SHASTA LAKE WEST WATERSHED ANALYSIS

October 2000

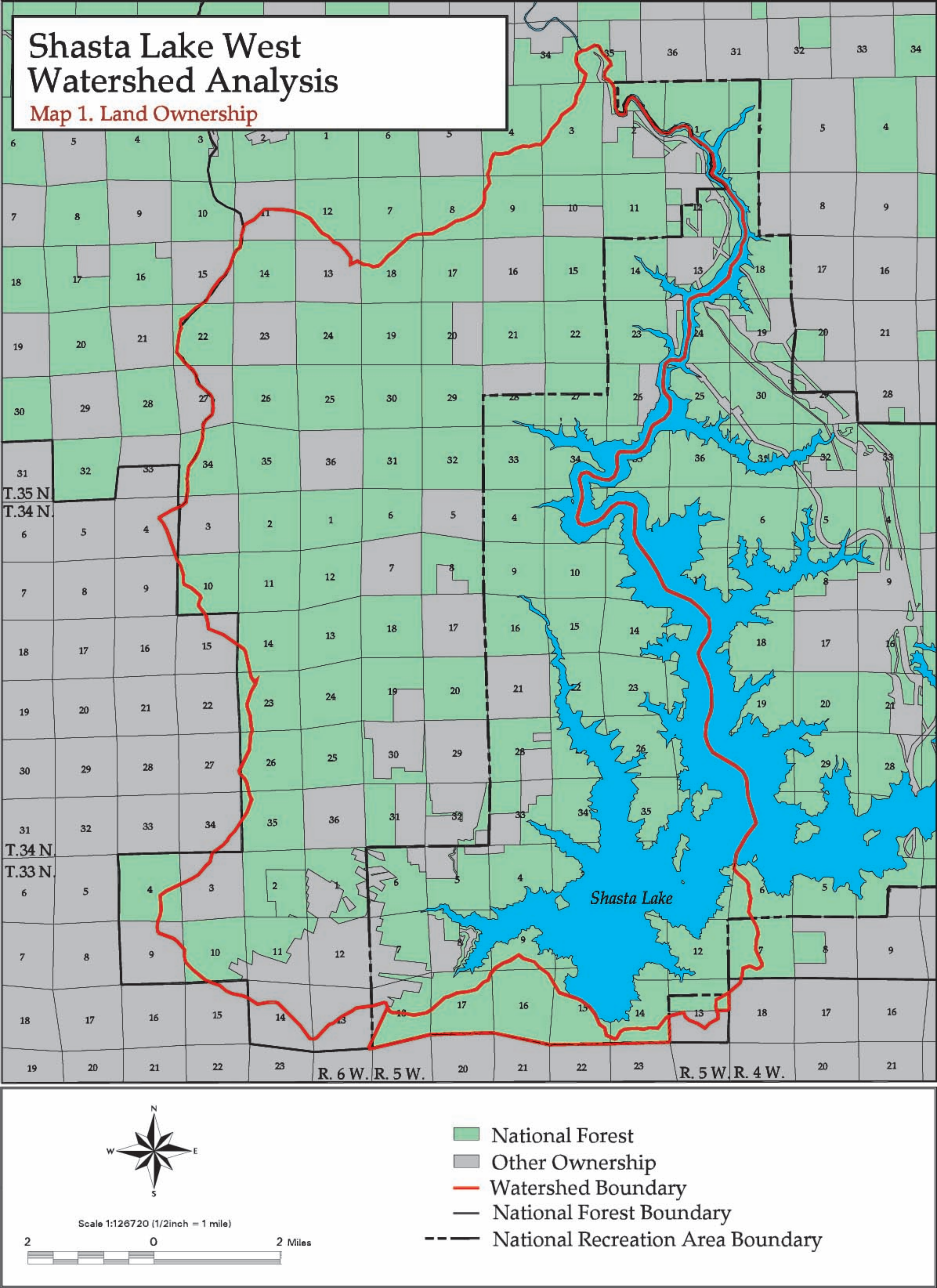
Prepared for Ecosystem Recovery Efforts in the Shasta Lake West Watershed

Table of Contents

Preface

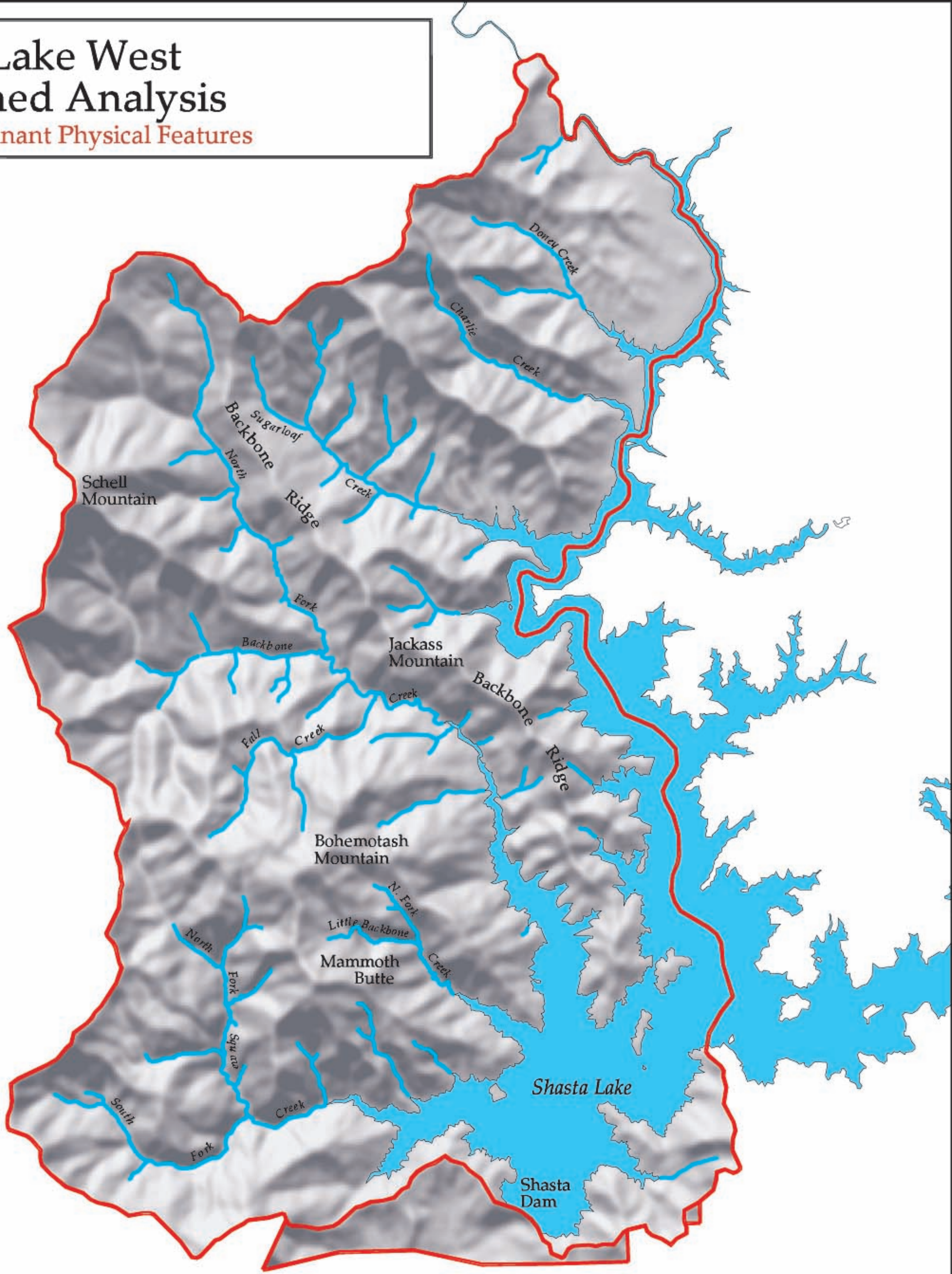
List of Maps

Cover Photo: Straw bale check dams trap sediment and prevent channel downcutting in high intensity burn areas in the Charlie Creek drainage. January 1999.


Shasta Lake West
Watershed Analysis
Map 1. Land Ownership
T.35 N.
T.34 N.
T.34 N.
T.33 N.
Shasta Lake
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
N
S
E
W
National Forest
Other Ownership
Watershed Boundary
National Forest Boundary
National Recreation Area Boundary
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles

Shasta Lake West Watershed Analysis

Map 2. Dominant Physical Features



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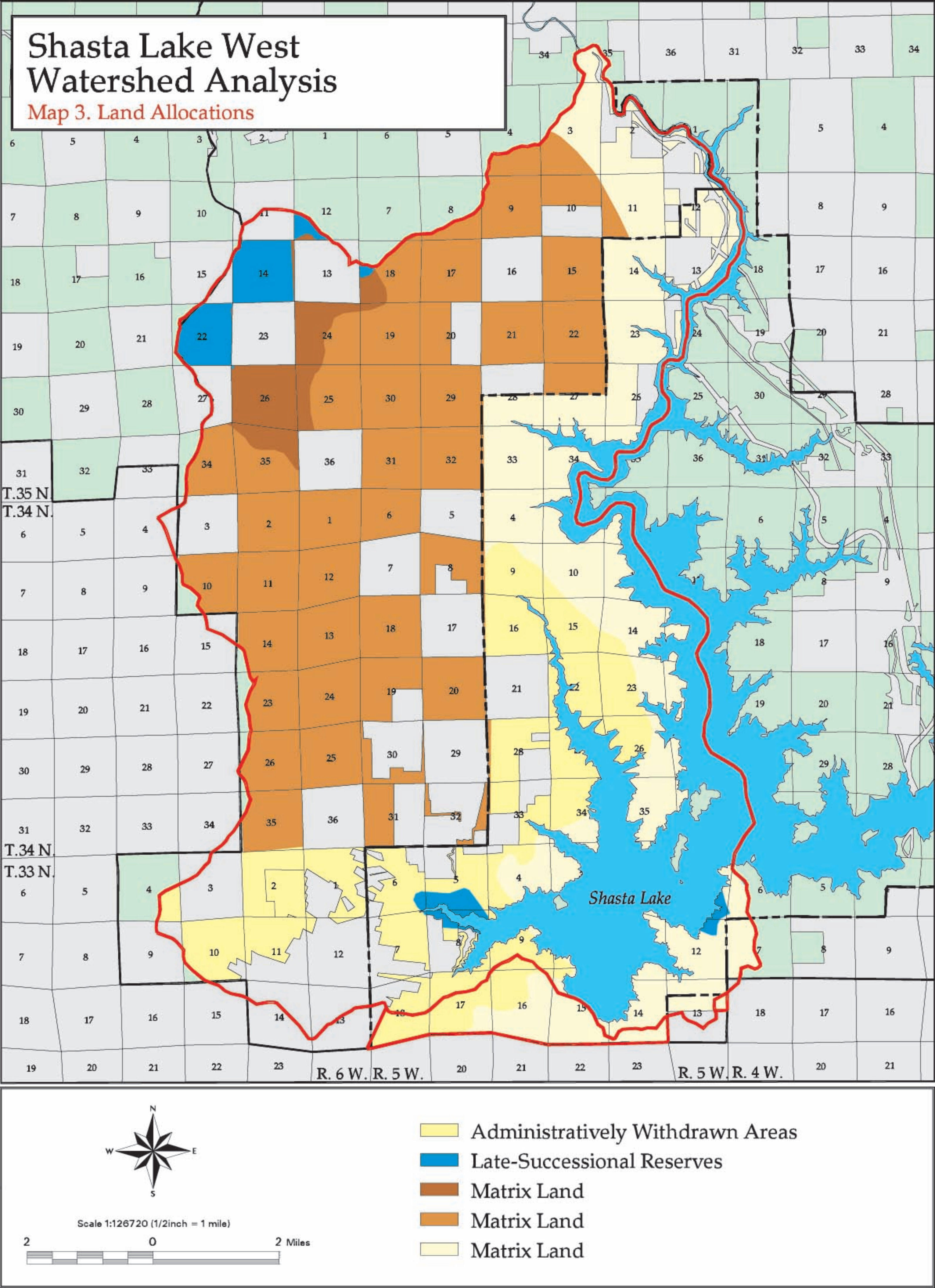
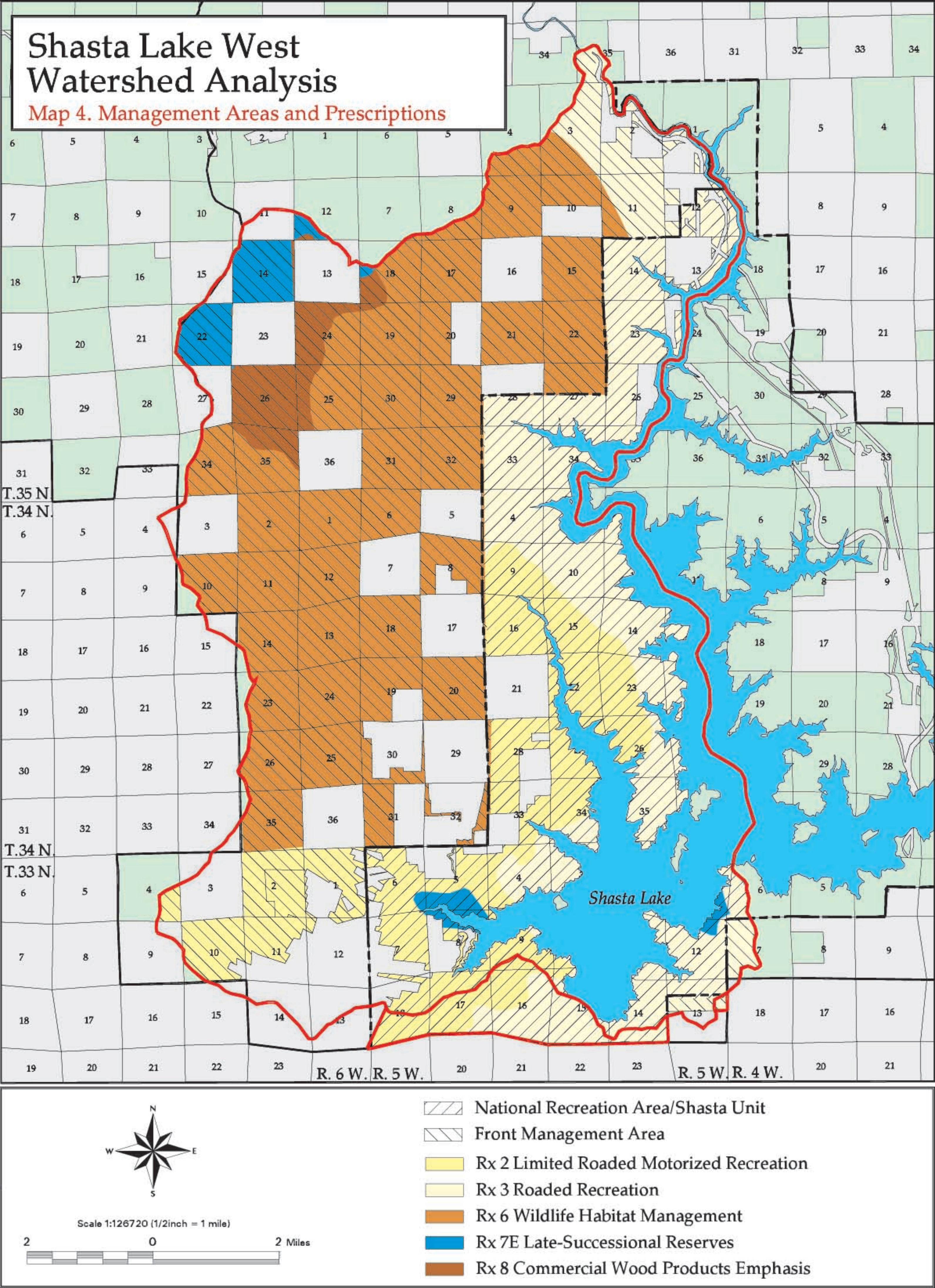
2 0 2 Miles

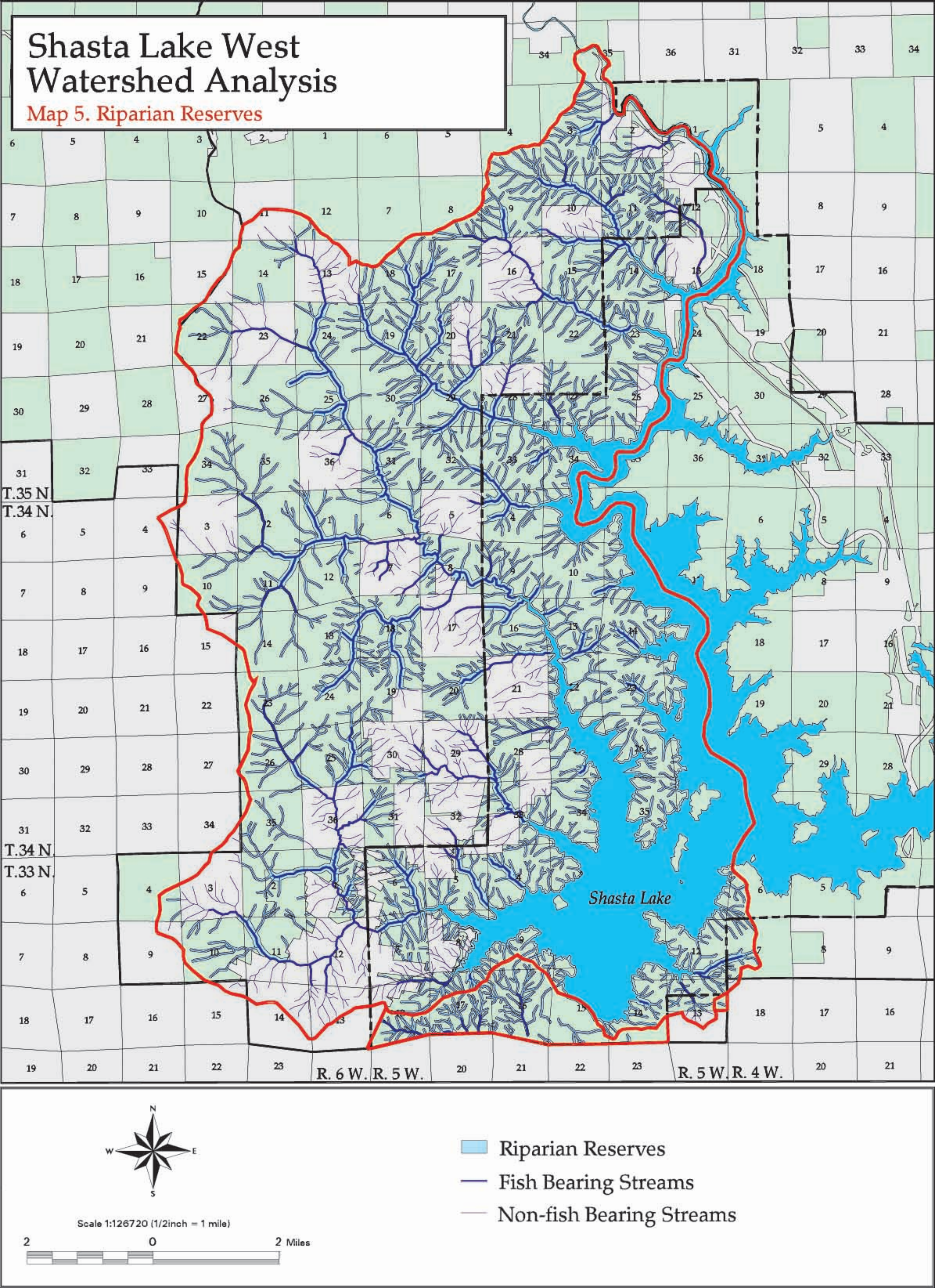


Shasta Lake West
Watershed Analysis
Map 3. Land Allocations
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2 0 2 Miles
Administratively Withdrawn Areas
Late-Successional Reserves
Matrix Land
Matrix Land
Matrix Land

Shasta Lake West Watershed Analysis

Map 4. Management Areas and Prescriptions

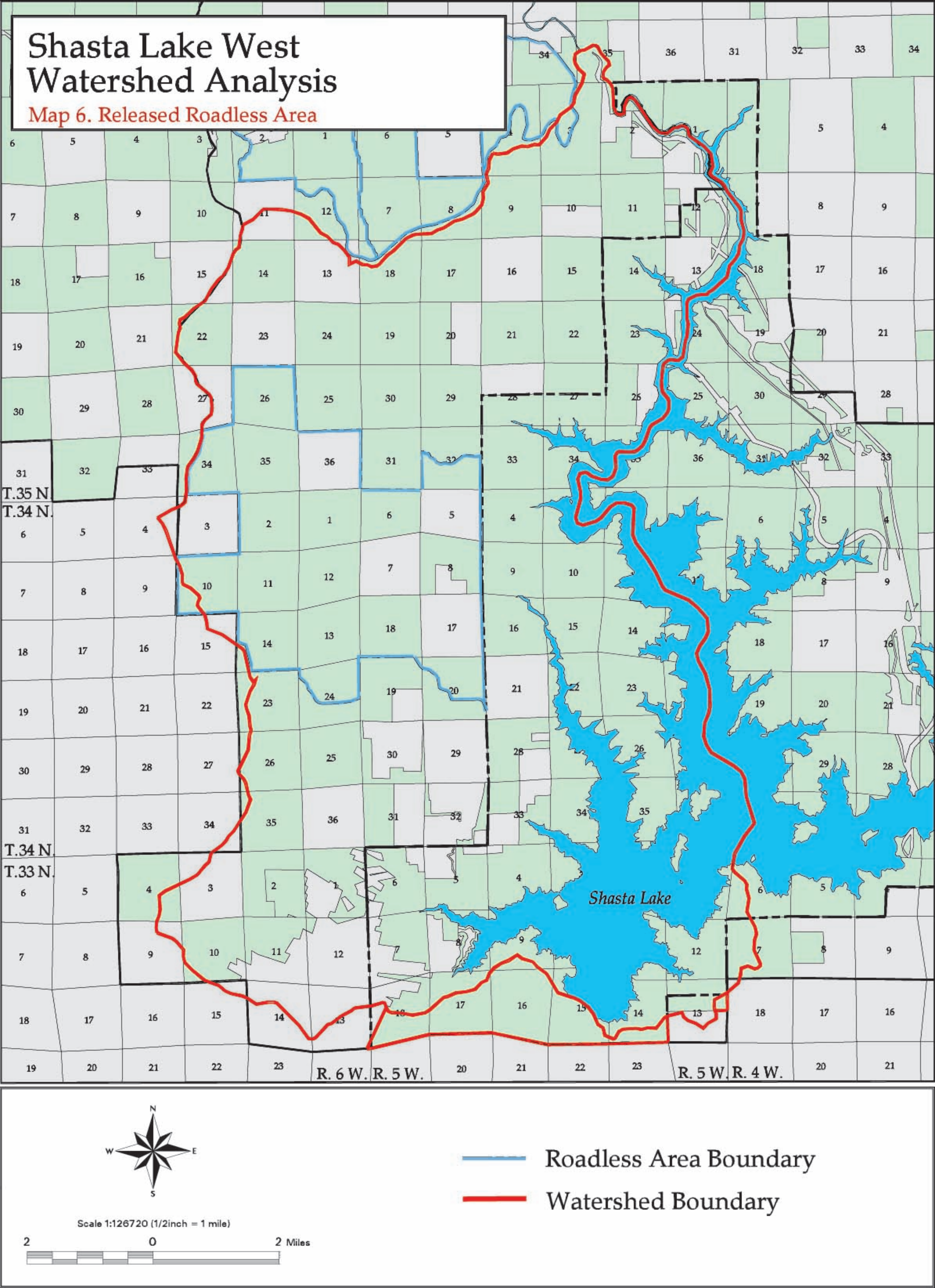


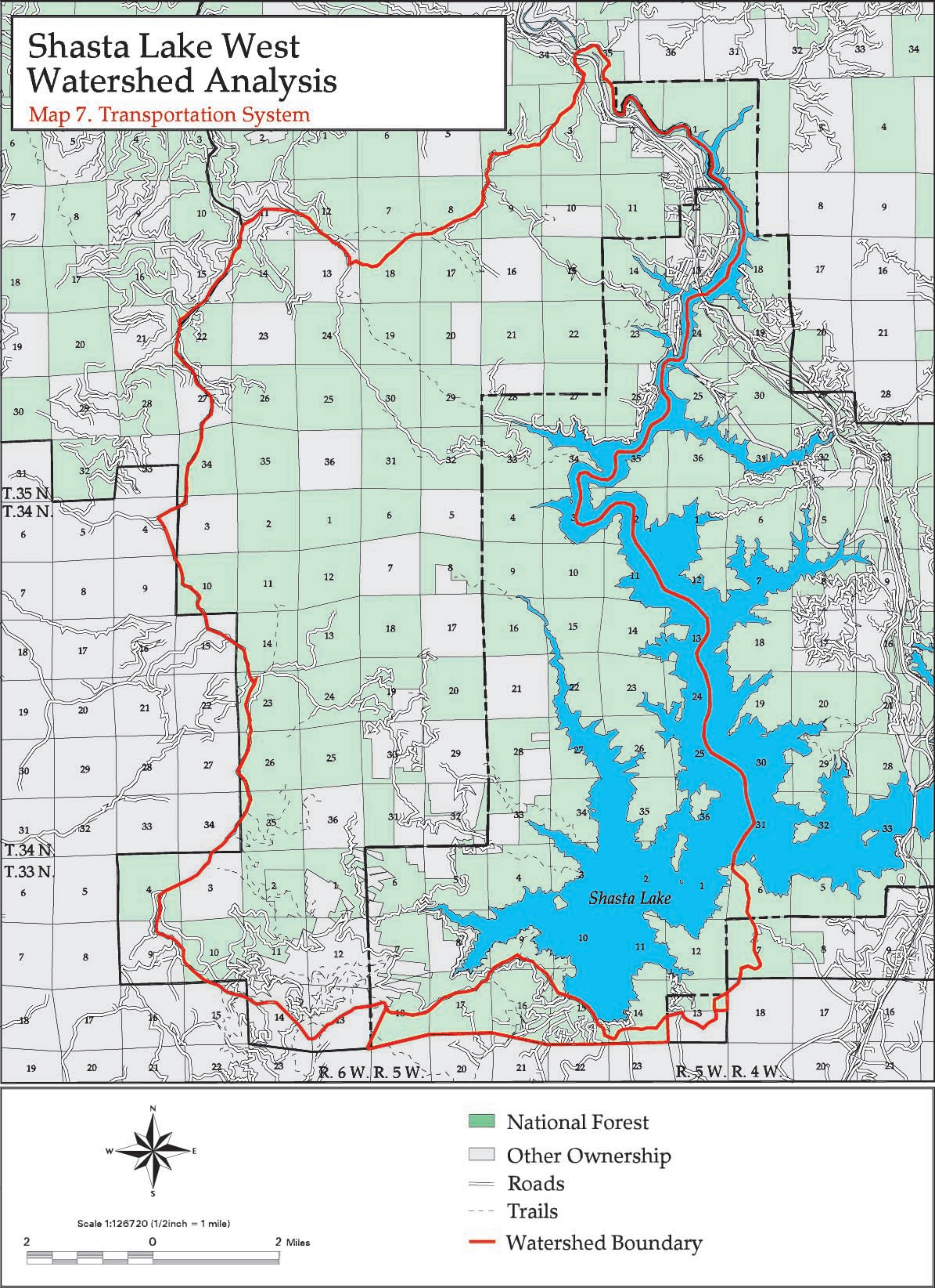


Shasta Lake West
Watershed Analysis
Map 5. Riparian Reserves
Shasta Lake
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
N
S
E
W
Riparian Reserves
Fish Bearing Streams
Non-fish Bearing Streams
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles

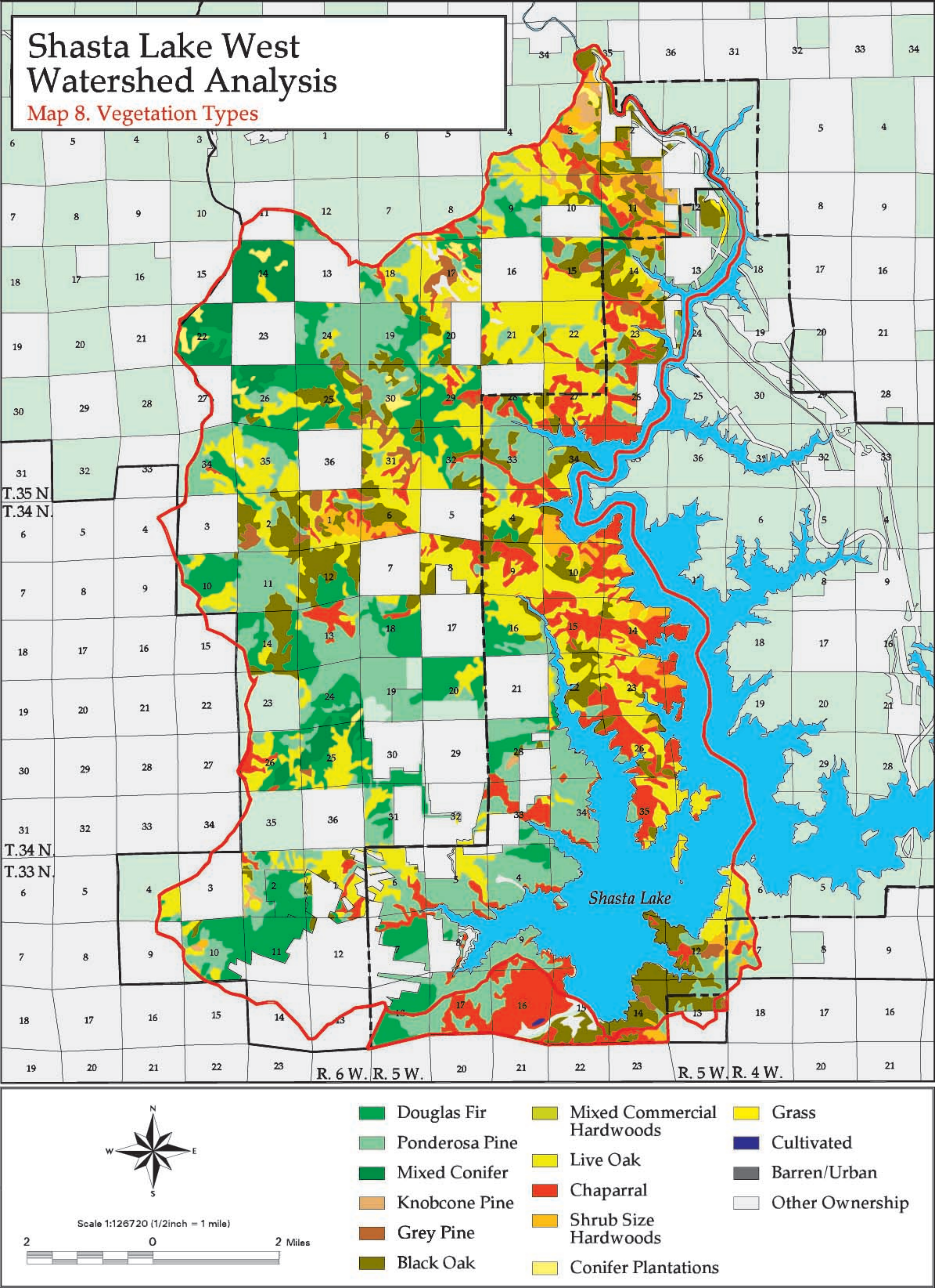
Shasta Lake West Watershed Analysis

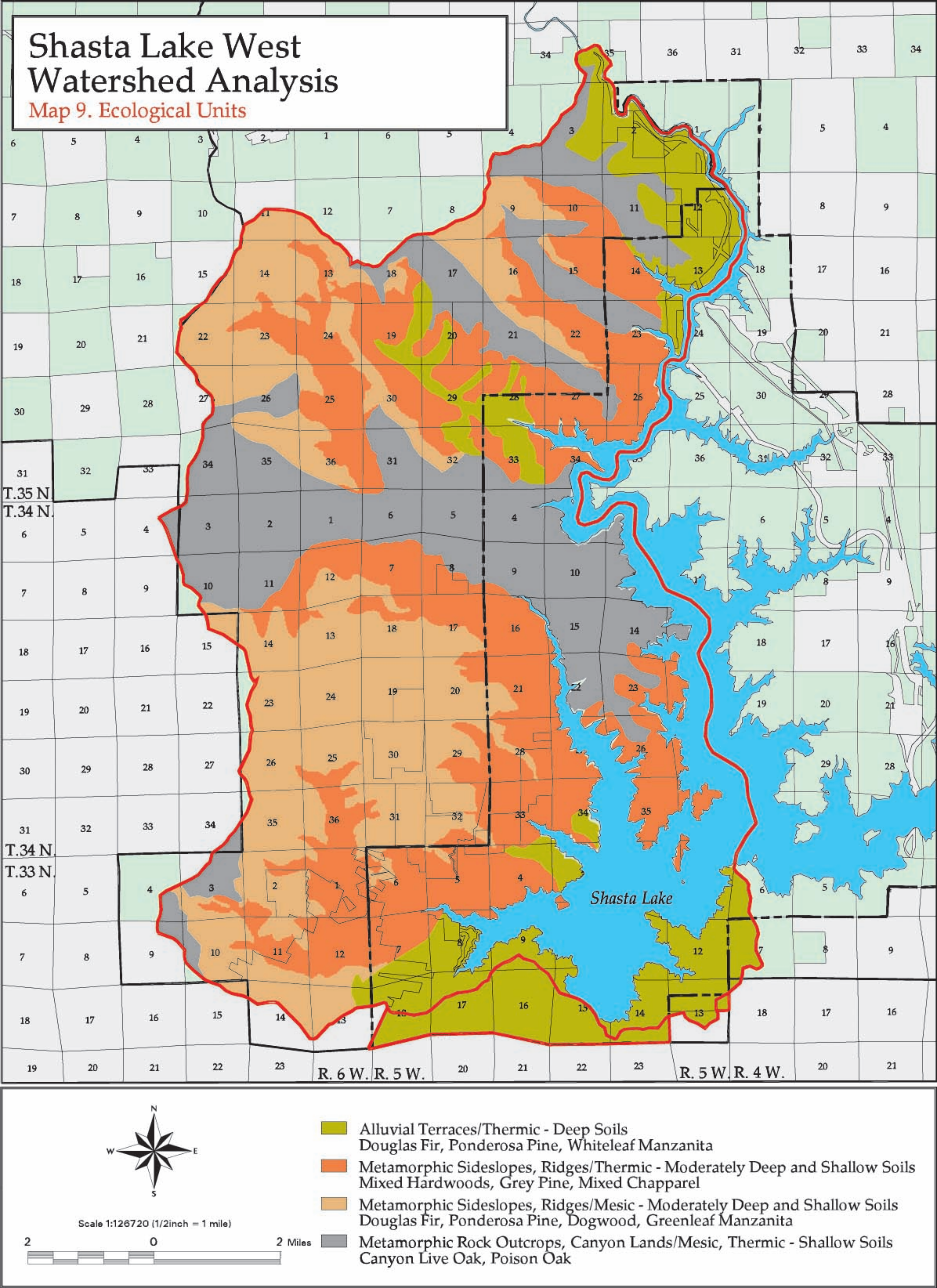
Map 6. Released Roadless Area

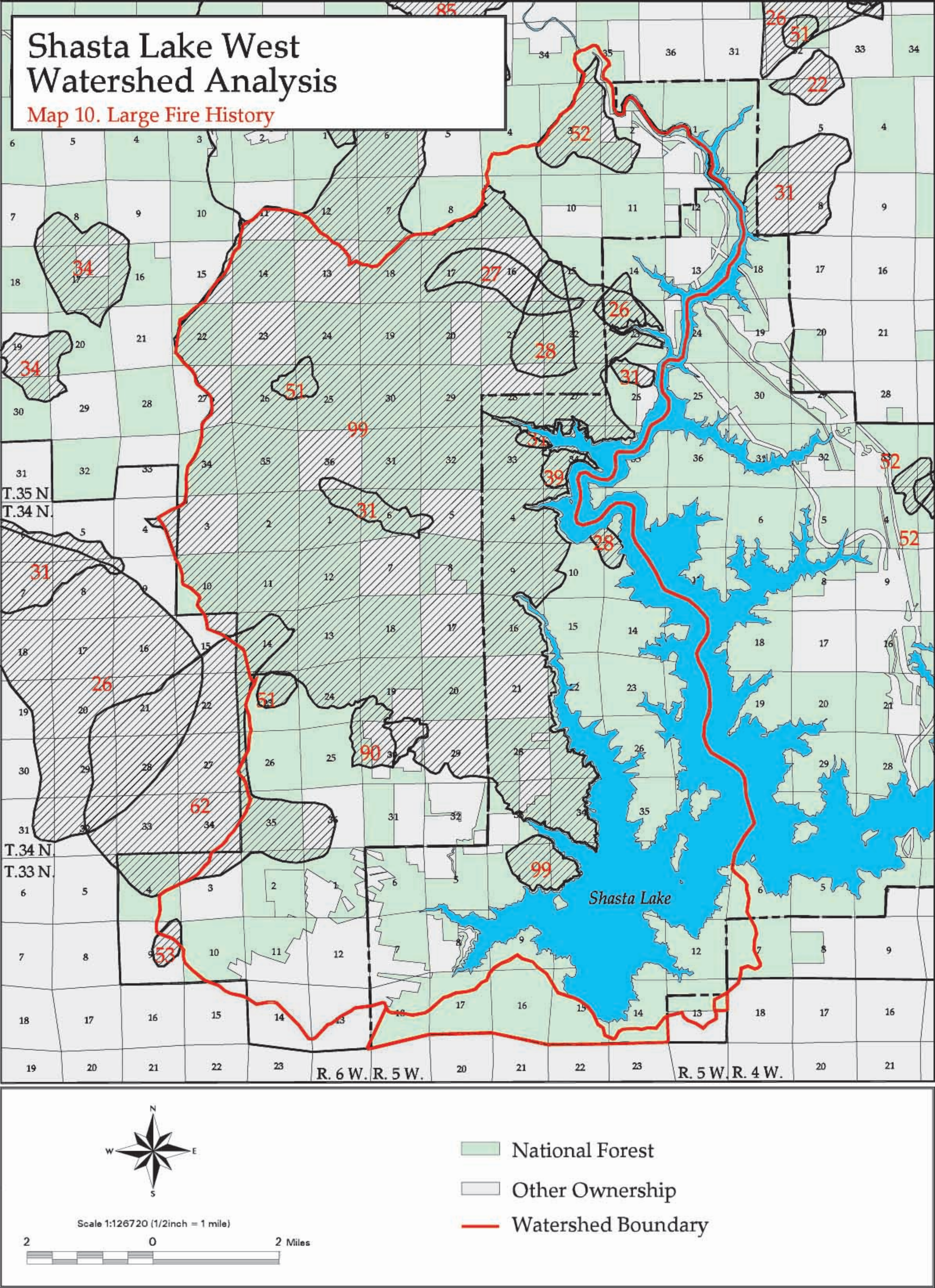


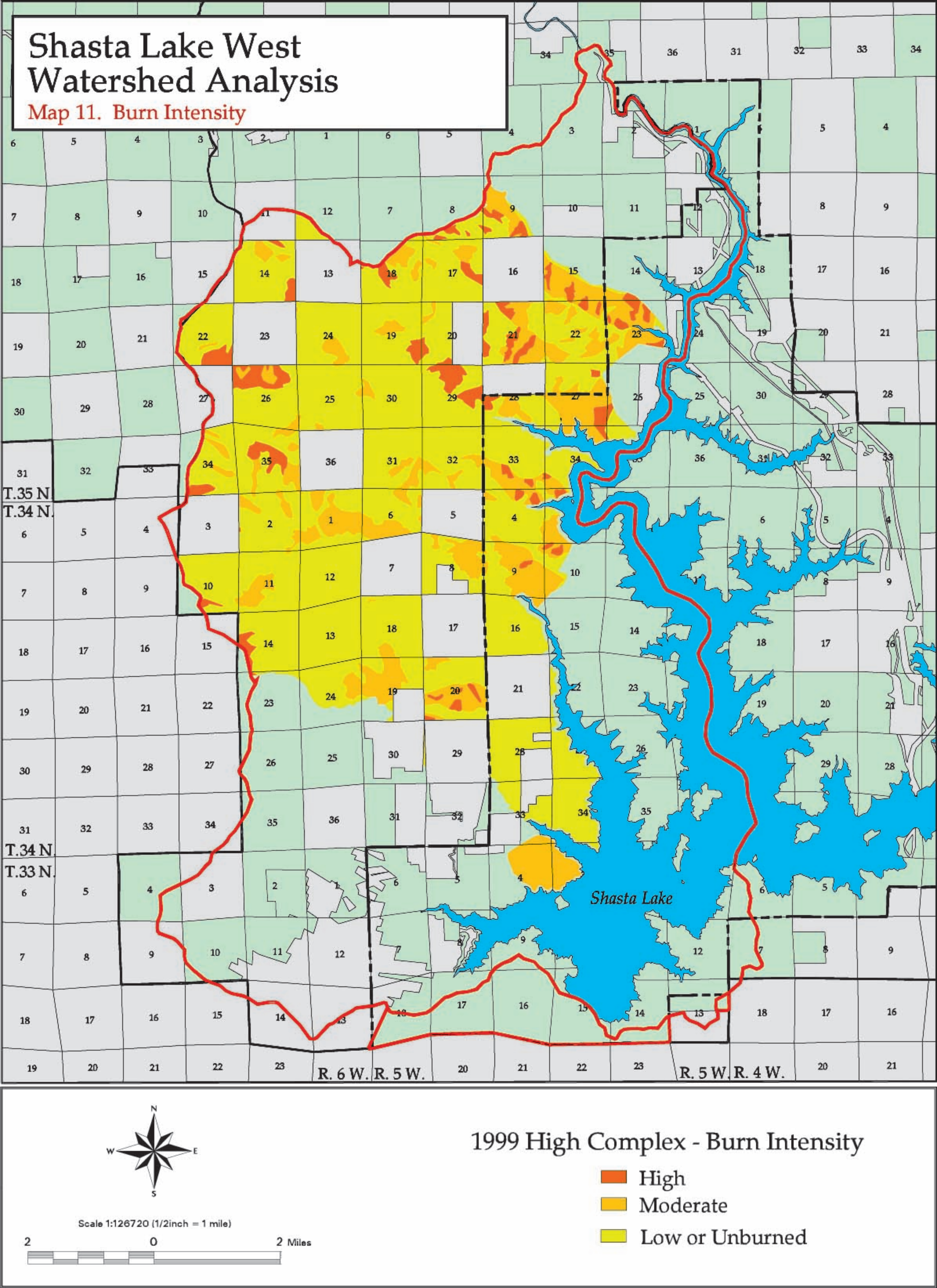


Shasta Lake West
Watershed Analysis
Map 7. Transportation System
T.35 N.
T.34 N.
T.34 N.
T.33 N.
Shasta Lake
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
N
W
E
S
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles
National Forest
Other Ownership
Roads
Trails
Watershed Boundary

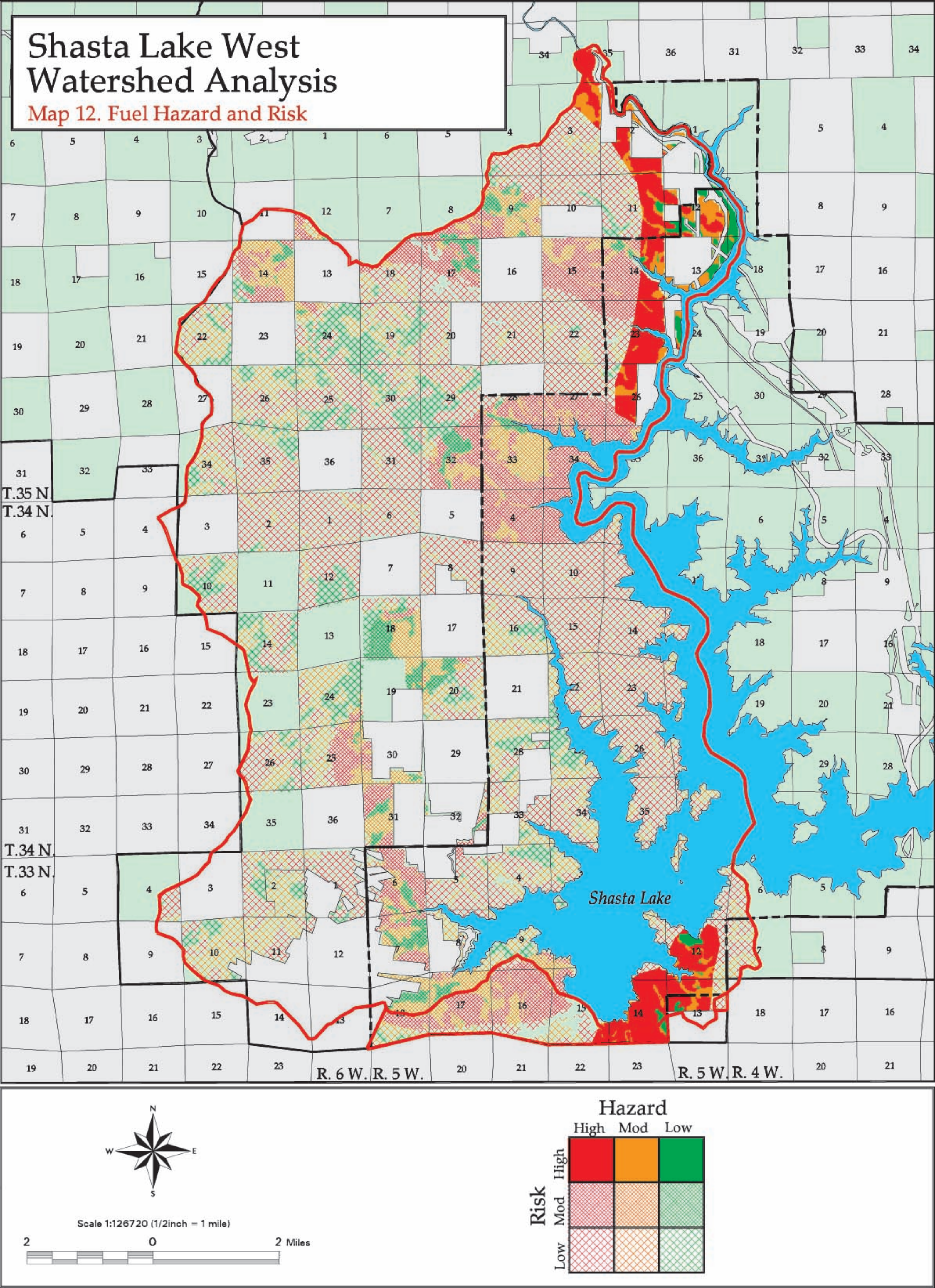

Shasta Lake West
Watershed Analysis
Map 8. Vegetation Types
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles
Douglas Fir
Ponderosa Pine
Mixed Conifer
Knobcone Pine
Grey Pine
Black Oak
Mixed Commercial Hardwoods
Live Oak
Chaparral
Shrub Size Hardwoods
Conifer Plantations
Grass
Cultivated
Barren/Urban
Other Ownership

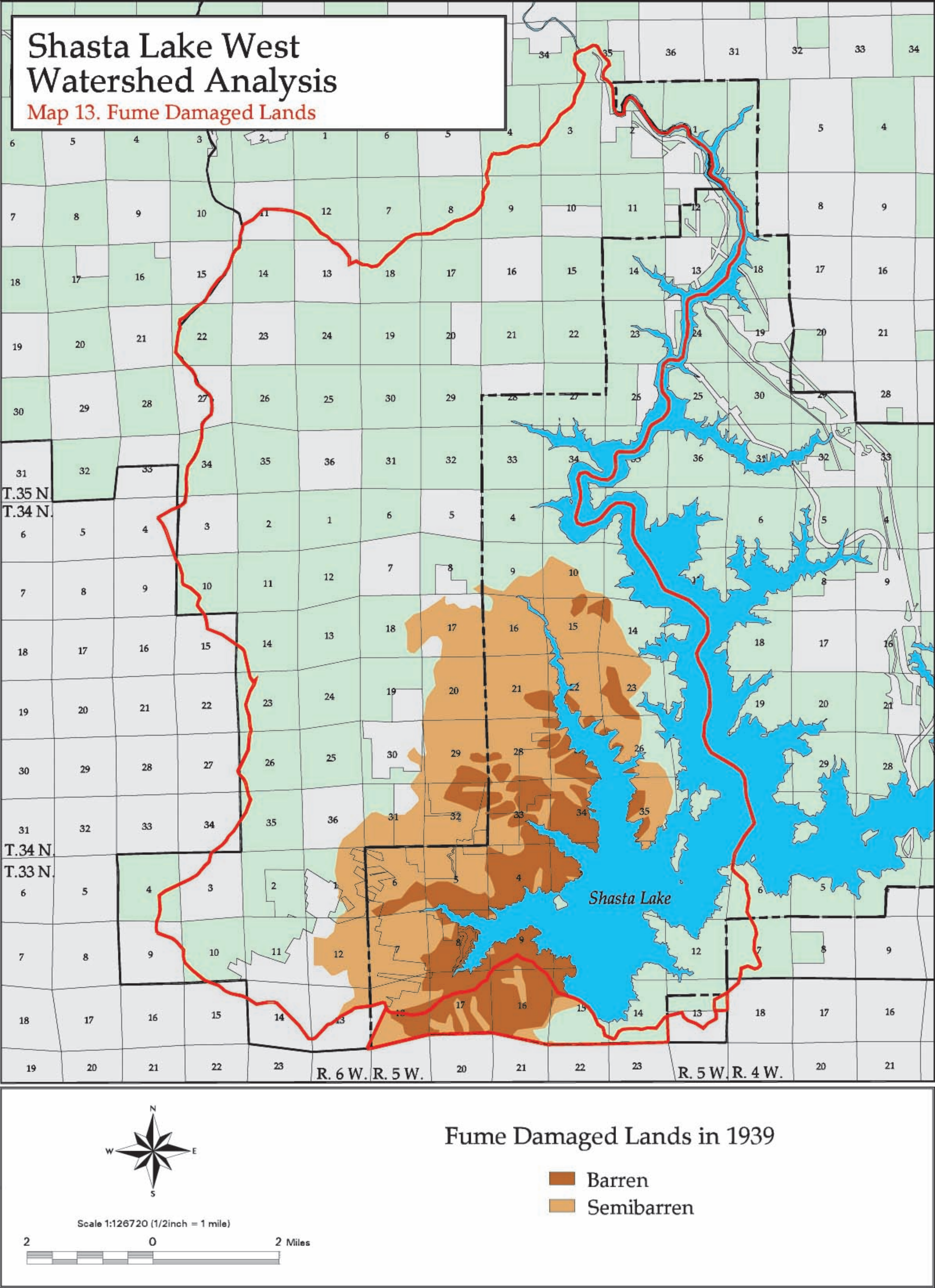

Shasta Lake West
Watershed Analysis
Map 9. Ecological Units
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2 0 2 Miles
Alluvial Terraces/Thermic - Deep Soils
Douglas Fir, Ponderosa Pine, Whiteleaf Manzanita
Metamorphic Sideslopes, Ridges/Thermic - Moderately Deep and Shallow Soils
Mixed Hardwoods, Grey Pine, Mixed Chapparel
Metamorphic Sideslopes, Ridges/Mesic - Moderately Deep and Shallow Soils
Douglas Fir, Ponderosa Pine, Dogwood, Greenleaf Manzanita
Metamorphic Rock Outcrops, Canyon Lands/Mesic, Thermic - Shallow Soils
Canyon Live Oak, Poison Oak


Shasta Lake West
Watershed Analysis
Map 10. Large Fire History
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2 0 2 Miles
National Forest
Other Ownership
Watershed Boundary



Shasta Lake West
Watershed Analysis
Map 11. Burn Intensity
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2 0 2 Miles
1999 High Complex - Burn Intensity
High
Moderate
Low or Unburned


Shasta Lake West
Watershed Analysis
Map 12. Fuel Hazard and Risk
T.35 N.
T.34 N.
T.34 N.
T.33 N.
R. 6 W.
R. 5 W.
R. 5 W.
R. 4 W.
Shasta Lake
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles
Hazard
High
Mod
Low
Risk
High
Mod
Low



Shasta Lake West
Watershed Analysis
Map 13. Fume Damaged Lands
T.35 N.
T.34 N.
T.34 N.
T.33 N.
Shasta Lake
R. 6 W. R. 5 W.
R. 5 W. R. 4 W.
N
S
E
W
Scale 1:126720 (1/2inch = 1 mile)
2
0
2 Miles
Fume Damaged Lands in 1939
Barren
Semibarren

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 (ROD, 1994).

The Shasta Lake West Watershed Analysis was prepared in conjunction with ecosystem recovery efforts for areas of the Shasta Lake West Watershed that were burned during the High Complex Fire (1999) and unburned portions of the watershed that continue to be at risk to stand replacing fires. A watershed analysis must be completed prior to conducting ground disturbing activities in Riparian Reserves. This watershed analysis assesses the current condition of Riparian Reserves, identifies the Desired Future Condition (DFC) for Riparian Reserves, and recommends potential restoration or recovery actions/treatments in Riparian Reserves.

For the purposes of this first iteration, the Shasta Lake West Watershed Analysis has been limited to a single issue: Fire Recovery Planning in Riparian Reserves. The analysis was restricted to one issue because funding was not available to complete a comprehensive watershed analysis for the Shasta Lake West Watershed. All of the information needed to address fire recovery planning in Riparian Reserves is included in this document. Because the scope of this analysis is narrowed to a single issue, the analysis is not comprehensive. It is recognized that there are additional issues that should be addressed at the watershed scale in subsequent iterations of this analysis. Because this analysis is not comprehensive it is only applicable to the fire recovery projects and should be updated prior to planning additional projects in the watershed.

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

- Characterization of the watershed
- Identification of issues and key questions
- Description of current conditions
- Description of reference conditions
- Synthesis and interpretation of information
- Recommendations

While restricted to a single issue, this analysis does provide an overview of the physical, biological and human features for public lands in the entire watershed in chapters 1, 3, 4 and 5. This information is needed to assess the issue within the context of the physical and biological features, physical and biological processes and human uses in the watershed. Information in chapters 2 and 6 is mostly limited to issue recommendations.

This Watershed Analysis is a left-side planning document (plan to project) and is not a decision document. Recommendations presented in this analysis will be evaluated further in the NEPA process.

Shasta Lake West Watershed Analysis

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Chapter 1

Characterization of the Watershed

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 ecosystem elements and those occurring in the river basin or province is established. This chapter provides the watershed context for identifying elements that should be addressed in the analysis.

The topics covered in this chapter are:

- Location and Watershed Setting
- Relationship to Larger Scale Settings
- Physical Features
- Biological Features
- Human Uses
- Land Allocations and Management Direction

1.1 Location and Watershed Setting

The Shasta Lake West Watershed is located 8 miles north of Redding, California. The watershed is located entirely within Shasta County.

The Shasta Lake West Watershed drains an area of about 65,456 acres; 51,944 acres of which are National Forest (Map 1 – Land Ownership). All tributaries within the watershed flow into the Sacramento River Arm of Shasta Lake. The Shasta Lake West analysis area includes an additional 1,900 acres of land located south of Shasta Lake and outside of the watershed. This additional acreage is included because it is too small to be analyzed independently in a separate watershed analysis.

The northern and western boundaries of the analysis area are delineated by long ridgelines that span the distances between Sugarloaf, Dog, Schell, Wild Cow and East Shirt Mountains. The eastern border of the watershed is the Sacramento River Arm of Shasta Lake. The southern end of the analysis area is delineated by the boundary of the Shasta-Trinity National Forest (includes the additional 1,900 acres).

1.2 Relationship to Larger Scale Settings

The Upper Sacramento River Basin

The Shasta Lake West Watershed is located within the Upper Sacramento River Basin. The watershed drains approximately 17 percent of the Upper Sacramento River Basin. The Upper Sacramento River Basin contains the Sacramento River and all of its tributaries (excluding the Pit River) above Shasta Dam.

The Upper Sacramento River Basin drains an area of roughly 600 square miles. Its headwaters include portions Mount Shasta, Trinity and Klamath Mountains. The terrain in the basin is steep and mountainous. Prominent features in the basin include Shasta Dam, Shasta Lake, Castle Crags, Mount Shasta and Interstate 5. The basin is primarily forested with mixed conifer species at higher elevations and oak woodlands, scattered pine and brush at lower elevations.

Climate in the Sacramento River Basin is characterized by cool, wet winters and warm, dry summers. Annual precipitation in the watershed varies from a low of 30 inches north of Mount Shasta City to a high of 80 inches near High Mountain.

Timber management is the dominant land use activity in the basin. Recreation use in the basin is high, especially in the National Recreation Area at Shasta Lake and along the Interstate 5 corridor. The basin also contains all of the Castle Crags Wilderness and a portion of the Mount Shasta Wilderness.

1.3 Physical Features

The Shasta Lake West Watershed is characterized by rugged, steep topography. Prominent physical features include Backbone Ridge, Schell Mountain, Bohemotash Mountain, Shasta Lake and Shasta Dam (Map 2 – Dominant Physical Features). Elevations range from 1,065 feet at Shasta Lake to over 5,100 feet on Schell Mountain.

Climate

The climate of the watershed is typified by mild, wet winters and hot, dry summers. The annual average precipitation for the watershed is 70 inches. Snow rarely accumulates in the watershed below 4000 feet in elevation.

Geology and Erosion Processes

Geologic formations in the Shasta Lake West Watershed include the Balaklala rhyolite, the Kennett formation and the Bragdon formation. Active debris slides and flows, along with colluviation, are the major geomorphic and mass wasting processes in the watershed. The vast majority of debris slides and flows are concentrated in the southern one-third of the watershed. Soils are mainly derived from metamorphic rocks and deep alluvium.

Hydrology – Stream Channels – Water Quality

Hydrologic features in the Shasta Lake West Watershed include Shasta Lake, the Sacramento River and numerous perennial, fish-bearing streams. Large perennial streams in the watershed include the Sacramento River, Big Backbone Creek, Sugarloaf Creek, Charlie Creek, Doney Creek and Squaw Creek. Water quality is generally very good in Shasta Lake and its tributaries. Acid mine drainage has and continues to impair water quality in Little Backbone and Squaw Creeks.

1.4 Biological Features

Vegetation

Vegetation in the Shasta Lake West Watershed can be broken down into seven basic vegetation types: Douglas fir-Mixed Conifer forest, Mixed Conifer, Ponderosa Pine, Canyon Oak Woodland, Black Oak Woodland, Gray Pine Woodland and Chaparral. Elevation ranges for these vegetation types are between 1,065 feet (lake shore) and 5,100 feet (Schell Mountain). This elevation gradient travels through two transition zones: 1) Valley (<1,500 feet) and Lower Montane (Foothill) vegetation types and 2) Lower Montane (1,000 to 3,500 feet) and Montane (>3,000 feet) vegetation types. Plant species diversity is very high.

The vegetative cover (also referred to as available fuel) in the Shasta Lake West Watershed is best described as both complex and diverse. Lower elevation fuels consist of a mix of chaparral and hardwoods; mid-elevation slopes are within a transitional zone that contains both the chaparral/hardwood mix and a mixed conifer component; and higher elevation sites are dominated by mixed conifer overstory with brush species in the understory primarily in open areas. An exception to this trend is the Riparian Reserve corridor where conifers can span from lower to upper elevations. Natural soil type changes and mining disturbances also affects fuels and vegetation patterns in the watershed.

Species and Habitats

Listed Species

Large ponderosa pine trees within one mile of Shasta Lake provide existing and potential nest sites for bald eagles. Eagles are more likely to nest in trees that are located close to water. The density of large snags in the southern watershed is generally low due to poor site productivity. Snags provide roosting sites for eagles, as well as habitat for cavity nesting birds.

Potential habitat for the Elderberry Beetle may be present in the watershed. Elderberry bushes are mostly found within riparian zones. Habitat surveys indicate that some scattered elderberry bushes are present, however the plants are not big enough and too scattered to provide habitat for the Elderberry beetle.

Spotted owls are not present in the watershed. The habitat is too fragmented, hot, and open for this species. Shasta Lake is a dispersal barrier to spotted owls. Spotted owls occur over the divide north of the watershed in the Dog and Slate Creek drainages.

Sensitive Species

The Shasta salamander has not been observed in the watershed. The Shasta salamander prefers limestone outcrops but may inhabit similar rocky areas. Limestone outcrops are scattered throughout the southern third of the watershed. The Shasta Salamander may be present in these and other rock outcrops.

Fishers have not been observed in the watershed, but are likely present in low numbers in riparian corridors. Goshawks and martens have not been observed in the watershed but are present at higher elevations further north. Pallid and big-eared bats have not been observed but may occur in the watershed.

Survey and Manage Species

The hesperion snail was found in South Dog Creek drainage (north of the watershed). Church sideband snail is widespread in the area burned by the High Complex Fire.

Harvest Species

The Shasta Lake West Watershed provides abundant winter range for deer. The Backbone Ridge area is known for providing excellent winter range for deer. The acorn crop from black oak and several other brush species provides good forage. Turkey and bear are also common in areas of the watershed containing black oak stands.

Shasta Lake has both a warmwater and coldwater fishery. The larger perennial streams in the watershed usually contain rainbow trout under 6" long.

1.5 Human Uses

Developments within the watershed include multiple resorts, campgrounds, boat ramps, roads and trails associated with Shasta Lake. Fishing, boating, hunting, hiking, OHV-use and camping are very popular recreation activities. The watershed has a moderate to high level of use due to its proximity to Redding. The main Forest Development roads in this watershed include the Bohemotash Road (35N05), Sugarloaf Mountain Road (35N06), and Lakeshore Road (35N08). Trails include Sugarloaf Trail 5W17 and a system of OHV trails associated with the Chappie OHV Park southwest of Shasta Dam.

1.6 Land Allocations and Management Direction

Management direction for the Shasta Lake West 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.* Additional management direction for the NRA is provided in the *Whiskeytown-Shasta-Trinity National Recreation Management Area Management Guide.*

Management direction for the Shasta Lake West Watershed is summarized in this section.

Land Allocation

The ROD identifies five land allocations within the Shasta Lake West Watershed analysis area (Map 3 – Land Allocation):

- 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 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).
- 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).
- Late-Successional Reserves
  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-437). A portion of LSR RC-334 is located within the northwestern corner of the Shasta Lake West Watershed. Two smaller LSR's (eagle management) are located adjacent to Shasta Lake in the southern portion of the watershed.

Management Prescriptions

The Shasta-Trinity National Forest Land Management Plan identifies six Management Prescriptions in the Shasta Lake West Watershed (see Map 4 – Management Areas and Prescriptions and Map 5 – Riparian Reserves). They 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 (4-37)
- VIII - Commercial Wood Products Emphasis (4-67)
- IX - Riparian Management (LMP 4-59) *
- XI - Heritage Resource Management (LMP 4-50) **

  * mapped separately due to complexity. See Map 4 - Riparian Reserves.

  ** unmapped - occurs as minor inclusions within other prescriptions

Roadless Area

The Shasta Lake West Watershed contains 10,749 acres of the Backbone Released Roadless Area (Map 6 – Released Roadless Areas. Management guidelines for roadless areas are currently being developed. The Forest Service has published the Roadless Area Conservation Draft Environmental Impact Statement (DEIS) and Proposed Rule (May 2000). The DEIS is currently available for public review and comment. The DEIS excludes areas which were inventoried as roadless, but have roads which were constructed during the past 20 years. Portions of the Shasta Lake West Watershed contain lands in this exclusion category.

Management Area

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 Shasta Lake West Watershed (Map 4 - Management Areas and Prescriptions). They are Management Area #8 (Shasta Unit, LMP 4-111) and Management Area #13 (Front, LMP 4-133).

Management Units

The Shasta Lake West Watershed lies within two different management units. The Shasta-McCloud Management Unit Manages all lands in the northern half of the watershed. The Whiskeytown-Shasta-Trinity National Recreation Area (W-S-T-NRA) manages the southern half of the watershed. The National Recreation area and Shasta-McCloud Management Unit boundaries are identical to the Shasta and Front Management Areas shown on Map 4.

Land Allocation or Management Prescription	Area	
	Acres NF	% USFS
Riparian Reserves		
IX Riparian Reserves on NFS Lands	14,425*	27.8*
IX Shasta Lake Water Surface Area	8,112	15.6
Administratively Withdrawn Areas		
II Limited Roaded Motorized Recreation	8,968	17.3
XI Heritage Resource Management	**	**
Matrix		
III Roaded Recreation	11,774	22.7
VI Wildlife Habitat Management	19,961	38.4
VIII Commercial Wood Products Emphasis	1,610	3.1
Late Successional Reserves		
VII Late-Successional Reserve 7L	1,182	2.3
VII Late-Successional Reserve 7E	336	0.6
Total - All National Forest Land	51,944	77.1
Total - All Private Land	15,412	22.9
Total – Watershed Area	67,356	100

Table 1-1: Acreage summary by land allocation and management prescription within the Shasta Lake West Watershed. Acreage totals include the 1,900 acre addition south of Shasta Lake.

* Streamside Riparian Reserve acreage has not been subtracted from other prescription acreages shown in table (i.e., all other allocations acreages include some Riparian Reserve acreage). Shasta Lake surface area is Riparian Reserve and is not included in other land allocations.

** 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.

Chapter 2

Issues and Key Questions

2.1 Background

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. Watershed concerns are identified and framed within the context of issues.

Part 2 of *Ecosystem Analysis at the Watershed Scale, Federal Guide for Watershed Analysis, Version 2.2* (August 1995) lists seven core topics that should be addressed in all watershed analyses. The core topics and core questions that accompany each topic address the basic ecological conditions, processes, and interactions (elements) at work in the watershed.

Watershed Core Topics

1. Human Uses
2. Vegetation
3. Species and Habitats
4. Erosion Processes
5. Hydrology
6. Stream Channels
7. Water Quality

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. Due to limited time and resources this watershed analysis has been confined to a single issue. The issue addressed in this analysis is Fire Recovery Planning in Riparian Reserves burned during the High Complex Fire. This issue has been emphasized because it triggered the need for this watershed analysis.

Watershed Issue (applicable core topics are in parentheses)

- Fire Recovery Planning for Riparian Reserves (1, 2, 3, 4, 5, 6, 7)

Because this watershed analysis is confined to a single issue it will be necessary to revise the analysis prior to planning additional projects or activities outside the scope of fire recovery projects in the Shasta Lake West Watershed. General background information for the entire Shasta Lake Watershed is presented in Chapters 1, 3, 4, and 5 however Chapters 2 and 6 contain only the information needed to address the issue that triggered the need for this analysis. Additional issues will be added to Chapter 2 during subsequent iterations of this analysis and Chapters 3-6 will be updated accordingly.

2.2 Issue: Fire Recovery Planning for Riparian Reserves.

The High Complex Fire burned 31,371 acres (47 percent) of the Shasta Lake West Watershed in August-September, 1999. Approximately 18,570 acres of Riparian Reserves were burned at varying intensities during the fire. Fire recovery assessments for the Mammoth and Shasta Lake West burn areas studied the effects of the fire on the burned areas and discussed the ecosystem implications of the fire (January 2000). The assessments also outlined possible restoration strategies for establishing healthy ecosystems in the burn areas. Riparian Reserves that would benefit from restoration projects were identified during initial field reconnaissance for the Mammoth and Clear Creek LSR fire recovery Environmental Assessments. This watershed analysis is being prepared to determine the current condition and desired future condition for Riparian Reserves and provide direction for restoring Riparian Reserves affected by the High Complex Fire.

Key Questions:

- What are the current conditions for Riparian Reserves that were burned in the High Complex Fire?
- How did the High Complex Fire affect Aquatic Conservation Strategy Objectives in the Shasta Lake West Watershed?
- What is the desired future condition for Riparian Reserves that were burned in the Shasta Lake West Watershed?
- What Riparian Reserve fire recovery restoration treatments will establish healthy and sustainable ecosystems in the Shasta Lake West Watershed?

Chapter 3

Current Conditions

3.1 Human Uses

The Shasta Lake West Watershed experiences a large amount of human use due to its close proximity to Shasta Lake and the communities of Lakehead and Redding. This use is concentrated primarily around water-based recreation activities at the lake itself and on other recreation activities such as off-highway vehicle use and hunting.

Some of the human uses occurring in the NRA include boating (motor, houseboat), swimming, jet skiing, water skiing, fishing, sightseeing and hang gliding. Hunting is a very popular activity throughout the watershed.

Recreation use in the Whiskeytown-Shasta-Trinity National Recreation Area (W-S-T-NRA) is very high. Approximately 35% of all recreation activities occurring in the Shasta Lake-Whiskeytown Recreation Area occur within the Shasta Lake West Watershed. Approximately 80 percent of recreational use is associated with Shasta Lake. The remaining 20 percent is split between Shasta Dam and OHV use throughout the watershed.

Off-highway vehicle use is a popular recreation activity in the watershed. The Chappie-Shasta OHV Area is located in the southwest portion of the watershed and is jointly managed by the Forest Service and Bureau of Land Management. The OHV area consists of an OHV staging area, campground, day use site and a large backcountry system of OHV roads and trails located in the southwestern portion of the watershed. The Bureau of Land Management is using funds provided by the State OHV commission to acquire private lands within the Chappie-Shasta OHV area through exchange or purchase to consolidate federal ownership for better management.

Hiking and mountain biking are also popular activities in the watershed. Several trails in the watershed experience light to moderate levels of use. These trails include the OHV trail system, a portion of the Sacramento River Trail below Shasta Dam (Rails to Trails project), Dry Creek and Sugarloaf trails.

The Forest Service manages numerous recreation facilities in the Shasta Lake West Watershed. Four privately managed marinas are located in the watershed. They include the Digger Bay Marina, Sugarloaf Marina, Lakeshore Marina and Antlers Marina. Other permitted uses include several RV parks, RV campgrounds, and rental cabins in the upper Sacramento arm of Shasta Lake. Forest Service recreational facilities located within the watershed include the Centimandi and Sugarloaf boat ramps; the Fisherman’s Point and Shasta picnic areas; the Shasta, Antlers, Lakeshore East and Gooseneck Cove campgrounds; and the Old Man and Beehive undeveloped dispersed camping areas.

Shasta Dam is located in the watershed and is a major tourist attraction. Completed in 1945 and managed by the Bureau of Reclamation, Shasta Dam is the cornerstone of the Central Valley Project. The dam is a 533-feet tall concrete gravity structure, and the reservoir that it impounds has a total capacity of 4,552,000 acre-feet. The dam stores runoff from the Pit, Sacramento and McCloud River Basins (total drainage area = 6,665 mi^2). The total surface area of Shasta Lake when it is full is 29,500 acres. Some of the uses Shasta Dam is managed for include floodwater control, storage of surplus winter runoff for irrigation, hydropower generation and recreation.

The community of Lakehead is located in the watershed on the west side of the Sacramento Arm. One private residence, accessible only by boat, is located up Big Backbone Creek. The Lakeshore Guard Station (Forest Service Fire Station) is located within the watershed near Lakehead.

Numerous abandoned copper mines are located throughout the watershed. Many of these mines have problems with acid rock drainage (see Water Quality, 3.5). Actions to reduce acid rock drainage have occurred and/or are occurring at most of the mines throughout the watershed. The Golinksi Mine is the only mine with acid rock drainage problems located on public land. Problems with acid rock drainage from the Golinski Mine are currently being mitigated (see Water Quality, 3.5).

The amount of facilities managed by the Forest Service is sparse outside of the Shasta Unit of the NRA (W-S-T-NRA). Several Forest Service managed facilities are located on Sugarloaf Mountain. They include a radio tower and facility under special use permit, and a fire lookout tower on the summit of Sugarloaf Mountain.

The transportation system in the watershed totals approximately 236 miles (181 miles of roads and 55 miles of trail) (Map 7 – Transportation System). Over 38 miles of this system is paved road associated with campgrounds, boat ramps, trailheads, and other developments, but much of it is low standard native surface road that originated as early fire roads and access to various mines in the area. The current road density is approximately 2.5 miles of road per square mile of land, primarily concentrated in the southwestern part of the watershed (area of Shasta Lake not included in road density calculation).

The watershed contains numerous pre-historic and historic sites that are heritage resources. See Chapter 4 for a summary of Native American use and heritage resources in the watershed.

3.2 Vegetation

Vegetation of the Shasta Lake West Watershed

The Shasta Lake Watershed is vegetated by Douglas fir-mixed conifer forest, mixed conifer, ponderosa pine, canyon oak woodland, black oak woodland, gray pine woodland and chaparral. Vegetation types for the watershed are shown in Map 8 (Map 8 – Vegetation Types).

The vegetative communities occurring in the Shasta Lake West Watershed are a product of the geology, soils and climate of the watershed. When the vegetation, geology and soils information is integrated along with other variables such as aspect it is possible to define general ecological units for the watershed. The ecological units for the Shasta Lake West Watershed are shown in Map 9 (Map 9 – Ecological Units). The ecological units are described as follows:

Alluvial Terraces, Thermic

Deep, unconsolidated soils deposited as an ancient floodplain of the Sacramento River and its tributaries. Typical slope range: 10 to 25%.

Typical vegetation types are: Douglas fir-ponderosa pine stands with whiteleaf manzanita understory, and whiteleaf manzanita chapparal with gray pine or knobcone pine.

These soils have been severely eroded by the effects of the smelter era and by shoreline erosion from Shasta Lake.

Metamorphic Sideslopes and Ridges, Thermic

Moderately deep (20 –40") and shallow (<20") soils derived from metamorphic lithologies. Contains occasional limestone outcrops. Typical slope range: 20-60%.

On moderately deep soils and on eastern, western or northern aspects typical vegetation types are: Mixed, low elevation hardwoods including bigleaf maple, black oak, canyon live oak, California buckeye, bay laurel and scattered conifers, mostly gray pine.

On shallow soils and south aspects typical vegetation types are: Mixed chapparal including whiteleaf manzanita, canyon live oak, shrub black oak and poison oak and scattered gray pine. These soils were also affected by the smelter era erosion. Most have developed gravel pavements.

Metamorphic Sideslopes and Ridges, Mesic

Moderately deep and shallow soils derived from metamorphic lithologies, occasional limestone outcrops. Typical slope range: 20-60%

Typical vegetation types are: Douglas fir-ponderosa pine forest with an understory of flowering dogwood and greenleaf manzanita.

Metamorphic Rock Outcrops and Canyon Land, Mesic and Thermic

Shallow soils and rock outcrops derived from metamorphic lithologies. Steep, canyon-like slopes. Typical slope range: 40-70%.

Typical vegetation types are: Canyon live oak with poison oak understory.

Sensitive Plants

There are no Known populations of Threatened, Endangered, Sensitive or Survey & Manage Plant species in the watershed. There are no known populations of Survey & Manage Bryophytes or Fungi. There are two populations of *Arnica venosa (*veiny arnica), a forest endemic plant species, in the watershed. There is also potential habitat for *Neviusia cliftonii*, along Big Backbone Creek and Little Backbone Creek where limestone rock outcrops are found.

Potential Habitat for Special Status Plants, Bryophytes & Fungi In the Shasta Lake West Watershed			
Species	**Status**	**Habitat**	**Nearest population to watershed**
Vascular Plants			
Arnica venosa Veiny arnica	Endemic	Hot dry slopes under p. pine, black oak and Doug fir. Usually on N-facing aspects or ridgetops. Elevation: 1500-5000 feet.	There are two populations in the watershed: 14-5, T35N, R5W, S 32. 14-30, T33N, R5W, S7&8, and T33N, R6W, S12.
Cypripedium faciculatum Clustered lady's slipper	Sensitive S&M Strategy 1&2	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; 1300-6000 feet elev. Widespread but sporadic.	No known populations on the Shasta side of the forest. There are several populations on the Trinity side of the forest.
Cypripedium montanum Mountain lady's slipper	Sensitive S&M Strategy 1&2	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; 1300-6000 feet elev. Widespread but sporadic.	There is one known population along the Soda Creek Rd., approx. 18 miles N/E of the watershed.
Lewisia cantelovii Cantelow's lewisia	Sensitive	Moist rock outcrops in broad-leaf & conifer forests; elev. 500 to 3000 feet.	There are two populations near Lamoine, approx. 2 miles north of the watershed.
Neviusia cliftonii Shasta snow-wreath	Sensitive	North-facing slopes on limestone-derived soils, within riparian zones; Elev. 2400 to 3000 feet?	3 miles east in Waters Gulch. There is a small amount of limestone outcrop in Big Backbone Ck. And Little Backbone Ck.

Bryophytes			
Ptilidium californicum Pacific fuzzwort	S&M	White fir, Douglas fir, red fir, tanoak; small to large dbh trees, snags, stumps above 3,500 ft.	One population occurs approximately 11 miles north of the watershed in the Halls Gulch drainage.
Fungi			
Otidea leporina, O. onotica, O. smithii Rabbit ears, donkey ears	S&M PB	Moist, cooler late-successional conifer forests	Del Norte and Humboldt Co. O. leporine, Near Sims; w. slope Sacramento River above tributary to Mears Ck.
Polyozellus multiplex Blue chanterelle	S&M PB	Associated with roots of true fir (Abies spp.), Mid elevation, late-successional.	Humboldt Co., Hoopa Indian Reservation
Sarcosoma mexicana Poor mans licorice/ Giant gel cup	PB Strategy 1,2 &PB	On rotting wood or duff under conifers at low to high elevations	Siskiyou Co., Belnap Springs, NE of McCloud

Table 3-1: Potential Habitat for Special Status Plants, Bryophytes & Fungi in the Shasta Lake West Watershed

Survey and Manage species that may or do occur in the Shasta Lake West Watershed are shown in Table 3-1. Only Survey & Manage species with potential habitat in this watershed were addressed in this table. Several fungi and one vascular plant were not mentioned due to a lack of late-successional and old-growth habitat at higher elevations.

Timber Management

The Shasta Lake West Watershed contains approximately 18,500 acres of commercial forest lands. This is approximately 42 percent of the National Forest lands within the watershed. Commercial forest lands have conifer forest types dominated by Ponderosa Pine, Douglas fir, White fir and Incense Cedar. Noncommercial forest lands within the watershed include chaparral (approximately 7,200 acres), Knobcone and Gray Pine (approximately 1,100 acres) and hardwood types, Black and Live Oak, (approximately 14,900 acres).

Seral stage diversity within the conifer forest types is dominated by open mid-seral stages. About 72 percent of the conifer types are in the 3a and 4a stages. Less than 1 percent is in the 4c older type and 1.5 percent is in the early seral stage.

The fires of 1999 severely impacted approximately 2,500 acres of commercial forest land. These acres were burned at high or moderate intensity resulting in conifer tree mortality of 70 to 100 percent. Table

3-2 displays acres burned for all vegetation types and as a percentage of the total acres burned within the fire perimeters. Approximately 13.5 percent of the commercial forest land in the watershed burned at a high or moderate intensity.

The remaining commercial forest land acres within the fire area burned at low intensity or did not burn. Although there will be some mortality within these acres, it will not affect stand structure.

Logging has created both chaparral stands and early seral conifer stands of pine and Douglas fir. Most of the recent logging has occurred on private lands. The most recent logging is associated with salvage from the 1999 High Complex Fire. As of this date, no salvage logging has occurred on the public lands within the High Complex Fire of 1999. There has also been no commercial logging on the public lands within the watershed within the last 10 years.

Vegetation Type	Acres burned at High/Mod. Intensity	Acres burned at Low/No Intensity	% of total Acres burned at High/Mod. Intensity
Mixed Conifer	260	1060	6
Douglas Fir	650	5850	16
Ponderosa Pine	1500	9000	36
Knobcone/Gray Pine	150	1000	4
Black Oak/Live Oak	40	14970	1
Chaparral	1500	5700	36
Plantations	80	240	2
Total	4180	37820	

Table 3-2: Acres of vegetation type listed according to burn intensity in the Shasta Lake West Watershed.

Fuels

This section of the vegetation analysis correlates the potential interaction of the vegetation/fuel and fire in the landscape. When discussing fire over a landscape or watershed, it is helpful to explain some basic fire ecology information for the Shasta Lake West Watershed. The term fire ecology refers to fire’s role (historic, present and predicted) in the surrounding ecosystem.

Role of Fire

The role of fire in landscape ecology is confounded by a lack of understanding of the relationship between pattern and process. Pattern, or architecture of the forest as described by species composition and structure, including fuel amounts, size classes, and arrangement, clearly affects the manner in which the process, fire, burns. Yet the behavior of fire is only partly dependent on pattern, as the fire behavior “triangle” includes not only fuels and topography but also weather (Agee 1997), which is marginally influenced by pattern.

Fire History / Fire Return Interval

Most fire history studies attempt to describe how often fires occurred in the study area within the period that has sufficient evidence for fire history reconstruction. These temporal patterns are usually described either as fire frequencies (number of fires per unit of time) or fire return intervals (FRI= time between successive fires) for a specified area. The range of FRIs can provide important information regarding the development of species composition and age structures of forests (Caprio and Swetnam 1995; Skinner and Chang 1996).

The Southern Cascades Province is characteristic of a short return interval, low intensity surface fire regime. The complexity of the fuel regime in the Shasta Lake West watershed area makes it difficult to classify an estimated average FRI. The area's FRIs can best be described by each fuel-type previously described in a broad/general basis by elevation (CH 1, Section 1.4 Vegetation, Fuels). The mixed conifer fuel-type is common to the middle-upper reaches of the Shasta Lake West Watershed and includes ponderosa pine at the drier ends of the mixed conifer zones. Mixed conifer and ponderosa pine fuel types are both characteristic of short interval fire adapted regimes. Pine sites may have shorter intervals of fire disturbance (5-15 years) due to drier site conditions and extended burn seasons where middle elevations and transition zones to mixed conifer stands may experience a change from frequent low intensity surface fires to that of infrequent high intensity stand replacement fires (ie, Mammoth Fire area). Correspondingly, higher elevation moist sites within the same fire regime have changed from infrequent low to moderate intensity surface fires to infrequent low, moderate, and high intensity stand replacement fires (ie, Reptile Fire area to the north of the watershed). The hardwoods and brush species on the lower-middle portions of the watershed have also evolved under a fire regime of low to moderate intensity surface fires at short to moderate FRIs (7-25 years). This hardwood/chaparral fuel type has also changed to less frequent higher intensity fire cycles (ie., south aspect of Mammoth Fire area).

The reason for the change to less frequent fire occurrence and higher intensity fire behavior throughout the forest areas can be attributed to the exclusion of natural wildfires over the past century. This lack of fire in the ecosystem has resulted in changes to plant communities in both Riparian Reserves and adjacent hillsides. The changes include type conversions and increases in stand age, stand densities and dead and down woody debris. Recent research indicates that forest communities in the Klamath Mountains have become more homogeneous due to effective fire suppression activities (Taylor and Skinner, 1998).

The fire history for the Shasta Lake West Watershed is shown in Map 10. The map shows that the High Complex Fire (1999) is by far the largest fire to occur in the Shasta Lake West Watershed over the past 80 years. Most of the other fires shown on Map 10 occurred in the 1920's, therefore it can be assumed that the High Complex Fire burned an area that had not experienced a large fire for at least 70 years (possibly much longer). If it is assumed that the normal fire return intervals for the watershed ranged between 3-25 years, then anywhere from 3 to 22 large fires have been excluded from the watershed due to successful fire suppression.

Wildfire Hazard and Risk

Fire analysis identifies the susceptibility of a watershed to wildfire in terms of risk and hazard. Risk applies to the probability of an ignition occurring as determined from historical fire record data. Hazard identifies the availability of fuels to sustain a fire and using fire modeling results in varied severity levels of fire behavior prediction. Where high risk coincides with high hazard, the probability of catastrophic fire is more likely.

Fire behavior is a function of fuels, weather, and topography. The fuels leg of this triangle relates directly to standing vegetation as well as dead and down surface fuels. Initiation of crown fire behavior (extreme severity level) is a function of surface fireline intensity and variable of the tree crown layer. Where forest structure affects fire behavior, fire behavior also affects forest structures as discussed previously. The effect from fire absence in the Shasta Lake West Watershed is most apparent in standing live fuels that develop dense fire ladders from the surface to live tree canopies. The 1999 fire event resulted in 1,430 acres of high intensity burn, 4,760 acres of moderate intensity and 25,190 acres of low intensity or unburned area in the Shasta Lake West watershed (all numbers are approximate) (Map 11 – Burn Intensity Map for High Complex Fire). Given the current conditions in this watershed, based on the compounded hazardous fuels situation, estimates are that the next fire event in this area is likely to be more extensive and destructive than the 1999 event. The analysis of stand structure data within the watershed indicates that an estimated 60 percent of the existing National Forest stands in the analysis area are likely to generate or allow crown fire behavior in a future wildfire event, given fire intensity levels expected from characteristics fuel models assigned (Map 12 – Fuel Hazard and Risk).

Areas within the watershed at higher risk to catastrophic fire are those that obtain all the critical characteristics of fuel, weather, and topography that contribute to crown fire or stand replacement fire behavior.

The Shasta Lake West Watershed has approximately 24,153 acres that have probable potential to produce catastrophic fire behavior (see Map 12). The fire effects on vegetative resources including sensitive Riparian Reserves within these high risk areas will likely be replacement in nature.

Based on the fire analysis combining the variables of hazard and risk, fire susceptibility in the Shasta Lake West Watershed is characterized in Table 3-3 and on Map 12 - Fuel Hazard and Risk.

Risk	High Hazard	Moderate Hazard	Low Hazard
High	1985	749	316
Moderate	5285	3024	1179
Low	16883	7487	3683

Table 3-3: Fire susceptibility in the Shasta Lake West Watershed. Acres Do not include all public lands in the watershed (see Map 12).

3.3 Species and Habitats

The Shasta Lake West Watershed has a typical distribution of wildlife species for Douglas fir/mixed conifer/ponderosa pine/gray pine forests of northern California. Elevation and exposure are primary influences on the distribution of these forest habitats. Douglas fir occurs on north and east slopes, especially at higher elevations over 3000 feet, but Douglas fir are also a component of mixed conifer forests where the exposure is slightly warmer or elevations are lower. The driest habitat types occur adjacent to Shasta Lake on south slopes. These areas are often vegetated by brushfields and gray pine. Ponderosa pine also occurs in these areas but it is more prevalent on eastern and northern slopes.

When the High Complex Fire burned through the watershed it affected portions of all habitat types. Small amounts of old growth habitat were burned, further reducing the amount of this already limited type. Thousands of acres of open forest with brush were burned during the fire. The consumption of older decadent brushfields benefited wildlife by creating a more diverse array of early, mid and late seral habitats in the watershed. Thousands of acres of unburned, decadent brush fields are still present in the watershed.

The High Complex Fire had a positive overall effect on wildlife habitat conditions in the Shasta Lake West Watershed. Decadent areas of chaparral were abundant prior to the fire due to approximately 80 years of successful fire exclusion. Some forested stands were decadent, affording cover but little to no palatable forage for wildlife species inhabiting the watershed. The 1999 fires have resulted in a proliferation of early seral vegetation (grasses, forbs, shrubs, young trees) in the burned areas. The increase in early seral vegetation has, in turn, increased seral stage diversity throughout the burn area.

The 1999 fires had a negative effect on late-seral forested habitats. Late-seral habitats with well-developed conifer overstories were present in small patches at high elevations in the watershed prior to the fire. Conifer mortality was high in late-seral stands that were burned at moderate and high intensities.

The High Complex Fire coupled with salvage activities on private lands created extensive areas of early seral habitat and removed many snags from burned areas. Early seral habitat, hardwood stands and small conifer stands will be abundant within several years as vegetation recovers.

Listed Species

The Shasta Lake West Watershed contains three bald eagle territories on the Sacramento Arm. The named territories are Little Squaw, Bass point and Frost Gulch. Two of the nest territories located adjacent to Shasta Lake are Managed Late-Successional Reserves (MLSRs) shown on Map 4. While only 2 territories are shown on the map, all known eagle nest sites should be managed as MLSRs. The locations and boundaries of the MLSRs are currently being updated to adjust for changes in eagle nesting locations. These eagle nest territories contain large Ponderosa pines that serve as nesting and roosting trees for bald eagles. The High Complex Fire did not affect the three eagle nest territories. The quality of some future nesting and roosting territories along the lakeshore may have been reduced due to mortality of some pine.

Corridors of late-successional or old growth habitat suitable for use by spotted owls are too fragmented by fire and logging activities to be of use for decades. Future owl dispersal will most likely be limited to areas north of the Shasta Lake West Watershed.

Elderberry bushes are not abundant in the watershed and do not appear to be common enough to support populations of the endangered elderberry beetle.

Sensitive Species
Sensitive species that occur or may be present within the watershed include Shasta salamander, fisher, goshawk, pallid bat and big-eared bat. These species may be absent or are present in low numbers due to naturally limited or unsuitable habitat. The High Complex Fire and subsequent harvest activities have further fragmented habitat.

Survey and Manage Species
Survey and manage species that are present or may occur in the watershed include the hesperion snail and church sideband snail. Forest canopy cover is critical to these species. Habitat for all species of snails was degraded due to the fire, but refugia are present and it is likely the species will move out into burned areas as the habitat becomes suitable again.

Harvest Species
Examples of harvest species in the Shasta Lake West Watershed include deer, bear, lion, bobcat, gray squirrel, turkey, quail, rabbit, dove and pigeon. The watershed contains excellent winter range for deer particularly on and adjacent to Backbone Ridge. Hardwood stands scattered throughout the watershed provide excellent cover and forage for wildlife.

Most harvest species were benefited from the effects of the High Complex Fire. Small animals and birds that form a prey base for large predators and raptors benefited from the fire due to an increase in early seral habitat. Food supplies in high intensity burn areas were diminished due to loss of vegetation, but the fire resulted in increased food supplies in low and moderate intensity burn areas due to vegetation resprouting and increased acorn production. Some large dead and down woody debris was burned by the fire, however replacement debris is already being created as fire killed conifers fall over. On the whole, more shelter and food supplies were created than lost due to the fire.

Fisheries

Shasta Lake has both a warmwater and coldwater fishery. The warmwater fishery is dominated by spotted bass, smallmouth bass, black crappie, channel catfish and bluegill. The coldwater fishery is composed of rainbow trout, brown trout, and chinnook salmon. Native species such as white sturgeon, Sacramento blackfish, hardhead minnow, riffle sculpin, Sacramento sucker, and Sacramento squawfish are also present, but receive little fishing pressure. Fish habitat for warmwater species is limited by the lake of cover and reservoir drawdown. Habitat for coldwater species is considered good.

Within the analysis area there are several streams that flow into Shasta Lake. The largest of these include: the Sacramento River, Big Backbone Creek, Little Backbone Creek, Sugarloaf Creek, and Squaw Creek. Little Backbone and Squaw Creeks are biologically dead because toxic effluent from local mines has contaminated these two streams. During periods of heavy rain increased discharges laden with metals can cause fish kills in Shasta Lake.

The other large drainages (Sacramento River, Big Backbone Creek, Sugarloaf Creek) contain perennial fish-bearing streams. Fish habitat within these streams is considered good to fair. The dominant fish species within these streams is rainbow trout, but any of the fish found within the lake may also be found within the lower stream reaches, except sturgeon, which are too large. The other streams: Dry Fork, Charlie, Doney, Little Sugarloaf, Elmore, Alder, Adler, Shoemaker, and Bull Creeks are intermittent streams that contain fish during high flows when the lake is full. The lower reaches of these streams probably serve as spawning sites for lake-run rainbow trout during the spring. Habitat within these small streams is limited by low water flows and steep gradients and, except for spawning, is considered poor.

3.4 Erosion Processes

Geology

The Shasta Lake West Watershed is located within the Klamath Mountain Geomorphic Province in the north end of the Sacramento Valley. The formations in the watershed range in age from Devonian to Recent. The oldest are found in the south and progressively get younger to the north. Respectively these are: the Balaklala rhyolite, the Kennett formation in the Bohemotash Mountain area and the Bragdon formation in the Sugarloaf, Dog Creek Mountain area.

The Balaklala rhyolite is a group of light-colored rhyolitic flows and pyroclastic rocks, the latter forming about one-fourth of the formation. This formation has been important in the local mining history since all known base-metal ore bodies of the local mining district are in the Balaklala.

The Kennett formation overlies the Balaklala and is composed of black cherty shale, tuff, and limestone. The shale forms the lower part of the formation, while the upper part is formed by limestone that was once a coral reef. Geomorphologically, it is exposed as an erosion remnant on crests of hills and ridges southwest of Backbone Creek to Mammoth Butte.

The Mississippian age Bragdon formation overlies the Kennett and is composed predominantly of shale but contains conglomerate and sandstone. Much of the contact between the Bragdon formation and the Balaklala rhyolite in the Bohemotash Mountain quadrangle is a fault contact.

Two types of Recent deposits are distinguished: Alluvium, and landslide deposits. Little residual soil remains on the higher slopes, but in places these slopes are covered with rock debris or with a thin layer of soil and rock debris. Alluvium and surface mantle, for the most part, are limited to valleys and to low foothills. Areas in the higher foothills and mountains are covered with a mixture of coarse and fine rock debris that contains enough soil in the interstices of the rocks at many places to support a dense growth of chaparral. These areas are particularly common on north-or east-facing slopes. An exception might be the Balaklala rhyolite. Here considerable areas of mixed soil and rock debris are formed, partly because the coarse-phenocryst rhyolite weathers more easily than other varieties and partly because some of this rock is at or near the altitude of the old Klamath surface (next section) and was deeply weathered during an earlier cycle.

Geomorphology

Diller (1894) identified a surface of low or moderate relief that existed in Pliocene or Miocene time in most of the area now occupied by the Klamath Mountains (the "old" Klamath surface). Uplift of the area into a high plateau in Pliocene or early Quaternary time renewed the cutting power of the streams, which deeply dissected the old surface. There are remnants of erosion surfaces of low relief located on the sides of canyons that may represent a system of dissected terraces.

Traces of older landscapes generally are preserved only on the *higher* slopes but the interfluves between the deeply incised present tributaries are smooth. Headward erosion of tributaries and the destruction of interfluves by slumping are rejuvenating the topography of much of the area. Also, some of the ridges and peaks of moderate altitude below the old Klamath surface have subdued and rounded forms and a gentle convexity, indicating a mature topography.

Some lower slopes have accumulated rock debris and soil as much as 100 feet thick. The unstratified deposit is composed of rock fragments as much as one-foot in diameter in a matrix of red soil. This unusually thick mantle was formed by colluviation and rainwash from the higher slopes, many of which now are bare. The eroded material aggraded lower slopes, and the increased runoff on the denuded upper slopes accelerated the process. Steep-walled gullies, as much as 75 feet deep along the road to the Mammoth mine, are now working headward in the mantle of wash.

Landslides are a common feature of the area because the walls of the gullies and the canyon slopes along most of the streams are oversteepened. The slides range from small mudflows and slumps along gullies to large debris slides, flows, and landslides that are several thousand feet across (such as the Balaklala Angle Station gossan landslide). Slumping occurs along oversteepened drainage areas where the soil and subsoil cover is deep or where the rocks are soft and deeply weathered. Slides and sheet wash supply much debris to the streams during the rainy season. Larger slumped areas cause temporary dams across the streams, and the breakdown of the loose damming material causes disastrous floods in some canyons. The canyon side of an old terrace level, where it has been oversteepened by Recent stream erosion, is a common location for a landslide. Gully erosion is widespread especially in the southern one-third of the area where almost every draw is occupied by an active mass wasting feature (which amounts to literally thousands). A large part of the gullying was initiated or greatly accelerated by the removal of the timber for mining purposes and the destruction of timber, brush, and grass cover by fumes from heap roasters and smelters during the early mining operations[1].

The present dendritic drainage pattern appears to be superposed from the old Klamath surface onto the older rocks, and except in local areas and where streams follow well developed faulting or sheeting in the older rocks, the streams are not controlled by structures in the underlying rocks. Most of the streams are cutting narrow "V"-shaped canyons at the present time, but where bodies of harder rocks have impeded downcutting, a few streams have reaches with a low gradient and locally some gravel fill. In an area where there are a few large perennial streams but many small ephemerals that run only in the rainy season, the difference in topographic expression between the two types is noticeable. The large

[1] The smelter built by the Mountain Copper Co., Ltd. Began operations at the town of Keswick on the Sacramento River in 1896, and at the peak of its operations in 1904 was treating 1,000 tons of ore per day. The sulfur content of the Iron Mtn. Ore was first reduced by heap roasting in piles of ore that were scattered along the railway and fired by cordwood. As much as 350,000 tons of ore was burning at one time in heaps, before charging into the blast furnace.

streams at some places cut more rapidly than the tributaries, and the latter have discordant junctions. Hanging junctions of this type are common along some sections of Backbone Creek.

Historically the area has included many mines that have been productive, and many prospects. The ore consists of large bodies of massive pyrite that contain copper and zinc sulfides and minor amounts of gold and silver. The ore bodies have been mined primarily for copper and zinc, although massive pyrite has been mined at the Iron Mountain mine for sulfur. Only the Iron Mountain mine has been operated continuously in recent years.

Soils

Soil parent materials in the watershed can be characterized as either metamorphic rocks, deep alluvium or sedimentary rocks (limestone). Soils overlying metamorphic rocks are generally shallow to moderately deep and very gravelly; erosion potential is moderate to low. Soils overlying alluvium are deep, fine –textured and mostly unconsolidated; erosion potential is high to very high. Yearly precipitation totals in the watershed range from 50 to 70 inches, almost entirely as rain.

When the watershed was denuded of vegetation during the copper smelting era, extreme soil erosion occurred. On the alluvial terraces the extent of erosion was disastrous. Metamorphic surfaces experienced accelerated erosion and lost much of their topsoil. Alluvial surfaces also experienced accelerated surface erosion, but what is most striking is that they all eroded into a network of deep gullies. What had been a terrain of gently sloping terraces became a landscape of steep-sided gullies up to 20 feet deep. The gullies continued to erode for many years after smelting ended in 1910. Despite a massive effort to plug and dam the gullies from 1910 to 1960, they are only beginning to stabilize today.

3.5 Hydrology, Stream Channels and Water Quality

Hydrology

The Shasta Lake West Watershed drains mountainous terrain vegetated with chaparral, oak woodlands and mixed conifer forests. The total drainage area of the watershed including the Sacramento River Arm of Shasta Lake is 102 square miles. Hydrologic features found within the watershed include stream channels, the Sacramento River Arm of Shasta Lake and springs. Shasta Lake occupies 12.7 square miles (12 percent) of the watershed area when the lake is full. The Sacramento River Arm of Shasta Lake spans a distance of approximately 22.5 miles from its upstream end to Shasta Dam.

The watershed contains approximately 314 miles of ephemeral streams, 133 miles of intermittent streams and 73 miles of perennial streams. Intermittent streams differ from ephemeral streams in that they flow for several months a year while ephemeral streams only flow during precipitation events. The drainage density of stream channels in the watershed is 5.82 mi/mi^2 (watershed area used for calculation of drainage density does not include area beneath Shasta Lake). The watershed does not contain any wet meadows, wetlands or natural lakes.

Shasta Lake is a large artificial impoundment on the Sacramento River 11 km upstream from Redding, Shasta County, California. The reservoir was formed in 1944 by the construction of Shasta Dam, for the purposes of irrigation, hydroelectric power generation and flood control. At full pool Shasta Lake has a surface elevation area of 29,500 acres and has 365 miles of shoreline. The maximum depth of the lake is 517 feet.

Stream Channels

Stream channels in the Shasta Lake West Watershed are composed primarily of upland swales and intermittent and ephemeral streams with lesser amounts of perennial streams. Some of the larger perennial streams in the watershed include Big Backbone, Squaw, and Sugarloaf Creeks. Smaller tributaries to Shasta Lake found in the watershed include Doney, Charlie, and Little Backbone Creeks.

The morphology of stream channels in the Shasta Lake West Watershed is a reflection of natural geologic and fluvial processes. Stream channel morphologies in the southern third of the watershed have also been influenced by land use activities. Very little channel morphology information is available for stream channels in the watershed. Spot observations of channel morphologies taken during Burn Area Emergency Rehabilitation surveys (1999) and fire recovery planning (2000) indicate that most of the stream channels are incised within bedrock parent materials. Because they are cutting through bedrock the morphology of the larger stream channels is generally very stable. Field inspections of Charlie Creek one month and 10 months after the burn showed no evidence of channel downcutting or bank erosion resulting from the winter runoff that followed the High Complex Fire.

Stream channels in the southern third of the watershed show more signs of instability than those to the north due to catastrophic erosion that occurred throughout the early 1900's. Almost every stream channel in the southwestern third of the watershed was impacted by copper smelting activities. Fumes from the copper smelters killed vegetation on hillslopes throughout the watershed. The vegetation died and was not replenished leaving hillslopes with highly erodible soils vulnerable to winter rains. The hillslope erosion that followed over the next several decades was severe. Thousands of gullies were created and large amounts of soil eroded into the Sacramento River. Following the creation of Shasta Lake intensive erosion control programs were employed in an attempt to minimize hillslope erosion and stabilize the gullies. Today the gullies have largely been revegetated and are continuing to slowly recover. The risk of further gully destabilization due to vegetation loss from wildfire is still high in the watershed.

Drainages in the Shasta Lake West Watershed that were affected by the High Complex Fire in 1999 include Charlie Creek, Sugarloaf Creek, Big Backbone Creek and Little Backbone Creek. The High Complex Fire did not burn in the Squaw and Doney Creek drainages. The hottest and most extensive burns that affected Riparian Reserves occurred on the north side of lower Sugarloaf Creek, the entire Charlie Creek drainage and south of the Little Backbone Creek Arm of Shasta Lake on the Mammoth peninsula. Pockets of high and moderate burn intensities were scattered throughout the Big Backbone Creek drainage. More information on the effects of the fire on Riparian Reserves is presented in Chapter 5 in the issue discussion section.

Water Quality

The quality of water in the Shasta Lake West Watershed is generally very good. Water quality in the lake is monitored by the Central Valley Regional Water Quality Control Board. A thorough discussion of water quality for the lake is beyond the scope of this analysis. Much of the water quality information presented in this section was originally prepared for the McCloud Arm Watershed Analysis (1998). This information is also applicable to the Sacramento River Arm of Shasta Lake.

The greatest water quality concerns in the watershed are associated with acid rock drainage, discussed at the end of this section, and the existing and potential turbidity levels in Shasta Lake. Habitat conditions for aquatic species, visual quality and other recreation values are impaired during periods of high turbidity when large volumes of sediment are suspended in the lake (NRA Management Guide, 1996). Factors contributing to turbidity include peak flows, shoreline erosion from wave action and water level fluctuations in the reservoir. The fine-textured clays that line much of the reservoir perimeter are the source of most of the turbidity that occurs during drawdown periods.

Water quality is excellent during base flow periods in the summer months in streams that are not impacted by acid rock drainage. Increased turbidity levels can occur in the winter months in response to large rainfall events. Increased turbidity levels were noted in some streams, such as Sugarloaf and Charlie creeks, during the first several months following the High Complex Fire. Subsequent observations did not reveal any additional problems with turbidity.

In addition to increasing turbidity, peak flows occurring during the winter months also transport large quantities of woody debris into Shasta Lake. The large concentrations of debris provide increased habitat for aquatic organisms but also present a hazard to boaters. Large concentrations of woody debris that accumulate in the reservoir after large floods, such as the 1997 event, are removed from the reservoir on an annual basis.

One of the reasons that water quality in Shasta Lake is generally very good is that most of the water in the lake is transported through the reservoir to the Sacramento River annually. Inflows from Shasta Lake's major tributaries (McCloud, Pit and Sacramento Rivers and Squaw Creek) continually replenish the lake with fresh, high quality water. The total annual inflow to Shasta Lake is approximately half as large as the total storage capacity of the lake (NRA Management Guide, 1996). This high turnover rate insures that water quality remains very good. Water quality monitoring in Shasta Lake continues to be a concern due to the large number of recreation users that visit the lake each summer.

Water quality in the Shasta Lake West Watershed is generally very good in the northern tributaries to Shasta Lake. These include Big Backbone Creek, Sugarloaf Creek, Charlie Creek and Doney Creek. Charlie Creek serves as the domestic water supply for the city of Lakehead.

Water quality in the Squaw and Little Backbone Creek drainages is improving but is still impacted by acid rock drainage (ARD) resulting from copper mining activities in the late-1800's and early 1900's. Acid rock drainage occurs when sulfide minerals and naturally mineralized rock left in the underground mines and waste rock piles are oxidized. The discharge, or acid rock drainage, results in increased concentrations of metals in streams and the reservoir. Acid rock drainage has lowered fish productivity in drainages below the mines and has also been the cause of fish kills in Squaw Creek (MRRC and Brown, 1997). While approximately 90 percent of the contamination in Squaw Creek has been eliminated the contaminated reaches of Squaw and Little Backbone Creeks still cannot support a fishery due to the high metal content in the water.

Intensive efforts to clean up sources of acid rock drainage have been ongoing in the watershed for the past 20 years. Mines in the watershed where remediation projects have been implemented or are being planned or currently implemented include the following:

West Squaw Creek:	Early Bird, Balaklala, Keystone and Shasta King mines.
Little Backbone Creek:	Mammoth and Golinski mines.

Reduction of ARD from the Golinski Mine is the responsibility of the U.S. Forest Service. Efforts are currently underway to mitigate acid rock drainage by plugging two adits at the mine site. Other possible remediation measures include the construction of an artificial wetland complex to treat ARD.

A complete discussion of acid rock drainage problems in the Shasta Lake West Watershed is beyond the scope of this analysis, which is focused on fire restoration activities. For more information on acid mine drainage and the history of copper mining please refer to the listed references MRRC and Brown, 1997 and Kristofors, 1973. Both of these references are on file at the McCloud District.

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. Changes from reference conditions to current conditions are summarized in the following narrative.

4.1 Historic Overview

Reference Conditions Prior to 1800

Very little information is available for reference conditions for the Shasta Lake West Watershed. Prior to 1800 vegetation was dominated by open stands of pine and mixed conifer forest with a chaparral understory. Species of conifer and chaparral were the same as presently exists. Pine was probably a more dominant species in the mixed conifer forest. Seral stage diversity was greater with more old growth and late successional stands. Late successional forest probably made up 40-50% of the commercial forest lands in the watershed. Mid-seral forest probably made up 20-30% of the commercial forest lands and early seral forest the remaining 20-40%. Natural disturbances such as fire, floods, winds and snow had the greatest influence on stand structure and composition.

Natural wildfires and Native American burning were probably common prior to 1880. Fire was an important process that controlled fuels and the distribution and age of vegetative communities throughout the watershed. Wildfires kept most stands in open conditions, with the riparian areas having the greatest stand densities.

Harvest species that were common in the watershed included deer, elk, black and grizzly bear, beaver, mountain lion, coyote and bobcat. Habitat for wildlife species was probably excellent as was instream habitat for the anadromous and resident fisheries. Water quality in the Pit and Sacramento Rivers and their tributaries would have also been excellent.

Native American Use

Native American groups inhabited the watershed for thousands of years prior to European settlement. Native Americans hunted and gathered food and other supplies in the Shasta Lake West Watershed area. When the first fur trappers followed the Sacramento River in search of beaver they found the area populated by the *nomtipom* or Upper Sacramento River Wintu. Most of the Wintu villages were located on terraces lining the Sacramento River that are now inundated by Shasta Lake. The Wintu traveled to the upland, forested areas of the watershed to the west to collect acorns, gray pine nuts, buckeye, and other food and non-food materials. Tributary creeks were rich in suckers, and the Sacramento River was a source of salmon.

Although relatively little archaeological investigation has been conducted in the immediate area, a major exception was the excavation of two large prehistoric villages at Delta, commissioned in 1985 by the CalTrans relocation of Interstate 5[2]. These sites along with two others at LaMoine and Pollard Flat resulted in the establishment of a prehistoric chronology stretching over 5,000 years into the past. Dating techniques—radiocarbon and obsidian hydration—and differences in artifact types and prehistoric land use patterns led the investigators to divide prehistoric time in the area into three periods. Only the latest is associated with or temporally equivalent to the Wintu occupation. Earlier groups hunted on the slopes and ridge tops, fished in the creeks, and collected large quantities of pinenuts from gray pine, camping where their pursuits took them.

Very little archaeological reconnaissance was conducted prior to the filling of Shasta Lake. Four prehistoric villages were recorded just upriver from Shasta Dam, but apparently the Sacramento River Arm was not surveyed, with efforts concentrated on the McCloud Arm. Other than sites located at the upper end of the Sacramento Arm, which are exposed when lake levels drop, no villages have been recorded on the river. A number of prehistoric sites have been recorded along Sugarloaf Creek and Backbone Creek, and the crest of Backbone Ridge. Sites are to be expected along creeks, major ridgelines, and mid-slope flats near water such as the site at Maple Springs.

Reference Conditions from 1800 to Present

The past 150 years have brought many changes to the physical, biological and human elements of the watershed. The Sacramento River trail was first explored in 1830 by Hudson's Bay trapper Peter Skene Ogdon. The trail came to be known as the west branch of the California-Oregon trail. During the gold rush the route became a major mule trail and later a wagon road connecting Shasta and Yreka.

Although some gold mining was conducted at such points as Kennett and Dogtown (Delta), the Sacramento River did not play a major role in the mining industry until the 1890's when the copper boom began. The area of the Shasta Lake West Watershed in which copper mining activities took place was known as the West Shasta Mining District. The copper resource in the district was developed in the late 1800's. For about 20 years, copper and zinc ore was produced from numerous underground mines in the watershed. Towns and transportation networks were quickly established in the lower watershed

[2] Delta, LaMoine, and Pollard Flat are located north of the watershed. Information from these archaeological sites is used to develop an understanding of Native Americans that lived downstream in the Shasta Lake West Watershed.

along the Pit and Sacramento Rivers. Kennett, a boomtown serving the Mammoth and Balaklala Mines, was the second largest town in Shasta County in 1910. Coram, just downstream from Shasta Dam, was home for the copper smelter that caused major pollution to the air, killing vegetation and people alike. By the 1920's both were gone, and although Kennett is now below the waters of Shasta Lake, many related features such as mines, tramlines, and some parts of the town lie on the slopes well above the lake level.

The impacts to the Shasta Lake West Watershed from mining activities were severe. Map 13 shows the extent of fume damaged lands in the Shasta Lake West Watershed[3]. The following excerpt from Kristofors, 1973 provide a brief summary of the effects of the smelters on hillslope erosion and vegetation.

> *"Before the smelters began operating, the mountains above the Sacramento River Canyon were covered with a lush coniferous forest. The major species of this forest were ponderosa pine and Douglas fir. At lower elevations along the river, the forest gave way to a chaparral belt of which white-leaf manzanita was the dominant species. Many trees were logged for mining operations before they were damaged by smelter fumes. Most of those which were left did not escape fume damage."*
>
> *"The smelter fumes upset the natural vegetation balance. Severe erosion resulted after large areas were denuded of vegetation. Topsoil was washed off of mountain slopes, making it difficult for conifers to regenerate naturally. After smelting operations ceased, manzanita was best able to reestablish dominance in devastated areas.[4]"*

Restoration programs targeted at reducing hillslope erosion were slow to be implemented. The completion of Shasta Dam in 1945 triggered the start of extensive erosion control programs due to fears of reservoir sedimentation. Restoration programs consisted of check dam construction in gullies, hillslope terracing, planting of broadleaf vegetation on the check dams and the reforestation of entire watersheds with ponderosa and Jeffrey pine. Most of the erosion control work in the Shasta Lake West Watershed took place from 1957 to 1962 (Kristofors, 1973).

The copper mining era also left a legacy of water quality problems associated with acid rock drainage (ARD). The worst of these were located south of the watershed in the Spring Creek drainage, however the water quality of Squaw and Little Backbone Creeks was degraded due to acid rock drainage (see Section 3.5).

In 1916 the California-Oregon trail was modernized by the Division of Highways and renamed the Pacific Highway and later called Highway 99. Some portions of Interstate 5 still follow this route. This was also the route followed by the Central Pacific Railroad, which was extended northward from Redding in 1872. Settlements sprang up along many of the railroad stops such as Morley, Elmore, Pollack, Antlers and Delta, many of which are now underwater.

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[3] Map 12 was produced based on Map 8, found in Kristofors, 1973. The original source of the map is 'Vegetation Types of California, Redding Quadrangle, U.S. Department of Agriculture, forest Service, 1939.'

[4] Kristofors, K.V., 1973. The Copper Mining Era in Shasta County, California, 1896-1919: An Environmental Impact Study. M.S. thesis, California State University, Chico, 147 p.

The construction of Shasta Dam had a tremendous influence on the watershed. Begun in the late 1930s, the dam project brought thousands of workers into the area. Although most lived south of the project area in the "dam boomtowns," many residences, dormitories, offices and warehouses were located near the construction site. Coram, largely deserted after the close of the copper industry, was resurrected as the terminus of the nine-mile long conveyer belt, which brought aggregate from Redding. Massive stockpiles, a warehouse and fabricating plant were located on the west bank of the river. Several other sites related to the construction of the dam have been recorded in the area, some below the high-water level of Shasta Lake and some above. Construction of the dam also triggered the development of additional road systems in the lower watershed.

The construction of Shasta Dam and filling of Shasta Lake had a major impact on the surrounding natural environment. The dam put an end to the anadromous fisheries resource in the Pit, McCloud and upper Sacramento Rivers and inundated many miles of streamside riparian corridors.

Beginning in the mid 1800's European settlers began to harvest timber in the watershed. The structure and composition of the forest in the watershed changed as logging activities increased. Copper mining, as previously discussed, had a great impact on forests in the Mammoth Butte/Bohemotash Mountain Area. Conifer forests were replaced by chaparral types that have perpetuated to this day. Knobcone pine has replaced some mixed conifer forest types as a result of the intense wildfires.

The mining activities and the construction of Shasta Dam are two activities that have had the greatest impact on the Shasta Lake West Watershed over the past century. Other land-use activities that have affected the watershed include the following.

- A gradual increase in the effectiveness of fire suppression activities reduced the role of natural fire in the watershed resulting in the advancement of vegetation to mid and late seral stages and increases in fuels.

- Over the past 50 years numerous recreation facilities have been developed around Shasta Lake including trails, campgrounds, boat ramps, and OHV park.

- Development of the urban interface, infrastructure and transportation system along the Sacramento River corridor.

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 issue and core topics listed in Chapter 2. The issue is addressed in two formats. In the first format the key questions developed for the 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 the issue. Key questions are answered where possible and data gaps and information needs are identified.

The issue addressed in this chapter is **Fire Recovery Planning For Riparian Reserves**. Topics discussed for this issue include:

Current Conditions for Riparian Reserves in the High Complex Burn Area
Effect of High Complex Fire on Aquatic Conservation Strategy Objectives
Desired Future Condition for Riparian Reserves
Fire Recovery Restoration Treatments

The second format presents the existing condition, causal mechanisms for change, trends and conclusions for each watershed core topic. Some topics addressed in Chapters 3 and 4 are not addressed in Chapter 5 if they are not related to the issue and are not currently important for the development of recommendations.

Core topics addressed in this chapter include:

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

Key Questions:

- What are the current conditions for Riparian Reserves that were burned in the High Complex Fire?
- How did the High Complex Fire affect Aquatic Conservation Strategy Objectives in the Shasta Lake West Watershed?
- What is the desired future condition for Riparian Reserves that were burned in the Shasta Lake West Watershed?
- What Riparian Reserve fire recovery restoration treatments will establish healthy and sustainable ecosystems in the Shasta Lake West Watershed?

5.1 Current Conditions For Riparian Reserves in the High Complex Burn Area

The High Complex Fire burned a total area of 31,371 acres or 47 percent of the Shasta Lake West Watershed. Approximately 18,570 acres of Riparian Reserves were burned in the fire. Burn intensity maps created immediately following the High Complex Fire in 1999 were used to determine the acreages of Riparian Reserves burned at high, moderate and low burn intensities. Approximately 361, 1,419 and 16,788 acres of Riparian Reserves burned at high, moderate and low intensities, respectively. Definitions and descriptions of burn intensity categories are provided below.

High Burn Intensity: Areas were mapped as having burned at a high intensity if greater than 50 percent of the forest canopy was completely consumed by the fire. Consumption of tree needles in high intensity burn areas was close to 100 percent and the ground cover was totally consumed. High intensity areas were also delineated if the soil displayed a high amount of hydrophobicity in response to the fire.

Moderate Burn Intensity: Moderate intensity burns were characterized by fires that mostly burned close to the ground. Fire escape into the canopy was minimal (0-50 percent of the canopy was burned). Moderate intensity burn areas were characterized by complete consumption of needles from some conifers and widespread scorching of the canopy of most conifers and hardwoods. Ground cover in moderately burned areas was only partially consumed. On the High Complex Fire many conifer stands mapped with a burn intensity of 'moderate' were scorched by the fire. Vegetative mortality was generally very high in areas that burned at moderate intensity.

Low Burn Intensity: Low intensity burns were characterized by ground fires that did not carry flame into the canopy. Needles remained on conifers in low intensity burn areas and ground cover was mostly preserved. Conifer and hardwood mortality was generally low in areas burned at low intensity. Low intensity burn areas have been aggregated with unburned areas due to the difficulty of distinguishing between them. Field inspections indicate that the amount of unburned area located within fire perimeters is small when compared to the area burned at a low intensity.

Riparian Reserves that burned at high and moderate intensities mostly consisted of upland ephemeral and intermittent stream courses. Fires occurring in upland areas generally burned swales, ephemeral, and intermittent channels at the same intensities as the adjacent hillslopes. The lack of observable differences between upland Riparian Reserves and adjacent hillslopes can be attributed to the prolonged absence of precipitation during the summer which results in the depletion of moisture in upland Riparian Reserves and creates favorable conditions for fire (Skinner, 1997[5]). Burn intensity in upland Riparian Reserves was also influenced by local weather conditions and back burning activities. In some cases swales and channels were observed to have enhanced fire activity by concentrating heat and funneling the fire upward through the incised drainages. In addition to upland areas, this type of fire activity was also observed on lower slopes and lower ridges within small drainages adjacent to large perennial streams and Shasta Lake.

Very few large perennial channels in the watershed were affected by high or moderate intensity burns. Notable exceptions include some reaches along Sugarloaf and Charlie Creeks. Large perennial channels generally burned at low intensities and experienced little hardwood and conifer mortality. Moderate intensity burns were common on hillslopes that were vegetated by live oak or chaparral and located adjacent to perennial channel Riparian Reserves.

Fire impacts to vegetation with Riparian Reserves were highly variable and were dependent on a wide variety of factors including fire intensity, fire behavior, fire weather, vegetation type, vegetation density and age, topographic factors such as slope, aspect, and elevation, and local soil moisture conditions. With the exception of the Mammoth area near Shasta Lake, very little high or moderate intensity burn occurred within mixed conifer, Douglas fir and Ponderosa pine vegetation types located within Riparian Reserves. High and moderate intensity burns were largely confined to conifer stands located adjacent to the Riparian Reserves. The largest concentrations of conifers burned at high and moderate intensities within Riparian Reserves were located in the northern half of the Mammoth Fire, and north of Bohemotash Mountain in the Shasta Lake West Watershed. The amount of large woody debris and the fuel loading in these areas will increase due to the high conifer mortality.

The majority of Riparian Reserves vegetated with hardwoods and chaparral burned at low intensities. Moderate and high intensity burns within these vegetation types were prevalent throughout the Charlie Creek drainage, and on south facing aspects in the lower reaches of Sugarloaf and Big Backbone Creeks. Hardwood dominated stands and chaparral burned at moderate and low intensities are recovering rapidly from fire impacts. Observations taken in December 1999 indicate that resprouting of oaks and ground cover commenced immediately following the fires.

The 1999 fires appear to have done little to reduce the threat of another large fire event within the watershed. The majority of vegetation in the fire analysis areas burned at low intensities. The low intensity burn reduced ground fuels in some areas but also increased fuel loads in other areas due to partial die-off of vegetation. Fuel loadings appear to have increased in conifer stands that burned at moderate and high intensities. Future fires may burn hotter in areas of heavy fuel accumulations resulting in adverse impacts to aquatic and riparian resources.

[5] Skinner, C.N., 1997. Fire history in Riparian Reserves in the Klamath Mountains. Presented at the Symposium on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management, San Diego, CA, 12 p.

5.2 Effect of High Complex Fire on Aquatic Conservation Strategy Objectives

Management of Riparian Reserves is guided by the Aquatic Conservation Strategy (ROD, 1994). The Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. A summary of the High Complex Fire effects on Aquatic Conservation Strategy objectives is presented in Table 5-1.

Aquatic Conservation Strategy Objectives	Wildfire Effects within Riparian Reserves
1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.	The High Complex Fire had a positive effect on objective 1. Fire suppression activities appear to have decreased vegetation diversity in many areas of the Klamath Mountains (Taylor and Skinner, 1998). The patchy mosaic of high, moderate and low intensity burns in the area burned by the High Complex Fire enhanced the diversity and complexity of watershed and landscape-scale features.
2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.	The fire had mixed effects on objective 2. Physical connectivity should be improved in some areas due to the removal of surface vegetation in brushfields and understory vegetation in hardwood and conifer stands. Connectivity within conifer dominated forests near the watershed divide was reduced due to the fire.
3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	The fire had a slightly negative to neutral effect on objective 3. The wildfires did not burn at high intensities within the majority of Riparian Reserves. Channel banks and bottom configurations were not affected in most of the Riparian Reserves that burned at high or moderate intensities. Little evidence of channel woody debris consumption was observed in the fire area. Fire suppression rehabilitation and BAER rehabilitation projects prevented channel downcutting in response to winter runoff events. All channel types appear to be recovering very rapidly from fire induced impacts.
4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	The fire had a negative effect on objective 4. Hillslope erosion, stream turbidity, and sedimentation all increased after the fire. Water quality impacts were partially mitigated by fire suppression and BAER rehabilitation projects. Negative impacts to water quality should be restricted to the first winter following the fire. Impacts to water quality are believed to be within the natural range of variability for water quality parameters following wildfires.

Aquatic Conservation Strategy Objectives	Wildfire Effects within Riparian Reserves
5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The fire had a neutral to slightly negative effect on objective 5. Erosion of fine sediments from the burned area was observed during the first fall rains, and some streams showed high amounts of turbidity and deposition of fine sediments. Concerns associated with increased sediment delivery were partially mitigated by fire suppression and BAER rehabilitation projects. Despite the increase in sediment production, the amount of sediment being mobilized and transported in the watershed does not appear to fall outside of the natural range of variability following a large wildfire event.
6. Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high and low flows must be protected.	The fire had a positive effect on objective 6. Fire suppression activities over the past 75 years have resulted in increased amounts of water use by vegetation. The wildfires reduced the amount of vegetation in areas that burned at high and moderate intensities. Summer base flows should show small increases in response to the reduction of water use by vegetation in areas burned at moderate and high intensities. Flood peaks may also be higher over the first 1-5 winters following the fire.
7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The fire had a neutral effect on objective 7. With the exception of the Sacramento River, well-developed floodplains are not present along mountain streams within the fire analysis areas. No wetlands or meadows occur in the Shasta Lake West Watershed.
8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.	The fire had a positive effect on objective 8. The reintroduction of fire to Riparian Reserves, unburned for 75 years as a result of effective fire suppression, should restore and maintain species composition and structural diversity of plant communities in Riparian Reserves. More in-depth study will be required to assess the effects of low, moderate and high intensity burns on this objective.
9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.	The fire had a positive effect on objective 9. The reintroduction of fire in the watershed should benefit all habitat types. As with objective 8, more in-depth study will be required to assess the effects of low, moderate and high intensity burns on native plant, invertebrate, and vertebrate riparian-dependent species.

Table 5-1: Effects of Fire on ACS Objectives.

5.3 Desired Future Conditions for Riparian Reserves

The desired future condition (DFC) for Riparian Reserves in the burned areas of the Shasta Lake West Watershed differs according to Riparian Reserve type, ecological unit, land-use history, management unit and land allocation. In order to develop the desired future condition for Riparian Reserves the information from this analysis was combined with existing DFC information for the Shasta Lake National Recreation Area and Clear Creek LSR to develop a DFC for Riparian Reserves based on the location and position of Riparian Reserves within the Shasta Lake West Watershed. All recommendations for Riparian Reserve treatments provided in Chapter 6 of this document should move the Riparian Reserves toward the DFC described below.

A discussion for the Desired Future Condition of all lands within the Shasta Lake West Watershed is beyond the scope of this analysis. The Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area and the Clear Creek Late-Successional Reserve (RC-334, LSR Assessment Revision) contain additional information on desired future conditions for the entire landscape not found in this document. The desired future condition for all public lands within the Shasta Lake West Watershed Analysis should be developed in subsequent iterations of this analysis.

Desired Future Condition

Riparian Reserves in the Shasta Lake West Watershed contain a mosaic of vegetation types, ages, densities and size classes that benefit a wide variety of plant and animal species. Forest stand densities within and adjacent to Riparian Reserves are managed to protect forest health and vigor recognizing the natural role of fire, insects and disease and other components that have a key role in the ecosystem. Important structural attributes that should be present in Riparian Reserves include live old-growth trees, standing dead trees, fallen trees or logs on the forest floor, logs in streams, multiple canopy layers, smaller understory trees, canopy gaps and patchy understory. The amounts and combinations of the structural attributes should vary by Riparian Reserve type and location.

In a general sense upland Riparian Reserves should be managed for a variety of vegetation age classes and vegetative compositions that reflect variability associated with frequent fires of varying intensity, while lowland Riparian Reserves should be managed for old growth and late-successional vegetation characteristic of less frequent fire return intervals. Some of the factors that should be considered in the identification of desired vegetative communities include Riparian Reserve type, adjacent land allocation, amount and types of human activities, fire management plans (including planned fuel breaks), fire return intervals, fire history, fire risk/hazard, slope position, aspect, soil productivity and management feasibility.

Conifers and hardwoods in stream channel Riparian Reserves are generally present in higher densities than in the surrounding landscape. Conifers within stream channel Riparian Reserves are generally larger and more abundant than conifers on midslopes and ridgetops. Changes in stand densities between Riparian Reserves and adjacent areas are generally more pronounced in the larger perennial stream channel Riparian Reserves than in upland intermittent stream channel Riparian Reserves located close to ridgetops. Riparian Reserves associated with upland intermittent channels tend to have vegetative characteristics similar to that of the surrounding uplands and reflective of more frequent, low and moderate intensity fire.

Stand understories within Riparian Reserves are generally less open when compared to the surrounding landscape. Understory vegetation in upland stream channel Riparian Reserves is more open than stream channel Riparian Reserves located in midslope and lowland areas. The density and age of understory vegetation in Riparian Reserves is maintained by wildfire and/or prescribed fire.

Wildfire and prescribed burning play key roles in managing fuels in all Riparian Reserve types. Fuel conditions in Riparian Reserves should generally result in low to moderate fire behavior during wildfires and prescribed fires. Prescribed burns occur by allowing fires started in upland areas to back downslope into Riparian Reserves.

Fuel concentrations in upland Riparian Reserves tend to mimic that of adjacent upland areas. Fuel concentrations in lowland Riparian Reserves are generally heavier than adjacent lands due to longer fire return intervals. Heavier pockets of fuels will occur in Riparian Reserves located in cool, moist sites, such as those found on north and east tending slopes, or low on the slope adjacent to perennial streams. Drier sites located on south and west tending aspects and upper slope positions will generally contain lighter fuel loadings, with fewer scattered pockets of heavy fuel. Fuels concentrations are maintained at low levels around pockets of larger conifers in Riparian Reserves.

Unstable areas are managed as Riparian Reserves. Extensive gully networks in the southern third of the watershed continue to show signs of improving stability. Where warranted, additional erosion control projects are pursued in association with other management activities. All gullies and unstable areas continue to revegetate. Large woody debris is common in gullies and aids in gully stabilization. All management activities that occur within and adjacent to unstable area Riparian Reserves are designed to not affect or reduce instability.

Stream channels are stable and stream canopy cover is moderate to high (70-90%) for all large perennial channels. Stream channels and riparian areas contain suitable habitat for all aquatic species. Sedimentation and turbidity occur very infrequently in response to wildfires, peak flows or natural instability.

Riparian Reserves that provide habitat for threatened, endangered and sensitive species are managed for the protection, enhancement, and restoration of these species and their habitats. The spread of weed plant populations within Riparian Reserves and surrounding areas has been arrested and native plants are being reintroduced where suitable.

Fish habitat in Shasta Lake is managed to enhance inland coldwater and warm water fisheries for sport fishing and a wildlife prey base. Quality fisheries and wildlife habitat is maintained and enhanced for indicator and emphasis species at various lake levels. Fish habitat in all fish bearing streams is managed to provide for a healthy, productive fishery that is consistent with non-disturbed environments.

Water quality in Shasta Lake remains excellent and is managed cooperatively with the Central Valley Water Quality Control Board. Water quality in streams and springs that do not have problems with acid rock drainage (ARD) remains in excellent condition. Water quality in ARD affected reaches of Squaw and Little Backbone Creek continues to improve over time as remedial projects are implemented.

Human uses occurring within Riparian Reserves do not negatively affect values associated with Riparian Reserves or Aquatic Conservation Strategy objectives. With the exception of high use recreation areas around Shasta Lake, roads are generally not present within Riparian Reserves. Roads are well drained and maintained to prevent influxes of road sediments into stream channels. Vegetation management activities occur within Riparian Reserves only when they are needed to establish the desired future condition for fuels and vegetation in Riparian Reserves.

5.4 Fire Recovery Restoration Treatments

The purpose of this section is to identify potential restoration treatments for burned areas in and adjacent to Riparian Reserves in the Shasta Lake West Watershed. Potential treatments were identified based on the results of the Shasta Lake West Area and Mammoth Fire Assessments and subsequent field investigations and reviews.

Prior to discussing potential restoration treatments it is necessary to review restoration work that has already taken place in the areas burned in the High Complex Fire. Extensive erosion control projects were implemented after the fire throughout the burn area. Restoration projects addressed erosion and water quality concerns and many of the projects occurred within Riparian Reserves. The two types of restoration activities that have already taken place include **fire suppression rehabilitation** and **burned area emergency rehabilitation**.

Fire suppression rehabilitation activities were implemented to repair damage done by fire suppression activities. Almost all of the rehabilitation efforts were focused on preventing hillslope erosion from firelines, safety zones and roads. Fire suppression rehabilitation activities were extensive and focused on the waterbarring and mulching of approximately 80 miles of fireline in the areas affected by the High Complex Fire. Other activities that took place during fire suppression rehabilitation included roadside mulching, safety zone mulching, fireline seeding, and the respreading of vegetation on firelines.

Burn area emergency rehabilitation funds were used to mitigate resource damage caused by the fires as opposed to fire suppression activities. The scope of BAER rehabilitation projects was determined based on the resource values of concern for each fire area. Resource concerns included threats to human life, property, loss of control of water, threats to water quality and threats to long term soil productivity. As with the fire suppression rehabilitation activities, BAER projects were focused on preventing erosion and slope instability in areas of the fires that burned at high intensity. BAER projects in the Shasta Lake West Watershed were focused on the Charlie Creek drainage. Projects that were accomplished through BAER funding included aerial seeding of 450 acres of high intensity burn areas, hillslope mulching and straw wattle installation, and construction of check dams and log grade stabilizers to prevent channel downcutting.

When combined the fire suppression and BAER rehabilitation activities addressed most of the potential erosion problems in the High Complex Fire area. A very dry early winter allowed cereal grains that were aerial seeded to take root. By late December the grasses were already three inches tall in most of the seeded areas. The risk of impacts to water quality and fisheries resources was greatly reduced as a result of the rehabilitation activities and the lack of large early winter precipitation events. The large amount of the fire area burned at low intensity also benefited hydrologic and fisheries resources by buffering impacts from areas burned at moderate and high intensities.

The restoration activities that have been accomplished addressed water quality and hillslope erosion concerns but did not address more long-term problems associated with fuels and vegetation. Based on the differences between current and desired future conditions additional treatments are needed to restore vegetation and fuels conditions in Riparian Reserves and adjacent hillslopes.

In almost all cases the differences in vegetation and fuels between current and desired conditions point to the need for the reintroduction of fire into Riparian Reserves. The ecological function of fire in Riparian Reserves could be restored through the use of mechanical vegetation treatments, prescribed fire and let-burn policies developed in fire management plans. Ephemeral and intermittent stream channel Riparian Reserves in the Klamath Mountains are adapted to fire return intervals of 1-2 decades (Skinner, 1997). The exclusion of natural wildfires over the past century has affected all Riparian Reserves types by increasing concentrations of both live and dead fuels, increasing water use by vegetation, and preventing the introduction of early seral vegetation normally established after wildfires. Changes in vegetation type, age, and density may be affecting other physical and biological processes and functions normally attributed to riparian areas. Higher burn intensities during future fires could result in catastrophic loss of vegetation, increased hillslope erosion and negative impacts to aquatic and riparian resources unless fire is reintroduced as a natural disturbance in Riparian Reserves and on adjacent hillslopes.

Riparian Reserves in the Shasta Lake West Watershed have vegetation treatment needs that are similar to that of the surrounding landscape. Both burned and unburned Riparian Reserves would benefit from fuels treatments designed to reduce the build-up of dead and down material and reduce dense understory vegetation. The need for vegetation treatments appears to be particularly pronounced in stands dominated by conifers. Fuel concentrations in conifer stands are much greater than those in hardwood stands in both burned and unburned areas.

Vegetation management activities that could be used to treat Riparian Reserves include prescribed burning, hand piling and burning, chipping adjacent to roads, thinning, and biomassing of smaller materials. These treatments could occur in Riparian Reserves provided that the proper mitigation measures were taken to minimize ground disturbance and Best Management Practices were adhered to. Examples of mitigation measures could include wet weather operating restrictions and equipment exclusion zones around stream channels, steep slopes (>30 percent) and unstable areas.

5.5 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	Conclusions
Vegetation Management			
The High Complex Fire burned through the Shasta Lake West Watershed in a mosaic of unburned, low, moderate and high burn intensities. Opportunities exist to treat fuels and salvage timber in some burn areas, however these opportunities are predicated on an array of different management guidelines. Vegetation management options differ by land allocation, prescription, vegetation type, management area and management unit.	High Complex Fire. Multiple management areas and prescriptions.	Static.	All proposed vegetation treatments should be planned in accordance with the appropriate management guidelines for each land allocation, management prescription, management area and management unit.
Intense fire activity has left large areas of dead fuels along the shore of Shasta Lake. This area provides foreground views to boaters on Shasta Lake.	High Complex Fire. Fire suppression.	The trend for visual quality is relatively static. Visual quality will improve slowly as vegetation recovers.	There is a need to consider visual quality impacts in the design of all fuels treatments along the Shasta Lake Shoreline. Carefully planned fuels treatment projects may accelerate the improvement of visual quality along the lake.
Approximately 40% of the commercial lands in the watershed are within the Backbone Released Roadless Area. These lands may be unavailable for future timber management and may be at higher risk for future stand replacing fires. Currently, there are no plans to salvage fire killed trees or treat fuels within this released roadless area.	Fire suppression. Management policy for Released Roadless Areas is currently being revised.	Continued fuels build-up and increased hazard of catastrophic fire in Backbone Released Roadless Area.	Many of these areas will revert to early seral brush and knobcone pine. Because this area has a high occurrence of natural ignitions from lightning, future stand replacing events are anticipated.

Fire Management			
The overall fire hazard in the watershed remains high.	Fire suppression. High Complex Fire (creation of dead and down fuel in high intensity burn areas).	Fire hazard will increase over the next decade. Ground fuels will increase throughout the burn area as burned snags fall down and accumulate on the forest floor.	There is a need to plan and implement activities that will reduce fire hazard in the watershed.
The urban interface around Lakehead continues to be a high-risk area for wildfires.	Fire suppression.	Continued fuels build-up and increased fire hazard if no action is taken to reduce fuels problems near the urban interface.	There is a high risk of large fires in the Shasta Lake West Watershed. There is a need to mitigate the risk by managing vegetation in the watershed to reduce fire hazard. There is a need to assess the overall fire risk and hazard around the urban interface.
Road Management			
The road system in the watershed receives a fair amount of maintenance due to the influence of the NRA, the OHV park, and the intermix of private timberland and associated timber harvest activities. The presence of the OHV park right next to a designated roadless area makes additional road closures problematic.	Continued OHV use of system and non-system roads and trails.	The trend for the condition of the road system is currently static, although current harvest of salvage timber on private timberlands may mean no timber haul (or road maintenance) for some time. (Assumes no action on part of FS).	There is not a need to re-evaluate road management plans in the Shasta Lake West Watershed at this time. Road management plans for the Backbone Roadless Area should be reviewed pending development of new management guidelines and during Access Travel Management Planning.
Recreation Management			
Recreation use is very high in the Shasta Lake West Watershed. The majority (approximately 80%) of recreational pursuits take place on and around Shasta Lake. Other major uses include OHV use in the Chappie-Shasta OHV area and sightseeing at Shasta Dam.	Improvement and promotion of recreation facilities. Management emphasis on recreation in the W-S-T-NRA. Increasing population in Northern California.	The trend is for a projected increase in recreation activity in the watershed that is proportional to population growth in the Northern California.	Recreation use will continue to increase in the Shasta Lake West Watershed. There is a need to continue to actively manage recreation activities in the watershed and to modify existing plans to adjust for changes in human use trends, patterns and numbers.
Heritage Resources			
Heritage resources in the watershed are mostly related to Native American village sites and to historic mining activities. Many of the village and mining sites were never surveyed and are beneath Shasta Lake.	Inundation of sites following completion of Shasta Dam.	Static.	Heritage resource sites will continue to be managed under current standards and guidelines. Opportunities to survey sites beneath Shasta Lake should be evaluated and pursued where feasible during drought periods when lake levels are exceptionally low.

5.6 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	Conclusions
Vegetation has begun to recover throughout much of the area burned by the High Complex Fire. Recovery has been rapid in hardwood and chaparral types that burned at low and moderate intensity. Recovery is slower in conifer stands that burned at moderate and high intensities.	High Complex Fire. Variations in burn intensity and vegetation tolerance to fire. Fire suppression and timber harvest have created denser, younger conifer stands that are vulnerable to stand replacing fires.	Vegetation will continue to naturally recover throughout the burn area. Recovery will be rapid in hardwood stands and considerably slower in conifer stands that burned at high or moderate intensities.	Most of the area burned by the High Complex Fire will recover naturally. There is a need to control fuel loadings in early and mid seral conifer stands in order to prevent the loss of the entire stand during future fires.
Little change to the overstory canopy has occurred in areas that received light underburns during the High Complex Fire. The overstory canopy was lost in most high and moderate intensity burn areas.	High Complex Fire. Variations in burn intensity and vegetation tolerance to fire.	Continued natural recovery of vegetation in high, moderate and low intensity burn areas.	Early seral habitat will be abundant in areas burned at moderate and high intensities. The reduction in understory vegetation in low intensity burn areas will encourage the development of a conifer overstory.
Vegetation in the Shasta Lake West Watershed has changed from late-successional dominated forests to mid and early successional dominated forests.	Mining, logging and wildland fires, both natural and man-caused, have been responsible for vegetation changes. Fire suppression activities have increased fuel loadings and resulted in higher intensity burns.	Late-successional forests continue to decline in the watershed due to both fire and logging.	There is a need to promote and preserve all late-successional forests in the Shasta Lake West Watershed.
Fuel loadings continue to be high in unburned areas. Many Riparian Reserves have fuel loadings similar to upland areas and are in need of fuels treatments.	Fire Suppression (fire exclusion).	Continued increase in fuel loadings in unburned areas.	The natural role of fire in reducing fuels needs to be restored in the Shasta Lake West Watershed. Achieving a more open understory in all vegetation types will benefit wildlife and support fire suppression and risk reduction activities.

The wildfires of August 1999 have changed fuel conditions in the watershed. Large amounts of fire-killed trees and vegetation have created areas of heavy standing dead fuel loading which will become dead/down fuels in the near future. The potential for future catastrophic wildfires is further exacerbated as understory vegetation reestablishes in these same areas. In areas that were unburned or received only a light burn, dense understory vegetation provides a vertical fuel ladder that increases the potential for catastrophic crown fires.	High Complex Fire. Fire Suppression.	Continued increase in fuel loading in moderate and high intensity burn areas and in unburned and low intensity burn areas. Increases in fuel loading will be most prominent in conifer stands.	There is a need to reduce current fuel loads by creating more open understory conditions. The natural role of fire needs to be restored within all land allocations in the watershed.
Many trees that initially survived the fire are at risk to stress and insect infestations	High Complex Fire. Post fire induced stress.	Additional tree mortality over next several years.	There is a need to monitor burned areas to identify additional tree mortality and to determine if additional fuels treatments are needed.
Non-native species may have been introduced to the burn area during hillslope mulching and aerial seeding activities that occurred immediately following the High Complex Fire.	High Complex Fire. Burn Area Emergency Rehabilitation (contaminated seed and straw mixes).	Trend for non-native species introduction is not known.	There is a need to monitor for non-native species introduction in areas where burn area emergency rehabilitation treatments occurred.

5.7 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	Conclusions
Habitat for species dependent on early seral vegetation will increase throughout the area burned by the High Complex Fire. The quality of forage for wildlife has also increased in the burn area. Generalized predators should benefit from increase in prey production over next decade.	High Complex Fire.	Habitat for species dependent on early seral vegetation will continue to improve.	The High Complex Fire provided benefits to species dependent on early seral vegetation. Benefits should be greatest in hardwood stands that burned at low or moderate intensities and in chaparral that burned at high intensities.
Populations of hesperion snail and church sideband snail (Survey and Manage species) were reduced or eliminated in high intensity burn areas on public and private lands. More information is needed on the distribution of other S&M species in the watershed.	High Complex Fire. Private land management.	Recovery of mollusk populations will be slow in intensively logged areas due to scarcity of woody debris, refugia and shade (~100 years). Recovery should be faster in burned areas that maintain some of the attributes noted above (~10-30 years).	Mollusk populations will gradually recover in the burn area. Additional survey and inventory needs in the watershed include snails, shrimp, invertebrates, amphibians, old-growth associated vascular plants, lichens, fungi, and bryophytes.
Pre-fire snag levels were low in the watershed due to poor productivity and past timber harvest. Most of the existing snags are too small, but enough bigger snags are present now to achieve the minimum snag density of 3-4 per acre per 40-acre unit. This target will only be achievable in forested stands on public lands that burned at moderate and high intensities.	High Complex Fire. Soil erosion and vegetation loss from smelters. Timber harvest.	Trend is for increased numbers of snags for a decade in burned areas on public lands.	Snag numbers will increase in the watershed over the next 10 years. Some areas will be deficient in large snags.

All harvest species, predator/prey species and fish are recovering in burned areas.	High Complex Fire has resulted in the creation of earlier seral habitat.	Trend is for strong recovery of all harvest, predator/prey and fish species.	The High Complex fire will ultimately benefit all harvest species, and predator/prey species.
Marginal habitat for sensitive species has declined in the watershed. Limited habitat for sensitive species was present in the watershed prior to the High Complex Fire.	The High Complex Fire had a neutral effect on habitat. Private and public logging has fragmented and removed large portions of marginal habitat.	Habitat for sensitive species will recover over a period of several decades.	There is a need to maintain, enhance and preserve habitat for sensitive species. Old growth and/or late-successional habitats in the Shasta Lake West Watershed are limited by the climate (warm, hot summers) and low soil productivity. Only high elevation areas in the northwest quarter of the watershed appear to have the capability to support late-successional habitats.
Bald eagle habitat has diminished slightly due to mortality of shoreline forage and roost trees. Bald eagle habitat remains adequate in the Shasta Lake West Watershed. No bald eagle nest territories were burned in the High Complex Fire. Understory fuel continues to accumulate in adjacent to bald eagle nest trees.	The High Complex Fire killed some small pine trees in the vicinity of Shasta Lake	The trend for bald eagle habitat is static.	Bald eagle habitat was relatively unaffected by the High Complex Fire. Current trends in fire suppression and vegetation management in the Shasta Lake West Watershed will lead to more losses of the ponderosa pine nest/perch component at Shasta Lake. Existing nest sites may be at risk to catastrophic fire. There is a need to evaluate the condition of the four existing bald eagle nest sites. Other areas adjacent to the lake that contain 4S ponderosa pine stands should be evaluated to determine if they meet the criteria for suitable eagle habitat. Sites with highest potential should be identified and managed for bald eagle habitat.
Intense fire activity has left concentrations of dead fuels along the shore of Shasta Lake. This condition increases the risk of catastrophic wildfire and the potential for the loss of critical habitat elements for the bald eagle. Fuel loads are also high around potential and existing bald eagle nest trees in unburned areas.	High Complex Fire. Fire suppression.	The trend is for increased fuel loading in high intensity burn areas as snags fall and accumulate on the ground and vegetation recovers.	Shoreline areas of Shasta Lake provide a long-term reserve of replacement bald eagle nest trees. There is a need to treat fuels adjacent to potential and existing bald eagle nest sites.

Habitat for Elderberry beetle has declined in the Shasta Lake West Watershed. Elderberry beetle is not believed to be present in the watershed.	The High Complex Fire burned scattered Elderberry bushes. Overtopping trees suppress elderberry bushes. Fire suppression.	Elderberry beetle habitat is declining in unburned areas and may improve slightly in burned areas and riparian areas.	The High Complex Fire had both beneficial and negative effects on the distribution of Elderberry bushes. Not enough information is currently available to assess the long-term impacts to Elderberry beetle habitat. The fire may rejuvenate elderberry in areas where overtopping vegetation was burned at high intensity.
Marginal habitat for the Northern Spotted owl has declined in the Shasta Lake West Watershed. Owl dispersal is now limited to north of the watershed in the Dog Creek drainage. Previous owl use in the watershed has never been observed.	The High Complex Fire burned some marginal but suitable habitat on the periphery of occupied habitat. Fire salvage activities on private lands following the fire further increased habitat fragmentation.	A slight decline in owl numbers is expected. A slight increase in genetic isolation is expected.	The High Complex Fire coupled with fire salvage activities has reduced the amount of habitat (already marginal) for the Northern Spotted owl.
Habitat for coldwater and warmwater fish species in Shasta Lake is considered good. Instream habitat is considered good to fair with the exception of Little Backbone Creek and Squaw Creek.	Acid rock drainage. Historic mining.	No change in habitat quality for Shasta Lake or fish-bearing streams.	With the exception of Squaw and Little Backbone Creeks, fish habitat in the watershed is in good condition. Remediation work has resulted in substantial water quality improvements in Squaw and Little Backbone Creeks, however the water remains too contaminated to support fish.

5.8 Erosion Processes

Core Questions (from WA Guide):

- What are the natural and human causes of change 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	Conclusions
Severe gully erosion is widespread in the southern one-third of the analysis area. Virtually every draw contains an active mass wasting feature. Extensive erosion control recovery efforts have reduced erosion and aided in the stabilization of gullies in the southern 1/3 of the watershed.	Copper mining activities. Loss of vegetation due to smelter fumes.	Most of the gullies are slowly stabilizing but full recovery and stabilization of the gully network will take centuries.	The southern one-third of the analysis area remains in a highly degraded condition due to the legacy of copper mining activities. The gully networks that cover the southern third of the watershed are only beginning to show signs of stabilizing. Due to their history of instability the unstable areas in the southern third of the watershed are all designated as Riparian Reserves. Complete stabilization of the gullies will take centuries. The potential impacts of future projects on the gullies must be considered when planning fire recovery and other projects in the southern one-third of the watershed.
Landslides are less prevalent in the northern 2/3 of the watershed.	Lack of fume damaged lands from copper mining activities.	The concentration of landslides should remain static.	The High Complex Fire has not resulted in any observed increase in landslide activity in the northern 2/3 of the watershed. Landslide activity should not increase providing that potential landslide areas are identified prior to ecosystem recovery projects and that BMP's and mitigation measures are applied to each project.

Hillslope erosion increased slightly over pre-fire levels during the winter following the High Complex Fire. Increased hillslope erosion was evident in high intensity burn areas. Hillslope erosion should decrease to pre-fire levels as vegetation recovers.	Majority of High Complex Fire burned at low to moderate burn intensity.	Hillslope erosion should stabilize at pre-fire levels over the next 2 years.	Currently there is no information to support further fire related erosion control treatments in the watershed.
Surface erosion and channel sedimentation following the High Complex Fire have been minimized in the Charlie Creek drainage due to burn area emergency rehabilitation projects.	BAER treatments. Channel check dam construction. Hillslope mulching. Aerial seeding.	Trend is static. Erosion control treatments functioned for first winter following fire.	No further action is needed to stabilize stream channels or reduce hillslope erosion in the Charlie Creek drainage.

5.9 Hydrology, Stream Channels, Water Quality

Core Questions (from WA Guide):

- What are the natural and human causes of change between historical and current hydrology, stream channel and water quality processes in the watershed?
- What are the influences and relationships between hydrology, stream channel and water quality processes and other ecosystem processes (e.g., vegetation, woody debris recruitment)?

Present Condition	Causal Mechanisms	Trends	Conclusions
The High Complex Fire has altered hydrologic conditions in Riparian Reserves. Base flows in streams located in drainages that burned at high and moderate intensities may be slightly higher than normal and may persist later into the summer. Peak flows may also show small increases in the affected watersheds.	The removal of vegetation by the fire has temporarily decreased the amount of water used by vegetation. More water is available to maintain and augment streamflow.	Base and peak flows should return to pre-fire levels within the next several years as vegetation recovers.	Base flows should remain above pre-fire levels for several years due to both the High Complex Fire and fire salvage activities. Peak flows may also increase in drainages that were burned at moderate or high intensities. Large perennial channels such as Sugarloaf, Backbone and Charlie Creeks (excluding gullies) are generally stable and resistant to disturbance from peak flows.
Hillslope erosion increased following the fire, however erosion rates are decreasing rapidly to pre-fire levels. Fine sediments appear to have been transported through the drainage network rather then deposited in stream channels.	High Complex Fire increased erosion. Flashy winter runoff events combined with steep channel gradients facilitated the movement of sediment through the drainage network. Vegetative recovery and BAER treatments have reduced hillslope erosion.	Hillslope erosion and sedimentation are all diminishing rapidly with vegetative recovery.	The watershed is recovering quickly from the High Complex Fire. Despite some increases in hillslope erosion and sediment, stream channels were largely unaffected by the fires.
Turbidity levels in some of the Shasta Lake arms in the watershed increased during the winter of 1999-2000.	High Complex Fire Loss of vegetation and increased hillslope erosion.	Turbidity levels are expected to return to pre-fire levels in 2001.	The High Complex Fire resulted in short term increases in stream and lake turbidity.

Vegetation in Riparian Reserves is recovering rapidly from fire impacts. Vegetation is recovering rapidly in oak woodlands and at a slower pace in mixed conifer forest. Some Riparian Reserves burned at high and moderate intensities are in need of fuel treatments. Recovery is progressing rapidly in all Riparian Reserve types, however recovery appears to faster in the larger perennial draws located in the drainage bottoms than in the upland channel network.	Lower burn intensities in Riparian Reserves. Rapid recovery of vegetation in Riparian Reserves.	Continued recovery of Riparian Reserves over time.	Riparian Reserves are recovering quickly from the High Complex Fire. With the exception of undesirable fuel loading in some areas, the High Complex Fire has had a largely neutral effect on Riparian Reserves.
Burn area emergency rehabilitation treatments have mitigated erosion concerns in high intensity burn areas.	Hillslope mulching has reduced erosion and limited the amount of sediment transferred into intermittent stream channels. Channel grade control structures have trapped sediment in the channel bed and limited downstream movement of sediment to Shasta Lake.	Decreased hillslope erosion as vegetation recovers.	The greatest potential impacts to riparian and aquatic resources were associated with erosion from both fire lines and high intensity burn areas. Extensive rehabilitation of fire lines, safety zones and water developments has mitigated the risk of increased hillslope erosion, turbidity and stream sedimentation. Burn area emergency rehabilitation activities have addressed erosion concerns on hillslopes burned at high intensities.
Acid rock drainage continues to be a problem in the Squaw and Little Backbone Creek drainages.	Historic copper mining activities.	The trend is for a continued reduction in acid rock drainage over time as more rehabilitation projects occur.	Mitigation measures designed to reduce acid rock drainage have been successful (over 90% reduction in metal loading in Squaw Creek). While continued reductions in ARD are expected, it is unlikely that ARD levels will ever be reduced to levels that will allow for the recovery of aquatic life to impacted streams.
The quality of water in Shasta Lake continues to be excellent.	Large annual turnover rate (annual inflows equal approximately ½ water storage capacity).	Static.	The water quality of Shasta Lake should remain excellent.

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 (see preface for limitations of the analysis).

This chapter is organized by focusing on needs and opportunities identified in Chapter 5.

Recommendation topics in this chapter include the following:

Riparian Reserve Management
Other Resource Recommendations

This chapter closes with a list of potential projects developed from the analysis.

6.1 Riparian Reserve Management

The High Complex Fire had neutral to beneficial effects in most Riparian Reserves within the Shasta Lake West Watershed. Some Riparian Reserves are in need of fuels treatments in both burned and unburned areas of the watershed. The following recommendations address potential treatments in Riparian Reserves that are associated with fire recovery projects. Treatments are only recommended if they will move vegetation closer to the desired future condition for vegetation in Riparian Reserves.

- Identify Riparian Reserves that are in need of fire recovery treatments. Apply vegetation treatments where needed to develop desired future conditions for Riparian Reserves as described in section 5.3. Use thinning, biomass, chipping and hand piling/burning to achieve DFC for Riparian Reserves. In almost all cases the objective of the vegetation treatments should be to reduce fuel loads, improve wildlife habitat and protect mature and late-successional habitat in Riparian Reserves.

- Use prescribed fire to reduce fuel loading and improve wildlife habitat in intermittent and perennial stream Riparian Reserves. Allow fire to back into Riparian Reserves during prescribed burning activities. Prescribed fire should be used as a tool to manage fuels and vegetation where it is needed to reduce fuel loadings and improve wildlife habitat.

- Prohibit all mechanical equipment use on the Mammoth peninsula in order to prevent erosion and destabilization of channels and gullies. Any removal of fuels and timber on the Mammoth peninsula on Shasta Lake should be done by helicopter so that ground disturbance is minimized. All future projects planned for areas impacted by smelter fumes should address potential impacts to erosion processes (see Map 12).

- Flag and avoid all active gullies on the Mammoth peninsula. Do not remove timber from these areas. Selectively fell small, sub merchantable conifers in areas where gullies are not currently active to enhance slope stabilization and reduce post-fire erosion.

- Follow Best Management Practices (BMP's) for all fire recovery projects. Adherence to all BMP's will prevent adverse impacts to water quality and will protect Riparian Reserves. Examples of BMP's that will play an important role in Riparian Reserve and water quality protection in the Shasta Lake West Watershed include the following:

Practice #	Best Management Practice
1.5	Limiting operating period of timber sale activities
1.6	Protection of Unstable Areas
1.8	Streamside Management Zone Designation
1.9	Determining tractor loggable ground
1.10	Tractor skidding design
1.13	Erosion prevention and control measures during timber sale operations
1.14	Special erosion prevention measures on disturbed land
1.16	Log landing erosion prevention and control
1.17	Erosion control on skid trails
1.19	Streamcourse protection
1.22	Slash treatment in sensitive areas
2.7	Control of road drainage
2.23	Road surface treatment to prevent loss of materials

All BMP's are listed and described in Water Quality Management for National Forest System Lands in California, Best Management Practices. 2000. U.S. Department of Agriculture, Forest Service, Pacific Southwest Region.

- Monitor fire recovery activities in Riparian Reserves. Determine if project objectives were accomplished and if mitigation measures were effective in preventing erosion. Determine if the project was effective in accelerating Riparian Reserve recovery and furthering the attainment of the desired future condition.

6.2 Other Resource Recommendations

The following recommendations are based on information not related to the issues or key questions. These recommendations are summarized briefly because they are related to treatments that are currently proposed as part of the fire recovery plan or are being considered for future projects in the watershed.

- Assess fire hazard and risk on public lands located adjacent to the Lakehead urban interface. Identify potential projects for fuels treatments to reduce the fuel hazard and risk of fire starts in the urban interface.

- Evaluate opportunities to treat excessive fuel loads around eagle nesting sites in areas not burned by the High Complex Fire around Shasta Lake. Consider visual quality and protection of existing and potential eagle nest trees when planning treatments.

- Consider visual quality concerns when planning projects that treat fuel loads adjacent to Shasta Lake in areas of chaparral that burned during the High Complex Fire.

- Evaluate opportunities to salvage merchantable timber from all high and moderate intensity burned areas. These areas should also have all sub merchantable trees felled and biomassed or piled for burning where feasible. Reforest all salvaged areas and burned over plantations with an appropriate mix of conifer trees within 1 year of salvage or site clearing. Follow-up treatments of anticipated chaparral sprouting and seeding must be done to ensure establishment of a future conifer forest.

- Identify and plan fire recovery projects in the Backbone Roadless Area. Tier all ecosystem recovery efforts to the most current management policy for roadless areas and LMP standards and guideline for land allocations and prescriptions in the roadless area.

- Improve fire suppression abilities and fire fighter safety by treating fuels along selected ridgelines to minimize the spread of fire within and out of the watershed. Thinning activities should focus on the reduction of both ground and vertical fuel ladders.

- Thin overstocked stands to improve future growth and yield of wood products on matrix lands and to move stands towards late seral conditions in other land allocations.

- Use prescribed fire to burn dense, decadent chaparral to reduce the acres of decadent and highly flammable shrub species and improve wildlife habitat.

- Monitor Burn Area Emergency Rehabilitation treatments to determine if non-native species were introduced during mulching and aerial seeding operations.

- Monitor fire recovery activities to determine if recovery treatments are effective at accomplishing project objectives.