting processes and surface erosion processes are active. Large increases in suspended sediment concentrations and turbidity levels often occur during high flows. Field observations of high flows in the watershed suggest that suspended sediment and turbidity levels decrease rapidly after peak flow events.

In contrast to suspended sediment and turbidity, changes in the distribution of bedload following peak flows may be long lasting. Field observations of Salt Creek and Squaw Creek in the vicinity of Madrone Campground following the 1997 Flood indicate that the redistribution of bedload was substantial in these channels. While newly aggraded reaches were readily apparent initial observations found it much more difficult to identify reaches where channel degradation or the creation of deep water areas had occurred. Increased bedload concentrations in Squaw Creek and the lower reaches of its larger tributaries could be due mass wasting activity and the effects of past fires (see Hillslope and Stream Channel Morphologies, Section 4.2).

Sediment derived from road surfaces is a primary source of turbidity in many of the tributaries to Squaw Creek. With the exception of several small segments of paved road adjacent to Squaw Creek, no paved or gravelled roads exist in the entire watershed. No turbidity or suspended sediment data are available for Squaw Creek or its tributaries during storm flow, however highly turbid runoff from roads has been observed during winter storms. Increased in-stream turbidity from road sediments appears to be limited to the duration of storm runoff events. Research in other watersheds in Northern California has shown that increased turbidity from roads and timber harvest activities is generally not detectable during summer base flow periods when storm runoff is not occurring (Kopperdahl, et al., 1971). The amount of sediment eroded from road surface is believed to be greatest in the fall due to higher amounts of vehicle use and erosion from construction and maintenance activities. In its present condition the road system will continue to be a chronic source of suspended sediments to Squaw Creek and its tributaries.

Although they have not been a problem in recent years, catastrophic wildfires have the greatest potential to detrimentally influence water quality in the Squaw Creek Watershed. The combination of a large, stand replacing wildfire followed by a wet winter will increase erosion, which would in turn raise suspended sediment concentrations, turbidity, bedload and other parameters to levels detrimental to beneficial uses in the watershed.

Due to the absence of natural wildfires over the past 50 years, fire management has begun to use prescribed fire as a tool to reduce fuels and improve wildlife habitat in the watershed. Monitoring efforts have been undertaken to determine how erosion processes and vegetation are affected by prescribed burning. In 1995 a prescribed burn was conducted in the Garden Creek drainage. In order to determine how the burn affected Aquatic Conservation Strategy objectives (including water quality and hillslope erosion processes), eight photo points located in and adjacent to ephemeral and intermittent channels were established within the proposed burn area. The points were visited prior to and following the prescribed burn which occurred in February 1995. Results from the monitoring study indicate that the prescribed burn did not impact water quality or erosional processes in the Garden Creek drainage (Garden Creek Watershed Monitoring Report, 1995). No erosion was evident at any of the photopoints despite large peak flows that occurred in January (prior to the burn) and in March following the burn. The results from this report indicate that prescribed burning did not have a detrimental affect on water quality or erosion processes in the Garden Creek drainage, however additional monitoring needs to be done to determine how other areas, particularly those prone to instability, respond to prescribed fire.

While the monitoring report identified no observable impacts, it should be noted that considerable hillslope erosion was present in the Garden Creek area in 1944. Hillslope impacts observed in the 1944 aerial photography are probably due to large fires that occurred in the late 1800's. The Garden Creek area has largely recovered from these fires however some remnants of hillslope impacts are still observable on the 1995 aerial photography. More monitoring is needed in order to determine not only the effects of prescribed burns on inducing hillslope erosion, but also the effects of prescribed burning on the recovery rates of previously burned areas.

3.7.2 Water Temperature

Natural processes and land-use activities that remove vegetation such as wildfires, mass-wasting, timber harvest, and road construction can affect water temperature by removing vegetation and increasing the exposure of surface water to sunlight. Changes in water temperature due to the removal of the forest canopy can last for several decades. Water temperature recorders were placed in Squaw Creek and selected tributaries during 1994 and 1997 to collect base line data and to determine downstream trends in water temperature. The maximum daily water temperatures for Squaw Creek and its East and North Forks are shown in Figure 3-4. The highest temperatures were observed in Squaw Creek at Chirpchatter Campground and above the North Fork confluence. High temperatures were measured on July 20th, 1994 when the water temperatures in Squaw Creek at Chirpchatter and above the North Fork peaked at 77.2 and 78.8 degrees Fahrenheit, respectively. The lowest maximum temperatures were observed in the upper reaches of Squaw Creek above the West Fork of Squaw Creek and in the tributaries. On July 20th maximum temperatures in upper Squaw Creek, the East Fork and the North Fork were 61.2, 69.0 and 62.1 degrees Fahrenheit, respectively.

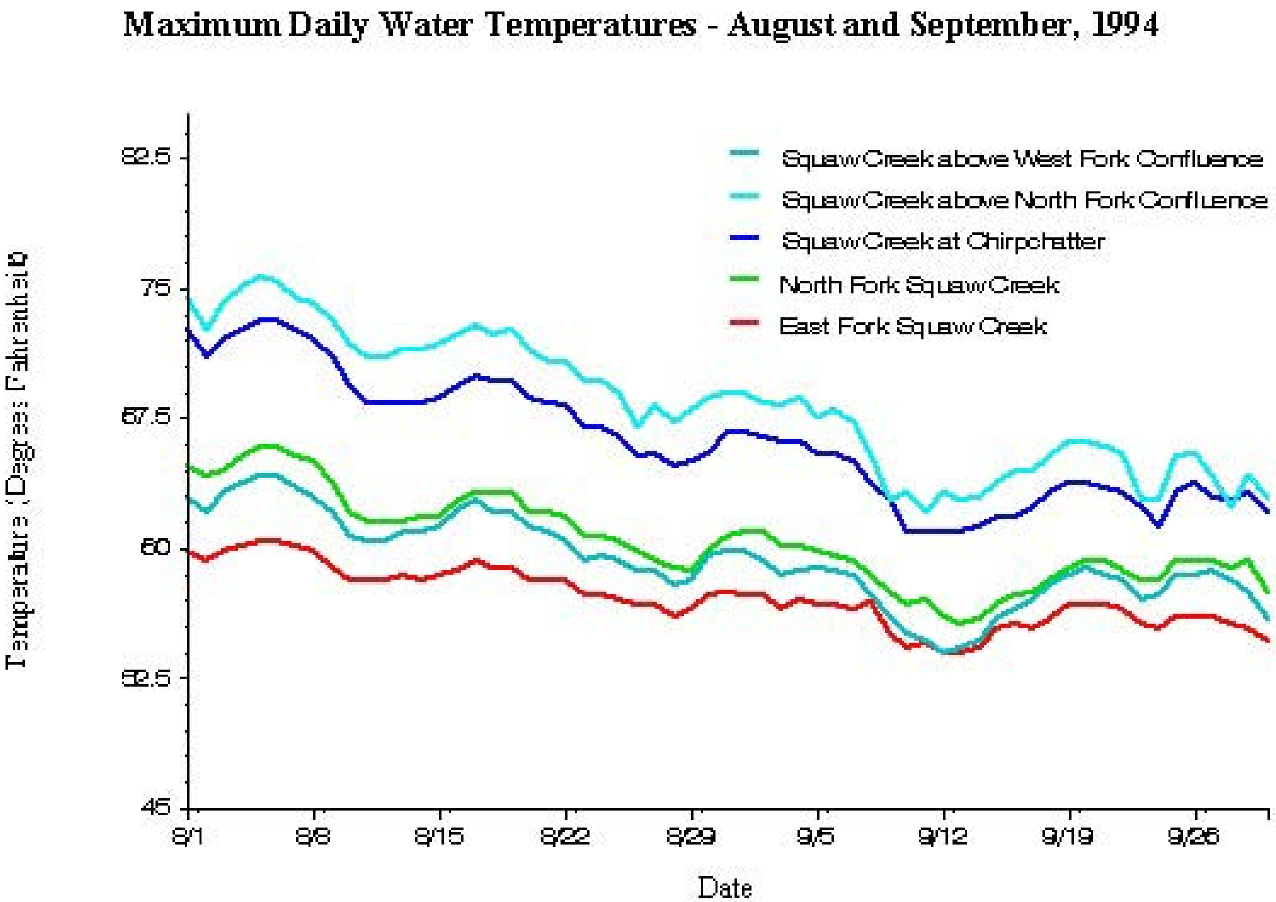


Figure 3-4: Maximum daily water temperatures for Squaw Creek a nd selected tributaries.

Water temperature data for Salt Creek and its East and North Forks were collected during the summer of 1997 in order to monitor the effects of a large debris flow which removed much of the stream shading canopy on the West Fork of Squaw Creek (Figure 3-5). Water temperature data show that the debris flow impacted West Fork of Salt Creek had higher water temperatures than the East Fork of Salt Creek. While the effects of the reduced canopy cover appear obvious, the discrepancy in water temperature between the East and North Forks may also be due to other factors including differences in tributary drainage areas, water residence times and differences in the amount of timber harvest and roads occurring in each tributary.

3.7.3 Effects of Mining Activities

Historic mining activities in the southern half of the watershed have resulted in the degradation of water quality and aquatic life in the lower reaches of streams tributary to the Squaw Creek Arm of Shasta Lake. Water quality in Town and Horse Creeks has been impaired by acid mine drainage (AMD) emanating from the Bully Hill and Rising Star mines (CH2M HILL, 1991; CH2M Hill, 1988). Acid mine drainage occurs when water enters the underground workings of

Maximum Daily Water Temperatures - August and September, 1994

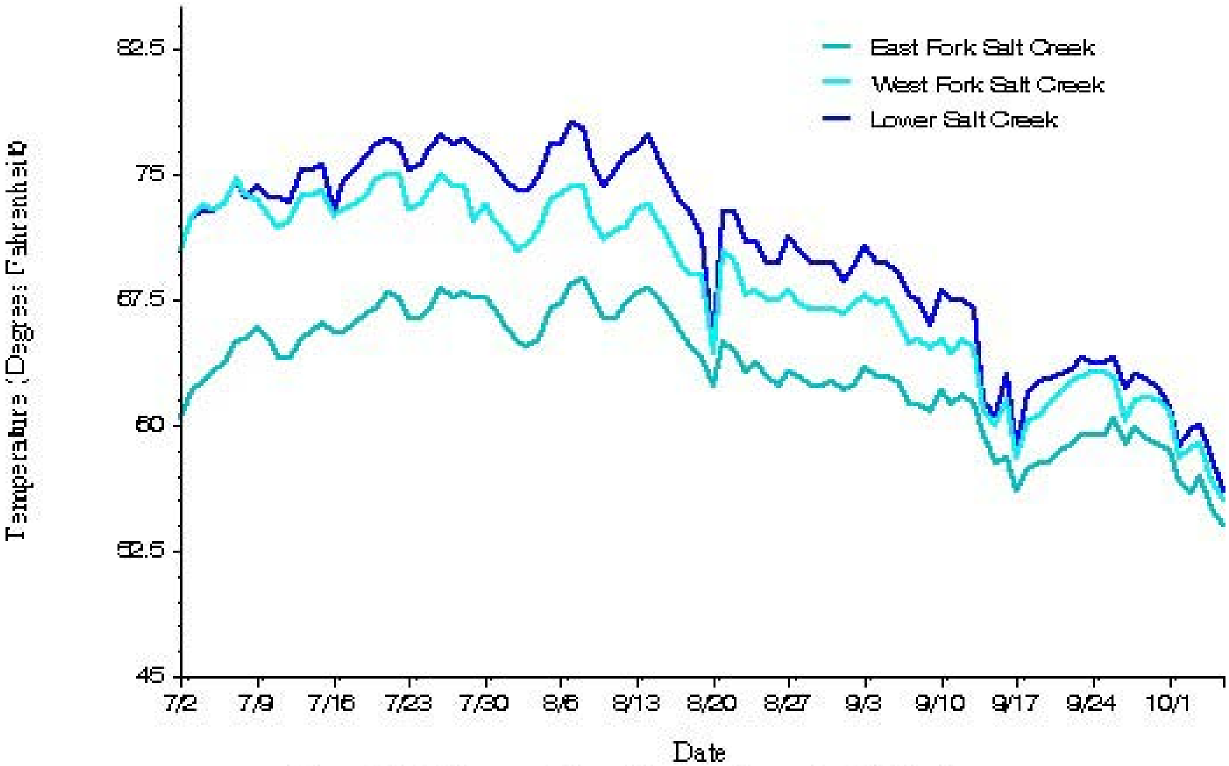


Figure 3-5: Maximum daily water temperatures for Salt Creek an d tributaries.

the mine through infiltration or by direct surface inflow. The chemical reactions responsible for the creation of acid mine drainage are described by CH2M HILL as follows:

> "AMD originates when water passes through fractures and underground workings of the sulfide orebody. Oxidation of iron pyrite in the exposed sulfide ore produces sulfuric acid, which is flushed through the orebody by percolating water. The sulfuric acid in turn attacks other sulfides, thus mobilizing metallic ions. As a result, the AMD has low pH and high concentrations of metals such as copper, zinc, and cadmium" (CH2M HILL, 1991).

The Bully Hill and Rising Star portals are point sources for the release of acid mine drainage to Town and Horse Creeks, respectively. Additional non-point sources present at both mines include waste rock piles, tailings, smelter wastes, and seeps. Both of these mines are located on private lands. Further information regarding water quality problems associated with the mines can be obtained in the reports referenced above, on file at McCloud Ranger District.

The California Regional Water Quality Control Board ('Board') is responsible for water quality on Shasta Lake.   The 'Board' recently issued an order requiring the owners of the Bully Hill and Rising Star Mines to cease and desist from violating waste discharge requirements (Order No. 97-215, 1997). The Board also has established waste discharge and monitoring requirements that regulate the amounts of metals that can be released from both mines (Order No. 97-214, 1997). Potential methods of decreasing ADM to levels that will meet these requirements are currently being evaluated.

3.7.4 Shasta Lake Water Quality

The quality of water in Shasta Lake is considered to be very good (NRA Management Guide, 1996). The California Regional Water Quality Control Board has responsibility for monitoring water quality on Shasta Lake. With the exception of the aforementioned problems at the Bully Hill and Rising Star Mines and the turbidity problems described below, no significant problems with water quality are known to exist in the Squaw Creek Arm of Shasta Lake.

According to the NRA Management Guide, the greatest water quality problem in Shasta Lake is the increase in turbidity levels that accompanies large runoff events. The causes of turbidity in the Squaw Creek Arm of the lake include mass wasting activity, sediment runoff from roads and hillslopes, shoreline erosion from wind and wave action and fluctuations in reservoir levels (NRA Management Guide, 1996).

With respect to other water quality parameters, the NRA guide concludes that "present and potential problems with sedimentation, nutrients, and bacteria are minor when compared with existing and potential turbidity, debris, and chemical-spill concerns" (NRA Management Guide, 1996). The low level of concern is partly due to the lack of recreational developments in the Squaw Creek Arm. Additional water quality information for Shasta Lake is available in the National Recreation Area Management Guide and the McCloud Arm Watershed Analysis.

CHAPTER 4

REFERENCE CONDITIONS

The purpose of this chapter is to explain how ecological conditions have changed over time as a result of human influence and natural disturbances. A reference condition for natural features and processes is developed for comparison with the current conditions. The effects of new and evolving land-use activities to the natural features and processes occurring in the watershed are discussed.

This chapter begins with a historic overview which summarizes the natural processes and land-use activities in the watershed. The remainder of the chapter follows the seven core topics presented in Chapter 3. Each core topic is discussed in the context of the appropriate time frame. In all cases a reference condition for each core topic is developed with the assumption being that the conditions for each core topic were within the natural range of variability (no land-use disturbance from humans) prior to 1850. Many of the inferences developed for reference conditions prior to 1850 are speculative in nature since there is little existing data to verify actual conditions. It is also acknowledged that the assumption of 'no human disturbance' prior to 1850 does not include changes to the landscape brought about by Native Americans. Discussions for the core topics are organized according to the following time periods:

- Pre-1850 — This a period before significant Anglo-American influences. The ecosystem was believed to be functioning under essentially natural conditions at this time.
- 1850-1945 — This is a period during which human influences began to affect natural processes in the watershed.
- 1945-Present — This period begins with the completion of Shasta Dam and chronicles the past 43 years of activity in the watershed.

4.1 Natural Processes Overview

This overview briefly lists and describes the natural processes that served as the primary controls for reference conditions for the watershed analysis core topics of vegetation, species and habitats, erosion processes, hydrology, stream channels and water quality. Events and processes are arranged according to their overall influence on watershed processes and the time scales over which they operate to affect other processes and conditions. Land-use activities that affected or altered the condition of the core topics from reference conditions to current conditions are discussed in section 4.2 (Human Uses). A discussion of the influence of each land-use activity on each core topic follows in sections 4.3-4.8. Overlaps and patterns of interaction between land-use activities and natural processes are depicted in Figure 4-1.

Natural Processes

• Klamath Mountain Uplift	Uplift of the Klamath Mountains began in the Middle Pleistocene (1.5 million years before present) and continues today. Uplift of the Klamath Mountains influences all natural processes in the watershed.
• Climate	Long term shifts in climate from hotter/drier periods to wetter/ cooler periods affect erosion processes, vegetation, fires, etc.
• Floods and Mass Wasting	Large floods and mass wasting events affect erosion processes, hydrology, water quality, stream channels, etc. Large flow events occurring over the last half century include the floods of 1955, 1974 and 1997. Large mass wasting events include the Salt Creek episode which occurred during the 1997 Flood.
• Fires	Large fires occurring in 1872 and 1898 burned over most of the Squaw Creek Watershed. These fires were stand replacing in nature.

4.2 Human Uses

Information for past human activities was compiled from resource specialists, environmental reports and historic studies. Much of the information below was obtained in the document entitled "Shasta Lake Ranger District, Glimpses of the Past" by Elaine Sundahl, September 1995.

4.2.1 Native Americans

Pre-1850 Very little is known regarding how Native Americans affected the ecology of the Squaw Creek Watershed. It is likely that Native Americans burned off vegetation in the watershed in order to increase game populations. Updates of this analysis should include a comprehensive look at the role of Native Americans in the watershed.

4.2.2 Minerals/Mining

1853 Mining in the area first began in 1853, when placer gold was discovered in Town Creek east of Bully Hill. A gold rush ensued and many placer claims were located, most of which were of little value. The placer gold was derived in large part from the lode deposits on Bully Hill, and silver and copper were found with gold in the placers.

1862 In 1862 gold was found in the surface rock on the Excelsior claim near what was to become the mining town of Copper City. As a result of this discovery another rush into the area was begun for the location of the supposed rich veins of gold and silver, when supposedly "the hills were covered by locations for many miles". The discovery of native gold and silver in oxidized outcrops of ore in 1862 resulted in the first mining boom in the area and let shortly thereafter to the discovery of the Bully Hill and Afterthought mines to the east.

1900-1910 The history of copper mining in the watershed has been one of intermittent activity. Prior to 1900, repeated attempts were made to treat the base-metal ores but little success was attained. The main periods of activity were from 1900-1910, and from 1921 to 1927. There were two mines located within the southern third of the watershed adjacent to and within what is now Shasta Lake. A third, the Rising Star Mine was located immediately east of the boundary. The Copper City mine area was between Zinc Creek and Baxters Gulch, about 1 mile southwest of Bully Hill.

Exploration of the small but spectacular surface ores was done in the Copper City mine area during the early years. Despite the fairly extensive amount of work, the only known production from the mine areas was 25 tons of ore assaying 8 percent copper, $40 per ton of gold, and $20 per ton in silver shipped in 1863 to Wales, and 119 tons of sulfide ore mined in 1926 and 1927.

4.2.3 Roads and Timber Harvest

Pre-1800 Access in the Squaw Creek watershed was limited to foot and pack trails prior to the beginning of mining activities (and related wagon trail access) in the late 1800's.

1916 Forest map shows trail system linking guard stations via Curl Ridge, Garden Ridge, Squaw Creek and other areas. Some wagon and rudimentary auto roads are in place linking mining operations and associated settlements.

1930's In order to pursue timber harvest opportunities and to provide alternative access around Shasta Lake CCC's construct Fender Ferry Road as new "truck" road from Delta on Sacramento River (State Highway 99) to Fender Ferry crossing on the Pit River and Montgomery Creek (State Highway 299). Planned Shasta Dam and Lake will inundate many existing mines, related settlements and roads.

1941 Fender Ferry bridge constructed across Pit River.

1950-1980 Steady rise in timber harvest and road building activities, primarily on private timberland.

1990-Present Some new road construction continuing on private timberland although primary roads are in place. Severe winter storms cause higher than normal road damage, especially on Fender Ferry Road FA 27, where some of the original culverts and other infrastructure are 60+ years old and are reaching the end of their useful life.

4.2.4 Fire Suppression

<u>1905</u> National Forest established, beginning of fire suppression.

<u>1905-20</u> Horse/mule fire suppression.

<u>1916</u> Fire suppression activities occurring in watershed. Trail systems along the major ridges patrolled regularly by horseback and high points serve as fire lookouts. Construction of permanent lookouts begins.

<u>1920-45</u> Mechanized fire trucks.

<u>1945-Present</u> Aircraft, retardant planes, and helicopters. Fire suppression effectiveness increases.

4.2.5 Grazing

<u>1850</u> First ranchers moving into Squaw Creek area.

<u>1870-1905</u> Forest grazing management plans indicate that some 7000 head of cattle were grazed on the McCloud, Squaw Creek, and lower Pit River between 1870 and 1905. Burning of rangeland to enhance forage was common-place.

<u>1918-1919</u> Squaw Creek Ranger District issues six grazing permits for Salt Creek allotment, (located west of Chirpchatter Mountain) consisting of 1480 acres, totaling 322 head of stock. "The Squaw Creek allotment, which extended from Curl Ridge eastward to the divide between Squaw Creek and Iron Canyon, and from North Fork Mountain and Fish Camp northward to the head of the Squaw Creek drainage, is listed in the Squaw Creek District Grazing Atlas as having 30 permittees for 1919, 25 for 1920, and 22 in 1921. Carrying capacity is given as 2678 cows and horses and 2882 sheep and goats" (Sundahl, 1995).

<u>1912-1955</u> Tilden, Walter, Carrol and Bertchell Boyle graze 600-700 head of cattle + yearlings and 'two year olds' in Squaw Creek Watershed. Grazing seasons generally run from mid-May into October. Other permittees located within or in close proximity to Squaw Creek Watershed include Williams, Smith brothers, Stillwater Land and Cattle, Hunt and Hathaways, Chattams and Clarance Buchbaugh. Ranchers routinely burn throughout the watershed in order to enhance forage for cattle and game species. At peak of grazing period in early 1900's approximately 10,000 cattle are grazed from lower Squaw Creek, Potem Creek to Big Bend in a 192 square mile area (Boyle, 1998-letter).

<u>~1916</u> National Forest rangers adopt a policy of suppressing all fires on the forest. Ranchers resist these efforts and continue to burn for approximately 25 years. With decreasing fires the quality of forage begins to decrease leading to the eventual demise of grazing in the watershed.

<u>1945</u> Grazing permits expire following completion of Shasta Lake. Grazing activity ends.

4.2.6 Reservoirs

1938 Construction of Shasta Dam begins.

1945 Shasta Dam and Reservoir completed. Approximately 9.2 miles of lower Squaw Creek are inundated by Shasta Lake. The reservoir dramatically alters the natural distribution and types of aquatic species found in the Squaw Creek Arm and in the Squaw Creek and its tributaries (see Fisheries 4.3.1). Original location of Squaw Creek District headquarters is inundated by lake.

1948 Forest Service assumes management of Shasta Lake.

4.2.7 Forest Service Activities and Recreation

1862-64 Odd-numbered sections Squaw Creek Watershed and vicinity granted to Central Pacific Railroad under the Railroad Land Grant Acts of 1862 and 1864.

1905 Shasta Forest Reserve established by President Theodore Roosevelt.

1907 Shasta National Forest atlas shows six ranger stations present within Squaw Creek Watershed.

1916 Shasta National Forest Map indicates that only one ranger station remains in Squaw Creek Watershed (located on Squaw Creek downstream of Horse Creek confluence).

~1920 New Squaw Creek District headquarters established on lower Squaw Creek near Didallas Creek confluence. District headquarters in use until 1938. Use continues at Upper Squaw Creek Guard Station referenced above for the same period.

1938 District headquarters moved to Redding and district renamed Redding District.

1938-57 John Gilman is District Ranger. Much of his time is spent at Madrone Guard station located 1/2 mile north of the present location of Madrone Campground.

1940 Squaw Creek Guard Station constructed to house engine crew.

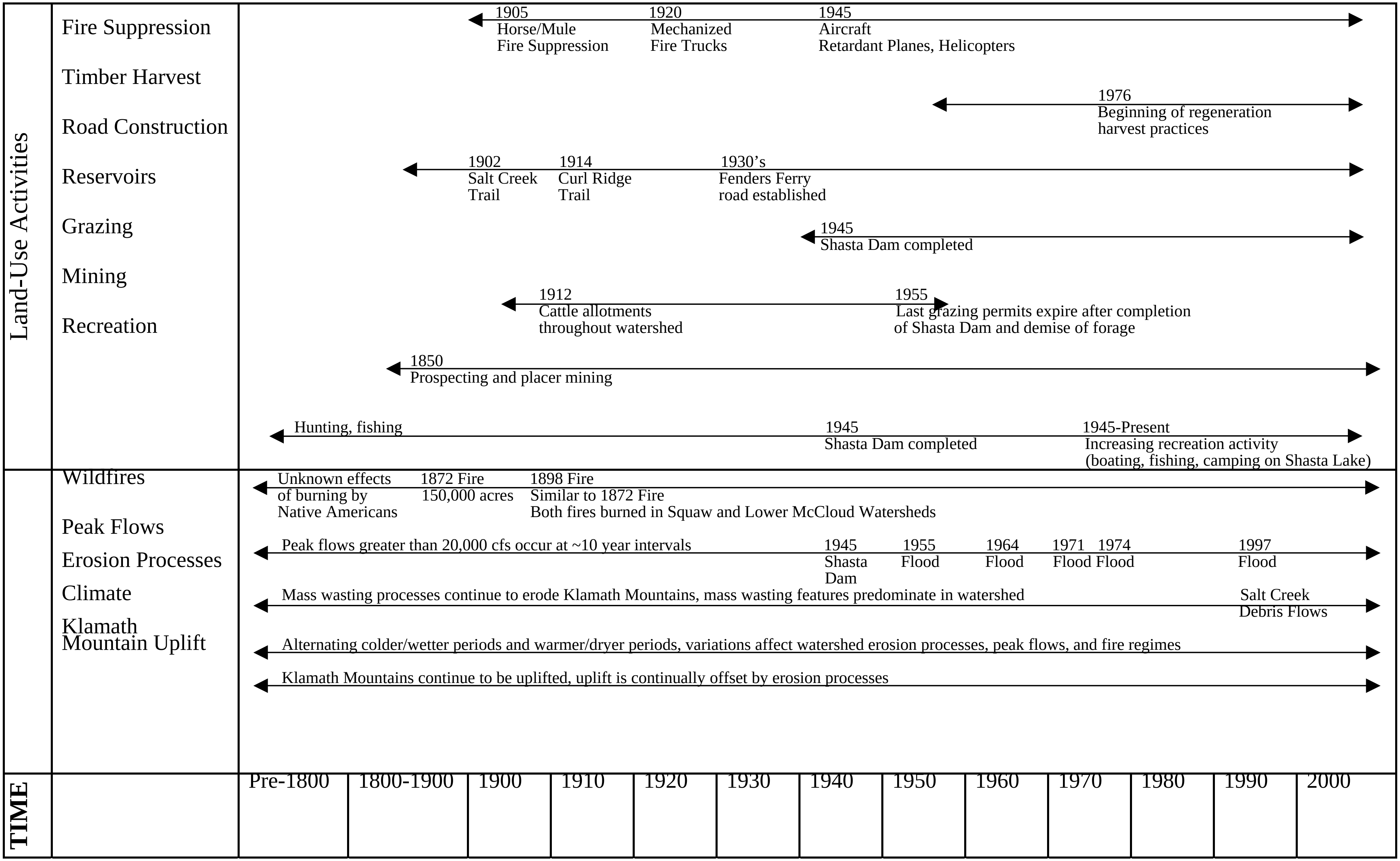


Figure 4-1: Natural processes and human use activities that influenced erosion processes, hydrology, channel morphology and water quality in the Squaw Creek Watershed. Most significant events are noted on timelines. Only larger events are shown. All floods where discharge above Shasta Lake exceeded 20,000 cfs from 1946 to present are shown.

4.3 Vegetation

4.2.1 Past Vegetation Types

Pre-1850

Due to the large amount of human disturbance that took place in this watershed between the 1850's and the present, it is very difficult to make assumptions as to what the watershed was like prior to European settlement. Information presented on vegetative conditions prior to 1850's is mostly speculative and derived from studies done in other areas similar to Squaw Creek.

Old growth and late seral habitat has probably always been in short supply in the Squaw Creek Watershed. There are several factors that could have accounted for the lack of old growth and late seral habitat in the watershed prior to European settlement.

1. **Climate:** Very long, hot, dry summers with cool, rainy winters. Snow falling only at higher elevations.

2. **Fire:** Fires in the Klamath Mountain Section were characterized by frequent, low to moderate intensity surface fires. A study conducted by Alan Taylor of Pennsylvania State University and Carl Skinner of PSW in Redding suggests fire return intervals of 7-35 years for various sites over a 300-400 year period, with a fire return interval of 10-17 years. These estimates correlate well with those reported by Agee (1991) and Wills (1991) (Section Description for the Klamath Mountains Section, 1994).

3. **Soils:** This watershed is dominated by very steep (60-80% slopes) mountain sideslopes and steep (40-60%), dissected mountain sideslopes. The upper half of the watershed is dominated by medium to deep soils. The lower half is dominated by medium to shallow soils which are more conducive to growing black oak/canyon live oak communities, shrubby hardwoods and chaparral.

4. **Elevation:** Ranges from 1065 feet along Shasta Lake to 5300 feet at Shoeinhorse Mountain. This represents an elevational transect which covers a transition zone from foothill vegetation types and montane vegetation types.

The pre-settlement landscape was probably exceptionally patchy, containing a complex mosaic of age, size and structure. Old growth/late seral habitat was probably located in riparian areas, north slopes and areas with deeper, more productive soils (Wills, 1991). In the northern half of the watershed, Douglas fir would have been the dominant conifer with sugar pine, ponderosa pine and incense cedar present in smaller amounts. Black oak, big leaf maple and/or canyon live oak would have been important hardwood associates. Pacific dogwood and California hazel were shrub associates. The southern half of the watershed and the upper slopes would have been more open with ponderosa pine being more dominant. There may have been more open areas occupied by native perennial grasses and native forbs. Due to frequent fires chaparral would have been plentiful, but the age class and density was probably more varied than it is today. Frequent low to moderate intensity fires would have resulted in fewer shrubs and fewer young trees which would have produced a more open understory and mid-story canopy. Fire also maintained the oak woodlands by controlling conifer regeneration and shrub growth.

The south facing slopes in the southern portion of the watershed were probably scattered with ponderosa pine and gray pine with patches of knobcone pine. The chaparral was probably not as dense and decadent as it is today.

1850-1945
This was a period of great change for the watershed. By 1850, miners and ranchers were moving into the southern end of the watershed. Areas where Native Americans had camped and fished became ranches. Towns began to build up around mines like the Bully Hill Mine. Range was needed for cattle and other livestock.

Orchards and row crops were planted on the stream terraces. For example, the area now called Wheeler Ranch still has an old orchard, and there are other fruit trees scattered throughout the area left from old homesteads. Settlers needed wood to build businesses, homes, fences and bridges. They also needed wood for fuel. Trees were removed for all of these reasons. Fires were set to clear areas and encourage grasses for livestock forage. According to newspaper accounts from 1872, one of these fires got loose and burned most of the watershed. The same thing happened again in 1898. Much of the vegetation in the area was destroyed. Livestock owners utilized prescribed fire to burn over areas that were grazed by animals each year. One of the primary results was the loss or reduction of conifer and hardwood growth or regeneration on sites capable of producing such species.

1944 photos show the evidence of the stand replacing fires of 1872 and 1898, as well as repeated burning by ranchers. Old growth/late seral habitat was absent from a large portion of the watershed. Even many riparian areas were without shrub or tree cover. Tree cover was only spared on some north slopes and some riparian areas. Scattered old growth trees can be found on upper slopes, ridges and in riparian areas. In 1907, the Shasta National Forest was formed. By 1910, the forest service stopped, or attempted to stop, the practice of permittees burning over grazing areas as they went out or came off of the allotments. A few ranchers refused to stop, and continued to burn into the 1920's and 30's. This was also the time period when many of the exotic plants were brought into the area. The introduction of exotics coupled with grazing activities resulted in a decline in annual and perennial native plants. Fire suppression efforts were begun and burning by stockmen declined. This allowed the regeneration of many areas by conifers and hardwoods to begin.

By the 1930's, the mining boom was over and burning by stockmen had stopped. The construction of Shasta Dam, begun in 1938 and completed in 1945, created a reservoir which inundated 9.2 miles of lower Squaw Creek above it's confluence with the Pit River. Any Old growth/late seral habitat that was remaining in the area below the high water mark was removed. 1944 aerial photos show few trees of any size. Shrubs are very much in evidence. Riparian areas, especially in the lower half, tend to quite open with few trees or shrubs.

1945-Present
Old growth/late seral habitat is at a premium, and generally found in riparian areas, north facing slopes and scattered on upper slopes and ridgetops. Logging and road building began in the 60's and 70's, mostly on private land. 1980 aerial photos show an increase in hardwoods and conifers. Shrub fields are past mature, and as extensive as ever. However, young conifers and oaks are beginning to show up. The number of roads increased dramatically on private land. The 1990 aerial photos show a small amount of logging was done on forest service land in the upper half of the watershed. Knobcone stands which regenerated after the last fires are beginning to look decadent, and some have fallen down. 1995 aerial photos show conifers and oaks still increasing, and most have reached the mid to late mature seral stage. Ecological Unit Inventory data shows most tree stands to be approximately 80 years of age, and

shrub stands to be very decadent. Most riparian vegetation has recovered dramatically. Prescribed fire has been used in the Town Mountain, Horse Mountain areas to open up shrub fields in past years mostly for wildlife habitat improvement. The latest burn took place in March, 1998. The Garden Creek/Garden Ridge area was burned in 1995.

4.2.2 Past Fire Regimes

Pre-1850
Mixed conifer forest is one of the more complex vegetation types to describe in terms of natural fire response and fire regimes. Mixed conifer forests generally consisted of a variety of vegetation species with varied response to fire disturbance (see 4.2.1). The vegetation types present in the watershed today reflect not only the past geological and climate events but the influence of Native Americans and European settlers. Pre-settlement fire histories in mixed conifer forest show a pattern of lengthening fire return intervals with increasing elevations. The intensity of these fires was generally low due to fire frequencies that kept residual fuel loading down and eliminated vertical fuel ladders. The typical return interval for this fire regime was probably within an interval of 8-30 years depending on geographical features. Prior to 1850 an unknown amount of Native American burning may have occurred in the watershed. Unfortunately little is known as to the extent of Native American burning during this period.

1850-1945
The role of humans in altering natural fire regimes was first detectable in the mid-1800's. The large fires of 1872 and 1898 which burned much of the southern half of the watershed were attributed to stockman and native Americans who burned off the encroaching understory in order to produce more palatable forage for grazing and to enhance habitat for game species to improve hunting. Vegetation patterns were likely beginning to show the effects of a more efficient suppression effort as well as a decline in grazing and Native American burning. What was once a short return, low intensity fire regime was likely changing to one of infrequent fires that were of moderate to high intensity. As a result of the earlier large fires in the 1800's there appears to have been more pure brush fields present in the watershed. Observations from T.B. Tillicoot, a forest ranger in the area in 1913 noted: "On brush areas of the oak subtype in the Squaw Creek watershed, yellow pine did not appear until about 20 years after the last fire." He also noted that: "Over most of the forest, (where) burns have occurred within the last 20 years, the reproduction is in the majority of cases in the seedling stage." While it appears that much of this watershed was recovering from these early large fires, fire was not completely excluded. The "Boyle brothers" began grazing cattle in the watershed in 1912. It was told that "individual stockman and sportsman routinely took the responsibility of burning all the acres deemed to thick with brush or timber." Much of the decadent knobcone pine within the lower elevations likely appeared in this era through the advent of several smaller wildfire events.

1945-Present
The past fifty years had a dramatic effect on fire regimes in the watershed. Fire suppression technology increased to include aerial retardant capabilities, organized suppression forces, lookouts and modern fire apparatus that could successfully suppress fires and reduce the probability of large destructive wildfires. The price to pay for this technology was increased surface fuels and fuel ladders that increased the probability stand replacing fires. The absence fire disturbance over the past seven to ten decades has set a scenario for more large, less frequent, destructive fires. Much of the harvesting done within this era on private and national forest has likely contributed to the probability of higher surface fuels and a more volatile fire hazard condition. Vegetation surveys conducted during the 1994 Ecological Unit Inventory found that brush heights in timbered stands were approximately 4-5 feet tall. Timbered stands also were

shown to have an average of 30% brush coverage. From this information it is apparent that the historical role of fire in maintaining a more open canopy and low surface fuel profile is disappearing.

4.2.3 Changing Role of Fire

Fire Regimes

The many combinations of fire regimes and forest types in the Pacific Northwest are a product of repeated fires at variable intensities. Many of the fires are ignited by natural sources such as lightning and others can be traced to human sources. Vegetation types found in most drier forest types in the western United States appear to have been influenced or controlled by Native American burning. The historical fire regime of the Squaw Creek Watershed was one of low to moderate severity where fires burned at 1-25 year intervals maintaining species diversity and moderating stand density. In this historical regime Ponderosa Pine likely had a more competitive advantage in the presence of fire that it lost in a fire free environment over the past 7-10 decades.

That this regime has transitioned is evident from early descriptions of the Squaw Creek watershed. Mr. T.B Tillicoot, then the Assistant Forest Supervisor on the Shasta National Forest, described the drainage in 1913 noting: "The dominance of yellow pine after a large fire that covered much of the watershed in 1898." The current dominance of Douglas-fir and hardwoods show an apparent transition and thus also a transition in fire regimes.

Past Large Fire History

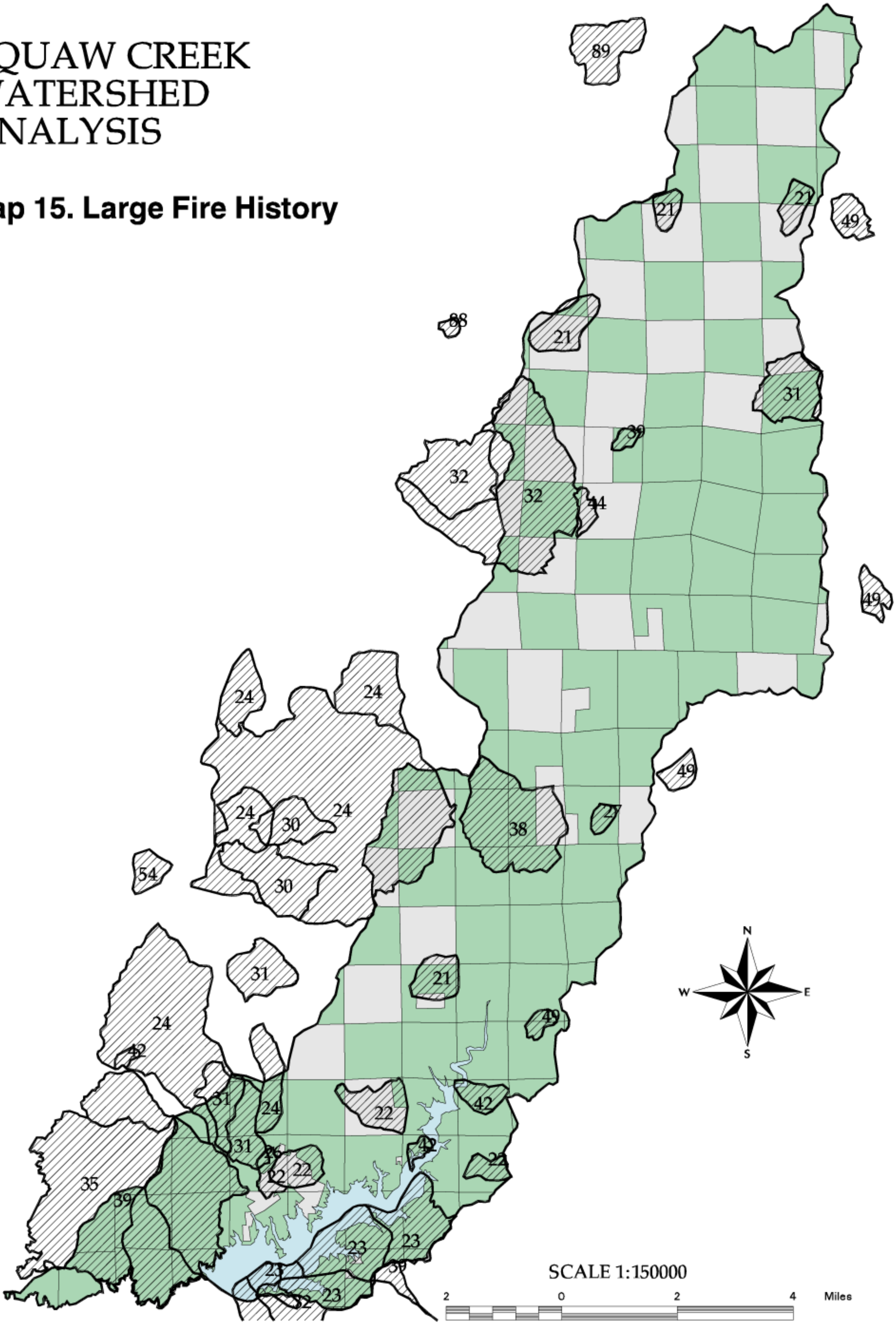
There have been have been several large fires recorded in the watershed. The earliest records are primarily found in newspaper clips as well as notes from early Forest Service Rangers. In 1913 T.B. Tillicoot mentioned previously noted: "In the late summer and fall of 1872 a fire swept over the north slope of the Pit River as far as the divide between the Pit River and Squaw Creek. The entire Squaw creek drainage and the lower McCloud River as far north as Chatterdown creek was involved (affected by the fire). The same area was covered by a fire in 1898." These pre-1900 fires covered approximately 75% of the watershed. Large fires from 1900 to present were smaller and fewer in number. Large fires occurring in the watershed are shown on Map 15.

Year Span	Total Years	Total Burned Acres	Acres Per Decade Burned
1850 - 1871	22 yrs	49,500	22,000
1872 - 1898	25 yrs	49,500	20,000
1899 - 1920	21 yrs	None Recorded	-0-
1921 - 1949	28 yrs	21,000	7,500
1950 - 1997	47 yrs	None Recorded	-0-

Table 4-1: Large Fires (100+ acres). The large fire history shows a declining fire disturbance. Hardwood dominated sites as well as large stands of Knobcone Pine indicate that what fires have occurred since the 1900's have likely been high severity events.

SQUAW CREEK WATERSHED ANALYSIS

Map 15. Large Fire History



Fire Effects and Fire Disturbance

Fire regime transitions occur when fuel profiles are altered. In the Squaw Watershed such profile changes can be derived by observations from historical records as well as successional modeling of stands over time without fire disturbance. Where frequent low intensity fires kept sites open there was a lower likelihood of large fires destroying the dominant overstory. Long periods without fire disturbance resulted in increased surface fuel buildups and increased stand densities. These changes resulted in fuel model transitions that trend toward increased fire intensities, scorch heights, and negative fire effects on vegetation, soils, riparian areas and air quality.

Historical Range of Variability

The range of variability for fire disturbance regimes appears to have changed dramatically. Historical fires burned frequently and at low intensities. Current fires burn infrequently and usually at moderate to high intensities. The changed in vegetation species, densities, and the general fuel profiles suggest that the current condition of the watershed may not be sustainable given historical patterns and processes. The historical range of variability while not recipes can certainly be reference points to assess the probability of sustainability of the watersheds resources from catastrophic fire events.

Year	1870	1900	1920	1944	1975	1997
STRATUM	4N/G----------------> 2P ------------------------------> 3P/2G------------------------------------>4G					
FUEL MODEL	9/10 --------------->5 --------------------------------> 9/5 ---------------------------------------> 10/5					
STRATUM	3P/S -------------->BR--->HW					
FUEL MODEL	9/8 -----------------> 4- ---> 6/4					
FREQUENCY	Frequent-----------> Infrequent--->					
FIRE INTENSITY	Low -----------------> Mod/High ------------------->High--->					

Table 4-2: Fuel Model Transitions
BR=brush, HW= hardwoods

4.4 Species and Habitats

4.4.1 Overview

Many wildlife species that we are familiar with today were present in the Squaw Creek Watershed prior to European settlement. Species that formed large herds (deer, elk), were far roaming (grizzly bear, black bear, wolves, wolverine), and were restricted to special habitats (cavity nesters, bats) may have been present in greater numbers due to the large expanses of suitable habitats found in the watershed prior to European settlement. In contrast, late-successional species may have been less abundant due to a more open native landscape (Cranfield, 1984 and Dunaway, 1964).

In the late 1800's livestock grazing, and homesteading began to change the landscape. Wildlife species that were considered threats were extirpated, such as the grizzly bear and wolf (Cranfield, 1984). The elk were also extirpated, possibly due to over-hunting as occurred with elk in the Trinity Alps (Cranfield, 1984). Of these extirpated species, only the elk made a comeback after reintroduction in 1913.

The major contributor to the change in habitat was fire suppression. Fire suppression practices caused a decrease in populations of deer and other species due to the loss of early seral habitats (Smith & Murphy, 1980). Conversely, fire suppression most likely expanded the population and distribution of many species which utilized late-successional patches found in the watershed (e.g., Northern spotted owl, Northern flying squirrel). Increases in human activities such as road construction and timber harvesting may have also contributed to a movement of wildlife out of the watershed or decline in habitat use for some species (deer, elk) due to disturbance and exposure (Smith & Murphy, 1980). Species that may have proliferated in the human altered environments are expected to be more common today than before European settlement (e.g., late-successional species, coyote, raccoons).

4.4.2 Old Growth/Late Seral Habitat

Pre-1850

Late-successional habitat was closely associated with the major tributaries to Squaw Creek (1944 aerial photos). The remaining landscape consisted of open forested habitats (<60% canopy closure) with early seral shrub or herbaceous understories, hardwood/conifer, oak woodland and chaparral habitats. Because of the open nature of most of the landscape, late successional species would have been restricted to the stringers and adjacent forested stands.

1850-1945

Settlement along Squaw Creek is likely to have resulted in a loss of corridors of late seral habitat which may have been present adjacent to the creek on terraces. The amount of timber harvested by early settlers is unknown, however the scope of timber harvest activities is believed to have been small, with the most significant timber harvest occurring in the lower watershed along Squaw Creek and its major tributaries.

Widespread burning in the watershed by ranchers sustained early seral habitats through the early 1900's. A shift from burning to fire suppression was the catalyst for conversion of early seral habitats to late seral habitats. As fire suppression became more efficient less of the land was maintained in an early seral or open forested stage. Consequently, the distribution and population levels of late successional species slowly increased. A more dramatic increase occurred between 1945 and the present.

1945-Present
Late successional habitat that survived pre-1945 disturbance continued to mature between 1945 and 1998. Late-successional species responded to this habitat increase and are now found throughout the northern portion of the watershed. Though fire suppression improved some stands, other stands may have become less suitable for wildlife because of increased dead/down loads, dense, single species understories, and the shading out of shade intolerant species. Excessive buildup of dead/down wood on the forest floor could have inhibited visibility and accessibility of prey species for avian predators like the goshawk and spotted owl. Dense understory regeneration by shade tolerant species could have obstructed the movement of avian predators and decrease the overall species composition. Increased canopy closure could have led to shading out of oaks and other shade intolerant species existing in the understory. Removal of these species would eliminate structural diversity as well as forage, such as mast and herbaceous vegetation important to many wildlife species.

With the introduction of timber harvest in 1966, some of this late-successional habitat was fragmented, mostly in the northern third of the watershed by the Forest Service and private timber companies, and in the mideastern section by private timber companies. Some clearcut areas could have mimicked natural openings of early seral habitat utilized by predatory species, but at the cost of fragmentation. Harvest units were much larger than natural openings and different in overall composition. This fragmentation would have impacted late-successional species occurring there, but the extent, whether positive or negative, has not been documented since no surveys occurred before harvest activities. Despite the lack of surveys, much of the northern watershed contains existing or developing late-successional habitat, especially for the Northern spotted owl, and has hence been included as part of the LSR. Other late-successional habitat occurs outside the LSR, mainly along stream courses. Some of these habitat areas have become connected by corridors to the LSR.

4.4.3 Early-Mid Seral and Oak Woodland Habitats

Pre-1850
Within the open chaparral and oak woodlands, deer foraged, small mammals created burrows and harvested seeds (rabbits, ground squirrels), and other open habitat/early seral dependent species thrived (California quail, green-tailed towhee, lizards). Chaparral, grew mostly in the lower two-thirds of the watershed with limited distribution elsewhere. This habitat supported many wildlife species (green towhee, pallid bat, deer). Naturally occurring fires would have maintained forage in the form of herbaceous vegetation found amongst the chaparral and open forest understories. As the chaparral recovered, sprouting chaparral provided succulent vegetation. In undisturbed areas, mature chaparral produced-berries and dense cover.

Oak woodlands, mostly found in the lower two-thirds of the watershed supported hardwood dependent species (gray squirrel, band-tailed pigeon). Seasonal burning of oak woodlands by Native Americans preserved early seral habitats and benefitted early seral dependent species. Both natural and artificial fires usually burned cool and kept the hardwood understory relatively open, stimulated acorn production and vegetative growth, and maintained shrublands in a mosaic of seral conditions.

1850-1945
Between 1850 and 1945 little change occurred to early-mid seral oak woodland habitats. Although fire suppression was occurring throughout the early 1900's, the effectiveness of fire suppression activities was limited (see Map 15: Large Fire History).

1945-Present
As natural fires were suppressed, chaparral underwent maturation. Browsers were negatively affected as the chaparral became unpalatable and new growth became out of reach. Also, as the chaparral became decadent it provided less habitat for small to medium mammals, as branches near ground level matured or died. The accessibility for aerial foragers (golden eagle, great-horned owl) was reduced as less ground was exposed. Other species that feed on berries or use shrubs as cover (bear, birds, deer) benefited from the maturing chaparral.

Within the oak woodlands fire suppression reduced the amount of browse available in the understory in the form of either mast, herbaceous growth or early seral shrubs. Understory growth, which would mature or affect changes in species composition in the absence of fire, could have reduced the amount of ground water available to the mature acorn producing oaks, and hence, quite possibly the production of acorns. Herbaceous growth may have also been hindered since understory growth of shrubs and oak seedlings, usually tempered by frequent fire, would out-compete the herbaceous plants. Then, as with chaparral, shrub species in the understory would mature and become unpalatable to browsing species.

The decline of Elk populations in association with the loss of early seral habitats supports the belief that changes in the amount and age of chaparral and oak woodland habitats affected the wildlife utilizing them. At one time the greater landscape supported wide roaming elk populations substantially larger than the current population (Cranfield, 1984). In one area along Squaw Valley Creek to the north of the Squaw Creek Watershed, a Native American encountered an elk trail that appeared "as if a saw-log had been drawn repeatedly through the snow." He figured at least 1000 elk had passed through the area. At this time the Native Americans had taken over 100 cows for the winter (Cranfield, 1984). By 1972 the landscape was believed to support on average, only 484 elk (Dunaway, 1964 and addenda; Smith & Murphy, 1980). Based on existing knowledge, approximately 60-70 elk were introduced to the Squaw Creek Watershed in 1916 by the Redding Elks Club. Remnants of this lost herd still live within the Squaw Creek Watershed but the majority of the herd has moved to more suitable habitat to the north and east.

Despite the use of the watershed for grazing, the significant difference in what the landscape was able to support historically was attributed to the overall habitat composition of the area. Overall, the area was very different from traditional Rocky Mountain elk habitat (the introduced subspecies). The amount and distribution of grasslands and herbaceous growth, of which there was little and sparsely distributed, contributed most to this difference (Smith and Murphy, 1980). Because habitat needs of elk have been known to be similar despite geographical differences, the habitat limitations could have also affected the native subspecies of elk if they were still in existence.

Unlike adjacent watersheds, road densities are not believed to be high enough to have adversely affected elk habitat. Very little information exists regarding deer populations within the watershed, but they are expected to follow the same use and decline as that of elk.

4.4.4 Aquatic and Riparian Dependent Habitats

Pre-1850

Very little information has been documented regarding the condition and extent of aquatic and riparian habitats in the Squaw Creek Watershed, however it is likely that reference conditions for these habitats were excellent. Aquatic and riparian habitats were subject to period disturbances such as floods, debris flows, and occasional catastrophic fires. Species associated with aquatic and riparian habitats were fully adapted to these disturbances.

1850-1945

Species that were restricted to aquatic or riparian habitats (amphibians, willow flycatcher) may have been reduced in number or become less widespread due to habitat that was changed by cattle grazing and settlements along Squaw Creek.

Land use activities introduced by European settlers altered aquatic and riparian habitats throughout the Squaw Creek Watershed. Aquatic habitats were likely to have been severely degraded in lower Squaw Creek due to settlement and mining activities. Cattle grazing and associated burning probably affected aquatic and riparian habitats in the central and northern thirds of the watershed. Cranfield notes that conditions in the vicinity of Squaw Creek and the Lower McCloud Watershed were 'deteriorating' as a result of grazing (Cranfield, 1984). The deterioration could have referred to direct impacts on the riparian habitat or to indirect impacts, such as laying bare upland herbaceous habitat. Riparian habitat that was grazed reduced suitable nesting habitat for many neotropical migratory bird species. Likewise, aquatic amphibians dependent upon emergent vegetation for reproduction and cover were impacted by grazing. In addition, cattle most likely competed with other grazers and browsers which were already being impacted by reduced forage habitat in the uplands.

By 1907 the Forest Service began reducing the number of cattle grazing on the National Forest lands. With the reduction in cattle, introduction of grazing regulations and periodic resting of the habitat it is expected that aquatic and riparian species populations declined less quickly or stabilized. Then, with the construction of Shasta Dam in the 1940's, grazing was ended and riparian habitats continued to recover.

1945-Present

Much of the damage to riparian habitat, meadows and springs occurred in the early part of the century and it is possible that existing wildlife populations adapted, maintained 1940's population levels, or were locally extirpated. After the 1940's other impacts to riparian and aquatic populations occurred in the form of timber harvest and road construction. Riparian and aquatic wildlife species may have benefited from fire suppression as channels were stabilized and riparian vegetation protected.

In the 1970's and 80's timber harvest affected vegetation along a few intermittent and ephemeral stream channels in the northern portion of the watershed. The effect on wildlife associated species was not documented, but was most likely negative. In the years following the harvest, these streams have undergone a slow recovery, but it will take several decades before riparian habitats are returned to pre-harvest conditions. Elsewhere in the watershed, riparian associated species have been minimally impacted because of the limited amount and location of most timber harvest which occurred in the watershed on National Forest lands. Aquatic associated species, though, may have undergone a more significant impact where road construction occurred.

Roads impacted associated wildlife species where changes in the stream habitat occurred through the dissection of the stream, the direct or indirect input of debris into the stream and the increased flows and stream scouring. Where culverts were impassable, movement patterns of aquatic associated wildlife species were disrupted. Overall, road impacts have been restricted to a few sub-basins.

Increased sediment delivery to streams certainly would have negatively impacted stream dwelling wildlife which require oxygenated, rocky streams (e.g. Pacific salamander, tailed frog). The filling in of pools would also have affected a number of aquatic species which utilize pools for cover or foraging. The changes in the stream channel through scouring could have been beneficial in that sediments were removed and pools formed. Negative impacts would include initial damage to existing populations.

Fire suppression increased riparian vegetation along streams. With less fire burning through riparian habitat the vegetation was able to expand and stabilize. This change was beneficial to many riparian associated species as it expanded their distribution. Within streams, those aquatic associated species which favored cool water also benefited from the denser, more expansive riparian habitat. Others, which required some open areas along streams for sunning, were negatively impacted.

4.4.5 Habitat Elements

Pre-1850

Natural habitat elements within the watershed include snags, dead/down wood, caves and limestone outcrops. Though no historical documentation occurs for the densities of snags and dead/down, the densities most likely were less than current natural densities as the forested habitat was more open canopied due to wider spacing of trees. Within areas where denser spacing occurred, like the stream channels, the snag and dead/down wood densities most likely were similar to current densities in similar habitats.

The condition of existing caves and rock outcrops is unknown, therefore their historical condition could not be assessed. The current condition versus historical condition has mainly focused on the vegetation characteristics associated with the cave or rock outcrops. Vegetational characteristics were considered important because a cave opening covered by vegetation would have reduced air temperature within the cave as well as reduced airflow. Vegetation on rock outcrops would also reduce the air temperature in the fissures as well as provide a more protected environment for wildlife.

1850-1945

With the influx of Europeans and their working of the land, changes in the density of snags and dead/down material occurred, caves and rock outcrops may have been altered, and mines and buildings were constructed. With the increased density of forested habitats, the density of snags and dead/down material would have also increased, though the wildlife species composition may have changed.

Caves and limestone outcroppings have not changed in their overall composition. The vegetation around these structures may have changed as a result of European settlement, namely fire suppression. Vegetation growth would have increased around cave and possibly changed the caves internal environment. Exploration of caves is not expected to have altered the caves from an environmental standpoint as the cave locations and use has been closely monitored by the Forest Service in conjunction with local spelunking groups.

1945-Present

As the land was harvested, snag dependent species habitat was reduced. Snag retention within these areas varied over time, with only the later years (post 1980's) retaining snags for wildlife use. Recruitment trees for snags were also eliminated. Thus, those areas harvested since the 1970's wouldn't be expected to provide snags to benefit most snag dependent species even by the year 2050. The loss of the later seral stages, especially in the easternmost section of the watershed and the replacement of these to younger, smaller trees, effected the amount of recruitment of large diameter snags and down logs, necessary for sustaining historical populations of snag and dead/down dependent species such as black bear, fisher and pileated woodpecker.

Since the 1940's caves continued to be explored and buildings inhabited. Therefore, there has probably been very few changes in impacts to these areas and associated wildlife.

4.4.6 Fisheries

Pre-1850

Prior to 1850, the native fish assemblage within the Squaw Creek watershed was intact. The importance of Squaw Creek to local native fisherman was probably minimal as the Sacramento, McCloud, and Pit Rivers most likely served as the primary fishing areas, particularly when the salmon and steelhead moved into these rivers to spawn. Though this stream was probably not a significant subsistence fishery, the stream may have been used to secure an additional food source by the local native Americans and early white explorers. There are no records that specifically mention the fish inhabiting Squaw Creek during this period. The fish community most likely reflected those species living within the other three major river systems. Anadromous runs of coho salmon and steelhead were probably common within much of Squaw Creek, while Chinook salmon runs were probably restricted to the lower reach of the stream. Other fish residing within this stream during this time would have included the tui chub, Sacramento Squawfish, rainbow trout, hardhead minnows, Sacramento blackfish, Sacramento sucker, speckled dace, California roach and riffle sculpin. None of the introduced species that currently reside within this drainage were present during this time.

Because the fish species inhabiting Squaw Creek had evolved together and were adapted to the existing conditions, the fish community structure would have been stable and in balance. Stream processes during this time were functioning to provide excellent fish habitat. Bedload movement and large woody debris were in balance with channel functions and most likely provided an abundance of deep pools and runs. Under these conditions large fish would have been common.

1850-1945

Changes to the fishery and the aquatic habitat began taking place in the late 1800's and early 1900's. These changes were associated with the introduction of non-native fish species, mining, grazing, and recreation.

American shad were introduced into the Sacramento River system between 1871 and 1881. By 1879, they were well established as part of the basins anadromous fish community. Their presence would have resulted in competition for food and some displacement of native fish species. Shad were probably present within lower Squaw Creek, but probably were not present in much of the stream as they tend to prefer larger rivers. The development of the fish hatchery at Baird on the McCloud River as well as the fish hatchery in Sisson (Mt. Shasta) probably resulted in the introduction of other non-native fish species such as brown trout. However, due to the limited access, fish plants were most likely very limited and many of the introduced fish did not survive. Stocking records during the early 1900's are incomplete and vague.

Mining and grazing began in the early 1900's and by 1920 had become significant activities within the drainage. Mining, which was restricted to the lower end of Squaw Creek, had serious effects on the fishery and aquatic habitat. The mining and processing of copper and other heavy metals created water quality problems that would have resulted in significant fish kills. Though fish kills are no longer a problem in this area today, water quality is still an issue with the remaining mines even though they are inactive. Another effect of mining was associated with the smelting operations. The effects of this process within this area has been documented. Large areas were denuded as vegetation died-off, probably as a result of acid rain. This would have caused increases in water temperature, lower pH, loss of bank stability, increased run-off, increased sediment loads, and ultimately a loss in the quality and productivity of the aquatic environment.

Grazing during the later half of this time period was a significant activity throughout much of the watershed. Standards and guidelines that govern grazing use today were not in place. As a result, the effects of grazing probably caused damage to the riparian and aquatic resources in the watershed. The effects of grazing during this time were not well documented, however Cranfield noted that conditions in the vicinity of Squaw Creek and the Lower McCloud Watershed were 'deteriorating' as a result of grazing (Cranfield, 1984). Cattle grazing and associated burning probably affected aquatic and riparian habitats in the central and northern thirds of the watershed. Impacts associated with grazing most likely would have included bank trampling, loss of streamside cover, increased sedimentation, aquatic habitat simplification, and ultimately a loss of instream productivity and reduced fish abundance.

As recreation and other human uses increased, the occurrence of fire also increased. Several large fires burned significant portions of the watershed destroying timber and other vegetation. The effects of these fires was probably most pronounced on the upper and mid-stream reaches as these areas tend to burn fairly hot. The effects would have included an increase in peak flows, increased sedimentation, and a reduction in streamside cover. Recover of the aquatic habitat after most fires was probably rapid. The effects on the main stream corridor was probably minimal (as fires tend to burn cooler in the riparian bottoms) and were of some benefit as they resulted in the recruitment of large wood to the stream and riparian area.

Natural processes during this time were still functioning to provide excellent fish habitat. Channel functions in the larger streams were still in balance and provided an abundance of deep pools and runs. Large fish were still abundant and the fish community structure was still fairly stable in spite of some fish species introductions.

1945-Present

The completion of Shasta Dam in 1945 blocked the runs of salmon and steelhead from the system. The elimination of the anadromous fish runs changed the ecology of the area by removing an important food source, altering the fish community structure, and genetically isolating the rainbow trout. The dam resulted in simplifying and destabilizing the fish community as it effectively blocked several anadromous populations from the basin.

The completion of the dam and the creation of Shasta Lake converted about a third of the drainage from a stream environment into a lake environment. Those fish populations that require a stream environment to exist experienced habitat reduction which caused their population levels to sharply decrease. The formation of the lake and the development of a warmwater fishery adversely affected native fish populations even more. Introduced lake species such as bass, catfish, carp, and brown trout moved into the lower reaches of Squaw Creek. These introduced species often out-competed the native population or these introduced species became predators.

During this time grazing and mining activities ceased. The impacts associated with these activities are largely gone, however the effects of mining are still evident today, most notably as it affects water quality. Fish kills, if occurring, are probably very local and limited.

The completion of the Fenders Ferry road in the early 1940's brought an increase in recreational use to the area. This has resulted in an increase in fishing and the associated riparian use. The effect of angling on the fishery is minimal as use of this area is still considered low. The road also opened the area to timber harvest activities. This has resulted in the construction of additional roads often in steep or unstable terrain. The effect has been an increase in sediments loads due to erosion and landslides. This has adversely affected the watershed in some areas and has caused a reduction in the quality of the aquatic environment, most noticeably within the Salt and Winnibulli drainages. The effects are also evident in other streams, but to a much lesser degree.

Though severely altered, the fishery within the Squaw Creek watershed is still considered to be good. Except for those streams previously mentioned, channel functions are generally in balance and deep water habitat is still abundant. Large fish are still found in the streams, but are probably not as abundant as they once were. Fish habitat is still considered to be good in most of the drainage.

4.5 Erosion Processes

Pre-1850

From the middle of the Miocene to early Pleistocene Epochs (15 to 1.5 million years before present) topographic relief in the Klamath Mountains was low. Rapid uplift began in the early to middle Pleistocene, and has continued through the Present (Holocene) Epoch, elevating the Klamath Mountains to their present elevation.

As a consequence of uplift, downcutting occurred and erosional and depositional river terraces were left stranded on valley walls dozens to hundreds of feet above modern day river elevations. A classic early study by Diller (1902) described this succession of erosional surfaces which exist above the highest present day river gravels.

As mentioned in the previous chapter, mass-wasting is the dominant geomorphic process which has operated within the Quaternary Period (2 m.y.b. to present). Current mass-wasting features probably developed in the Pleistocene in response to continued uplift of the Klamath Mountains, channel incision and steep sideslopes, and the wetter climate associated with this Epoch. The wetter conditions contributed to more rapid weathering of rocks, elevated groundwater and pore water pressures, all of which influence mass-wasting. Because of these conditions, landslide activity was undoubtedly extensive with a significant portion of the features being periodically active. It follows that sediment production from Squaw Creek and its tributaries was probably very high during this time.

During the Holocene Epoch there was a significant climatic shift from the colder wetter sub-arctic-like climate to a warmer climate. This contributed to significant changes in the physical and biological processes within the Klamath Mountains. Stream runoff was reduced due to lower precipitation. It is likely that regional and local groundwater tables receded. One of the major causes of mass-wasting was reduced because of the reduction in groundwater. Many of the mass-wasting features which developed and were active in the Pleistocene became dormant during the Holocene with a relatively smaller percentage remaining periodically active to the present day.

1850-1945

During this period hillslope erosion processes were aggravated in the southern third of the watershed primarily as a result of mining activity and European settlement. Hillslope erosion processes in the remainder of the watershed were similar to reference conditions prior to 1850.

1945-Present

Aerial photographs have been used to chronicle changes in geomorphic processes and rates of change from 1945 to present. Aerial photographs taken in 1944, 1980, and 1995 were used to evaluate geomorphic processes and rates of change. These photographs demonstrate a substantial change in mass-wasting rates during this time period, which probably began to occur several decades before the earliest time period recorded (1944).

The 1944 photography show a landscape severely impacted by fire extending to the northernmost portions of the watershed (most likely the 1872 or 1898 fires). Barren, eroding slopes are ubiquitous across the landscape of the watershed (accounting for approximately 30-40 percent of the landscape). Every tributary stream shows signs of significant channel scour. Trees are only found in some north-facing slopes or deep canyons. Brush species dominate other slope aspects not occupied by active landslides.

1995 photos demonstrate that substantial recovery had occurred since 1944 except in the Garden Ridge area where a control burn occurred in 1995. Approximately 70 percent of the former active slides visible on the 1944 photography had been revegetated. Only the larger landslides (over 5 acres in size in 1944) were still apparent. Riparian corridors had also revegetated. Drainages downstream from the 1995 Garden Ridge fire do not show that they had fully recovered from the earlier 19th century fires. Revegetation of tree species was most evident on north-facing slopes.

Few investigators disagree that intense burns increase erosion and downstream sedimentation (Tiedemann, 1979; Wells, 1979). The effects of these fires upon the watershed can probably be extrapolated from past research. Sedimentation, increased turbidity levels, and mass erosion appear to be the most serious threats to water resources following fire. In the pine regions of the Sierras for instance, erosion was 2 to 239 times as great on burned areas (Haig, 1938). The debris bulking ratio (ratio of volume of debris to volume of water) has been shown to increase from 2 to 15 times following some fires. Increased debris bulking ratios coupled with increased storm runoff is the principal cause of debris flows. Increased sedimentation within the Squaw watershed may be the cause as to why the relative proportion of inner gorge areas is fewer than expected given the current tectonics of the area (see Map 14).

Burning the surface organic matter also removes the protective forest floor, volatilizes large amounts of nitrogen and smaller amounts of other elements, and transforms less volatile elements to soluble mineral forms that are easily leached. Heating the underlying soil layers also alters the physical, chemical and biological properties of the soil dependent upon soil organic matter. For instance the sealing of soil pores causes marked differences in infiltration and runoff characteristics.

Rowe et al., (1954) reported increases in peak discharge in a southern California watershed that varied from 2 to 45 times normal, depending on storm size, in the first year following fire. The time required for peak discharge to return to normal was from 30 to 70 years, depending on storm size and individual watershed characteristics. In addition to increased stormflows, there is also evidence that fires increase mean annual baseflow, and eliminate diurnal oscillations in flow. Also the initiation of spring discharge period can occur earlier in some burned areas.

All of these impacts could have occurred in fires of the intensity depicted in the early aerial photography, the results of which would have had profound effects on the ecosystem. Aquatic and herpetofauna would have been affected to the greatest extent.

Subsequent road and skid trail construction from timber harvesting and recreation activities have had an impact on soil and water resources in the forms described in the previous chapter, but these are relatively minor in relation to the fire impacts.

4.6 Hydrology

Pre-1850

Very little is known concerning reference conditions for base and peak flows in the watershed prior to 1850. Some inferences can be made regarding peak and base flows in the watershed based on the studies by Rowe, Teidemann and Wells (referenced in 4.5). Peak and base flows in the watershed were controlled by long and short term fluctuations in climate between wetter and dryer cycles as well as changes in vegetative composition brought about by wildfires. Peak and base flows were higher following wildfires due to less water intake by vegetation. During prolonged periods without wildfire, peak and base flows were lower due increased water use by vegetation. In addition to natural fires, an unknown amount of burning by Native Americans may have also influenced vegetation and water yield in the watershed.

1850-1945

The large fires of 1872 and 1898 burned much of the Squaw Creek Watershed and must have resulted in increased runoff from the watershed in the decades following these fires. Unfortunately the vegetative composition in the watershed prior to these fires is not known so the magnitude of the peak and base flow increases resulting from the stand replacing fires cannot be determined. Continued burning in the watershed done by cattlemen in order to perpetuate forage probably perpetuated high water yields initially resulting from the 1872 and 1898 fires. A reduction in watershed runoff probably began to occur following the onset of fire suppression activities that began when the Forest Service acquired the lower watershed in 1905. Because fire suppression has been so successful over the past 50 years the current water yield from the Squaw Creek Watershed may be lower today than at any time in the past 120 years.

1945-Present

Hydrologic conditions in the lower watershed were altered following the completion of Shasta Lake in 1945. Approximately 9.2 miles of Squaw Creek were inundated and much of the lower tributaries were submerged beneath the reservoir. The area of the Squaw Creek Canyon inundated by Shasta Lake totalled approximately 2400 acres at high water. The replacement of Squaw Creek with a freshwater lake had far reaching impacts on physical, biological and human processes and conditions in the watershed (see Human Uses, Species and Habitats and Water Quality for more information).

4.7 Stream Channels

Pre-1850

Prior to the mid-1800's stream channel morphologies were controlled by natural fluvial and erosion processes including peak flows and mass-wasting activity. No significant impacts related to land-use activities are known to have occurred prior to 1850, with the possible exception of the postulated increase in channel and hillslope instability due to fires set by Native Americans. As will be demonstrated below, the greatest impacts to channel morphologies in the Squaw Creek Watershed have been due to the influence of fires. More than any other land-use activity, channel morphologies were affected by fires due to the large areas of the watershed that were burned over.

1850-1945

Stream channel morphologies are believed to have been significantly impacted by the 1872 and 1898 fires as well as the numerous fires that followed. As mentioned previously, inspection of the 1944 aerial photography reveals that hillslope and inner gorge erosional processes were active throughout much of the watershed area that had been burned over during the fires of 1872 and 1898. Stream channels located adjacent to eroded hillslopes and within eroded inner gorges were undoubtedly also in a degraded condition due to the large influx of sediment.

The large fires occurring at the turn of the century resulted in improved forage for grazing activities occurring in the watershed in the early 1900's. While the effects of these fires on stream channels can be interpreted from the 1944 aerial photography, little is known as to how livestock may have impacted riparian systems. Without additional historical information it can only be speculated that some degree of bank erosion may have occurred in heavily grazed areas contributing to an already heavily impacted environment. Due to the wide and abundant distribution of stream channels throughout the watershed these impacts may have been minimized if the livestock were dispersed across the landscape.
The earliest demonstrated potential for land-use impacts to stream channel morphologies would have been during early gold prospecting efforts of the mid-1800's. Impacts from gold mining activities occurring during this period are not apparent in the watershed today.

Mining activities in the Copper City (Ydalpom) area had an undetermined impact on stream channels located in close proximity to the smelters and communities. The sulphur dioxide emissions from the Bully Hill smelter affected channel morphologies by killing vegetation and increasing erosion. The Bully Hill, Rising Star, Baxter and Winthrop mines were all located in the Squaw Creek Watershed. Sulphur dioxide released from the smelter(s) at Bully Hill and Winthrop killed vegetation and denuded hillslopes in the vicinity of Town Creek (see Kristofors, 1973: Map 8: Fume Damaged Lands in 1939, pg. 96). Kristofors references a 1921 report to the California State Legislature that states that the Winthrop and Bully Hill smelter(s) resulted in the complete devastation of 4,500 acres and the partial devastation of 22,500 acres in the Copper City area (see Kristofors, 1973: pg. 98). Fumes from an experimental smelter located at Herault, now inundated beneath Shasta Lake, may have also impacted vegetation and stream channels in the Azelle Creek area.

In addition to hillslope erosion, stream channels were also impacted directly from mining activities. Large spoil deposits from mining activities at Bully Hill were dumped directly into the Town Creek channel. Today acid mine drainage from one of the addits in the Bully Hill area virtually disappears beneath spoil piles in town creek (CH2M Hill, 1988). Spoil dumps also are sources of acid mine drainage to tributaries to Horse Creek (CH2M Hill, 1991). Considerably more information regarding mining activities in the Copper City area can be found in the references. Further field investigations would be required in order to determine the extent of mining impacts and the recovery of impacted areas in the drainages located near Bully Hill.

1945-Present

In contrast, fire suppression is probably the land-use activity that has had the greatest influence to channel morphologies since the early 1900's. A comparison of 1944 and 1995 aerial photography shows that riparian and/or terrestrial vegetation has been re-established in a majority of the channels that were denuded in 1944. While this comparison clearly suggests that riparian vegetation is recovering from earlier disturbances, it cannot be stated with certainty that the aquatic habitats and species associated with them have fully recovered.

While the 1944 aerial photography show the prevalence of hillslope and inner gorge erosion occurring in the tributary drainages to Squaw Creek any impacts to Squaw Creek that may have occurred in response to upslope erosion processes are not as visible, except in the lower reaches that are seasonally inundated by Shasta Lake. More research and field observations are necessary to determine the extent, causes and rates of sediment movement through the hydrologic system before recovery rates can be deduced.

The creation of Shasta Lake resulted in changes in the sediment transport capabilities of channels at the perimeter of the lake. Aggradation of sediment and channel bedload has occurred where channels enter Shasta Lake. The reservoir sedimentation process is believed to be slow due to soil and geologic conditions in the watersheds tributary to Shasta Lake (NRA Management Guide, 1997). This may be the case, however it should be noted that no information or studies are known to exist that address reservoir sedimentation in the Squaw Creek Arm.

Timber harvest and road construction activities impacted channel morphologies in areas where these activities were concentrated. The impacts from both of these are described in Chapter 3. From a historical perspective, impacts to stream channels in the watershed from roads and timber harvesting were greatest in the southern third from 1850-1945. The majority of the impacts were related to mining and road construction although some timber harvest did occur. After the completion of Shasta Lake, the focus of timber harvest and road construction shifted to the central and northern thirds of the watershed. The majority of these activities over the past 50 years have occurred on private lands.

4.8 Water Quality

Pre-1850

No known information exists concerning reference conditions for water quality in the Squaw Creek Watershed prior to 1850. With respect to turbidity and sedimentation water quality in Squaw Creek and its tributaries was probably excellent during baseflow periods with occasional increases in sediment and turbidity during peak or high flow periods. The highest turbidity and suspended sediment levels were most likely experienced during peak flows that spawned mass- wasting activity or during peak flows following large wildfires when hillslope erosion processes would be most active.

1850-1945

Gold and silver mining that occurred in the southern watershed in the 1850's and 1860's probably resulted in increased levels of turbidity and suspended sediments from placer mining activities, however this is speculative since there is no information available to substantiate this statement.

The most significant water quality impacts in the watershed associated with mining activities was undoubtedly in the tributaries to Squaw Creek and the Pit River located in close proximity to the Copper City area. The establishment of the communities of Delamar, Ydalpom, Herault and Winthrop probably resulted in some undetermined amount of water quality degradation such as sanitation. Mining activities associated with the Bully Hill smelter severely degraded water quality in Town Creek. Water quality in Horse and Town Creeks is still affected by acid mine drainage today (see Water Quality, Chapter 3).

An undetermined amount of water quality degradation may have occurred as a direct result of grazing activities, however without more detailed records this is speculation. Water quality impacts such as sedimentation from bank erosion and high amounts of nutrient inputs would have been dependent on the numbers of livestock and the amount to which the livestock were dispersed across the landscape.

1945-Present

Fire suppression activities indirectly affected water quality by reducing hillslope erosion in the watershed, thereby reducing the amounts of suspended sediment and bedload entering the channel network. As an example, comparison of the 1944 and 1995 aerial photographs show that hillslope erosion decreased during this period. This decrease is due to natural recovery aided by fire suppression activities coupled with the end to active burning to enhance range habitats.

The creation of Shasta Lake significantly affected water quality in the Squaw Creek Watershed by altering the distribution of water quality impacts in the watershed and changing the types of water quality impacts. In the southern watershed water quality impacts from the communities of Ydalpom, Winthrop and Herault ceased as these towns and their road systems were inundated by Shasta Lake. Acid mine drainage problems continued with the primary difference being that a reservoir rather than a river was being affected by mine discharge. As recreation increased so did the risk of water quality impacts associated with boating such as gasoline spills and sanitation problems.

Water quality impacts associated with timber harvest and road construction are described in Chapter 3. Impacts included increased erosion and sedimentation of stream channels that were located in close proximity to these activities. Over the past 50 years the majority of these impacts have occurred in the most heavily roaded portions of the watershed.

CHAPTER 5:

SYNTHESIS AND INTERPRETATION

The purpose of this chapter is to compare existing and reference conditions of specific ecosystem elements and to explain significant differences, similarities, or trends and their causes. The interaction of physical, biological, and social processes is identified. The capability of the system to achieve key management plan objectives is also evaluated.

This chapter addresses the issues and core topics listed in Chapter 2. Issues are addressed in two formats. The first format discusses each issue within the context of each applicable core topic. Additional topics that are not related to the issues are also addressed here if they are deemed to be important for guiding future management direction for the watershed, or will result in a recommendation. Conversely, some topics addressed in Chapters 3 and 4 such as minerals management are not addressed in Chapter 5 because they are not related to the issues and are not currently important for the development of recommendations. Conclusions are only provided if they address a management concern identified by the ID team that will lead to a recommendation in Chapter 6. Applicable core questions from the *Federal Guide for Watershed Analysis* are restated at the beginning of each section and are used to guide the analysis.

In the second format the key questions developed for each issue in Chapter 2 are addressed in the form of a narrative summary. Influences and relationships between human uses and natural processes are discussed within the context of each issue. Key questions are answered where possible and data gaps and information needs are identified.

Core topics addressed in this chapter are:

Human Uses Vegetation Species and Habitats Erosion Processes Hydrology Stream Channels Water Quality

Issues are addressed within the core topics shown in parentheses.

1. TES Species Habitat Management (Species and Habitats, Vegetation) 2. Management of Pure and Mixed Black Oak Stands (Vegetation, Species and Habitats) 3. Fire and Fuels Management (Vegetation, Species and Habitats and Erosion Processes) 4. Erosion and Mass Wasting Processes (Erosion Processes) 5. Aquatic Habitats (Species and Habitats, Stream Channels, Erosion Processes)

5.1 Human Uses

Core Questions (from WA Guide):

- What are the causes of change between historical and current human uses?
- What are the influences and relationships between human uses and other ecosystem processes in the watershed?

Present Condition	Causal Mechanisms	Trends
Timber Management		
Timber harvest activities have not occurred on Forest Service lands in the northern 1/3 of the watershed since 1989. No timber management activities are known to have occurred on public lands in the lower 2/3 of the watershed. Public lands located in the central portion of the watershed are designated as Prescription 8 lands (commercial wood products emphasis). These lands are primarily composed of pure and mixed black oak stands and have never been managed for commodity outputs. Timber harvest activities are occurring on private lands.	Creation of LSR limits opportunities on lands most suitable for timber management in northern 1/3 of watershed. Steep topography, riparian reserves and LSRs make timber extraction difficult. Economic considerations (prohibitive road construction costs, low timber value in conifer and pure and mixed black oak stands located in lower 2/3 of watershed) limit feasibility of timber extraction. Large, stand replacing fires occurring in late 1800's inhibited production of merchantable timber.	Levels of timber harvest in the watershed are currently static (→). No harvest is occurring on public lands. Future trends for timber harvest should be an increase from no harvest to low levels of harvest on public lands.
Road Management		
Road densities are low on public lands and high on private lands. No road construction is occurring on public lands.	Low levels of timber management on public lands over past century.	Road densities are expected to remain static, or decrease slightly due to lack of maintenance and self-closure (→,↘).
Some roads in the watershed are deteriorating due to lack of maintenance and damage from the large winter storms of 1995 and 1997. Some of the road infrastructure (culverts, bridges, etc.) are in poor condition and need to be replaced.	Large winter storms. Decrease in road maintenance funding. Lack of active management.	No improvements in road maintenance are expected based on current funding levels for road maintenance (→) .
The existing road system in the LSR portion of the watershed was originally designed to provide access for timber harvest. Management direction has changed to perpetuating or creating late-successional habitat. Roads are now managed for protection and maintenance of the LSR.	Changes in land allocation and management direction.	Static (→).
A checkerboard land ownership pattern occurs over much of the watershed. The Forest must provide reasonable access to adjacent landowners and must respect existing right-of-way and cost share agreements. The bulk of the road system and current activities are located on private land leaving limited opportunities for road management on National Forest lands. A potential land exchange in the northern third of the watershed would result in the	Current pattern of public/private ownership. Uncertainties of road management options due to uncertainties associated with future land exchanges.	Static (→).

acquisition of private lands with high road densities.		
Some private residences located along the Fender's Ferry Road are occupied on a year round basis. Issues could exist with the levels of maintenance currently occurring on the Fender's Ferry Road and the access needs and expectations of local residences. The Forest Service must grant access to private landowners but the agency is not responsible for maintaining access.	Current road management policies do not require the Forest Service to maintain roads for access to private property on a year-round basis.	Static (→).
Fire and Fuels Management		
Fire suppression activities have successfully prevented large, stand replacing fires over the past 60 years. Prescribed burning has occurred in the vicinity of Garden Ridge and Squaw Creek Arm over the past 5 years. Prescribed burning activities have been only moderately effective in reducing fuels. The risk of catastrophic fire is continuing to increase.	High fuels build up due to fire suppression. Increased risk of catastrophic fire.	Fire suppression should continue to effectively suppress fires, and fuels should continue to increase (↗). Prescribed burning is expected to increase (↗).
Recreation Management		
Recreation use is high on Shasta Lake.	Increasing area population in central valley and increased tourism.	Recreation use in the Squaw Creek Arm of Shasta Lake is expected to increase (↗).
Hunting, fishing and OHV use are the three main recreational activities occurring in the upper 2/3 of the watershed. Fishing use is concentrated along Squaw Creek. Use is highest in the vicinity of Wheeler Ranch, Madrone, and Chirpchatter areas. Hunting occurs throughout the watershed in roaded areas. Rock climbing is also occurring in the vicinity of Devil's Rock.	Poor accessibility in upper watershed. Lack of game (caused by lack of forage). High fisheries appeal for fishermen (remote, primitive conditions).	Small to no increases in hunting or fishing are expected within the next 25 years (↗,→).
Recreation management activities are limited in the upper two-thirds of the watershed. They include routine maintenance of Madrone Campground and a small amount of maintenance at Chirpchatter Campground. Recent activities include planning for the California Back Country Discovery Trail which will pass through the watershed, and signing of the Garden Ridge OHV trail.	Remoteness of watershed. Focus of activities in other areas of Shasta-Trinity National Forest.	Management trends are static (→).

Influences and Relationships:

- Effective fire suppression has resulted in an increase in late-seral habitats and a loss of early seral habitats and associated species. Effective fire suppression has also increased the need for vegetation management projects (prescribed burning, timber harvest).
- Catastrophic wildfires could result in the damage or loss of multiple resources including mid and late-seral vegetation/habitats, mid and late seral species, recreation values and aesthetics, and life and property.
- Degraded or poorly maintained roads are chronic sediment sources to streams. Increased sedimentation from roads could be impacting instream habitats and associated aquatic species. Roads are also aggravating hillslope erosion processes including mass wasting.
- Low standard roads are providing recreation opportunities for off-highway vehicle users. Given the low road densities in the watershed, even roads maintained at the lowest standard provide access to woodcutters, hunters, private landowners and other users. Low road densities are also preserving the isolation and primitive values of much of the watershed.

Conclusions:

- Active timber management is not occurring in the Squaw Creek Watershed for several reasons. Investigation of timber sale opportunities on prescription 8 lands in the central third of the watershed over the past two decades have consistently shown that timber resources are limited and that the extraction of these resources would not be economical. Management of the northern third of the watershed is focused on late-successional habitats which limits opportunities for timber management. No opportunities for timber management exist in the southern third of the watershed because site productivity is low and commercial forest lands are scarce to nonexistent. Timber harvest opportunities in the watershed should be considered within the context of addressing other resource concerns including risk of catastrophic fire, high fuel build-ups and loss of early and mid seral wildlife habitats. There is also a need to determine if non-conventional harvest methods such as helicopter logging (which is currently occurring on private lands in the watershed) could be utilized to meet resource objectives for timber, fuels and wildlife.

- Road densities in the Squaw Creek Watershed are relatively low (1.6 mi/mi^2) due to lack of management activities. Road densities should be minimized in Late Successional Reserves, Administratively Withdrawn Areas and Riparian Reserves. Road densities in the LSR are expected to drop as some low standard roads become undrivable due to revegetation (self-closure), unneeded roads are removed from the transportation system, or if private lands are acquired in land exchanges. There is a need to develop a transportation plan to identify key roads needed for management of public lands and access to private lands. The plan should also assess the current condition of each road (drivable, undrivable, etc.), identify maintenance and restoration needs and identify opportunities for road decommissioning.

- Based on fuel hazard and risk maps, there is a need to reduce fuel build-up in the watershed. This need is greatest in the northern third of the watershed where hazard/risk is high or moderately high. The central third of the watershed has the lowest hazard/risk rating (see Map 11). Parallel benefits from prescribed burning activities include development or maintenance of mid to early seral vegetation and the improvement of habitat for wildlife species dependent on mid and early seral vegetation. There is a need to identify opportunities for prescribed burning based on the resource needs mentioned above. There is also a need to determine where opportunities exist to combine prescribed burning activities with timber management. The remoteness of the northern watershed and the checkerboard ownership pattern of private and public lands present obvious deterrents to the development of prescribed burning activities. There is a need to assess the actual potential for implementing prescribed burning activities in the northern third of the watershed.

- Recreation use will increase in the Squaw Creek Arm of Shasta Lake. Recreation management activities should remain at low to moderate levels for the rest of the watershed. Recreation activities will continue to emphasize high quality experiences associated with the remoteness of the watershed, low levels of use, and primitive campgrounds.

5.2 Vegetation

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current vegetative conditions?
- What are the influences and relationships between vegetation and seral patterns and other ecosystem processes in the watershed?

Present Condition	Causal Mechanisms	Trends
Most oaks and conifers are in the early mature (30-60 years) and mid-mature (60-120 year) seral stages. Most trees in the watershed are between 50-80 years of age.	Wildfires occurring at the turn of century were stand replacing in nature. Use of fire as a tool by ranchers to create forage inhibited growth of conifers and oaks. Timber harvest removed mature conifers. Fire suppression encouraged the transition of early seral vegetation to late seral vegetation.	Oak and conifers continue to move into later seral stages. Vegetation ages are increasing (➚).
Old growth is present in the watershed in pockets of conifers scattered along ridgetops and within and adjacent to riparian areas. Old growth stands of canyon live oak and black oak are also present in the watershed.	Fire suppression. Microclimates (temperature, precipitation, soil water content) create conditions favorable to the establishment of old growth in riparian areas and along ridgetops.	Old growth is expected to increase in the LSR and within Riparian Reserves (➚).
The distribution of old growth in the watershed is believed to have always been limited.	Climate, historic fire frequency, soils and elevation all have influenced the development of old growth.	Old growth is expected to increase (➚).
Early seral habitats for all vegetation types are limited in the watershed.	Fire suppression has allowed vegetation to advance from early to later seral stages.	Trend is static (→).
According to a Hazard and Risk analysis approximately 99 percent of the Squaw Creek Watershed is at a moderate or high risk to catastrophic fire.	Fire suppression has resulted in increased fuels. Wet winters followed by hot, dry summers create conditions favorable to wildfire.	The risk of catastrophic fire is expected to increase (➚).
Prior to European settlement, fire played a major role in controlling vegetation types and seral stages in the watershed. The exclusion of fire has resulted in a shift of vegetation types and advancement of vegetation seral stages.	Shift from encouraging natural wildfires and burning to enhance forage for cattle (early 1900's) to suppression of all fires.	Trends in the influence of fire suppression on different vegetative communities are variable.
Over the past 75 years late successional habitat has increased on public lands in the northern half of the watershed.	Fire exclusion.	Late-successional habitat will continue to increase (➚).
Yellow star-thistle, Himalayan blackberry and other non-native species are competing aggressively with native vegetation. Disturbed lands are particularly vulnerable. Opportunities exist to control the spread of non-native vegetation at Wheeler Meadows and Chirpchatter C.G.	Introduction of non-native species during settlement of valley bottoms in the early 1900's.	Non-native species are continuing to spread throughout the watershed (➚).

Influences and Relationships:

- The age and types of vegetation occurring in the watershed influence water quality, hillslope erosion, fuel loadings, and wildlife species and habitats.
- The absence of fire has resulted in increased amounts of vegetation in the watershed which has resulted in increased water use by vegetation and reduced streamflow.
- Fire exclusion has encouraged the development of late-successional forests and a corresponding decrease in early seral vegetation. Habitat for species dependent on early seral vegetation has decreased.
- Fire exclusion has reduced hillslope erosion in the watershed, while simultaneously heightening the risk of increased soil erosion if a large fire occurs.
- Catastrophic wildfires can remove riparian vegetation which is critical to maintaining cooler water temperatures, increasing stream biotic potential and maintaining channel stability.
- Advancement of vegetation to mature seral stages may result in a change in vegetative management activities and corresponding human uses.

Conclusions:

- The condition of vegetation in the watershed influences wildlife habitat, fuel loads and structure and slope stability. Vegetation management through timber harvest or prescribed fire has the opportunity to decrease the risk of catastrophic fire and increase early seral vegetation and associated habitats.

- Developing late successional habitat should improve dispersal in the LSR. The LSR has potential to benefit immensely from the land exchange currently being considered by SPI. In its current form all private sections in the vicinity of the LSR would be acquired. Acquisition of these lands would eventually increase late-successional habitat and reduce fragmentation as late successional stands develop.

- Yellow star-thistle, Himalayan blackberry and other non-native species are likely to continue to displace native vegetation and infest disturbed areas in the watershed.

- There is a risk of losing large areas of developing late-successional habitat within the LSR to catastrophic wildfire. Stands of conifers and oaks throughout the watershed are at risk. There is a need to reduce fire hazard and risk in the watershed, to reduce surface fuel loads and to preserve developing late successional forests.

- There is a need to use vegetation management practices to create a mosaic of habitats throughout the watershed. Habitats for species dependent on early seral stage vegetation are lacking.

- There is a need to provide continued fire suppression in the watershed.

5.3 Species and Habitats

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current species distribution and habitat quality for species of concern in the watershed?
- What are the influences and relationships of species and their habitats with other ecosystem processes in the watershed?

Present Condition	Causal Mechanisms	Trends
Aquatic habitats for fish and amphibians are generally in good condition. Aquatic habitats appear to have recovered from the large fires that occurred in the late-1800's. Substantial recovery of aquatic habitats is believed to have occurred over the past 50 years (excepting the Salt Creek drainage area).	Fire suppression, establishment of vegetation, reduced erosion and reduced mass wasting activity have resulted in an overall improvement in aquatic habitat conditions from those that existed in the early 1900's.	Fish populations within streams are expected to remain stable (→). Fish and amphibian populations will fluctuate in response to future disturbance (stand replacing fires, mass wasting activity) due to changes in the quality of aquatic habitats.
The quality of aquatic habitats has deteriorated within some streams due to recent localized mass wasting activity.	The 1997 Flood was the catalyst for the initiation of large debris flows and debris torrents.	Reduced habitat quality and reduced populations of aquatic fauna within effected reaches Trend is static in disturbed areas (→).
The Squaw Creek Arm of Shasta Lake is currently a good fishery for both warmwater and coldwater species. Although Shasta Lake serves as a good reservoir fishery, warmwater fish production is limited by a lack of sufficient cover.	Loss of vegetative cover and trophic depression.	The lake environment is expected to continue to provide a good fishery regardless of watershed condition. Cover will continue to be a limiting factor (→).

Over 15 percent of the vegetation on public lands in the watershed is composed of late-successional vegetation. Late-successional vegetation, as defined for the 15 percent criteria, includes all 4G and 4N stands (LMP data). Actual old growth stands in the watershed do not exceed 15 percent. Current old-growth levels (assuming 4G stands meet old growth criteria) indicate that approximately 4 percent of the watershed is composed of old growth forests.	Effective fire suppression has encouraged the development of late-successional forests. Poor site productivity in the lower third of the watershed inhibits the development of late-successional habitat. The abundance of hardwood and mixed conifer stands in the central third of the watershed limits the amount of late-successional habitat. Large stand replacing fires occurring at the turn of the century have inhibited the development of old growth forests.	Late-successional habitat has been increasing in the watershed for the last sixty years (↗). Late-successional stands should continue to develop into old growth stands, providing they are not disturbed by fire.
Adequate, well-distributed habitat does not exist for the northern spotted owl and other old-growth and forest interior dependent species.	Historical fires inhibited development of late-successional habitat. Timber harvest on private lands has resulted in fragmentation of developing late-successional habitat. Poor site productivity in the southern third of the watershed inhibits the development of late-successional habitat. Late-successional habitat is naturally limited in the central third of the watershed where pure and mixed black oak stands predominate.	Late-successional and old-growth stands should continue to develop in the northern and central thirds of the watershed providing fire suppression continues to be effective (↗).
Shasta salamander habitat is present within the watershed within the Hosselkus limestone formation. Its distribution and extent is unknown.	Lack of recent survey since Pappenfus.	Trend is static (→).
Deer and elk distribution and extent of use is unknown for the watershed. Deer and elk forage is limited. Oak and chaparral habitat is in poor condition.	Lack of recent surveys for deer and elk. Fire exclusion has resulted in a decrease in early seral vegetation. Less forage is available for deer and elk.	The condition of oak and chaparral habitat for elk and deer will continue to deteriorate (↘).
Peregrine falcon activity has been observed in the watershed. One eyrie has been identified in the Low Pass area. The eyrie was active in 1993 but was not active in 1994.	Suitable habitat exists in Hosselkus limestone formation. Rock climbing activities may have contributed to the abandonment of eyrie adjacent to Low Pass road.	Rock climbing increasing(↗). Increased use of the limestone area could result in a decrease in eyrie use (↘).
Snags and dead & down material appear to meet minimum levels.	Maturation of natural habitat. Fire exclusion has allowed for the development of snags and dead and down wood. Limited timber harvest has occurred on public lands.	The amount of snags and dead and down material should increase due to continued fire suppression (↗).
Bat habitat has been identified at several locations, but presence is unknown.	Lack of survey.	Trend is static (→).

A land exchange is being considered in the northern third of the watershed which could turn some existing private land over to the National Forest. Acquiring these sections would result in the elimination of the checkerboard ownership pattern and increase the size of the LSR. This would allow for an eventual increase in late-successional habitat as cut over forest lands gradually recovered from timber harvest activities.	Land exchange.	The short term benefits to the LSR would be neutral (→). The LSR would benefit from the exchange in the long term as the vegetation on the acquired lands recovered and late-successional habitat was established (➚).
Inventories of survey and manage late-successional associated fungi, lichens, mollusks, bryophytes, and vascular plants have not been accomplished to date.	Lack of survey.	The trend is static however surveys should begin soon in conjunction with prescribed burn planning (➚).

Influences and Relationships:

- Catastrophic wildfire results in habitat loss.
- Catastrophic wildfire destroys important habitat components (snags, dead & down wood).
- Catastrophic wildfire destroys large woody debris in riparian areas and removes the source of future large woody debris.
- Catastrophic wildfire could create large areas of early seral habitat.
- When stream channels are destabilized by catastrophic wildfire, riffles tend to elongate resulting in a loss of pools and deep water habitat.
- Increased sediment loads following large wildfires results in a loss of spawning habitat.
- High site productivity and high precipitation make the watershed suitable for supporting late-successional habitat.
- Fire exclusion has allowed late-successional habitat to develop in the northern and central thirds of the watershed.
- There is a potential for losing large acreages of late-successional habitat to catastrophic wildfire.
- LSRs encourage development of vegetation conditions that improve slope stability and reduce hillslope erosion.
- LSRs encourage development of vegetation conditions that reduce peak flows.
- LSRs provide an ample source for the long-term recruitment of large woody debris in Riparian Reserves.
- Management for late-successional conditions tends to develop high fuel loads and fuel ladders.

Conclusion:

- Late-successional habitat needs in the watershed are being met by the LSR and Riparian Reserves. Snags and dead & down levels appear adequate at this time. Actual old-growth stands are still scarce.

- Early seral habitats are not present in the amounts necessary to support species dependent on these habitats. There is a need to develop a mosaic of age classes in chaparral habitats. There is a need to develop the grass/forb layer in oak and conifer habitat types.

- Survey and inventory needs in the watershed include: Peregrine falcon, bats, Shasta Salamander, deer and elk, sensitive plants, and old-growth associated vascular plants, mollusks, lichens, fungi, and bryophytes.

5.4 Erosion Processes

Core Questions (from WA Guide):
- What are the natural and human causes of changes between historical and current erosion processes in the watershed?
- What are the influences and relationships between erosion processes and other ecosystem processes (e.g., vegetation, woody debris recruitment)?

Present Condition	Causal Mechanisms	Trends
Dormant and active mass-wasting features are present throughout the watershed. High hazard areas occur primarily west of Squaw Creek in the upper two-thirds of the watershed and within south and west facing slopes. Active mass-wasting has declined by approximately 70 percent from conditions observed in the 1944 air photos.	Extensive, intense wildfires occurring in 1872 and 1898 denuded a major portion of the watershed which led to increased mass-wasting, sedimentation, and turbidity levels. Fire suppression activities this century have decreased the number of acres burned in the watershed. Variations in annual precipitation and the intensity of storms and peak flows affect erosion processes. Geologic bedrock, structure, and slope characteristics also affect erosion processes.	Trends in erosion and mass-wasting processes are highly variable. Erosion rates vary due to timing and magnitude of peak flows, variation in annual precipitation, the amount and magnitude of disturbance and specific geologic and soil characteristics. Overall the trend should be one of decreasing erosion and mass-wasting activity (↘).
Erosion of fine sediments and mass-wasting is occurring in heavily roaded areas.	Roads. Lack of maintenance. Peak flows. Geologic conditions	Decreased erosion with improved management of roads and vegetation (↘).
The decrease in wildfire has led to a corresponding decrease in soil erosion and mass-wasting activity.	Fire suppression.	Static in the absence of catastrophic wildfire (→).
The Salt Creek Drainage is in a degraded condition due to debris torrents and hillslope failures.	1997 New Year's Day Flood.	The drainage is recovering rapidly from flood impacts (↗).
The increased possibility of catastrophic wildfires will result in a corresponding increase in the risk of mass-wasting activity and hillslope erosion should a large portion of the watershed be affected by wildfire.	Routine fire suppression. Increased build-up of fuels.	The trend is for increasing **risk** of erosion and mass wasting (↗).

Influences and Relationships:

- Intense fire exerts pronounced effects on basic hydrologic processes, leading to increased sensitivity of the landscape to eroding forces and to reduced land stability. This is manifested primarily as increased overland flow, and greater peak and total discharge. These flows provide the initiating force for the transport of sediment through the watershed.
- Erosion responses to burning are a function of several factors including: degree of elimination of protective cover; steepness and aspect of slopes; type of soil and geologic bedrock; climatic characteristics; and rapidity of vegetation recovery. Sedimentation, mass-wasting and increased turbidity levels appear to be the most serious threats to water resources following fire.
- Burning the surface organic matter also removes the protective forest floor, volatilizes large amounts of nitrogen and smaller amounts of other elements, and transforms less volatile elements to soluble mineral forms that are more easily absorbed by plants or are lost by leaching. Heating the underlying soil layers also alters the physical, chemical and biological properties of the soil. Protection at the soil surface is reduced by losses of surface litter. Soil erodibility is increased because of the volatilization of soil organic matter and destruction of soil aggregates.
- The link between instability and aquatic ecosystems is widely recognized. Aquatic biota evolved in a particular environmental setting that included a natural distribution of mass-wasting features. Elimination of protective cover has been shown to cause temperature increases that might pose a threat to aquatic life. Unstable land becomes a problem only when the disturbance pattern is rapidly altered, or when changes defeat coping strategies.
- Reptiles and amphibians are also strongly influenced by mass-wasting processes because these processes create or destroy on-sight and downstream habitat. Increased sediment loads can fill pore spaces in gravels, preventing some species from living there. Unstable lands are an integral part of the natural habitat mosaic for these herpetofauna so the natural instability regime needs to be maintained if the natural variety and viability of the biota are to be sustained.
- Roads increase hillslope erosion and gullying by disrupting drainage patterns.
- Late-Successional Reserves encourage the development of vegetation conditions that improve slope stability and reduce hillslope erosion.

Conclusions:

- Fire suppression has reduced overall hillslope erosion and mass-wasting activity from the levels occurring at the turn of the century. Current trends in hillslope stability and mass-wasting activity could be reversed in the event of extensive stand replacing wildfires. Some erosion of fine sediments and sedimentation will continue under current maintenance levels. The large amount of mass wasting activity that occurred in the Salt Creek drainage indicates that, while overall erosion in the watershed may be lower than levels observed in 1944, large precipitation events can still cause significant hillslope erosion, even if wildfire has been absent for some time.

5.5 Hydrology

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current hydrologic conditions?
- What are the influences and relationships between hydrologic processes and other ecosystem processes (e.g., sediment delivery, fish migration)?

Present Condition	Causal Mechanisms	Trends
Peak and baseflows in Squaw Creek and its tributaries are believed to have decreased over the past 100 years.	Increased water use by vegetation due to fire suppression. Absence of large, stand replacing fires such as those that occurred in 1872 and 1898.	Increase in peak and base flows over past 100 years (➚). Currently static (➞).
Localized increases in peak flows may be occurring in heavily roaded areas that have experienced recent timber harvest activity.	Timber harvest and road construction.	Increase in peak flows over past 30 years (➚). Currently static (➞).

Influences and Relationships:

- Water yield (both peak and base flows) is increased by wildfire, prescribed fire, high road densities, and timber harvest activities.
- Water yield is influenced by the amount and age of vegetation occurring in the watershed.
- LSRs encourage development of vegetation conditions that reduce peak and base flows.
- Increased hillslope erosion often occurs simultaneously with peak flow events.
- Peak flows are important to the downstream transport of gravel and large woody material.

Conclusions:

- The total annual water yield from the Squaw Creek Watershed is believed to have decreased due to the absence of fire and the gradual recovery of vegetation following the large fires of 1872 and 1898. Peak and base flows in the Squaw Creek Watershed are believed to have been reduced from levels occurring in the early 1900's, however we have no scientific proof that current flows are outside of the natural range of variability for the watershed. More information is needed (specifically evapotranspiration rates from different types of vegetation) to determine how vegetation treatments will affect base flows and for what duration.

5.6 Stream Channels

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current channel conditions?
- What are the influences and relationships between channel conditions and other ecosystem processes in the watershed (e.g., in channel habitat for fish and other aquatic species, water quality)?

Present Condition	Causal Mechanisms	Trends
Stream channel stability is generally very good throughout the watershed. With the exception of the Salt Creek drainage, upland channels continue to revegetate and recover from periods of high instability identified in 1944 aerial photographs. Effective fire suppression has allowed forests to become established adjacent to headwater streams and increased the potential for the recruitment of large woody material to upland channels. Comparison of 1944 to 1995 aerial photographs indicates that there is more canopy cover over stream channels and that more large wood is available to for potential recruitment at present (1999) than at any time during the past 100 years.	Vegetative recovery from historic wildfires has reduced hillslope erosion and increased hillslope stability, which has in turn benefited instream habitats. Fire suppression has prevented the occurrence of large stand replacing fires.	Comparison of 1944 and 1995 aerial photography indicates that the area of the watershed that is actively eroding has decreased (↘). The potential of large woody debris recruitment to streams is increasing (↗).
Stream channels in the Salt Creek drainage are in a degraded condition due to the large debris flows and torrents that occurred during the 1997 Flood.	1997 New Years Day Flood.	Stream channel stability should increase overtime as riparian and instream habitats recover from flood impacts (↗).
Visual inspection of Squaw Creek indicates that the distribution of pools, riffles, and runs and the average depths of pools has changed in response to the 1997 Flood, however no actual data are available to confirm any changes to instream habitats.	1997 New Years Day Flood.	Trends in instream habitat parameters such as pool depth, and the distribution of pools, runs and riffles in Squaw Creek are currently unknown.
Large amounts of sediment have been introduced into some drainages as a result of mass wasting activity triggered by the 1997 Flood and other large winter precipitation events. Some mass wasting activity can be attributed to roads.	1997 New Years Day Flood. Roads.	Static (→).
Roads continue to be chronic sediment sources to streams with the greatest problems occurring in areas with high road densities.	Poorly located roads. Lack of maintenance. Use occurring during rainy season.	Static (→)

Influences and Relationships:

- Hillslope erosion following wildfire can deliver large volumes of sediment to the upland channel network.
- When stream channels are destabilized by increased sediment inputs, riffles tend to elongate resulting in a loss of pools and deep water habitat.
- Wildfires can remove riparian vegetation and reduce bank stability.
- Increased sediment loads following large wildfires can result in a loss of spawning habitat.
- Poorly designed road crossings can lead to increased sediment inputs to stream channels.
- LSRs encourage development of vegetation conditions that improve slope and bank stability.

Conclusion:

- Fire suppression has decreased sediment inputs and increased channel stability in some areas where fire has been excluded. There is a need to manage for the accumulation of fuels in areas where fire has been excluded. Fire should be reintroduced in the watershed in order to prevent the continued build up of fuels in fire prone areas and to reduce the risk of catastrophic fires. There is also a need to monitor the effects of prescribed fires on riparian reserves

- Mass wasting activity has decreased in many areas where prolonged absence of fire has allowed for the recovery of hillslope vegetation. As indicated by the Salt Creek debris flows and torrents, mass wasting events still occur in the absence of wildfires. Large precipitation events will continue to initiate mass wasting activity in the watershed.

- Low road densities in the watershed have kept road induced sediment problems to a minimum, however there is still a need to conduct a watershed improvement needs inventory to identify erosion problems associated with roads and implement corrective measures.

5.7 Water Quality

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current water quality conditions?
- What are the influences and relationships between water quality and other ecosystem processes in the watershed (e.g., mass wasting, fish habitat, stream reach vulnerability)?

Present Condition	Causal Mechanisms	Trends
Very little water quality data are available for Squaw Creek and its tributaries. Average summer water temperatures may be lower that during the early 1900's.	Fire suppression.	Instream water temperatures in Squaw Creek and its tributaries may have decreased over the past 50 years due to increases in shade provided by recovering vegetation in and adjacent to stream channels
Suspended sediment and turbidity levels are very low in the summer. Sediment and turbidity increase in the winter months during periods of high runoff. Sediment sources include hillslopes where mass wasting processes are active and roads.	Natural hillslope erosion. Roads. Rainy season logging.	Static (➞).
Localized water quality problems associated with acid mine drainage occur in the vicinity of the Bully Hill and Rising Star Mines. Restoration plans to reduce acid mine drainage to Town and Horse Creeks are currently being implemented under the guidance of the Water Quality Control Board.	Mining.	Mitigation and restoration measures should reduce acid mine drainage to streams (➘).

Influences and Relationships:

- Hillslope erosion following catastrophic wildfire can deliver large volumes of sediment to the upland channel network and increased suspended sediments and turbidity throughout the watershed.
- Large fires result in the formation of ash which can increase the pH of streams.
- Catastrophic wildfire removes riparian vegetation which is critical to maintaining cooler water temperatures.
- Increased sediment loads following large wildfires results in a loss of spawning habitat.
- Road building increases sediment delivery and transport into stream channels.
- Timber harvest can increase sedimentation.
- LSRs and Riparian Reserves provide greater crown cover that reduces water temperatures.
- Water quality affects aquatic species and riparian dependent wildlife species.

Conclusions:

- The quality of water in the Squaw Creek Watershed appears to be very good. No problems with turbidity or suspended sediments have been reported or observed in the field over the past 4 years.

- Opportunities to improve or maintain water quality are largely associated with improvement of road drainage.

- More water quality data is needed to quantify existing conditions for water quality parameters (pH, dissolved oxygen, conductivity, suspended sediments and turbidity) in stream channels and the Squaw Creek Arm of Shasta Lake.

- Future prescribed burning activity should be monitored to determine how burning effects turbidity, suspended sediments, hillslope erosion processes and the distribution of canopy cover.

5.8 TES Species Management

Key Questions (from Chapter 2):
- What TES species inhabit the watershed?
- Is there 15% late-successional habitat in the watershed?
- How may management activities impact TES species?
- Are there adequate travel corridors for TES species in the watershed?
- Are Riparian Reserve widths adequate for riparian travel corridors?

Discussion: TES species that inhabit, or are believed to inhabit the Squaw Creek Watershed include the American peregrine falcon, bald eagle, northern spotted owl, Shasta salamander, northern red-legged frog, northern goshawk, willow flycatcher, Pacific fisher, American marten and the northwestern pond turtle.

According to LMP vegetation data over 15 percent of the watershed contains late-successional habitat. The amount of late-successional habitat was determined by tallying the total acres of existing late-successional habitat and dividing the former by the total number of acres of public land that is capable of supporting late-successional habitat. Existing late-successional habitat included LMP vegetation types having a seral stage of 4. It should be noted that the denominator in this calculation (acres of capable public lands) did not include any chaparral, knobcone, canyon live oak, grasslands or pure and mixed black oak stands. Because only existing conifer sites were considered the percentage of late-successional habitat on capable lands was 62 percent. The percentage of actual old growth in the watershed was far less (approximately 4 percent).

Prescribed fire has the greatest potential to impact TES species due to the large area that may be affected in the southern third of the watershed. TES species that are also riparian dependent such as the Northern red-legged frog and Northwestern pond turtle may be affected by prescribed burning activities that occur in close proximity to riparian habitats. TES species dependent on late-successional habitats could be benefited by prescribed fire and other management activities that improve or enhance late-successional habitat.

Adequate travel corridors for TES species may not be present in the watershed due to fragmentation caused by timber harvest and from poor site productivity in the southern third of the watershed which limits the development of travel corridors containing late-successional attributes.

Riparian reserves containing stream channels (including Shasta Lake) occupy approximately 30 percent of public lands. Due to the high density of riparian reserves there should be ample travel corridors for dispersal. Riparian reserves widths should remain identical to the interim widths which are believed to be wide enough to serve as travel corridors.

5.9 Management of Pure and Mixed Black Oak Stands

Key Questions (from Chapter 2):
- How can we best manage the landscape to benefit elk, deer, bear and other oak-dependent species?
- Is the current land allocation (Prescription 8) compatible with managing to maintain the hardwood component in the watershed?

Discussion: Pure and mixed black oak stands occur within approximately 36 percent of the Squaw Creek Watershed (LMP data for Black Oak stands). Oak stands have progressed to an older seral stage throughout the watershed due to effective fire suppression. Management of pure and mixed black oak stands was identified as an issue for this analysis because no clear management direction was apparent for this vegetation type. Pure and mixed black oak stands generally dominate the Prescription 8 land allocation in the central third of the watershed. From a timber harvest and wildlife perspective, the emphasis of commodities production from prescription 8 lands does not appear to be appropriate for pure and mixed black oak stands. Managing these stands for commodity production would not create desirable wildlife habitat and is not economically feasible at this time. Previous attempts at commercial oak harvest have proven unsuccessful due to prohibitive harvesting costs associated with road construction and the low volumes available for harvest. Thinning of pure and mixed black oak stands is viewed as desirable by both wildlife and fuels in order to improve and diversify habitat for game species and to reduce the risk of catastrophic fire, however this type of management would better address wildlife concerns if stands were managed as Prescription 6 (wildlife emphasis) rather than prescription 8. For the reasons mentioned above it is recommended that the Shasta-Trinity National Forest redesignate Prescription 8 lands containing pure and mixed black oak stands as Prescription 6 in order to better address wildlife management goals for pure and mixed black oak stands in the watershed.

5.10 Fire and Fuels Management

Key Questions (from Chapter 2):
- What is the current fire regime in the watershed?
- What was the historic fire regime in the watershed?
- What is the potential for catastrophic fire in the watershed?
- What resources in the watershed are currently at risk to catastrophic fire?
- Under current management, what are the current trends for fire in the watershed?
- What is the desired role of fire in the watershed?
- How can fire be incorporated as an ecological process?

Discussion: There is historical evidence of large catastrophic wildfires in the watershed. Fire exclusion has created fuel profiles that connect surface fuels to crown canopies putting resources in the watershed at risk to catastrophic fire. The historical regime of frequent low intensity fires has transitioned to one of infrequent moderate to high intensity fires. Approximately 99% of the watershed is at moderate to high threat of replacement type fire events due to changing fuel profiles. These changes describe fire effects having a high probability of total tree mortality, probable erosion concerns, and a threat to life and property under worst summer conditions. Without changing the current fuel profiles through planned management activities, the desired role of fire as a natural disturbance that maintained fire dependent species, created diversity and reduced stand densities will be difficult to achieve. The introduction of fire through prescribed fire planning can imitate this now absent ecological process.

5.11 Erosion Processes

Key Questions (from Chapter 2):
- What erosion and mass wasting processes are dominant within the watershed?
- Where are these features located?
- What is the slope stability hazard associated with these features?
- What are the natural and human causes of changes between historical and current erosion processes in the watershed?

Discussion: Translational, rotational landslides, debris flows and torrents, inner gorge mass wasting and colluviation are the dominant processes. These features are located throughout the watershed, but they are most visible in the Salt Creek drainage due to their frequency and intensity. The slope stability hazard associated with these features tends to vary with specific features from extreme to none depending upon specific site conditions. Causes of changes between historical and current erosion processes include vegetative recovery, fire suppression, road construction and variations in maintenance levels.

5.12 Aquatic Habitats

Key Questions (from Chapter 2):

- How have stream channel processes and functions that govern the formation of fish habitat been affected by the recent increase in bedload?
- How have aquatic and riparian dependent species and their habitats been affected by the recent channel changes?
- How will future floods of different magnitudes effect the distribution of bedload and fish habitat.

Discussion: Any disturbance that results in erosion or loss of slope stability on a large scale will cause a reduction in habitat quality for fish and amphibians. This has been demonstrated in Salt and Winnibully Creeks where the occurrence of numerous debris flows and debris torrents has resulted in the aggradation of stream channels. These slides and torrents have introduced large amounts of bedload sediments that have obliterated deep water habitats and scoured riparian areas. Channel aggradation has, in turn, resulted in the loss of spawning habitat for fish. The removal of the riparian vegetation has also resulted in localized increases in water temperatures during low flow conditions. As a result, fish and herpetofauna populations within these areas have declined dramatically. Eventually the sediment will move out of the watershed and the habitats for the aquatic species will recover provided significant amounts of additional sediments are not introduced into these streams. Once this occurs aquatic populations within disturbed stream reaches will also recover.

CHAPTER 6:

RECOMMENDATIONS

The purpose of this chapter is to bring the results of the previous steps to conclusion, focusing on management recommendations that are responsive to the issues and watershed processes identified in the analysis. Monitoring activities are identified that are responsive to the issues and key questions. Data gaps and limitations of the analysis are also documented.

This chapter is organized by focusing on needs and opportunities identified in the "Conclusions" sections at the end of each item in Chapter 5.

Recommendation topics in this chapter include the following:

TES Species Habitat Management
Management of Pure and Mixed Black Oak Stands
Fire and Fuels Management
Erosion and Mass-Wasting Processes
Aquatic Habitats
Other Recommendations from Core Topics

Part 2 of Chapter 6 presents a list of potential projects developed from the analysis.

6.1 TES Species Habitat Management

Recommendation:

Increase the amount of early seral habitat in the watershed and improve the condition of existing early seral habitat.   Employ vegetation management practices including thinning, regeneration and prescribed fire to develop healthy early seral habitats. Priority vegetation types for developing early seral habitats include pure and mixed black oak stands and chaparral.

Related Core Topic(s): Vegetation, Species and Habitats, Erosion Processes, Human Uses, Stream Channels, Water Quality, Hydrology.

Rationale/Objective:

Early seral habitats for all vegetation types are limited in the watershed. There is a need to apply vegetation management practices to increase the diversity of habitats and to create a mosaic of early, mid and late seral habitats in the watershed. Enhancing and creating early seral habitats will provide forage for species dependent on these habitats.

Recommendation:

Improve forage in mid and late seral habitats by using prescribed fire to improve understory forage and reduce the risk of catastrophic fire.

Related Core Topic(s): Vegetation, Species and Habitats, Erosion Processes.

Rationale/Objective:

Some hardwood and conifer stands contain well developed overstory vegetation and relatively open understories. Prescribed fire can be effectively employed to further reduce fuel loadings in established conifer and hardwood stands. Prescribed fire may be used to increase forage for wildlife and to reduce fuel loads.

Recommendation:

Evaluate the condition of late successional habitat in the LSR to determine if any vegetation treatments would benefit developing late successional stands. Identify areas that will and will not require vegetation treatments in order to develop into late successional habitats.

Related Core Topic(s): Species and Habitats, Vegetation, Human Uses.

Rationale/Objective:

Adequate, well-distributed habitat does not exist for the northern spotted owl and other old growth and forest interior dependent species. The northern third of the watershed, located in the Late Successional Reserve, has the best potential to develop additional late successional habitat and improve existing late successional habitat. Additional surveys are needed to determine the current condition of developing late successional stands in the LSR.

Recommendation:

Survey for TES species in conjunction with project planning.

Related Core Topic(s): Species and Habitats, Human Uses.

Rationale/Objective:

There is a need to update survey information for TES Species. Surveys must be completed prior to initiating ground disturbing activities including prescribed burning and other vegetation management projects. Update watershed analysis with new information on TES species locations, areas surveyed and years surveys were accomplished. Additional surveys for Peregrine falcon, bats and the Shasta salamander are needed to identify suitable habitats and to determine species presence or absence.

6.2 Management of Pure and Mixed Black Oak Stands

Recommendation:

Amend Shasta-Trinity National Forest Land Management Plan by changing the prescription of Prescription 8 Matrix lands shown on Map 16 to Prescription 6 Matrix Lands.

Related Core Topic(s): Vegetation, Species and Habitats, Human Uses.

Rationale/Objective:

The area proposed for a change in management prescription is mostly composed of pure and mixed black oak stands. Investigations of the area undertaken by sale planners in the 1980's indicated that commercial treatment of these stands was not feasible.

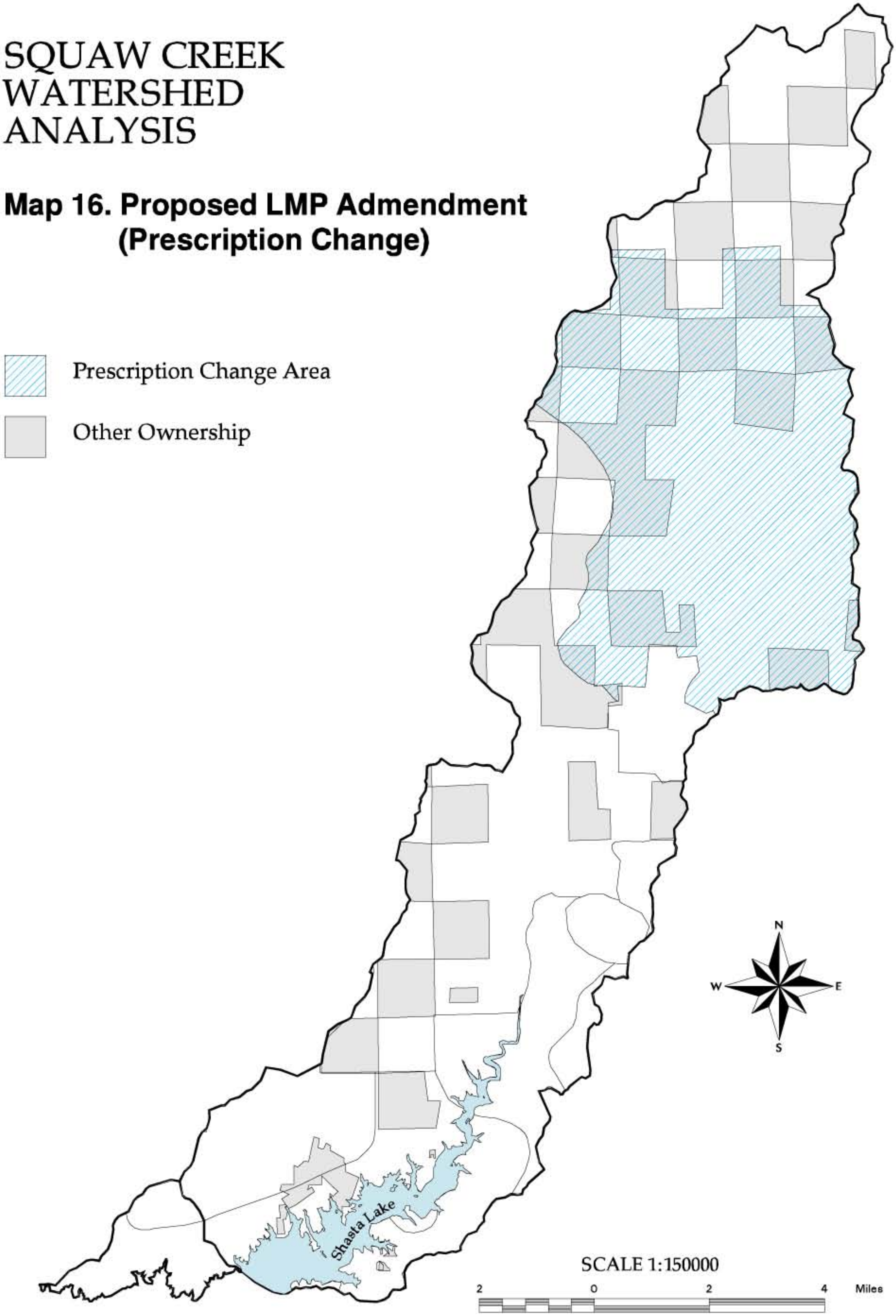
The pure and mixed black oak stands are some of the largest and most intact in Northern California. These stands provide valuable habitat to many wildlife species dependent on mid and late seral hardwood habitats.

Mixed conifer stands dominated by Douglas Fir are also present in the area where the prescription change is proposed (see map 9). Several attempts to harvest this timber in the 1980's were abandoned because the projects were not commercially viable. Most of the mixed conifer stands are located within or adjacent to Riparian Reserves and associated with fish-bearing streams (Overlay map 18-A over map 6 to see how potential treatment areas tend to lie within Riparian Reserves). Given the additional management restrictions on timber harvesting in Riparian Reserves, commercial harvest of these stands does not appear to be feasible.

Given the economic and management considerations mentioned above, the possibility of commercially treating hardwoods and conifer stands appears to be relatively small. Due to these limitations it would be more appropriate if these lands were managed for wildlife habitat emphasis (Matrix, Prescription 6) rather than commercial product emphasis (Matrix, Prescription 8). Management of the area as Matrix, Prescription 6 would permit timber harvest to occur but with an emphasis on enhancing wildlife habitat rather than producing commercial outputs.

SQUAW CREEK WATERSHED ANALYSIS

Map 16. Proposed LMP Admendment (Prescription Change)



Recommendation:

Identify opportunities for vegetation treatments including prescribed burning and commercial or non-commercial harvest in pure and mixed black oak stands.

Related Core Topic(s): Vegetation, Species and Habitats, Human Uses.

Rationale/Objective:

Pure and mixed black oak stands in the Squaw Creek Watershed are generally of uniform age and in mid to late seral stages. Managing for a mosaic of hardwood stands consisting of early, mid and late seral stages would benefit wildlife populations dependent on each of these habitats.

Pure and mixed black oak stands are at risk to catastrophic fire. Fire is a natural part of the ecosystem. Dead and down woody material is still surprisingly scarce beneath the overstory of many pure and mixed black oak stands. Opportunities exist to underburn these stands to remove light understory fuels without the risk of potential stand damaging fires that might occur if large concentrations of dead and down material were present. Underburning of the forest stands could encourage the production of forage for wildlife and create some natural openings for early seral stage vegetation.

6.3 Fire and Fuels Management

Recommendations:

Implement a long range fuel management program focused on critical hazard and risk elements identified in the watershed. The majority of this program would consist of prescribed burning; however, stand thinning and mechanical fuels treatment could be used where topography and access are favorable and where such treatments are consistent with current management direction (see Table 6-2). This program would be implemented in three phases as follows (also see Map 17). This program will be undertaken over a time span of decades. All of the phases and treatments described below should be considered within this time span.

Phase 1 - Continue existing prescribed fire projects.

This phase would continue the existing prescribed fire projects currently in planning and implementation stages. These projects include the Horse Mountain, Garden Ridge and Green Mountain prescribed burn areas (see Map 17). Together these areas total 7000 acres. The three burn areas are mainly composed of chaparral and pure and mixed black oak stands. The purpose of the burns is to reduce fuel loadings and improve/increase early seral habitats.

Phase 2 - Establishment of Fuel Management Zone (FMZ)

This phase will establish a complex of approximately 77 miles of FMZs along key ridgelines and roads. Total FMZ width for this phase will be 300 feet (150 feet on each side of the ridge) for a total of approximately 2734 acres within the watershed. This zone will serve as initial anchor points for a large prescribed burn program, as well as enhancement of future suppression efforts. At no single point in time will the entire FMZ system be in place. FMZs will be constructed as necessary to carry out phases 3 and 4.

Phase 3 - Expansion of FMZ down south facing slopes.

This phase will extend prescribed fire applications down south facing slopes where the highest probability of ignition currently exists. Approximately 4855 acres occur within this prescribed burn area. Focus areas will combine south slopes with oak chaparral species to accomplish both wildlife and fire management objectives.

Phase 4 - Expansion of prescribed burning to other critical areas.

This phase will focus prescribed fire efforts on landscape features that pose the greatest hazard and risk potential. This phase may include south aspects without oak and chaparral species and protection of structural property as well as other resource values. Approximately 5517 acres could be affected by this phase.

Table 6-1 summarizes the distribution of acres on National Forest ownership if the recommended fuel management program is fully implemented. The acres shown in the table are based on topographic features, aspect, and hazard and risk. They are included to display the relative area of land that would be treated at each phase and do not necessarily indicate the actual acres that would be treated. Actual acres are expected to vary at the project design stage and would be displayed in environmental documentation at that time.

	National Forest
Phase 1	7000 acres
Phase 2	2734 acres
Phase 3	4855 acres
Phase 4	5517 acres
Total	20,106 acres

Table 6-1: Potential acreage affected by each Phase of fuel management program.

Prescribed Burning

Prescribed burning would be the main activity in the fuel management program and would be implemented during all phases. Most burning would occur in Phases 3 and 4 on steeper slopes that are not suitable other vegetation treatments. Prescribed burning is an acceptable management activity within all land allocations and management prescriptions (see Table 6-2).

Stand Thinning/Mechanical Fuel Treatment

Stand thinning and mechanical fuel treatments (machine piling, etc.) would be used as alternatives to burning where slopes are suitable (generally <40%) and there is existing road access. Thinning would focus on reducing understory vegetation and retaining larger trees that form the overstory canopy. Such activities would occur mainly in Phase 2 where treatments are focused on ridgetop areas and then decline as the program moves into Phases 3 and 4 where treatments tend to occur on steeper slopes.

Stand thinning and mechanical fuel treatments should promote acceptable fuel profiles that reduce the risk of catastrophic fire. When possible, surface fuels should be kept below 15.0 tons/acre and stand densities below 10.0 kg/m^3 of crown bulk density.

Thinning may occur within Riparian Reserves if measures are included to minimize disturbance to ground cover and vegetation. However, mechanical fuel treatments are not considered appropriate due to the amount of ground disturbance.

Stand thinning and mechanical fuel treatments are permitted activities within the Limited Roaded Motorized Recreation Area. Helicopter removal is a permissible option that can be evaluated further in an environmental assessment.

Treatment Priorities

Although the fuels management recommendations are proposed as part of a long range program that covers several large watersheds, there is a need to focus, at least initially, on areas of highest resource values and highest resource risk. Areas identified as being high priority for treatment are:

- Ridgelines that provide protection for large amounts of old growth and late successional habitat (see Map 17.
- Areas of high fire hazard and risk (see Map 11).

Related Core Topic(s): Human Uses, Species and Habitats, Vegetation, Erosion Processes, Stream Channels, Hydrology, Water Quality.

Rationale/Objective:

Reduce stand replacement fire behavior by reducing surface fuels and stand densities to acceptable levels.

Protect existing watershed resources (especially the LSR) from stand replacement wildfire events through enhanced suppression and prescribed fire opportunities.

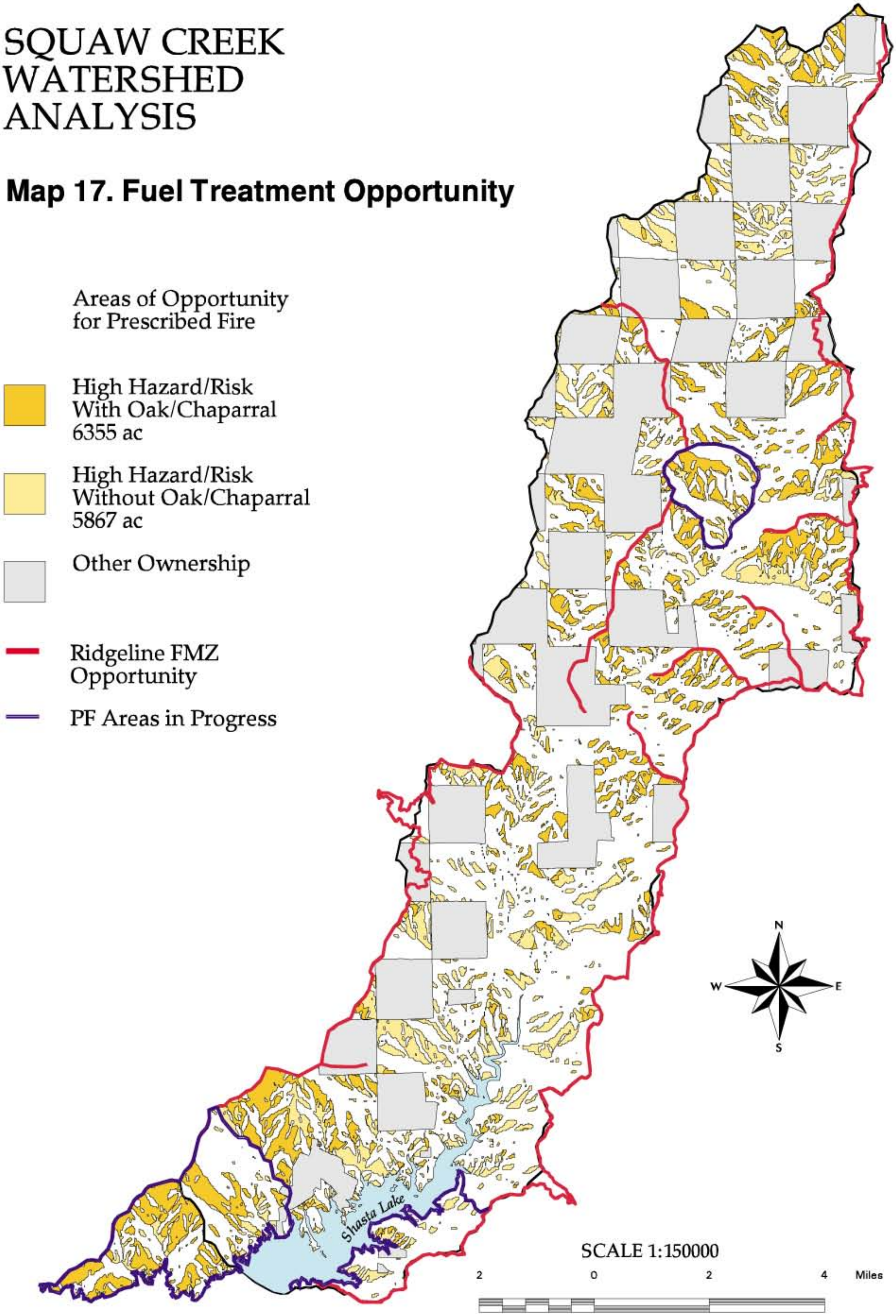
Create and maintain acceptable fuel profiles within the watershed that are characteristic of its natural fire regime.

	Land Allocation			
Activity	**Late Successional Reserve**	**Riparian Reserve**	**Unroaded Non-Motorized Recreation**	**Matrix**
Prescribed Burning	Permitted when aimed at reducing risk. (LMP 4-37 & 4-43)	Permitted when it contributes to attainment of ACS objectives. (LMP 4-57)	Permitted. (LMP 4-45)	Permitted or emphasized. (LMP 4-64 thru 4-67)
Stand Thinning	Permitted when aimed at reducing risk, and when beneficial to the development of late-successional forest conditions. (LMP 4-37 & 4-43)	Permitted when needed to attain ACS objectives. (LMP 4-54)	Mechanical / manual vegetation treatment methods are permitted but opportunities are very limited due to restrictions on road access. (LMP 4-45 & 4-46)	Permitted or emphasized. (LMP 4-64 thru 4-67)
Mechanical Fuel Treatment (machine pile, etc.)	Permitted when aimed at reducing risk. (LMP 4-37 & 4-43)	Not considered appropriate due to disturbance of ground cover and vegetation.	Mechanical / manual vegetation treatment methods are permitted but opportunities are very limited due to restrictions on road access. (LMP 4-45 & 4-46)	Permitted or emphasized. (LMP 4-64 thru 4-67)
Road Building	Permitted when benefits exceed cost of habitat impairment. (LMP 4-39 & 4-43)	Permitted when designed to meet ACS objectives. (LMP 4-54)	Not permitted. (LMP 4-45)	Permitted or emphasized. (LMP 4-64 thru 4-67)

Table 6-2: Compatibility of various fuel management activities with current management direction for the major land allocations and management prescriptions.

SQUAW CREEK WATERSHED ANALYSIS

Map 17. Fuel Treatment Opportunity



6.4 Erosion and Mass-Wasting Processes and 6.5 Instream Habitats

These two issues have been integrated here because the recommendations for both were identical.

Recommendation:

Conduct a comprehensive study that analyzes the effects of the 1997 Flood on stream corridor condition. Map and describe all flood features including debris flows, debris torrents and large log jams. Estimate total amount of material mobilized in debris torrents and debris flows. Map all mass-wasting features that were present prior to the flood. Identify any existing features that became active during the flood. Assess the effects of Salt Creek debris torrents on Squaw Creek below Salt Creek confluence. The report should also attempt to determine the reasons for the concentration and severity of impacts occurring in the Salt Creek drainage relative to neighboring drainages. An estimate of recovery times for hillslopes and aquatic habitats should also be included. Aquatic habitat surveys undertaken in the Salt Creek drainage during the Squaw Creek Watershed Ecological Unit Inventory should be repeated. Macroinvertebrate surveys should also occur.

Related Core Topic(s): Erosion Processes, Stream Channel, Vegetation, Species and Habitats, Hydrology, Water Quality, Human Uses.

Rationale/Objective:

Prior to the 1997 New Years Day Flood, the condition of riparian and aquatic habitats in Salt Creek was excellent. Aquatic habitat surveys undertaken during the 1994 Squaw Creek Watershed Ecological Unit Inventory indicated found more aquatic species present in the Salt Creek drainage than in any other area in the watershed. Almost every stream channel in the drainage was impacted by debris torrents. The magnitude of disturbance and the extent of impacts is high enough to warrant additional investigations into the causes and consequences of loss of aquatic habitats. Information from the study could be used for planning future projects (timber sales, prescribed burns, transportation plans) in the watershed.

Recommendation:

Determine effects of past floods and annual high flows on sediment transport and aquatic habitats in Squaw Creek. Select one reference reach for long term monitoring of instream habitats.

Related Core Topic(s): Erosion Processes, Stream Channel, Species and Habitats, Hydrology, Water Quality, Human Uses.

Rationale/Objective:

Field observations made in the Spring of 1997 and personal communication with local residences suggest that large quantities of sediment were delivered into Squaw Creek, but were not passed through the system, during the 1997 flood. Pools are believed to have become shallower and a considerable amount of aggradation is believed to have occurred in runs. Currently these observations are speculative. Pools and riffle habitats in Squaw Creek should be examined more thoroughly and changes in instream habitats monitored over time.

By selecting one reference reach for intensive monitoring, the amount of time needed for this project can be kept to within reasonable limits. Monitoring of the reach will only have to occur once a year, or even more infrequently after peak flows. Information gathered in this monitoring effort will allow the Forest Service to determine trends in habitat quality and patterns of sediment distribution in the reference reach. This information could lead to further studies targeted at the identification of sediment sources and their causes.

Recommendation:

Map relative landslide and stream recovery rates from the 19th century fires within various subwatersheds using historical aerial photos and GIS techniques.

Related Core Topic(s): Erosion Processes, Stream Channel, Species and Habitats, Hydrology, Water Quality, Human Uses.

Rationale/Objective:

The occurrence of slope failures depends generally on complex interactions among a large number of partially interrelated factors. Analysis requires evaluation of the relationships between various terrain conditions and landslide occurrences. Objective procedures are necessary to quantitatively support the slope instability and erosion assessments. This requires evaluation of the spatially varying terrain conditions as well as the spatial representation of the landslides. A geographic information system allows for the storage and manipulation of information concerning the different terrain factors as distinct data layers and thus provides an excellent tool for determining relative recovery rates across the landscape. Information from the study could be used for planning future projects (timber sales, prescribed burns, transportation plans) in the Squaw Creek Watershed.

Recommendation:

Continue warm water fish habitat improvement work within the drawdown zone of the Squaw Creek Arm of Shasta Lake. Habitat improvement should focus on the development of cover for young-of-the-year fish. Improvement techniques such as the construction of brush structures, willow planting and the seeding of annual cereal grains are recommended.

Related Core Topic(s): Erosion Processes, Species and Habitats, Hydrology, Water Quality, Human Uses.

Rationale/Objective:

Cover for the warmwater fishery is severely lacking within Shasta Lake, particularly for the young-of-the-year. Since most fish are subject to predation during one or more life stages, their first recourse as prey is to conceal themselves. Thus the availability of cover can contribute significantly to increased survival. By adding structure to a 'cover deficient' reservoir shore zone, fish habitat can be improved and local increases in productivity and growth can occur.

6.6 Recommendations Arising From Core Topics

Topic: Road Management

Recommendation:

Prepare **Access and Travel Management Plan** (ATM) for Squaw Creek Watershed. The plan should include two scenarios. Scenario 1 could be implemented immediately without the occurrence of any land exchanges. Under this scenario all roads needed to access private lands would be maintained as would current right-of-way and cost share agreements. Scenario 2 could be implemented following land exchanges. Under this scenario roads not be needed for access to private land or constrained by right-of-way or cost share agreements would be closed. Road management recommendations would vary according to land allocation (see Lower McCloud Watershed Analysis, Chapter 6, Road Management Recommendations for a sample of how potential road management activities that could occur following land exchange). A **Watershed Improvement Needs (WIN) Inventory** may also occur after or during ATM planning. The WIN Inventory will identify restoration projects targeted at reducing sediment problems with roads and improving road drainage. A determination of the intensity and scope of the WIN Inventory should be made during the ATM process.

Related Core Topic(s): Human Uses, Species and Habitats, Water Quality, Stream Channels, Hydrology and Erosion Processes.

Rationale/Objective:

Access and travel management planning is needed to determine levels of maintenance and recommendations for road closure or decommissioning.

If the SPI/USFS Land Exchange were to occur today, according to the most recent proposal, all sections in the northern third of the Squaw Creek Watershed would be exchanged to the Forest Service. These lands would likely be managed as late-successional reserves. Due to the existing high road densities on private lands in the northern third of the watershed there would be many opportunities for road closure and decommissioning.

Road management plans are needed to identify restoration opportunities in the Squaw Creek Watershed. Decommissioning of roads could reduce fragmentation benefitting wildlife. Reducing road sediment sources to streams could reduce erosion and benefit aquatic species and habitats, water quality, and stream channels.

Recommendation:

Consider planning and implementation of the following projects: 1. Brock Mountain road reconstruction (Road 35N02). 2. Low Pass 4WD Trail partial closure/trail conversion (Forest Trail 1W21). 3. Goose Gap Road system maintenance and closure (No Road #). 4. Road 35N07 maintenance and drainage improvement.

Related Core Topic(s): Human Uses, Erosion Processes.

Rationale/Objective:

Brock Mountain road reconstruction (Road 35N02)

Shown as 17.7 miles on T.I.S., this road is currently driveable for only about 11 miles. The primary use is for fire and recreation access to the area between the Pit River and Squaw Creek arms of Shasta Lake, including several spurs down to the lake. It also provides the only vehicle access to the 5,550 acre Devil's Rock-Hosselkus RNA. The road is approximately 60 years old and at one time accessed the Brock Mtn. Lookout. It is in fair condition from Fenders Ferry FA27 south to the Chirpchatter C.G. (approx. 0.5 mi.). South of Chirpchatter the road has several segments which are presently passable but which will continue to deteriorate to the point of being undriveable if corrective action is not taken in the next few years. Portions of the road are already unpassable including the segment of road from Brock Mt. to the west, which is impassable due to brushing in and minor erosion. Otherwise, considering the lack of scheduled maintenance in recent years, the road has held up relatively well. Some brushing and minimal work to keep the road open has been done by 4WD operators, hunters, fishermen, etc. The amount of work needed to keep the road open to the present low standard could range from a couple of days of tractor work to several weeks of handwork by a crew such as YCC or Jobs in the Woods, or perhaps a partnership with a local 4WD club (Note: The Civilian Conservation Corps originally built and maintained this road). It would primarily involve some clearing and widening and establishment of better drainage through construction of dips, waterbars, filling of ruts, maintenance of culverts, etc.

Low Pass 4WD Trail (Forest Trail 1W21) Sec. 28, 29, T35NR2W.

This trail provides the primary access to the Devil's Rock-Hosselkus RNA off the Brock Mtn. Road 35N02. It is a 4WD trail that has also been kept open through occasional visitor use. It has some rutting and erosion problems on steeper segments which, while relatively minor, are causing some sediment transfer and have the potential for eventually making the road impassable to vehicles. Approximately 0.75 miles of road are driveable at present. Depending on management direction, there are several options. One would be to close the trail to vehicles near the trail intersection with 35N02, effectively converting it from 4WD back to a foot trail. Without trail maintenance this prism would quickly brush in. The only thing keeping the road open now is the occasional 4WD use (keep in mind that the existing trail system in this area has not been maintained for years). Another option would be to keep the first 0.5 to 0.75 mile of the trail open to vehicles and construct a turnaround/trailhead at the terminus. In any event there are some drainage problems that need to be addressed (including the trail crossing of Low Pass Creek), in the same manner as described under the 35N02 road.

Goose Gap Road system (No Road #)   Sec. 10, T35NR2W.

This road, approximately 1 mile in length, was originally built in the early 1990's by private landowner James Smith along the old ridgetop 1W21 trail (across National Forest land) under a permit to access his land in Sec. 15, T35NR2W for the purposes of logging. This operation was involved in a timber trespass case. There are road drainage problems related to poor initial construction practices and lack of recent maintenance. A gate or other barricade was supposed to be installed near the intersection with Fender Ferry FA 27 but never was, resulting in wet weather use which has rutted the road to some extent. The recommendation is to do some blading to restore proper drainage along with installation of a suitable gate or guardrail barricade as originally proposed.

35N07 maintenance and drainage improvement

This road runs from FA 27 north past the Madrone C.G. to the Wheeler Ranch area, approx. 3.2 mi. Restoration work was done in 1996 consisting of spot rocking, culvert replacement, etc., however this work was impacted by the 1997 and 1998 storms. Some ERFO repairs are in progress, but new drainage and erosion problems have developed. There is a need to review the situation for additional non-ERFO restoration opportunities.

Topic: Non-Native Species Control and/or Eradication

Recommendation:

Develop strategy for treatment of non-native species in the Squaw Creek Watershed. Focus on Riparian Reserves and floodplain areas where populations of non-native species have displaced native vegetation. Identify possible treatment areas and methods for non-native species control or eradication. Possible treatment areas include Wheeler Ranch and Chirpchatter Campground.

Related Core Topic(s): Vegetation, Species and Habitats, Human Uses.

Rationale/Objective:

Non-native species have already colonized floodplains and terraces along Squaw Creek. Weedy species such as yellow star thistle, soft chess brome, cheatgrass and ripgut brome have replaced most native grasses and forbs. Star thistle can make up 40-60 percent of the vegetative cover on streamside meadows and terraces. Star thistle is unpalatable and poor in nutrition. Himalayan and cut-leaved blackberry, yellow star-thistle, and other exotic pest plants have the potential to eventually displace large areas of native riparian vegetation. Removal of non-native vegetation in Chirpchatter Campground could benefit wildlife species and habitats and recreation activities occurring in or near the campground.

Topic: Vegetation Management Activities on Matrix Lands

Recommendation:

In order to meet management objectives for matrix lands within the watershed the following silvicultural opportunities should be investigated. Priorities for vegetation management for commercial outputs include treating 400 acres of 4N and 500 acres of 4P stands with regeneration harvest. The second priority is to treat approximately 400 acres of early mature stands (3N&G) with commercial thinning. Opportunities for commercial harvest need to be considered within the context of achieving parallel benefits including creating early seral habitats for wildlife, reducing fire hazard, and reducing fuels. See Map 18-A for the location of 4N, 4P, 3N and 3G stands. Map 18-A is overlayed over Map 18 (Location 4G, 4N) in order to see how the potential treatment areas relate to the stands that will not be harvested in order to retain 15 percent late-successional habitat. As discussed in Chapter 3, no harvest will occur in 4G stands and in 2,652 acres of 4N. Overlay Map 18-A with Map 6 to see how Riparian Reserves affect treatment opportunities. Also overlay Map 18-A with Map 17 to identify where opportunities exist to combine timber harvest with fuels reduction and wildlife habitat improvement projects.

Related Core Topic(s): Vegetation, Human Uses, Species and Habitats, Erosion Processes.

Rationale/Objective:

The watershed is more deficit in early seral stage mixed conifer than any other seral stage. Limited timber harvest on public lands has greatly increased fuel loadings with increased fire hazard. Prescription 3, 6, and 8 lands need to be managed for early seral stage species and wood fiber production. The objective is to increase the amount of early seral mixed conifer from less than 1 percent to the minimum of 5 percent.

Topic: Management of Chirpchatter Campground

Recommendation:

Determine level of management to occur at Chirpchatter Campground. Currently the campground is managed as a dispersed recreation site, but the campground is not shown on Forest Service maps. The level of management of the campground should be determined (i.e. dispersed or developed).

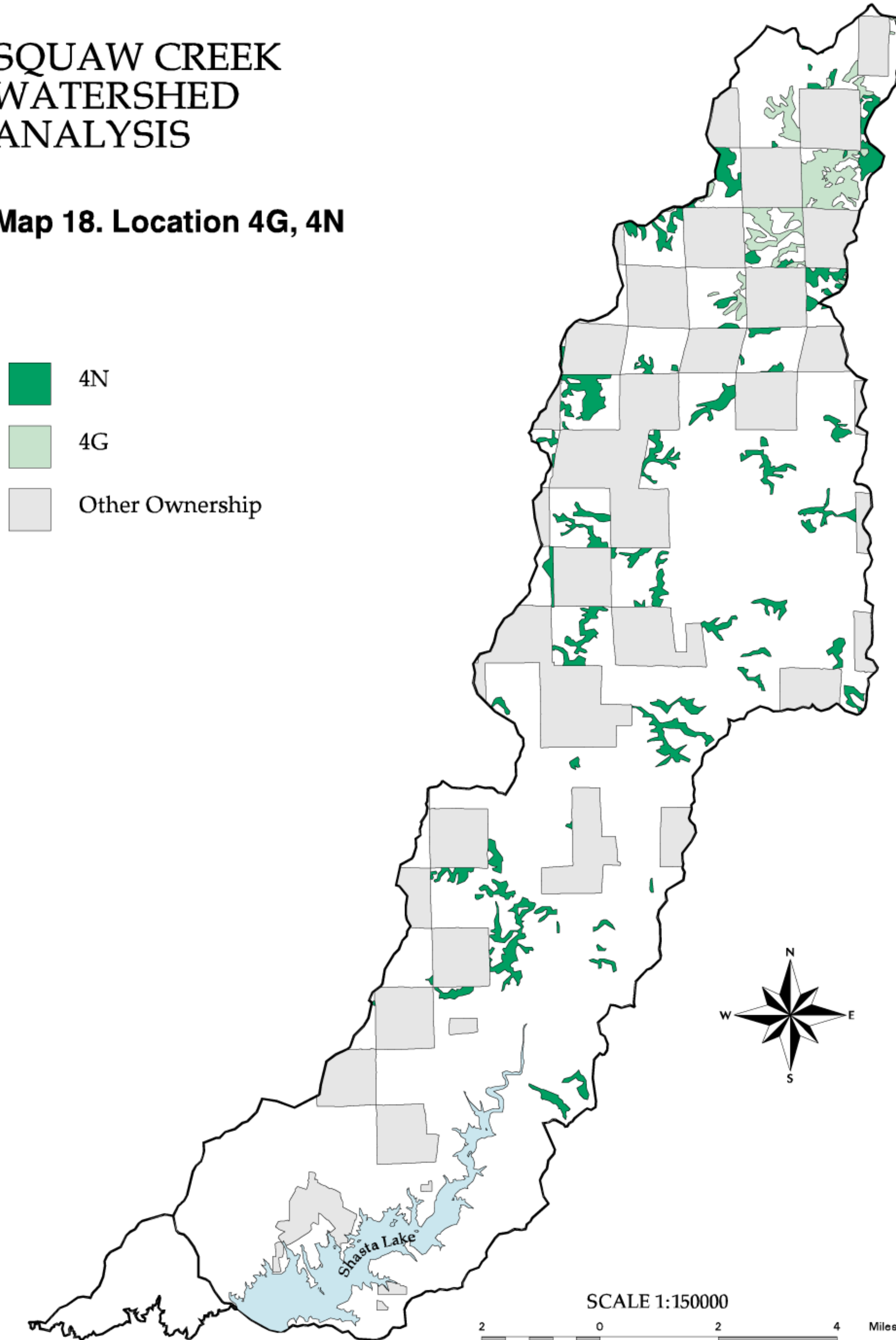
Related Core Topic(s): Human Uses, Vegetation.

Rationale/Objective:

The management level of Chirpchatter Campground needs to be determined in order to budget recreation funds appropriately.

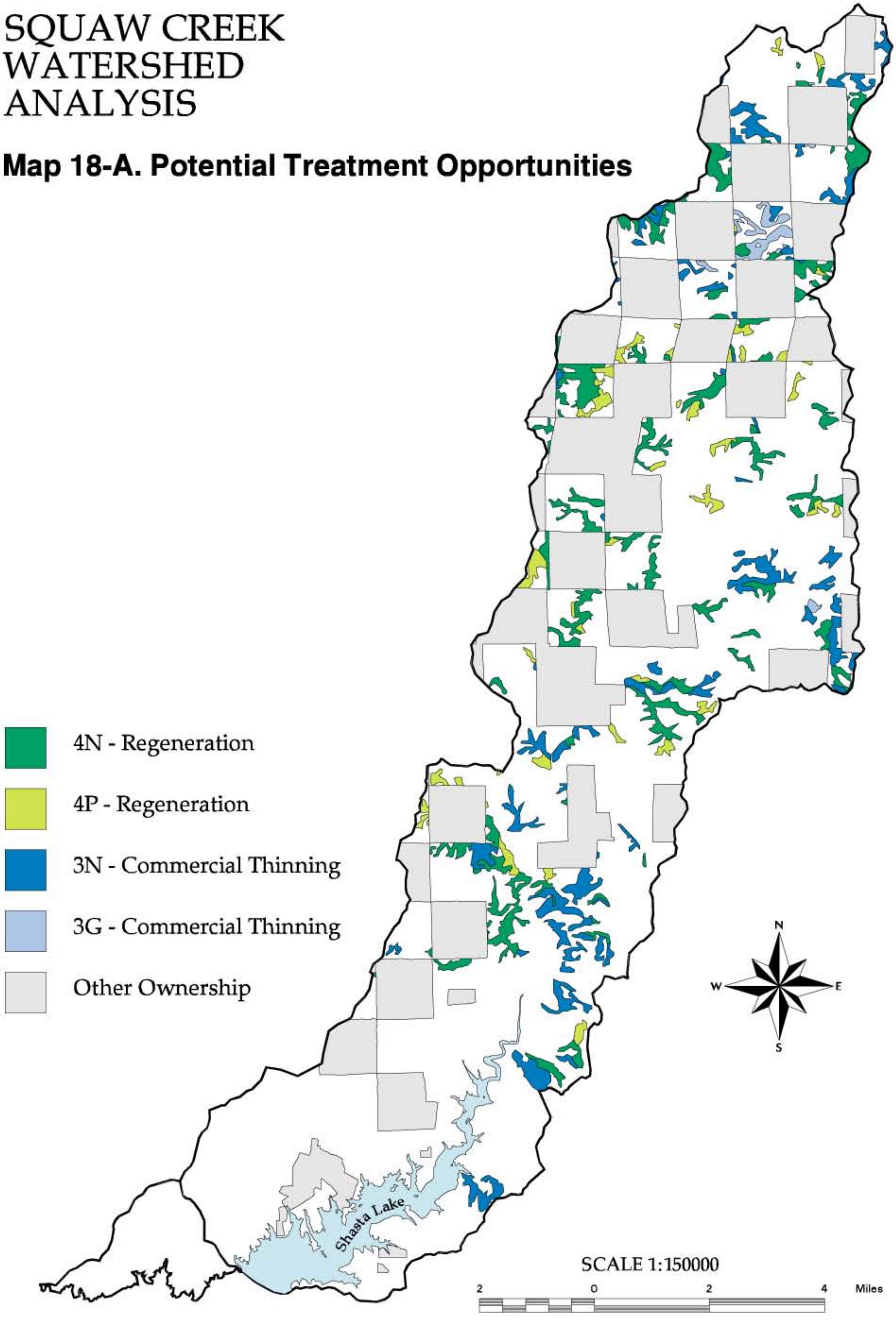
SQUAW CREEK WATERSHED ANALYSIS

Map 18. Location 4G, 4N



SQUAW CREEK WATERSHED ANALYSIS

Map 18-A. Potential Treatment Opportunities



Topic: Management of Squaw Creek Guard Station

Recommendation:

The Squaw Creek Guard Station is located at the Fenders Ferry Bridge on the east bank of Squaw Creek. The station has been abandoned for 13 years. During this period the station has been repeatedly vandalized and has fallen into a state of disrepair. The station should be evaluated to determine if it should be restored or removed. Temporary action should also be taken to restrict access into the facilities.

Related Core Topic(s): Human Uses.

Rationale/Objective:

In its current state the Squaw Creek Guard Station is at risk to continued vandalism and deterioration. Safety concerns also exist at the site which is full of debris and accessible to the public due to past vandalism. There is a need to come to closure on how the station should be managed. The centralized location of the station in the Squaw Creek Watershed could prove useful for future management activities. Restoration of the building could benefit heritage resources and recreation users.

Topic: California Back Country Discovery Trail

Recommendation:

Finalize location for Back Country Discovery Trail. Determine effects on transportation system management.

Related Core Topic(s): Human Uses.

Rationale/Objective:

The California Back Country Discovery Trail may be routed through the watershed, however the exact location of the trail has not been finalized. Off-highway vehicle use in the watershed will increase if a state OHV trail is officially designated. The final location of the trail needs to be identified so that the potential effects of the trail and its influence on management of the transportation system can be addressed.

Topic: Ecological Unit Inventory Data

Recommendation:

Incorporate all data from the Squaw Creek Ecological Unit Inventory into the Squaw Creek Watershed Analysis.

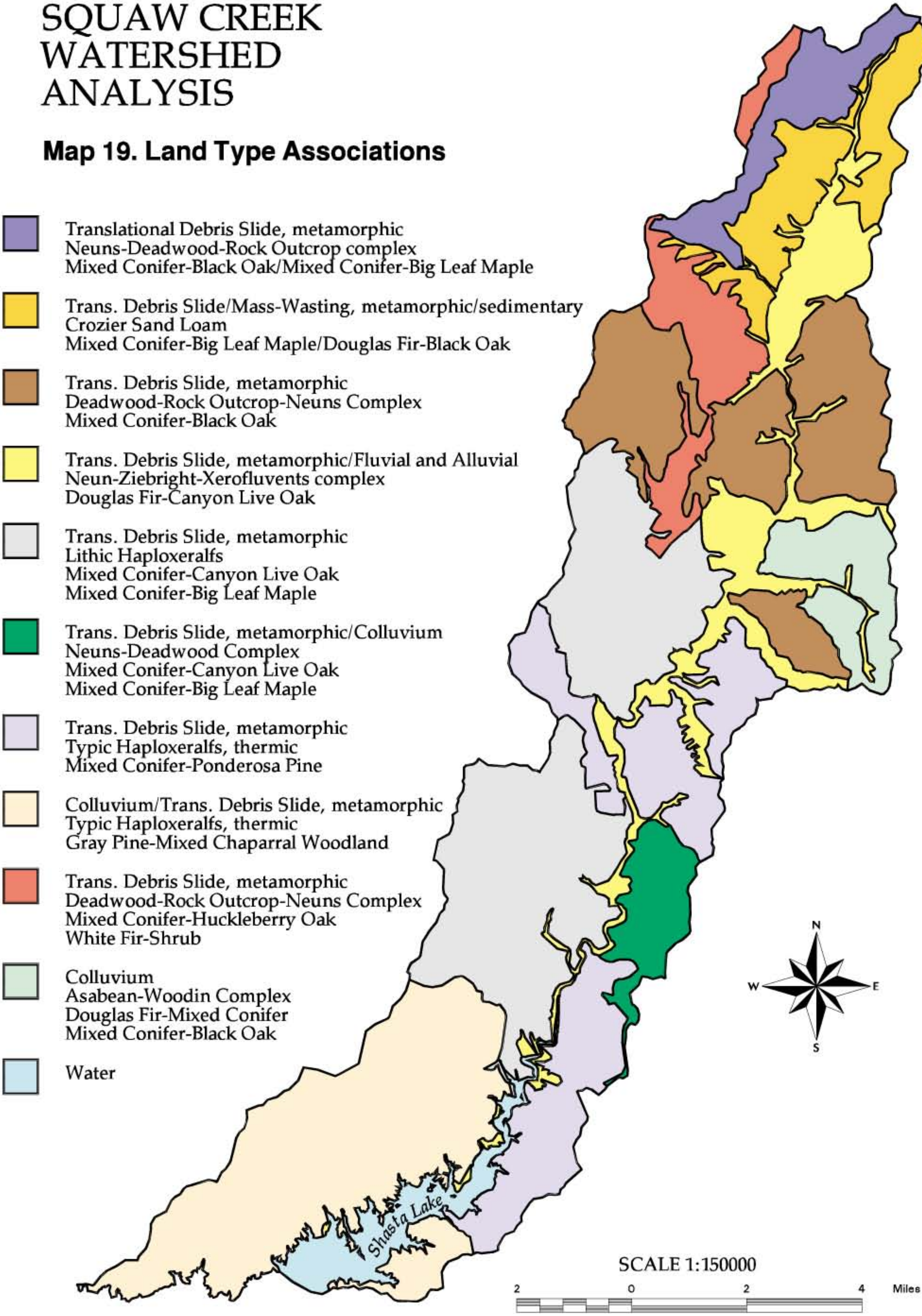
Related Core Topic(s): Vegetation, Human Uses, Species and Habitats, Erosion Processes, Water Quality, Hydrology, Stream Channels.

Rationale/Objective:

The Squaw Creek Ecological Unit Inventory (EUI) was conducted during the 1994 field season. The purpose of the inventory was to identify unique ecological types (areas having similar lithologies, geomorphologies, soils and vegetation) present within the watershed. A sample of ecological types is shown in Map 19. Detailed information was collected on existing and potential vegetation, soils, lithology, geomorphology, stream channel morphology and aquatic habitats. Some of the information from this 1994 inventory has been incorporated into this analysis, however much of the information was not applied due to lack of time and resources. This information could be very useful in providing further management direction for this watershed and should be integrated into this analysis in subsequent iterations.

SQUAW CREEK WATERSHED ANALYSIS

Map 19. Land Type Associations



6.7 Possible Management Practices

WA Recommendation	Possible Management Practices	Linkages	NEPA
A. Land Management			
1a. Implementation of long range fuel management program.	Prescribed fire. Thinning. Mechanical fuel treatments.	2a, 3a, 5a, 9a, 10a, 2b, 2c, 3c, 4c, 5c, 6c.	EA
2a. Non-native species control at Wheeler Ranch. Focus on Yellow Star Thistle.	Prescribed fire. Irrigation. Herbicide use.	1a, 3a, 6c.	EA/CE
3a. Non-native species control at Chirpchatter Campground. Focus on Himalayan blackberry.	Prescribed fire. Irrigation. Herbicide use.	1a, 2a, 3b, 6c.	EA/CE
4a. Low Pass 4 Wheel Drive partial closure/trail conversion (Forest Trail 1W21).	Partial closure, partial conversion of road to trail. Conversion of entire road to trail. Road drainage improvements below closed portion.	5a, 6a, 7a, 4c.	EA/CE
5a. Brock Mountain road reconstruction (Road 35N02)	Road maintenance and drainage improvement.	1a, 4a, 6a, 7a, 4c.	CE
6a. Road 35N07 maintenance and drainage improvement.	Road maintenance and drainage improvement.	4a, 5a, 7a, 4c.	CE
7a. Goose Gap road system maintenance and closure.	Road drainage improvement. Road closure (possibly seasonal).	4a, 5a, 6a, 4c.	CE
8a. Fish habitat improvement project in drawdown zone of Shasta Lake (Squaw Creek Arm)	Construction of brush structures for cover. Willow planting. Seeding of hillslopes with annual cereal grains.	1c, 6c.	CE
9a. Identify opportunities for vegetation treatment in pure and mixed black oak stands.	Prescribed burning. Non-commercial harvest. Commercial harvest. Woodcutting.	1a, 6c.	EA/CE
10a. Commercial timber harvest.	Commercial thinning of 400 acres of 3N and 3G stands. Regeneration of 400 acres of 4N and 400 acres of 4P stands.	1a, 4c, 6c.	EA
B. Watershed Planning			
1b. Land Management Plan Amendment.	Change prescription of Matrix lands from 8 (commercial wood products emphasis) to 6 (wildlife habitat emphasis).	None.	?

2b. California Back Country Discovery Trail.	Designation of route and impacts to transportation system.	4c.	NA
3b. Management of Chirpchatter Campground.	Official designation of management level to occur at Chirpchatter Campground.	1a, 3a.	NA
4b. Management of Squaw Creek Guard Station.	Decision as to what to do with barracks and historic office.	None.	NA
C. Research Inventory and Monitoring			
1c. Salt Creek flood effects study.	Aquatic habitat assessment, mapping of debris flows and torrents. Recommendations for future management activities.	8a, 10a, 2c, 3c, 4c.	NA
2c. Squaw Creek habitat monitoring.	Squaw Creek habitat assessment. Recommendations for future management activities.	1a, 8a, 1c, 3c, 4c.	NA
3c. Post 1900 landslide and channel recovery rate mapping.	Watershed wide estimates of recovery times following debris flows and torrents. Recommendations for future management activities.	1a, 1c, 2c, 4c, 5c, 9a, 10a	NA
4c. ATM Plan and WIN Inventory.	Transportation plan for watershed identifying maintenance and road decommissioning opportunities.	1a, 4a, 5a, 6a, 7a, 3c, 9a, 10a.	NA
5c. Ecological Unit Inventory Data.	Apply information and data from 1994 EUI during subsequent iterations of this WA.	1a, 9a, 10a.	NA
6c. S&M Surveys	Survey for S&M species and identify potential species occurring in Squaw Creek Watershed.	1a, 2a, 3a, 8a, 9a, 10a, 1c, 2c.	NA

NA - No Environmental Assessment required.
EA - Environmental Assessment required.
CE - Categorical Exclusion is probably adequate.
EA/CE - Scope of the project will determine which documentation is appropriate.
LSRA - LSR Assessment required.

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Appendix B: Species List

List of Wildlife Species possibly occurring in the Lower McCloud Watershed. Species Listed by Guild Association. Species occurring in the Lower McCloud Watershed are very similar to those occurring in the Squaw Creek Watershed due to similar vegetation types, geology, soils and climate. This list should be updated and verified for the Squaw Creek Watershed.

HABITAT TYPES

MCN:	Mixed Conifer	DFR:	Douglas-fir
PPN:	Ponderosa Pine	WFR:	White Fir
VFH:	Valley Foothill Hardwood	MCH:	Mixed Chaparral
VRI:	Valley Foothill Riparian	RIV:	Riverine

GUILD(S)

AQFA:	Fast water required, usually indicating streams or river
AQSL:	Areas of slow water required, be they lacustrine or riverine habitat
AQUAT:	Can use either the fast or slow water components
C/C:	Cliff and caves
CHAP:	Chaparral communities
DEAD/D:	Dead and down material (logs, stumps, slash, litter, duff)
FOREST:	Can use any forested habitat
HDWD:	Hardwoods
LATE:	Late seral stages (4a, 4b, 4c) and multi-layered
OPEN:	Meadows, open areas, seral stages 1, 2, and 3a
OPEN-GRASS:	Seral stage 1; mutually exclusive from OPEN-SHRUB
OPEN-SHRUB:	All forested habitat types: openings, seral stages 2 and 3a
RIPAR:	Associated with riparian vegetation
SNAGCAV:	Tree cavity dependent species found in snags or live trees
T/R:	Talus and rocks

WHRI Wildlife Habitat Relationship ID code

STATUS

S&M	Survey and Management species listed in Appendix R of the Shasta-Trinity LMP, 1995
CSC	CDF 'Species of Special Concern' (Special 8/94)
C2	Catagory 2 Candidate for listing by USFWS (Special 8/94)
CaE	California State-listed Endangered (TES&P 1/95)
CaT	California State-listed Threatened (TES&P 1/95)
FS	Forest Service Sensitive (TES&P Animals of the Pacific Southwest Region 1/95)
FT	Federally Listed Threatened (Endangered and Threatened Animals of Calif. 1/95)
FE	Federally Listed Endangered (Endangered and Threatened Animals of Calif. 1/95)
FSC	Federal Species of Concern

NT Neotropical Migratory Birds

Wildlife Species Possibly Occurring in the Squaw Creek Watershed
and Associated with Habitat Types MCN, DFR, PPN, WFR, VFH, MCH, VRI, and RIV.
Species Listed by Guild Association.
Sparse to Dense Canopy (10-100%) and Seedling to Large Trees (5" to 40" DBH)

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
AQFA	A004	PACIFIC GIANT SALAMANDER		
	A026	TAILED FROG	CSC, FSC	
	A043	FOOTHILL YELLOW-LEGGED FROG	C2,CSC, FSC	
	B373	AMERICAN DIPPER		
AQSL	A006	ROUGH-SKINNED NEWT		
	A032	WESTERN TOAD		
	A039	PACIFIC TREEFROG		
	A040	RED-LEGGED FROG	CSC, FT, FSC	
	A046	BULLFROG		
	B006	PIED-BILLED GREBE		
	B010	WESTERN GREBE / CLARK'S GREBE		
	B044	DOUBLE-BREASTED CORMORANT	CSC	
	B051	GREAT BLUE HERON		
	B052	GREAT EGRET		
	B076	WOOD DUCK		
	B077	GREEN-WINGED TEAL		
	B079	MALLARD		
	B080	NORTHERN PINTAIL		
	B094	LESSER SCAUP		
	B149	AMERICAN COOT		
	R004	NORTHWESTERN POND TURTLE	C2, CSC, FS	
AQUAT	B104	HOODED MERGANSER		
	B105	COMMON MERGANSER		
	B110	OSPREY	CSC	*
	B113	BALD EAGLE	FT, CaE	
	B170	SPOTTED SANDPIPER		
	B293	BELTED KINGFISHER		*
	B343	CLIFF SWALLOW		*
	M112	BEAVER		
	M163	RIVER OTTER		
C/C	B108	TURKEY VULTURE		*
	B126	GOLDEN EAGLE	CSC	*
	B129	PEREGRINE FALCON	FE, CaE	*
	B265	GREAT HORNED OWL		
	B279	BLACK SWIFT	CSC	*
	B341	NORTHERN ROUGH-WINGED SWALLOW		*
	B343	CLIFF SWALLOW		*
	B344	BARN SWALLOW		*
	M021	LITTLE BROWN MYOTIS		
	M023	YUMA MYOTIS	FSC	
	M025	LONG-EARED MYOTIS	S&M, FSC	

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	M026	FRINGED MYOTIS	S&M, FSC	
	M027	LONG-LEGGED MYOTIS	S&M, FSC	
	M028	CALIFORNIA MYOTIS	C2, CSC	
	M032	BIG BROWN BAT		
	M037	TOWNSEND'S BIG-EARED BAT	C2, CSC	
	M038	PALLID BAT	CSC, S&M	
CHAP	B391	WRENTIT		
	B404	WATER PIPIT		*
	B482	GREEN-TAILED TOWHEE		*
	M038	PALLID BAT	CSC, S&M	
	M059	SONOMA CHIPMUNK		
	M119	BRUSH MOUSE		
	M149	GRAY FOX		
	M181	MULE DEER		
	R023	SAGEBRUSH LIZARD		
	R053	CALIFORNIA WHIPSNAKE		
DEAD/D	A004	PACIFIC GIANT SALAMANDER		
	A012	ENSATINA		
	A014	CALIFORNIA SLENDER SALAMANDER		
	A021	CLOUDED SALAMANDER		
	M117	DEER MOUSE		
	M120	PINYON MOUSE		
	M151	BLACK BEAR		
	M155	PACIFIC FISHER	C2, CSC, FS	
	M157	LONG-TAILED WEASEL		
	R048	RINGNECK SNAKE		
	R049	SHARP-TAILED SNAKE		
	R058	COMMON KINGSNAKE		
	R059	CALIFORNIA MOUNTAIN KINGSNAKE		
FOREST	B127	AMERICAN KESTREL		*
	B264	WESTERN SCREECH OWL		
	B267	NORTHERN PYGMY OWL		
	B279	BLACK SWIFT	CSC	*
	B294	LEWIS' WOODPECKER		*
	B300	WILLIAMSON'S SAPSUCKER		*
	B307	NORTHERN FLICKER		*
	M037	TOWNSEND'S BIG-EARED BAT		
HDWD	B052	GREAT EGRET		
	B116	COOPER'S HAWK	CSC	*
	B251	BAND-TAILED PIGEON		*
	B296	ACORN WOODPECKER		
	B303	DOWNY WOODPECKER		
	B326	ASH-THROATED WOODPECKER		*
	B362	WHITE-BREASTED NUTHATCH		
	B417	HUTTON'S VIREO		
	B418	WARBLING VIREO		*

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	B547	HOUSE SPARROW		
	M077	WESTERN GRAY SQUIRREL		
	M176	WILD PIG		
LATE	B051	GREAT BLUE HERON		
	B117	NORTHERN GOSHAWK	CSC, FS, FSC	*
	B134	BLUE GROUSE		
	B263	FLAMMULATED OWL		*
	B270	NORTHERN SPOTTED OWL	FT	
	B304	HAIRY WOODPECKER		
	B305	WHITE-HEADED WOODPECKER		
	B308	PILEATED WOODPECKER		
	B309	OLIVE-SIDED FLYCATCHER		*
	B317	HAMMONDS' FLYCATCHER		*
	B346	STELLER'S JAY		
	B356	MOUNTAIN CHICKADEE		
	B357	CHESTNUT-BACKED CHICKADEE		
	B361	RED-BREASTED NUTHATCH		
	B363	PYGMY NUTHATCH		
	B364	BROWN CREEPER		*
	B375	GOLDEN-CROWNED KINGLET		*
	B390	VARIED THRUSH		*
	B415	SOLITARY VIREO		*
	B438	HERMIT WARBLER		*
	B539	RED CROSSBILL		
	B546	EVENING GROSBEAK		
	M012	TROWBRIDGE'S SHREW		
	M030	SILVER-HAIRED BAT	S&M	
	M034	HOARY BAT		
	M079	DOUGLAS' SQUIRREL		
	M080	NORTHERN FLYING SQUIRREL		
	M129	WESTERN RED-BACKED VOLE		
	M151	BLACK BEAR		
	M154	AMERICAN MARTEN	CSC, FS	
	M155	PACIFIC FISHER	C2, CSC, FS	
	M159	WOLVERINE	C2, CaT	
	M177	ELK		
OPEN	B108	TURKEY VULTURE		*
	B126	GOLDEN EAGLE	CSC	*
	B140	CALIFORNIA QUAIL	CSC	
	B141	MOUNTAIN QUAIL	C2	
	B264	WESTERN SCREECH OWL		
	B265	GREAT HORNED OWL		
	B267	NORTHERN PYGMY OWL		
	B276	COMMON NIGHTHAWK		*
	B277	COMMON POORWILL		*
	B279	BLACK SWIFT	CSC	*

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	B281	VAUX'S SWIFT	CSC	*
	B307	NORTHERN FLICKER		*
	B354	COMMON RAVEN		
	B366	ROCK WREN		*
	B380	WESTERN BLUEBIRD		*
	B381	MOUNTAIN BLUEBIRD		*
	B489	CHIPPING SPARROW		*
	B505	SONG SPARROW		*
	B509	GOLDEN-CROWNED SPARROW		
	B512	DARK-EYED JUNCO		*
	B524	BREWER'S BLACKBIRD		*
	B538	HOUSE FINCH		
	B542	PINE SISKIN		*
	B543	LESSER GOLDFINCH		*
	M021	LITTLE BROWN MYOTIS		
	M025	LONG-EARED MYOTIS	S&M, FSC	
	M026	FRINGED MYOTIS	S&M, FSC	
	M028	CALIFORNIA MYOTIS	C2, CSC	
	M032	BIG BROWN BAT		
	M037	TOWNSEND'S BIG-EARED BAT		
	M049	SNOWSHOE HARE	CSC	
	M051	BLACK-TAILED HARE		
	M105	CALIFORNIA KANGAROO RAT		
	M142	HOUSE MOUSE		
	M145	PORCUPINE		
	M146	COYOTE		
	M151	BLACK BEAR		
	M156	ERMINE		
	M162	STRIPED SKUNK		
	M165	MOUNTAIN LION		
	M166	BOBCAT		
	M177	ELK		
	M181	MULE DEER		
	R004	NORTHWESTERN POND TURTLE		
	R022	WESTERN FENCE LIZARD		
	R042	NORTHERN ALLIGATOR LIZARD		
	R048	RINGNECK SNAKE		
OPEN-GRASS	B123	RED-TAILED HAWK		*
	B127	AMERICAN KESTREL		*
	B158	KILLDEER		*
	B199	COMMON SNIPE		
	B255	MOURNING DOVE		*
	B262	COMMON BARN OWL		
	B333	WESTERN KINGBIRD		*
	B341	NORTHERN ROUGH-WINGED SWALLOW		*
	B344	BARN SWALLOW		*

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	B389	AMERICAN ROBIN		*
	B404	WATER PIPIT		*
	B411	EUROPEAN STARLING		
	B521	WESTERN MEADOWLARK		*
	M018	BROAD-FOOTED MOLE		
	M072	CALIFORNIA GROUND SQUIRREL		
	M084	WESTERN POCKET GOPHER		
	M113	WESTERN HARVEST MOUSE		
	M133	MONTANE VOLE		
	M136	LONG-TAILED VOLE		
	M142	HOUSE MOUSE		
	R036	WESTERN SKINK		
	R051	RACER		
	R057	GOPHER SNAKE		
OPEN-SHRUB	B287	ANNA'S HUMMINGBIRD		*
	B318	DUSKY FLYCATCHER		*
	B326	ASH-THROATED FLYCATCHER		*
	B360	BUSHTIT		
	B368	BEWICK'S WREN		
	B376	RUBY-CROWNED KINGLET		*
	B377	BLUE-GRAY GNATCATCHER		*
	B382	TOWNSEND'S SOLITAIRE		*
	B407	CEDAR WAXWING		*
	B425	ORANGE-CROWNED WARBLER		*
	B426	NASHVILLE WARBLER		*
	B435	YELLOW-RUMPED WARBLER		*
	B436	BLACK-THROATED GRAY WARBLER		*
	B471	WESTERN TANAGER		*
	B477	LAZULI BUNTING		*
	B483	RUFOUS-SIDED TOWHEE		*
	B504	FOX SPARROW		*
	B510	WHITE-CROWNED SPARROW		*
	B536	PURPLE FINCH		*
	M057	ALLEN'S CHIPMUNK		
	M075	GOLDEN-MANTLED GROUND SQUIRREL		
	M152	RINGTAIL		
	M161	WESTERN SPOTTED SKUNK		
	R039	WESTERN WHIPTAIL		
	R040	SOUTHERN ALLIGATOR LIZARD		
RIPAR	A026	TAILED FROG	CSC, FSC	
	A039	PACIFIC TREEFROG		
	A040	RED-LEGGED FROG	FT, CSC, FSC	
	A076	WOOD DUCK		
	B105	COMMON MERGANSER		
	B115	SHARP-SHINNED HAWK	CSC	*
	B128	MERLIN	CSC	*

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	B129	PEREGRINE FALCON	FE, CaE	*
	B138	TURKEY		
	B255	MOURNING DOVE		*
	B293	BELTED KINGFISHER		*
	B299	RED-BREASTED SAPSUCKER		*
	B303	DOWNY WOODPECKER		
	B311	WESTERN WOOD-PEWEE		*
	B315	WILLOW FLYCATCHER	FS, SE	*
	B320	WESTERN FLYCATCHER		*
	B321	BLACK PHOEBE		
	B338	PURPLE MARTIN	CSC	*
	B339	TREE SWALLOW		*
	B340	VIOLET-GREEN SWALLOW		*
	B369	HOUSE WREN		*
	B370	WINTER WREN		
	B385	SWAINSON'S THRUSH		*
	B386	HERMIT THRUSH		*
	B430	YELLOW WARBLER	CSC	*
	B460	MACGILLIVRAY'S WARBLER		*
	B461	COMMON YELLOWTHROAT		*
	B463	WILSON'S WARBLER		*
	B467	YELLOW-BREASTED CHAT	CSC	*
	B475	BLACK-HEADED GROSBEAK		*
	B506	LINCOLN'S SPARROW		*
	B528	BROWN-HEADED COWBIRD		*
	B532	NORTHERN ORIOLE		*
	M001	VIRGINIA OPOSSUM		
	M003	VAGRANT SHREW		
	M052	MOUNTAIN BEAVER		
	M112	BEAVER		
	M153	RACCOON		
	M158	MINK		
	M163	RIVER OTTER		
	R061	COMMON GARTER SNAKE		
	R062	WESTERN TERRESTRIAL GARTER SNAKE		
	R063	WESTERN AQUATIC GARTER SNAKE		
SNAGCAV	B076	WOOD DUCK		
	B105	COMMON MERGANSER		
	B110	OSPREY	CSC	*
	B113	BALD EAGLE	FT, CaE	
	B127	AMERICAN KESTREL		*
	B263	FLAMMULATED OWL		*
	B264	WESTERN SCREECH OWL		
	B265	GREAT HORNED OWL		
	B267	NORTHERN PYGMY OWL		
	B270	NORTHERN SPOTTED OWL	FT	

GUILD(S)	WHRI	COMMON NAME	STATUS	NT
	B274	NORTHERN SAW-WHET OWL		
	B281	VAUX'S SWIFT	CSC	*
	B294	LEWIS' WOODPECKER		*
	B296	ACORN WOODPECKER		
	B299	RED-BREASTED SAPSUCKER		*
	B300	WILLIAMSON'S SAPSUCKER		*
	B303	DOWNY WOODPECKER		
	B304	HAIRY WOODPECKER		
	B305	WHITE-HEADED WOODPECKER		
	B307	NORTHERN FLICKER		*
	B308	PILEATED WOODPECKER		
	B326	ASH-THROATED FLYCATCHER		*
	B338	PURPLE MARTIN	CSC	*
	B339	TREE SWALLOW		*
	B340	VIOLET-GREEN SWALLOW		*
	B356	MOUNTAIN CHICKADEE		
	B357	CHESTNUT-BACKED CHICKADEE		
	B358	PLAIN TITMOUSE		
	B361	RED-BREASTED NUTHATCH		
	B362	WHITE-BREASTED NUTHATCH		
	B363	PYGMY NUTHATCH		
	B364	BROWN CREEPER		*
	B380	WESTERN BLUEBIRD		*
	B381	MOUNTAIN BLUEBIRD		*
	B411	EUROPEAN STARLING		
	M025	LONG-EARED MYOTIS	FSC, S&M	
	M027	LONG-LEGGED MYOTIS		
	M030	SILVER-HAIRED BAT		
	M077	WESTERN GRAY SQUIRREL		
	M079	DOUGLAS' SQUIRREL		
	M080	NORTHERN FLYING SQUIRREL		
	M155	PACIFIC FISHER	C2, CSC, FS	
T/R	B366	ROCK WREN		*
	B367	CANYON WREN		
	M066	YELLOW-BELLIED MARMOT		
	R071	NIGHT SNAKE		
	R076	WESTERN RATTLESNAKE		