Watershed Analysis
Pelican Butte Key Watershed

Klamath Ranger District, Fremont-Winema National Forests
October 2003

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INTRODUCTION

The Winema National Forest (WNF) of the U.S. Forest Service (USFS) contracted with SRI/SHAPIRO/AGCO, Inc. (SHAPIRO) to conduct an analysis of the Pelican Butte Key watershed (Figure 1). The analysis was completed pursuant to objectives outlined in "*Ecosystem Analysis at the Watershed Scale,*" *Federal Guide for Watershed Analysis, Version 2.2* (Revised August 1995; Portland, Oregon).

Watershed analysis is a component of the Aquatic Conservation Strategy in the Northwest Forest Plan. Complying with the Aquatic Conservation Strategy objectives means that an agency must manage the riparian-dependent resources to maintain the existing condition or implement actions to restore conditions. The baseline from which to assess maintaining or restoring the condition is developed through a watershed analysis.

The focus of this watershed analysis was to characterize the physical and biological processes and interactions of the Pelican Butte Key watershed as they relate to key issues, which include: 1) Water Quantity and Quality, 2) Wildlife and Biological Diversity, and 3) Aquatic Habitat.

Physical processes related to the issues were analyzed using a variety of methods and resources. The results of individual resource analyses were integrated to provide a description of the dominant processes affecting the watershed at a landscape scale and to identify restoration opportunities and land management recommendations. Data provided by the Bureau of Reclamation (BOR), Klamath Indian Tribes, US Forest Service (USFS), US Fish and Wildlife Service (USFWS), and Oregon Department of Fish and Wildlife (ODFW) was incorporated into the watershed analysis. Recommendations are intended to be general rather than site specific. Data included in the references and accompanying GIS analysis files should provide sufficient detail for resource managers to facilitate a more site-specific analysis during project planning.

A watershed analysis is recognized as an iterative process that evolves as information gathering and analysis techniques are refined. The initial analysis of the area was based on existing and available data, providing a framework on which to build future analyses. Because information was pulled from a variety of existing data sources and GIS layers, acre figures are not consistent throughout the document. These small differences do not detract from the overall description and conclusions reached about the watershed.

A draft Pelican Butte Key watershed analysis was produced in 1998 by the following interdisciplinary team of professional resource specialists:

SRI/SHAPIRO/AGCO, Inc.

George Berscheid	Principal-in-Charge
Robert Gill	Project Manager
William Lind	Assistant Project Manager/ Fisheries and Aquatic Habitat
Steve Daggett	Water Quality
Aaron English	Wildlife/Special Status Plants
Todd Reinwald	Soils and Erosion Processes
Alison Rhea	Hydrology

SUBCONSULTANTS

Walter Knapp	Silviculture/Vegetation

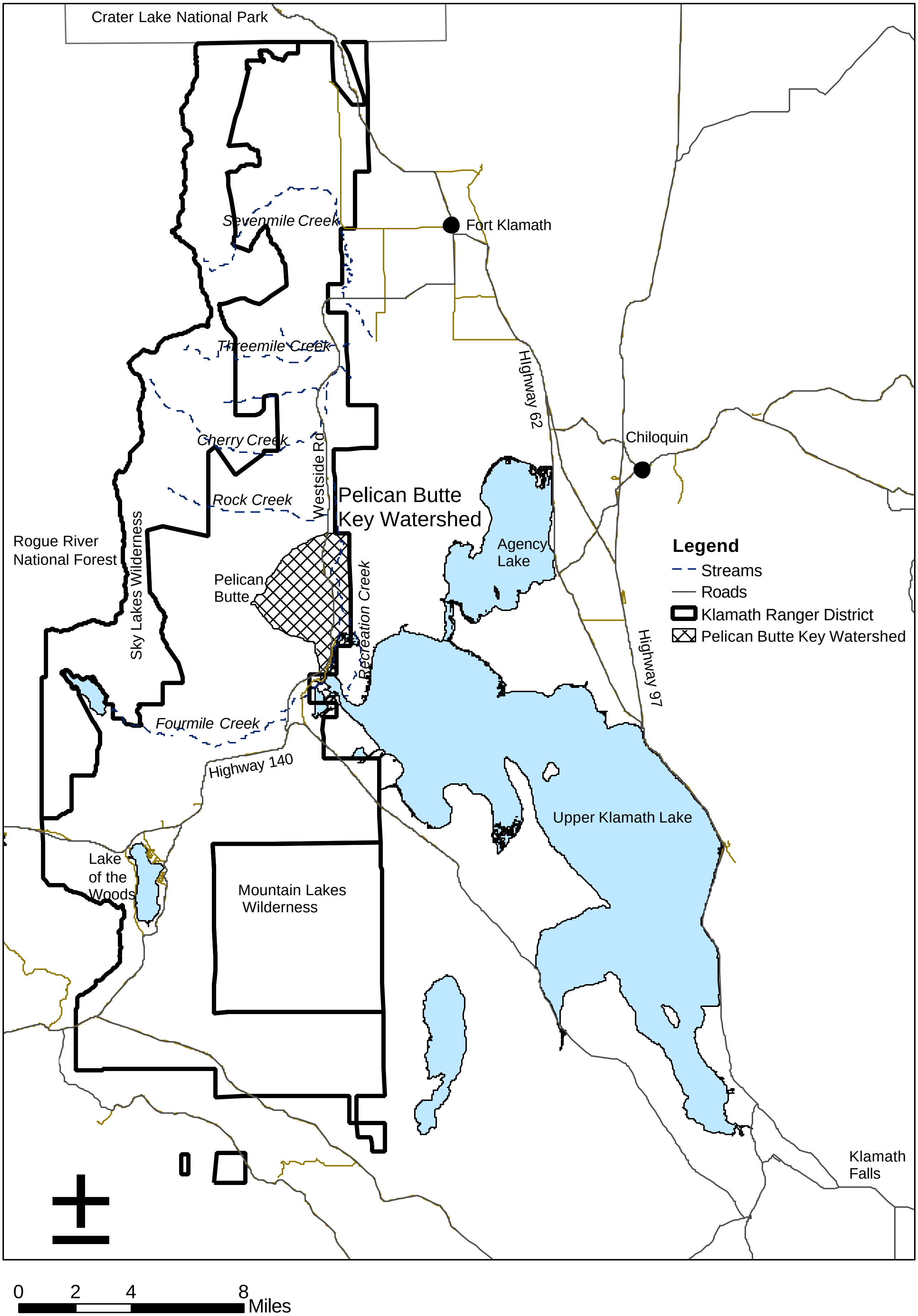
David Newton and Associates

Rick Ellis	Senior GIS/AutoCAD Designer
Steve Bruce	GIS Project Leader

In 2003, specialists from the Fremont-Winema National Forests reviewed the draft watershed analysis, edited, made corrections and updates, and produced a final document. This document now contains revisions submitted by the following specialists:

Brent Frazier	Forest Biologist
Phil Jahns	Silviculturist
Sarah Malaby	Botanist
Mike McNamara	Hydrologist
Trish Roninger	Wildlife Biologist
Terry Smith	Fish Biologist

Figure 1. Location of the Pelican Butte Key Watershed on the Klamath Ranger District



1.0 STEP 1 - CHARACTERIZATION

The purpose of Step 1 is to identify the dominant physical and biological processes and features of the Pelican Butte Key watershed that affect ecosystem function or condition. This provides the watershed context for identifying elements that need to be addressed in the analysis, including identifying the most important land allocations, objectives, and regulatory constraints that influence management in the watershed.

1.1 PHYSICAL CHARACTERISTICS

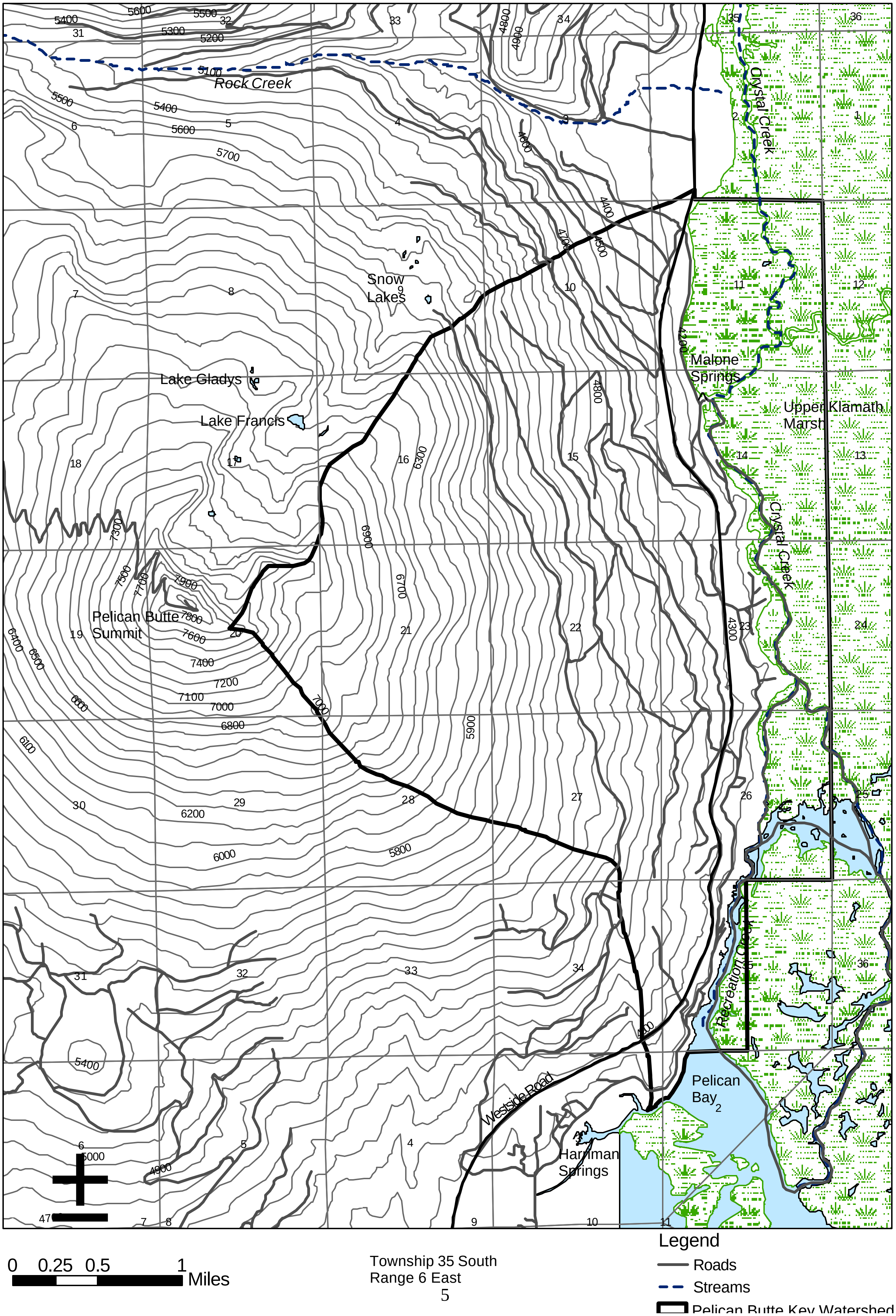
The Pelican Butte Key watershed has a drainage area of approximately 10.9 square miles (approximately 6,945 acres). It is not a true watershed, but a fragment not analyzed by the surrounding North Fourmile and Rock/Cherry/Nannie watershed analyses (USDA, 1994; 1996). The watershed drains the east slope of Pelican Butte, feeding water by Malone and Crystal Springs into Crystal and Recreation Creeks. Crystal Creek flows into Recreation Creek and Pelican Bay of Upper Klamath Lake. Recreation Creek also feeds Pelican Bay to the north of the Crystal Creek confluence. The watershed contains approximately 6 miles of perennial stream, including 3.7 miles in Crystal Creek and 2.3 miles in Recreation Creek (Figure 2). Except for Crystal Creek, all tributaries to Recreation Creek have intermittent, interrupted surface flow, infrequently occurring after snow melt and/or major storm events.

Recreation and Crystal Creeks are unlike typical lotic systems found in the Pacific Northwest, and can better be characterized as palustrine wetlands with little observable gradient or flow. At summer low flow, Recreation Creek has an average width ranging between 50 to 75 feet. At high flow, it is contiguous with Upper Klamath Lake and lacks a defined channel. Water depth ranges from 3 to 12 feet, averaging approximately 6 feet in depth and is widest by Rocky Point Resort. Instream substrate is almost entirely comprised of silts and organics, with isolated pockets of larger substrate artificially placed near boat landings and docks.

Elevations in the watershed range from approximately 4,100 feet to 7,800 feet just below Pelican Butte summit. Most of the watershed (97%) is located on USFS lands, administered by the Klamath Ranger District of the Fremont-Winema National Forests. Tracts of private land, totaling 168 acres, are located primarily along the lower portion of the watershed bordering Recreation and Crystal Creeks. The Pelican Butte Key watershed is bordered on the east side by the Upper Klamath Wildlife Refuge, administered by the U.S. Fish and Wildlife Service (USFWS). The Rocky Point Resort, a small privately owned resort, operating under special use permit, is located near the mouth of Recreation Creek at Rocky Point. The resort provides lodging, boating, and canoeing opportunities for tourists, fisherman, and hunters during the summer months.

Road density in the Pelican Butte Key watershed is lower (3.3 miles/square mile) than the average road density on the WNF (4.29 miles/square mile) (USDA, et al., 1993). Many roads in the watershed are closed seasonally (January 1 to August 31) to protect nesting bald eagles. Road density is somewhat higher than found in other nearby watersheds, including North Fourmile (2.27 miles/square mile) (USDA, 1996), and Rock, Cherry, Nannie (1.6 miles/square mile) (USDA, 1994).

Figure 2. General View of the Pelican Butte Key Watershed



Snowy, cold winters and dry, hot summers typify the climatic regime for the Pelican Butte Key watershed. Available weather data indicates that typically, most of the annual precipitation falls in December and January, with less than 12% falling during the summer months. The Pelican Butte Key watershed accumulates greater than average snow depth because of its geographic position on the east slope of Pelican Butte. Available snow depth data indicates that in most years a minimum of 2.5 to 3 feet of snow accumulation is on the ground by mid-December at the 6,000-foot elevation (Pelican Butte Corporation, 1996). The timing of snow pack melt is determined by the frequency, duration, and temperature of springtime rains.

The geology and climate typical of the area influences the hydrology of the Pelican Butte Key watershed. Pelican Butte is a cinder cone with high infiltration rates, low stream densities, and low instream flow rates (USDA, 1994). Recreation and Crystal Creeks, which form the down slope boundary of the study area, are the only defined perennial channels within the analysis area. Within the watershed, there are no defined stream channels, either ephemeral or perennial, that convey spring melt down slope. Spring melt is conveyed down slope in unconnected and poorly defined topographic swales or infiltrates into the fractured volcanics that comprise Pelican Butte. Snow melt then discharges at lower elevations in the form of spring or seep flow.

The high porosity of the volcanics that form Pelican Butte results in relatively rapid infiltration of spring melt and recharge of aquifers. Preliminary studies indicate the presence of two basic groundwater systems: a locally perched system and a regional system. The perched system is present in isolated areas and is highly influenced by previous glaciation and Mount Mazama (Crater Lake) ash flow deposits. There are no surface waterbodies within the watershed that would indicate the presence of a shallow groundwater system. The regional aquifer system receives recharge from annual precipitation and rapid infiltration. The springs are thought to reflect discharge from the regional system. Discharge of stored groundwater during the summer months from isolated springs at lower elevations provides some flow within Recreation Creek (Bunker, 1997, pers. comm.).

The dominant hydrologic (flow) characteristics for the watershed include rapid infiltration of spring snowmelt and lack of perennial stream channels that result in recharge of deeper aquifers. Discharge from aquifers is thought to support flow from perennial springs, flow within Recreation Creek, and recharge of surface flow within Upper Klamath Lake.

Historic flow patterns on the upper slopes of the Pelican Butte Key watershed most likely have changed little through time. Road building associated with logging may have altered the historic flow paths. However, because of the geologic nature of the area, including porous material and steep slopes, it is unlikely that road building has significantly altered the flow regime. Residential development at lower elevations in the watershed may have altered the historic groundwater flow regime. Human uses within this area may have resulted in a depression of the local aquifer storage volume. Local groundwater investigations would need to be conducted to confirm if, and to what extent, groundwater flow regimes have been altered.

The 1996 303(d) list of streams designated by the Department of Environmental Quality (DEQ) does not specifically list Recreation and Crystal Creeks as water quality limited; however, Agency Lake and Upper Klamath Lake, contiguous with Recreation and Crystal Creeks, are listed (DEQ, 1996). As designated in the Oregon Administrative Rules (OAR), official uses for the Klamath Basin waters, including Recreation and Crystal Creeks, are water supply (public, private, and industrial); irrigation and livestock watering; anadromous fish spawning and rearing (where natural conditions are suitable for salmonid fish use); resident fish and aquatic life; wildlife and hunting; fishing; boating and water contact recreation; and aesthetic quality.

Upper Klamath Lake is a large, shallow, hypereutrophic (very nutrient rich) lake covering approximately 64,000 surface acres. The lake is the largest freshwater lake in Oregon, with a maximum depth of 45 feet and an average depth of 8 feet. Nutrient production is very high, some of which is produced naturally in the form of phosphorous-rich springs entering the lake; however, agricultural runoff appears to contribute the bulk of the nutrients to lake eutrophication. High nutrient levels produce blue-green algal blooms during the summer which coincide with high water temperatures and fluctuating dissolved oxygen levels (Oregon Department of Fish and Wildlife [ODFW], 1981).

Since Recreation and Crystal Creeks are spring fed, they provide better water quality than that found in Upper Klamath Lake. Fish often seek refuge in Recreation and Crystal Creeks from high water temperatures, low dissolved oxygen, and high pH found in Upper Klamath Lake in late summer months (Kann, 1997, pers. comm.).

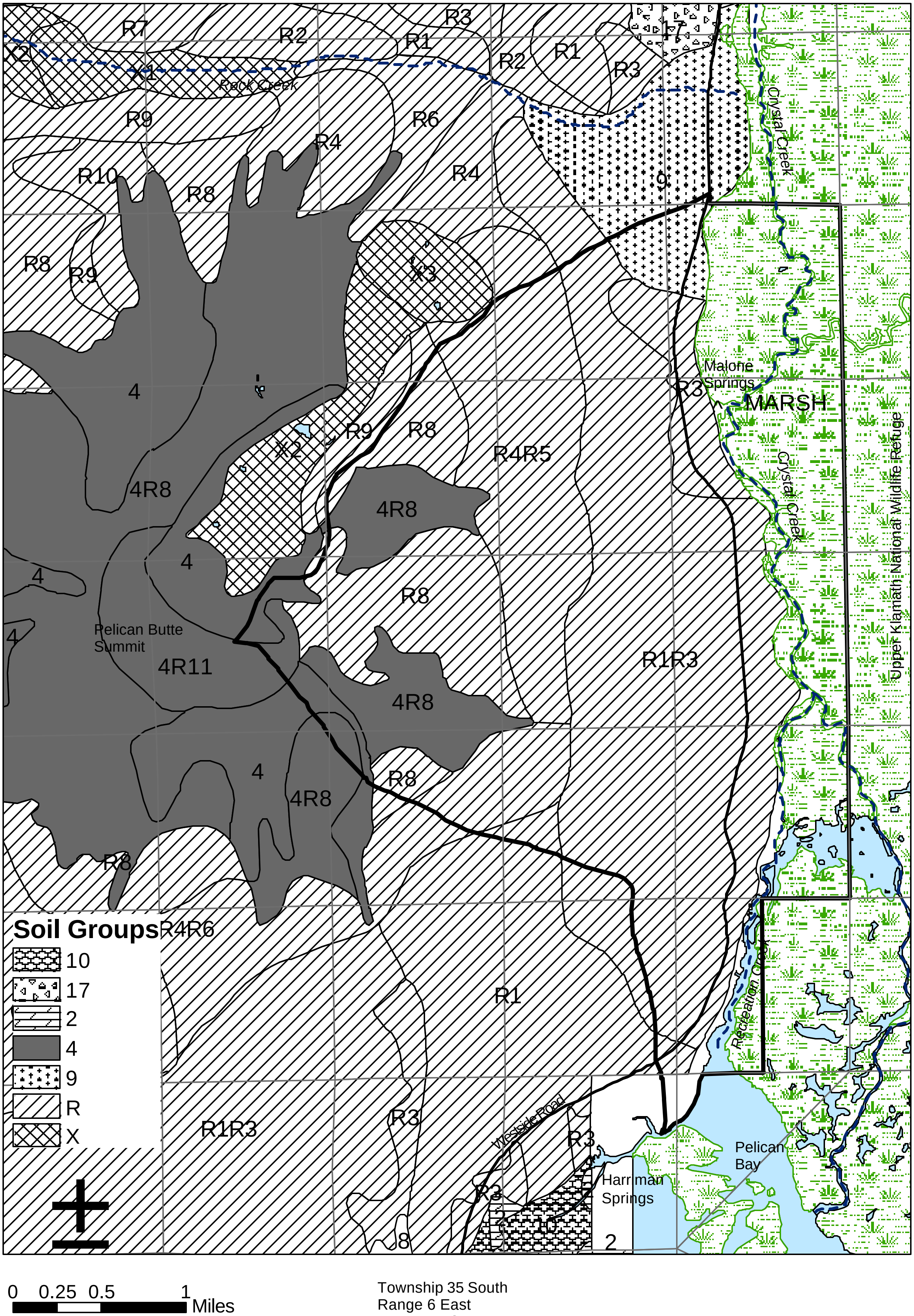
Soils within the watershed have formed from igneous and pyroclastic rocks associated with the formation of Pelican Butte and other volcanic features of the area. Flows of andesite lava from the butte are the primary foundation rocks that underlie the watershed. Additionally, airborne ejected material (tephra), such as ash and pumice, from the eruptions of Mount Mazama, Pelican Butte, and other local vents have been deposited over the watershed during alternating episodes of volcanic activity. Alpine glaciers historically existed at higher elevations. At the higher elevations of the butte, alpine glaciers mixed the variety of volcanic materials. The genesis of the soils existing in the watershed today is, in part, a result of these most recent and dominant geologic events (Carlson, 1979).

Carlson identifies two primary soil or land types that occur in the watershed, and designates them as, "Soil Group R landtypes" and "miscellaneous landtypes." Both groups occur on the long, east-facing sideslopes of Pelican Butte. They developed on convex, concave, and uniform slope configurations that range in steepness from 10% to 70%. Mostly, they have formed on two dominant landforms: sideslopes and footslopes of Pelican Butte, though some have developed on ridgetops and toeslopes. A third category represented in the watershed consists of vegetated marsh lands at the toe of the butte that are perennially inundated and constitute a portion of Upper Klamath Lake's western shore. (See Figure 3).

The "miscellaneous landtypes" (approximately 278 acres; 4% of the watershed) existing on the butte consist of extremely rocky rubble or talus (scree) slopes and have little or no soil beneath or within the rock. They are not productive enough to support continuous forest stands and they store very little water. Any vegetation that does exist there does so tenuously, being subject to harsh environmental conditions and a limited nutrient supply.

The "R Group" soils (5,139 acres; 74% of the watershed) present in the watershed are characteristically very rocky (>35% rock fragments) sandy loams and loams that are well drained and very permeable; water infiltrates them rapidly. Depth to bedrock generally ranges from 20 inches to more than 60 inches, with soils on the upper half of the butte being very shallow while soils on the lower half are moderately deep. Most "R Group" soil types are considered to be fairly productive, supporting continuous stands of mixed conifer forest vegetation (Table 1); however, those at higher elevations (>6,000 ft.) support plant communities that are considered to be somewhat less productive, though just as continuous. Plant communities growing in soils above 6,000 feet, especially those close to the ridge top,

Figure 3. Soil Types in the Pelican Butte Key Watershed



Township 35 South
Range 6 East

generally tend to be more sensitive and regenerate and grow slower than those below 6,000 feet, because of the cold conditions.

“X Group” soils, derived from glacial till, lie just outside the watershed boundary on the northeast slope of Pelican Butte. Small lakes and wetlands have formed in some of the depressions in this area.

Table 1. Inherent Forest Soil Fertility (based on Carlson, 1979).

Inherent Fertility	Acres	Percent of Watershed
Not applicable (marsh lands)	1,528	22
Low	278	4
Moderate	208	3
High	4,931	71

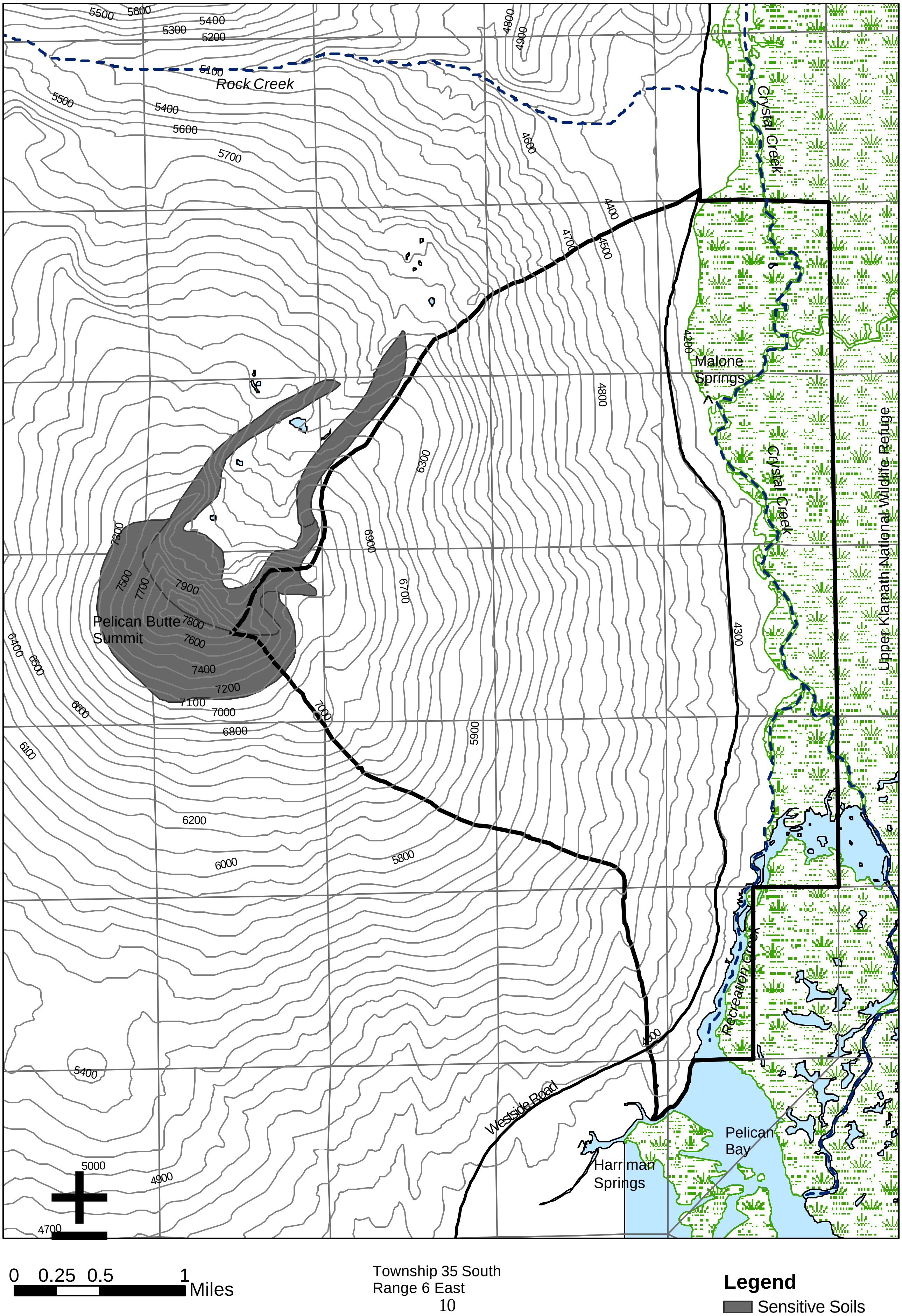
Certain soil types possess characteristics that make them sensitive to detrimental impacts from natural and anthropogenic disturbances. Some of these disturbances, such as compaction, can impact soil resources directly, adversely affecting inherent productivity. Some impacts such as accelerated erosion may also indirectly affect offsite resources such as aquatic habitat and water quality. Soil sensitivity is determined by the susceptibility of a soil type to suffer detrimental impacts, and its resilience to recover from those impacts and resume functioning at its productive capability (Bennett, 1994).

Most of the soil types in the drainage (Table 2) exhibit a low to moderate susceptibility to sustain impacts, and most are moderately resilient; however, some soil types are sensitive to disturbances that could potentially impede natural productivity, inhibiting vegetative proliferation. These soil types occur at the higher elevations along the shoulder slopes, ridge tops, and summit of the butte. (See Figure 4).

Table 2. Forest Soil Sensitivity to Disturbance.

Inherent Sensitivity	Acres	Percent of Watershed
Not applicable (marsh lands)	1,528	22
Low	94	1
Moderate	5,278	76
High	45	1

Figure 4. Soils Sensitive to Disturbance in the Pelican Butte Key Watershed



1.2 BIOLOGICAL CHARACTERISTICS

Vegetation within the Pelican Butte Key watershed closely resembles adjacent areas in the Rock, Cherry, Nannie, and North Fourmile Creek watersheds. Consequently, this analysis borrows heavily from the watershed analyses previously completed for those areas.

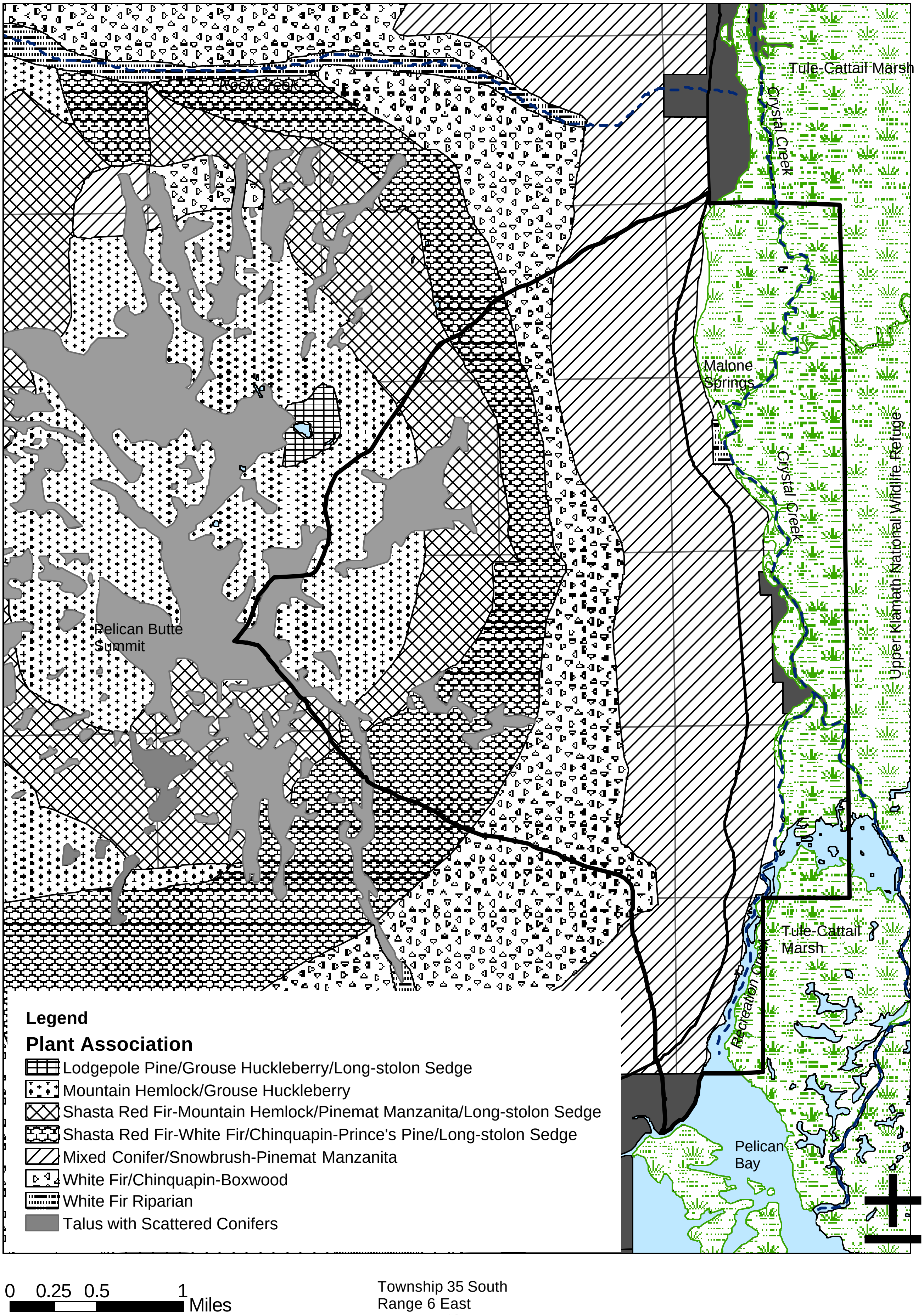
The forest lands within the Pelican Butte Key watershed follow an elevation gradient, rising through four vegetation zones (Franklin and Dyrness, 1973) from the Klamath Lake Basin to .25 miles below the summit of Pelican Butte. The white fir zone dominates the lower slopes to an elevation of about 5,500 feet, where it gives way to the Shasta red fir zone dominating the mid-mountain areas to about 6,000 feet. Above this lies the mountain hemlock zone, and finally, a narrow band of the whitebark pine zone just below timberline. Several plant associations have been identified within these vegetation zones (Hopkins, 1979) which provide localized ecological classification and management inferences. Non-forested communities occur on rock outcrops, talus and scree slopes. Figure 5 shows a map of the vegetation in the watershed. Table 3 shows vegetation structure by plant association.

Table 3. Plant Association and Size/Structure Classes in the Pelican Butte Key Watershed (1998).

	Plant Association								
Vegetation Size/ Structure	mt hemlock-grouse huckleberry	Shasta red fir-mt hemlock/ pinemat manzanita/ long-stolon sedge	Shasta red fir-white fir/chinquapin-princes pine/long-stolon sedge	white fir/chinquapin-boxwood	tule-cattail marsh	mixed conifer/ snowbrush-pinemant manzanita	private land	Talus with scattered conifers	Total
seed-sap-pole	0	0	0	0	0	33	0	0	33
pole-small	36	0	5	5	0	45	0	1	92
small-medium	0	0	11	0	0	8	0	1	20
pole/multisized +	43	38	12	79	0	804	6	8	990
small/multisized -	292	132	251	450	0	939	9	147	2220
small/multisized +	82	201	297	248	0	226	3	32	1089
small/multisized ++	0	133	182	53	0	2	0	9	379
medium/multisized +	0	5	0	0	0	0	0	0	5
pole/multisized low density	4	1	0	2	0	113	10	14	143
small/multisized low density	8	14	16	19	0	208	7	40	312
rock-sparse veg	1	1	4	0	0	2	0	36	44
shrub	0	0	0	0	8	10	0	0	18
meadow	0	0	0	0	1375	4	173	3	1555
water	0	0	0	0	46	0	0	0	46
Total	465	524	778	855	1429	2395	208	289	6945

Shaded rows indicate old growth structure
Low Density indicates crown closure <40%

Figure 5. Plant Associations in the Pelican Butte Key Watershed



Several ecological processes have affected the development of forests within the watershed. Natural succession, the gradual replacement of early seral plant species by shade-tolerant conifers, and disturbances such as fire, wind, insects, diseases, and timber harvest have influenced the development of the forest landscape, both now and in the past. The current and historic structure and composition of the forest is a result of the interaction of these factors. A detailed description of the ecological processes and comparison of historic and current conditions are provided later in this analysis.

Unique vegetation communities or special habitats occur in the Pelican Butte Key watershed. These generally are associated with springs, scree and talus slopes, and rock outcroppings. There are no known sites that support USFS Sensitive plant species within the watershed boundaries. Survey and manage fungi have been located in the watershed.

The Pelican Butte Key watershed contains a variety of habitat types which support a diversity of wildlife species. There are over 290 wildlife species that are either known to occur, or have potential habitat in the watershed. The majority of these species are associated with Recreation and Crystal Creeks and the vast marshlands of Klamath Lake National Wildlife Refuge, which occur at the base of the watershed.

This analysis will address Threatened and Endangered, Survey and Manage, Forest Service Region 6 Sensitive, and selected Forest Special Status species, as well as recreationally important species, such as Roosevelt elk, mule deer, cougar, and black bear.

Federally listed wildlife species in the watershed include the threatened northern spotted owl and bald eagle. Canada lynx is not known to occur in the watershed.

Two species on the R6 sensitive list are also known to be present in the watershed. Red-necked grebe and least bittern occur in the Upper Klamath Lake marsh and lake habitat. Potential habitat is present for a number of other sensitive wildlife species.

Geographic isolation, formed by tectonic plate activity, has resulted in habitat with diverse aquatic speciation in the Klamath Basin. Thirty-seven fish species are known to inhabit the Upper Klamath Basin, 17 of which are native, and 9 of which are endemic. At least 20 fish species have been introduced to the Upper Klamath Basin (Logan and Markle, 1993).
Prior to construction of the Copco dam on the Klamath River in California (1917), annual anadromous fish runs reached the Upper Klamath Basin. Since 1917, four additional dams have been constructed on the Klamath River, including the Linkville Dam at the outlet of Upper Klamath Lake in 1919. The lower dams do not allow fish passage, and have consequently extirpated anadromous fish runs to the Upper Klamath Basin, including Recreation Creek and Crystal Creeks.

The anadromous fish species that historically inhabited the Upper Klamath Basin include steelhead (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). Currently, both migratory and resident populations of native redband trout reside in tributaries to the Klamath River, Upper Klamath Lake, and in the lake itself. Remnant populations of bull trout also are found in tributaries to Upper Klamath Lake (Kann, 1997, pers. comm.). There are no known records documenting the existence of bull trout in Recreation or Crystal Creeks.

Three fish species that have been listed as threatened or endangered currently inhabit the Upper Klamath Basin. The Lost River sucker (*Deltistes luxatus*) and the shortnose sucker

(*Chasmistes brevirostris*) were listed as endangered by the U.S. Fish and Wildlife Service [USFWS] in 1988 (USDI, 1988). Although never documented, it is possible that these suckers may have historically spawned in springs feeding Crystal and/or Recreation Creeks since they were known to have spawned in nearby Harriman Springs of Pelican Bay (Kann, 1997, pers. comm.). The USFWS proposed critical habitat for Lost River and shortnose suckers in 1994, (USDI, 1994a) but critical habitat has not been designated. The Klamath River population segment of bull trout (*Salvelinus confluentus*) was listed as threatened in 1998 (USDI, 1998) and critical habitat proposed in 2002 (USDI, 2002). Recreation and Crystal Creeks are included in proposed critical habitat for all three species.

Fish species inhabiting the Upper Klamath Basin that have been identified as sensitive by the Forest Service are Pit-Klamath-Brook lamprey (*Lampetra lethophaga*), Klamath River lamprey (*Lampetra similis*), Slender sculpin (*Cottus tenuis*), Blue chub (*Gila coerulea*), Klamath largescale sucker (*Catostomus snyderi*), and redband trout (*Onchorhynchus mykiss* ssp.).

Fish use in Recreation and/or Crystal Creeks appears to be limited to migration, holding, refuge and rearing. The lack of suitable spawning substrate eliminates spawning potential for most species in Recreation Creek. Water depth and aquatic and terrestrial vegetation are the dominant forms of cover for fish in these systems. Although many pieces of large woody debris were noted in the channel, most were small, single pieces, partially embedded in the substrate, providing little cover for fish (Shapiro & Associates, Inc., 1997a).

1.3 LAND MANAGEMENT DIRECTION

The Winema Forest Plan as amended by the Northwest Forest Plan identifies the following management areas within the watershed area. Northwest Forest Plan allocations overlay existing Winema Forest Plan allocations, resulting in multiple objectives in some areas. In general, the most restrictive standards and guidelines apply. Management areas are listed in order of the land allocation hierarchy in the Northwest Forest Plan. (Table 4 and Figure 6.)

Late Successional Reserve #R0227. The objective of the Late Successional Reserve (LSR) is to maintain a functional, interactive, late-successional, and old-growth forest ecosystem. LSRs are designed to serve as habitat for late-successional and old-growth related species, including the northern spotted owl. There are approximately 3,120 acres of lands designated as LSR within the Pelican Butte Key watershed. Within LSR are bald eagle nesting, replacement, and winter roost habitat, as well as Pelican Butte Semiprimitive Recreation.

Administratively Withdrawn Areas include recreation areas and bald eagle habitat, where management emphasis precludes scheduled timber harvest. Under the Winema Forest Plan these areas include:

Bald Eagle Nest Areas - These management areas are designed to maintain, enhance, and provide bald eagle nest sites.

Bald Eagle Winter Roost Areas - These management areas are designed to maintain and enhance communal winter roosting habitat for bald eagles.

Pelican Butte Semiprimitive Recreation Area – This management area provides semiprimitive recreation opportunities in a predominantly natural appearing environment and includes the Sky Lakes B Roadless Area.

Developed Recreation – Developed recreation sites are located at the Rocky Point Resort and the special use recreation residence tract along Recreation Creek

Riparian Reserves These management areas are designed to protect the health of the aquatic ecosystems and species dependent on them. The riparian reserves also provide incidental benefits to upland wildlife species. These reserves will help maintain and restore riparian structure and functions, benefit fish and riparian-dependent non-fish species, enhance habitat conservation for organisms dependent on the transition zone between upslope and riparian areas, improve travel and dispersal corridors for terrestrial animals and plants, and provide for greater connectivity of late-successional forest habitat. Many of these areas overlay other land allocations; to avoid confusion, these areas are shown separately in Figure 7.

Matrix lands are defined as "all National Forest System lands within the range of the spotted owl but outside of LSR designated lands, Congressionally Reserved areas, Administratively Withdrawn Areas, and Riparian Reserves." The following management areas occur in Matrix designated lands within the Pelican Butte Key watershed:

Bald Eagle Nest Replacement Areas - These management areas are designed to develop and enhance replacement habitat for bald eagle nesting, roosting, and perching needs in the event of a catastrophic loss of existing habitat.

Table 4. Land Management Allocations in the Pelican Butte Key Watershed

Land Allocation	**Acres**
Northwest Forest Plan	
Late Successional Reserve	3284
Administratively Withdrawn	1373
Riparian Reserve	1408
Matrix	712
Private Lands	168
Total	6945
Winema Forest Plan	
Bald Eagle Nest Habitat	579
Bald Eagle Nest Replacement Habitat	2079
Bald Eagle Winter Roost	170
Developed Recreation	340
Semiprimitive Recreation	2045

Figure 6. Land Management Allocation in the Pelican Butte Key Watershed.

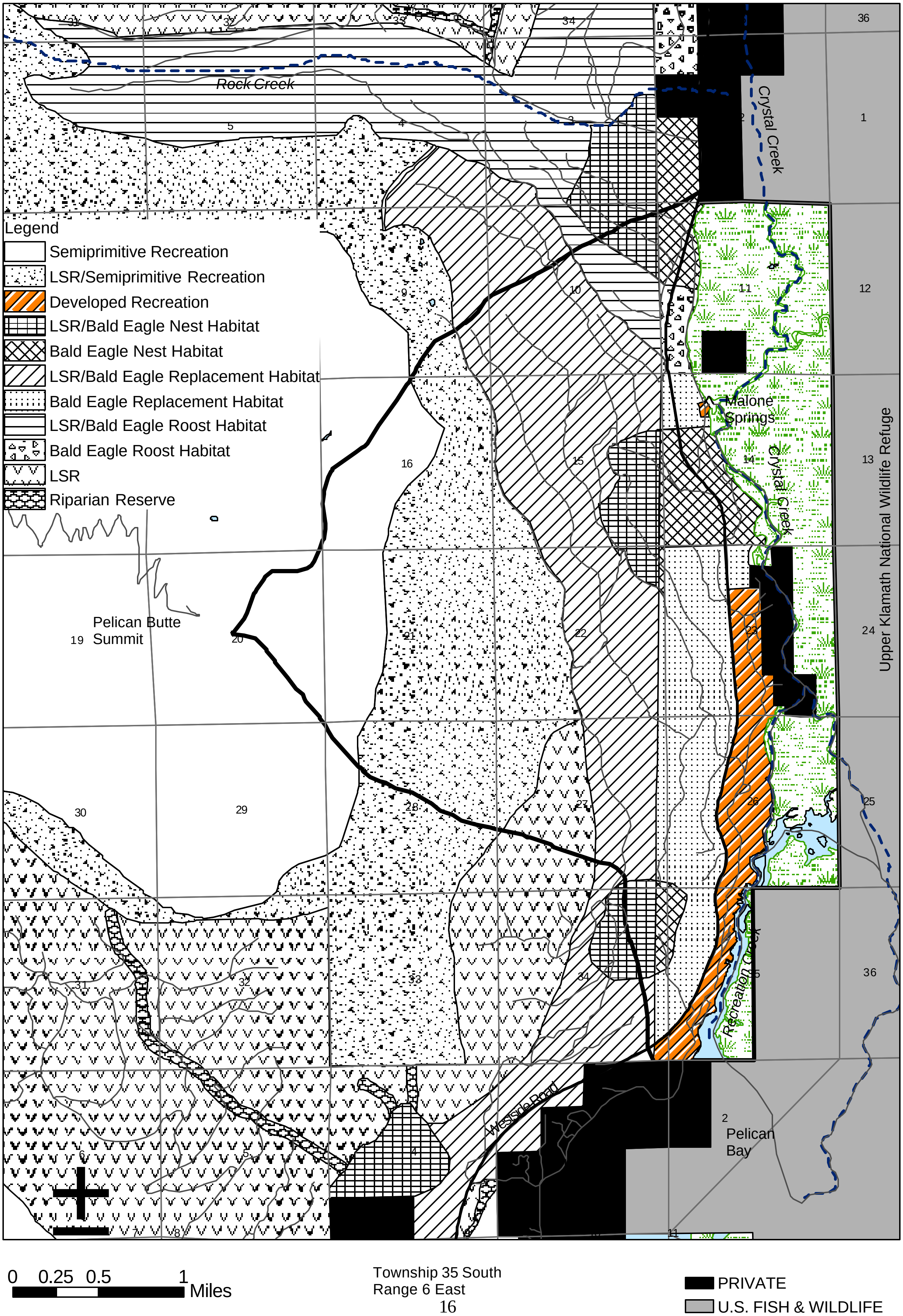
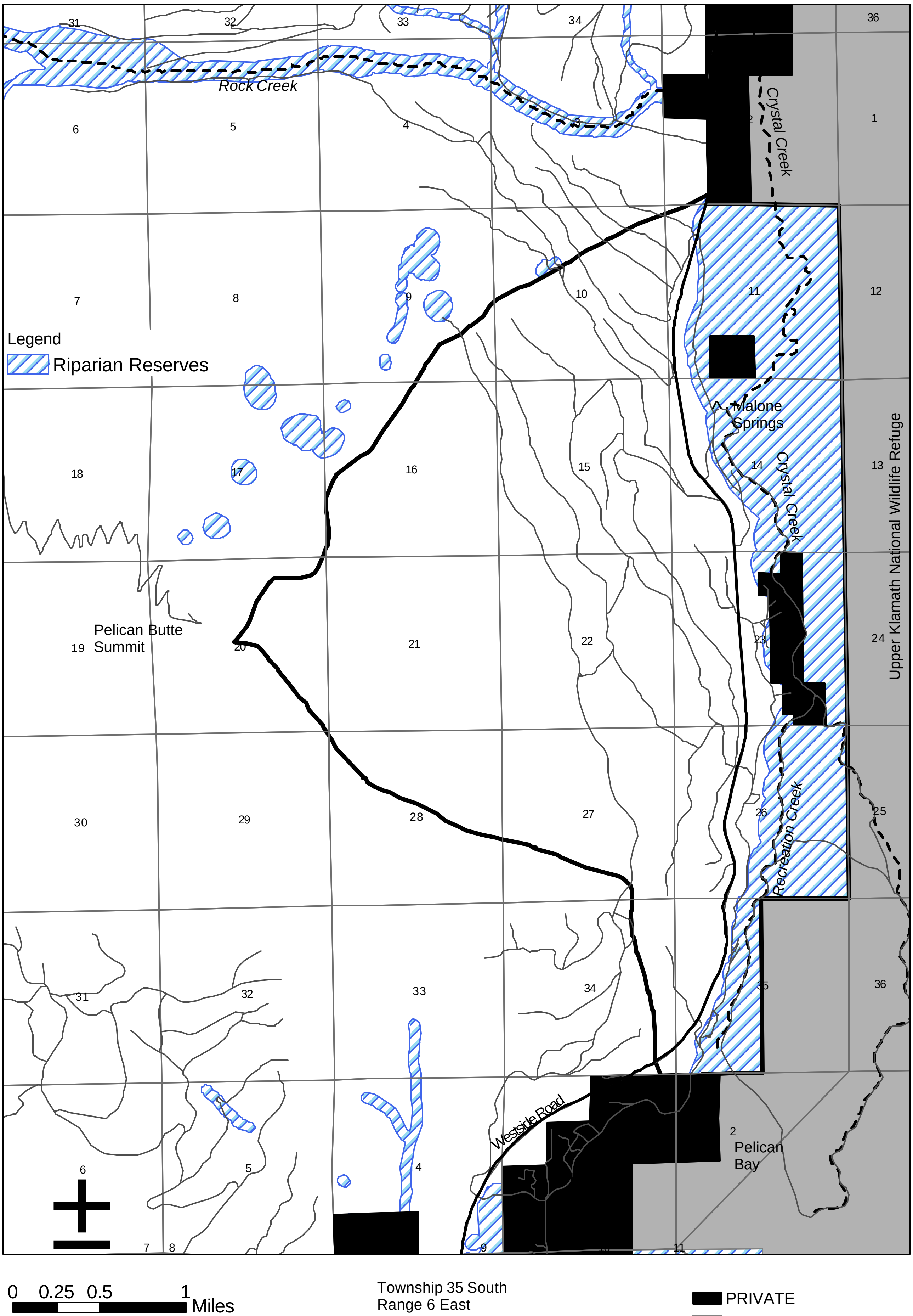


Figure 7. Riparian Reserves in the Pelican Butte Key Watershed



The Forest Ecosystem Management Assessment Team (FEMAT) classified Pelican Butte as a Tier 2 Key Watershed (OF-105) (USDA, et al., 1993). Key Watersheds are refugia, watersheds that are either currently providing or are expected to provide high-quality fish habitat and water quality. Key watersheds contain areas with good habitat as well as poor habitat. Those with existing high-quality habitat will serve as anchors for the potential recovery of depressed fish stocks; those with low-quality habitat and a high potential for restoration are expected to become future sources of high-quality habitat through restoration.

There are two types of Key Watersheds: Tier 1 watersheds are designated for contribution to conservation of habitat for at-risk fish species; Tier 2 watersheds (Pelican Butte) were designated for their importance as sources of high quality water.

Watershed analyses are required for Key Watersheds prior to implementation of most management activities. Minor activities, such as those that would be Categorically Excluded under National Environmental Policy Act (NEPA) regulations, however, may proceed prior to completion of the watershed analysis if they are consistent with Aquatic Conservation Strategy Objectives and Interim Riparian Reserves and Standards & Guidelines are applied (USDA and USDI, 1994b).

Management direction specific to Key Watersheds states that no new roads will be built, and that efforts shall be made to reduce existing system and non-system road mileage outside roadless areas. If funding is insufficient to implement reductions, there is to be no net increase in the amount of roads in Key Watersheds (USDA and USDI, 1994b).

2.0 STEP 2 - ISSUES AND KEY QUESTIONS

The formulation of issues and key questions focuses team efforts on the key elements of the ecosystem that are most relevant to management within the watershed. Three main issues identified for the Pelican Butte Key watershed are:

Water Quantity and Quality
Wildlife and Biological Diversity
Aquatic Habitat and Species

This watershed analysis will attempt to answer questions developed for each issue; however, lack of physical and biological data may limit the analysis. Some questions remain unanswered at this time.

2.1 WATER QUANTITY AND QUALITY

Water quantity and quality are important issues for the Pelican Butte Key watershed. This analysis will focus on understanding the roles of physical and hydrologic events and processes that determine whether water quantity and quality are in balance with the demands within the watershed.

2.1.1 Water Quantity

- What are the water quantity concerns for the watershed (including groundwater, springs, surface water, and Upper Klamath Lake)?
- What are the dominant hydrologic (flow) characteristics for the watershed (such as peak flows, minimum flows, total discharge)?
- Have historic flow patterns been altered? If so, how have they been altered and what caused the change?

2.1.2 Water Quality

- What water quality concerns are there in the watershed?
- What beneficial uses of water exist in the analysis area? Which water quality parameters are critical to these uses?
- What are the conditions and trends of beneficial uses and associated water quality parameters, and how do they compare to the historical or reference water quality characteristics of the watershed?
- What natural and human activities have resulted in a difference between current and historical water quality conditions in the watershed?
- What is the surface/groundwater interaction?

2.1.3 Soils and Erosion Processes

- What natural erosional processes (such as mass wasting and hillslope erosion) are dominant in the watershed?
- Where do natural erosional processes tend to occur?
- Have erosional processes, or the frequency and magnitude of these processes changed over time?
- Have management/human-related activities within the watershed affected these processes?
- What is the ability of the soil to promptly and adequately revegetate following disturbance (soil quality)?

2.2 VEGETATIVE DIVERSITY

2.2.1 Vegetation

- What was the historic vegetation pattern in the watershed?
- What is the current vegetation pattern? What changes have occurred over the past 100 years (fire, harvest, etc.)?
- Have insects, disease, or other factors affected forest health in the watershed?
- What is the potential for fire hazard?

2.2.2 Riparian Reserves and Riparian Condition

- Where are riparian reserves located in the watershed?
- What were/are the historic, existing, and desired conditions of the riparian zones? What are the vegetative characteristics of riparian reserves in the watershed?

2.2.3 Rare plants

- What Threatened, Endangered, Sensitive, and Survey and Manage plant species occur within the watershed?
- Where are they located?
- What percent of USFS lands within the watershed has been surveyed?

2.2.4 Noxious Weeds

- Where are noxious weeds located in the watershed and what is the magnitude of infestation?

2.3 TERRESTRIAL WILDLIFE

The following questions will focus on Threatened, Endangered, and Sensitive species, Survey and Manage species, Management Indicator Species and their habitat requirements.

2.3.1 Late Successional Habitat

- What is the location, current condition and distribution of late successional habitat in the watershed?
- Are LSR objectives being met?

2.3.2 Threatened, Endangered and Candidate Species

- How many spotted owls occur within the watershed and what is the location, current condition and distribution of spotted owl habitat?
- How many bald eagles occur within the watershed and what is the location, current condition and distribution of bald eagle habitat in the watershed?
- What other species have potential habitat in the watershed?

2.3.3 Region 6 Sensitive Species, Survey and Manage Species, and MIS

- What sensitive species are known to occur or have potential habitat in the watershed?
- How many great gray owls occur in the watershed? What is the quality of great gray owl habitat?
- What are the current habitat conditions for management indicator species?
- What surveys have been completed?

2.3.4 Big Game Habitat

- What high interest species (elk, mule deer, cougar, black bear) occur in the watershed?
- Where is the habitat for these species located within the watershed (including calving areas, summer range, and migration routes)?
- What human activity (logging, roads, farming) within the watershed limits use of the watershed by these species?

2.4 AQUATIC HABITAT

2.4.1 Channel Condition

- What are the basic morphological characteristics of the watershed?
- Is there evidence of channel change from historic conditions?
- How have past watershed disturbances affected channel form and stability?

2.4.2 Fish Habitat

- What is the current condition of fish habitat? How has fish habitat changed over time?
- How has connectivity with small tributaries or Upper Klamath Lake changed over time?

2.4.3 Aquatic Species

- What species were historically present in the basin?
- What species are currently present in the watershed? What is their distribution and abundance?
- Has the introduction of exotic species contributed to the decline of native stocks?
- What limiting factors affect fish in the watershed?

3.0 STEPS 3 AND 4 - CURRENT AND REFERENCE CONDITION

"Current Conditions" is intended to develop information relevant to the issues and key questions formulated in Step 2, at a level more detailed than described in Step 1, Characterization. This portion of the analysis will document the current range, distribution, and condition of the core topics and other relevant ecosystem elements.

"Reference Conditions" is intended to explain how ecological conditions have changed over time as the result of natural and anthropogenic disturbances. Where appropriate, a reference condition is determined and compared to current conditions and key management plan objectives.

3.1 PHYSICAL CHARACTERISTICS

3.1.1 Hydrology

Reference Condition

Obtaining historic flow data for perennial springs and surface flow within the Pelican Butte Key watershed was not possible due to a lack of available data. The dominant hydrologic source for the watershed is provided by the winter snow pack and subsequent spring melt. The timing and magnitude of spring melt is influenced by the water content and depth of snow pack, as well as the timing and magnitude of spring rains and accompanying temperatures. Prior to the influence of European logging and clearing of forests, snow pack accumulation would have been relatively uniform in forested areas, with canopy cover intercepting a majority of the snow fall. Spring melt would have been relatively rapid, generally occurring within a 30-day period during the warmer, late spring months. In periglacial times, several channels were present along the eastern face of the butte. These channels drained alpine glaciers located at higher elevations and routed glacial melt and sediments to Upper Klamath Lake below; however, since the retreat of glaciers the channels have filled in and become unconnected swales that may transport spring melt occasionally prior to infiltration and store accumulated sediments.

Current Condition

Human uses within the Upper Klamath Basin may have influenced the area's hydrologic regime by altering the base level and permanent recharge of the deep aquifers. Dams constructed within the Klamath Basin are expected to have altered the reference, or historic, flow regime within Recreation Creek by creating a new and consistent base level of 3.3 feet above normal high water. Additionally, withdrawals from the regional aquifer for human use have significantly increased since European occupation.

The geology of Pelican Butte influences the surface hydrology within the Pelican Butte Key watershed. The porous nature of the butte results in rapid infiltration of spring melt that results in little or no hillslope fluvial processes. As a consequence, there is no evidence of flowing surface waterbodies within the defined study area that could provide data regarding peak flows and/or discharge rates.

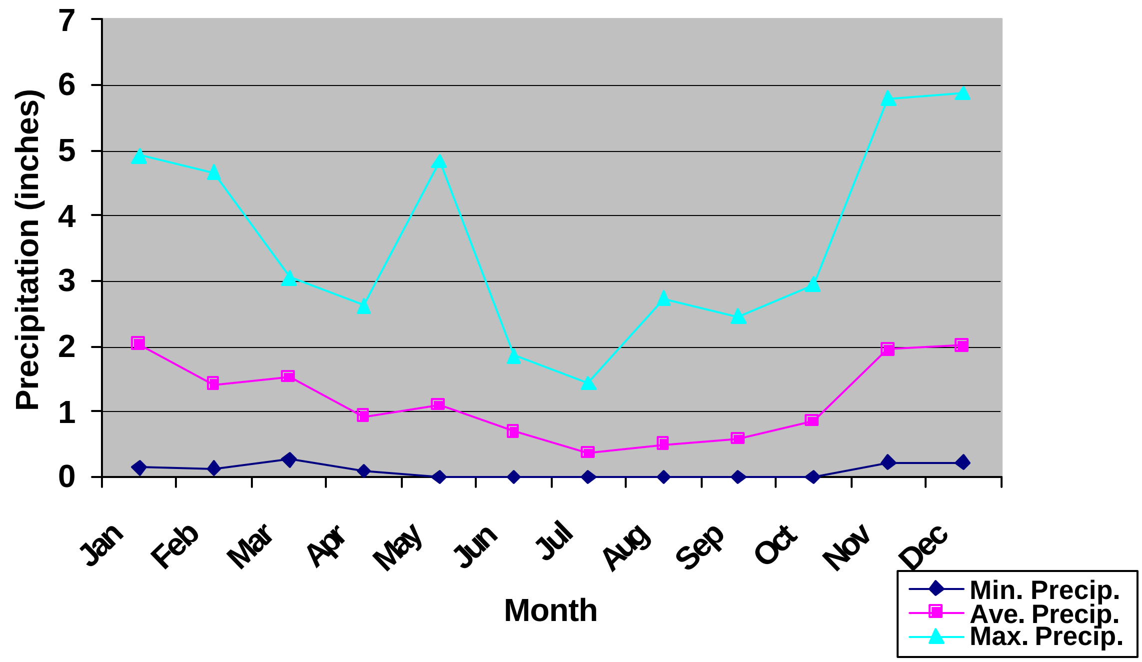
Snowy, cold winters and dry, hot summers typify the climatic regime for the Pelican Butte Key watershed. Data from Klamath Falls, the closest National Atmospheric and Oceanic Administration (NOAA) weather station, records an average annual precipitation of 13.66 inches (35 centimeters) annually. The Klamath Falls weather station is located approximately 28 miles to the southeast of the Pelican Butte Key watershed at 4100' elevation. The last 30 years of recorded weather data (1971-2001) shows that most of the annual precipitation falls in December and January, with less than 12% falling during the summer months in most years (Graphic 1).

Within the Pelican Butte Key watershed, precipitation falling during the winter months consists primarily of snow (Carlson, 1979) where deep snow packs can accumulate at higher elevations. Based on numerous snow depth recordings, the Pelican Butte Key watershed accumulates greater than average snow depth due to the geographic position of the watershed on Pelican Butte. Available snow depth data indicates that, in most years, a minimum of 2.5 to 3 feet of snow accumulation is on the ground by mid-December at the 6,000 foot elevation (Pelican Butte Corporation, 1996).

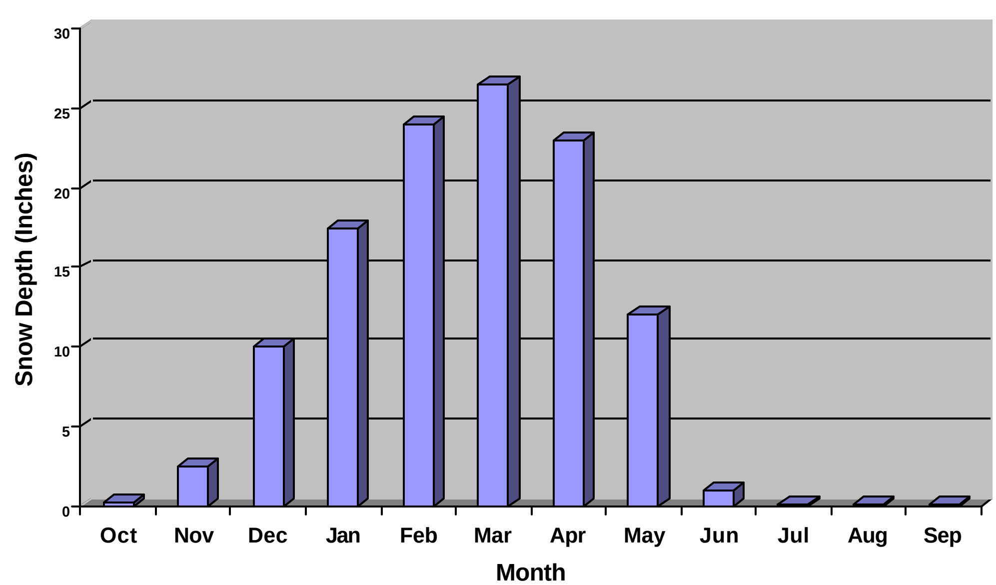
Lower amounts of precipitation concurrent with high air temperatures occur during the summer months. Frequent thunderstorms also accompany the summer months. Due to the rain shadow effect of the Cascades, annual precipitation decreases from the crest of Pelican Butte east to the lower elevations. Average annual precipitation ranges from 60 inches per year at the crest of Pelican Butte to 25 inches per year at lower elevations (USDA, 1994).

Snowtel data from the northwestern side of Pelican Butte at Cold Springs (elev. approximately 6,000 ft) is available. Graphic 2 shows the monthly snow pack depths, with the greatest accumulation occurring February through April (based on a 15-year period of record).

Graphic 1. Precipitation for Klamath Falls, Oregon (1971-2001)



Graphic 2. Monthly Mean Snow Depth at Camp Cold Springs, Oregon (Water Years 1982-1997).



The timing and duration of spring rains heavily influence the timing and amount of snow melt. Rain on snow events are common during the late spring. Remnant swales created in periglacial times that are currently reservoirs for stored sediments may intermittently transport limited surface runoff prior to subsurface infiltration. These swales are unconnected and do not provide for permanent channel flow. The majority of spring melt infiltrates into the porous strata prevalent in the Pelican Butte Key watershed. Infiltrated spring melt recharges the deep aquifers and eventually discharges as baseflow within Recreation and Crystal Creeks from perennial springs. There is one mapped perennial spring within the watershed (Malone Spring approximate elevation 4,100 feet) and at least 12 small unnamed springs at the bottom of the watershed.

Based on preliminary data (Bunker, 1997, pers. comm.) there are two groundwater systems: a locally perched groundwater system reflected in the intermittent lakes on the northeast slope of the butte just outside the watershed boundary; and a regional aquifer that recharges Upper Klamath Lake. The perched system consists of isolated groundwater bodies lacking direct connection to the regional aquifer. The shallow lakes and ponds are thought to be perched in low permeability glacial deposits and Mount Mazama ash.

The regional aquifer receives recharge from discharge occurring near the base of the butte adjacent to Upper Klamath Lake and marsh. Groundwater also discharges from rocks at the lake/marsh edge and from rocks underneath the lake/marsh. Cold springs located at the eastern base of the butte are fed by gravity flow from the upslope recharge areas west of the lake. The general flow direction of the deeper regional aquifer in the butte area is from west to east.

Alterations in hydrology between reference and current conditions can be primarily attributed to the construction of the Link River Dam that has altered the base level elevation of Upper Klamath Lake. This human alteration may have resulted in a higher and more constant base flow within Recreation and Crystal Creeks. Logging within the Pelican Butte Key watershed included primarily the thinning of stands at lower elevations. This is expected to have had little influence on hydrology because of the lower precipitation at these elevations and lack of hillslope fluvial processes.

3.1.2 Water Quality

Reference Condition

There is no existing water quality data to document pre-European or reference conditions in the watershed; however, Recreation and Crystal Creeks are both spring fed. High water quality likely existed in these streams prior to European settlement. Upper Klamath Lake, of which Crystal and Recreation Creeks are tributaries, and Agency Lake, which is hydrologically connected to Upper Klamath Lake, are each recognized as naturally highly eutrophic lakes (Johnson, et al., 1985).

Current Condition

Water quality is an important issue in the Pelican Butte Key watershed, and Upper Klamath Basin as a whole. The Northwest Forest Plan contains Aquatic Conservation Strategy Objectives applicable to all USFS lands:

Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain in 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.

Beneficial Uses Established by the State of Oregon

The Oregon DEQ is the state agency that administers state and federal environmental laws including those addressing water quality. These laws are translated into action through the Oregon Administrative Rules (OARs). Chapter 340, Division 41 of OAR (OAR 340-41) provides a broad framework for protection of water quality for each major river or drainage basin. Within this framework, water quality standards have been established to protect designated beneficial uses.

Beneficial water uses to be protected in the Klamath Basin are listed in OAR 340-41-962. Table 5 shows the beneficial uses for Klamath Basin waters, including surface water identified in the Pelican Butte Key watershed; those that occur on USFS lands; and those that are affected by USFS activities. Beneficial uses occurring in the Pelican Butte Key watershed and on USFS lands were determined through discussion with USFS staff, examination of water rights categories, ODFW hunting and fishing regulations, and field observations.

Table 5. Beneficial Uses of Surface Water in the Pelican Butte Key watershed

Beneficial Uses of Klamath Basin Waters Including Recreation Creek	Beneficial Use Occurs in Pelican Butte Key watershed	Beneficial Use Occurs on USFS Lands	USFS Activities Affect Beneficial Uses in Pelican Butte Key watershed
Water Supply - Public, Private, and Industrial	Y	N	N
Irrigation and Livestock Watering	Y	N	N
Salmonid Fish Rearing and Spawning	N	N	N
Resident Fish and Aquatic Life	Y	Y	Y
Wildlife and Hunting	Y	Y	Y
Fishing	Y	Y	Y
Boating	Y	Y	Y
Water Contact Recreation	Y	Y	Y
Aesthetic Quality	Y	Y	Y

There is one water right for domestic water supply within the watershed. The water source is a spring and the right is for 0.02 cubic feet per second (cfs). No additional water rights exist for other beneficial uses.

Recreation and Crystal Creeks are popular for boating, fishing, and wildlife viewing. Forty-two special use recreation residence cabins are located on USFS lands along Recreation Creek, and the Rocky Point Resort is located near the confluence of Recreation Creek and Pelican Bay.

Water Quality Standards and Beneficial Uses to be Protected

Water quality standards not to be exceeded and the beneficial uses they protect in the Klamath Basin are listed in OAR 340-41-965. The primary beneficial uses protected and the parameter used to monitor the applicable standard are shown in Table 6 (Table 2.3-2 DEQ, 1994). Additional beneficial uses protected by these standards include aesthetics, livestock watering, wildlife, and irrigation water supply.

Table 6. Oregon's Instream Water Quality Standards and the Primary Beneficial Uses They Protect.

Water Quality Parameter	Primary Beneficial Use Protected	DEQ Standards
Dissolved Oxygen	Fisheries and Aquatic Life	Not less than 8.0 mg/L, or not less than 90% saturation if pressure, altitude and temperature preclude attainment of 8.0 mg/L
Bacteria	Water Contact Recreation	30-day log mean of 126 E. coli/100 mL, minimum of 5 samples. No single sample greater than 406 bacteria/mL
pH	Fisheries and Aquatic Life	6.5-9.0 at <5000' elevation
Temperature	Fisheries and Aquatic Life	maximum 17.8 C
Turbidity	Fisheries and Aquatic Life	no more than 10% cumulative increase above background level.
Total Dissolved Gas	Fisheries and Aquatic Life	maximum of 110% saturation
Total Dissolved Solids	Drinking Water	no standard
Toxic and/or Carcinogenic Compounds	Drinking Water, Fisheries, and Aquatic Life	varies (see OAR 340-41, Table 20)

State Reporting on Status of Water Quality

Section 303(d) of the Federal Clean Water Act requires each state to develop a list of water bodies that do not meet standards, and to submit this list to the U.S. Environmental Protection Agency (EPA) every two years. For these waters, states are required to establish total maximum daily loads (TMDLs) in accordance with a priority ranking. A TMDL is the total amount of a pollutant that can enter a waterbody without causing it to violate the water quality standard for that pollutant. Once a TMDL is established, the "load" is divided into load allocations (nonpoint sources and natural background sources of pollution) and wasteload allocations (point sources of pollution).

A TMDL was approved in 2002 for Upper Klamath Lake and Agency Lake. The parameters covered under the TMDL are dissolved oxygen, chlolophyll a, and pH. Fourmile Creek and Rock Creek, tributaries to Upper Klamath Lake, also have approved TMDLs for summer temperature parameters. Several other Klamath Basin streams that were listed on the 1998 303(d) list have had their listing status updated to "attaining criteria". Further information on TMDLs and other programs can be found at DEQs website at: *http://www.deq.state.or.us*

Quantitative Water Quality Data

No water quality data is available for Crystal and Recreation Creeks within the boundary of this watershed analysis. Water quality data for Crystal Creek, below the watershed analysis boundary, was collected in 1991 and 1992 by the U.S. Bureau of Reclamation as part of an Upper Klamath Lake Wetlands Study (Sartoris and Sisneros, 1993).

The data from this study show that water quality fluctuated widely during 1991-1992. For example, water temperature ranged from 9.4 to 24.3 C (49 to 75 F), dissolved oxygen ranged from 1.8 to 10.6 mg/L, and pH ranged from 7.3 to 9.7. Water quality standards were not met on several occasions. The data have not been extrapolated to Recreation and Crystal Creeks in the watershed area, because of the potential for influence of Upper Klamath Lake on the water quality of the lower portion of Crystal Creek.

Characterization of Water Quality in Upper Klamath Lake

The Upper Klamath Basin has been the focus of several environmental issues in recent years; many of these issues involve water quality degradation. Activities associated with agriculture, such as regulation of lake levels, reclamation of wetland habitat, application of chemicals, and diversion/irrigation practices, can be correlated with decline of water quality in Upper Klamath Lake (USGS, 1993). Water quality in the lake often is poor with elevated pH levels, wide fluctuations in dissolved oxygen and carbon dioxide levels, and high water temperatures.

Although the lake was historically eutrophic, Upper Klamath Lake is now classified as hypereutrophic, most likely a result of human-caused changes which have increased the level of nutrient and energy inflow into the lake over background levels (Stubbs and White, 1993). High nutrient levels promote large blooms of the algae *Aphanizomenon flos-aquae*. These massive blooms cause extremely stressful conditions for fish, with pH levels in excess of 10.0 and dissolved oxygen concentrations near 0.0 mg/L (Stubbs and White, 1993; USDI 1994b).

Because water quality conditions within the main body of the lake can be stressful, if not lethal, to aquatic organisms, mass movement of fish to areas with fresh influxes of water occurs during summer months. This is a significant link between the Pelican Butte Key watershed and Upper

Klamath Lake. Recreation Creek in particular contributes a significant flow to Pelican Bay, an area that has been identified as important refugia habitat for fish during stressful summer conditions (USDI, 1994b).

Conclusions

No data is available to evaluate water quality related to the designated beneficial uses. However, it is important to note that Recreation Creek provides important refugia habitat to fish during periods of stressful summer conditions in Upper Klamath Lake. The deterioration of water quality conditions in Upper Klamath Lake has been documented, as previously discussed, and the cause has been attributed to agriculture and related activities. These same activities may have impacted the water quality in Crystal and Recreation Creeks, based on the hydrologic connection between the drainage canals, marsh, and creeks.

Because of the limited data, it is not possible to compare historical (desired) water quality conditions and current conditions, assess natural and human activities that may have affected current conditions, or address the more complex interactions between impacts, water quality, and other ecosystem processes. Within the watershed, human activities in and along the creeks, such as historic dredging, clearing of riparian and wetland vegetation, and homebuilding, may have impacted water quality in the creeks.

3.1.3 Soils and Erosion Processes

Reference Condition

Erosion and Sediment Regime

A sediment regime is the manner in which sediment and detritus materials are routed through a watershed system. There are generally four basic components: sediment production, storage, transport, and yield. When a particle of sediment is produced by an erosive mechanism, it is transported to either a storage site or to a water source. When the later occurs, it is termed sediment yield. A sediment budget is a characterization of those components and the linkages between them. It provides an understanding of the primary erosion and hillslope processes that route sediment through a watershed, thus providing a basis for estimating sediment yields, either qualitatively or quantitatively (Swanson, et al., 1982).

The background sediment regime in the Pelican Butte Key watershed is one where storage of sediment, including sediment inputs to the storage elements, is greater than sediment yield. Simplistically depicted:

Sediment Production < Sediment Storage > Sediment Yield

Soil produced *in situ* via weathering processes is either stored in place or transported via surface erosion and/or mass wasting (soil creep) mechanisms to other storage elements, or, it is slowly transported through the watershed to be delivered to Recreation and Crystal Creeks as sediment yield.

Surface Erosion Potential

The location, extent, and distribution of soil types on all lands within the 6,945-acre watershed are described and mapped in the WNF's Soil Resource Inventory (SRI) prepared by Carlson (1979). The inventory provides an accurate account of general soil characteristics and the landforms that occur in this and immediately adjacent watersheds. Interpretations of concerns associated with land management and natural resource use typically occurring in the watershed also are included in the inventory. The Klamath County Soil Survey has mapped soil types in the area on private and state lands, but has not mapped soil types on the majority of acreage of federal lands in the watershed; therefore, the SRI is the soil inventory used as the basis for analyzing soil characteristics and erosion processes in the watershed.

Inherent surface erosion in most of the watershed is generally low (Table 7, Figure 8), even on slopes greater than 20%. Additionally, the forest canopy and organic layers of litter and duff provide an effective ground cover that in an undisturbed condition exceeds 95%, limiting raindrop impact and wind erosion. Runoff is inherently low; most precipitation that reaches the ground infiltrates into the soil and underlying bedrock to be either stored or discharged as subsurface gravitational flow. Sheet, gully, and rill erosion are not the primary sediment producing processes in this watershed (Swanson, et al., 1982). Consequently, the reference surface erosion and sediment production rates are low.

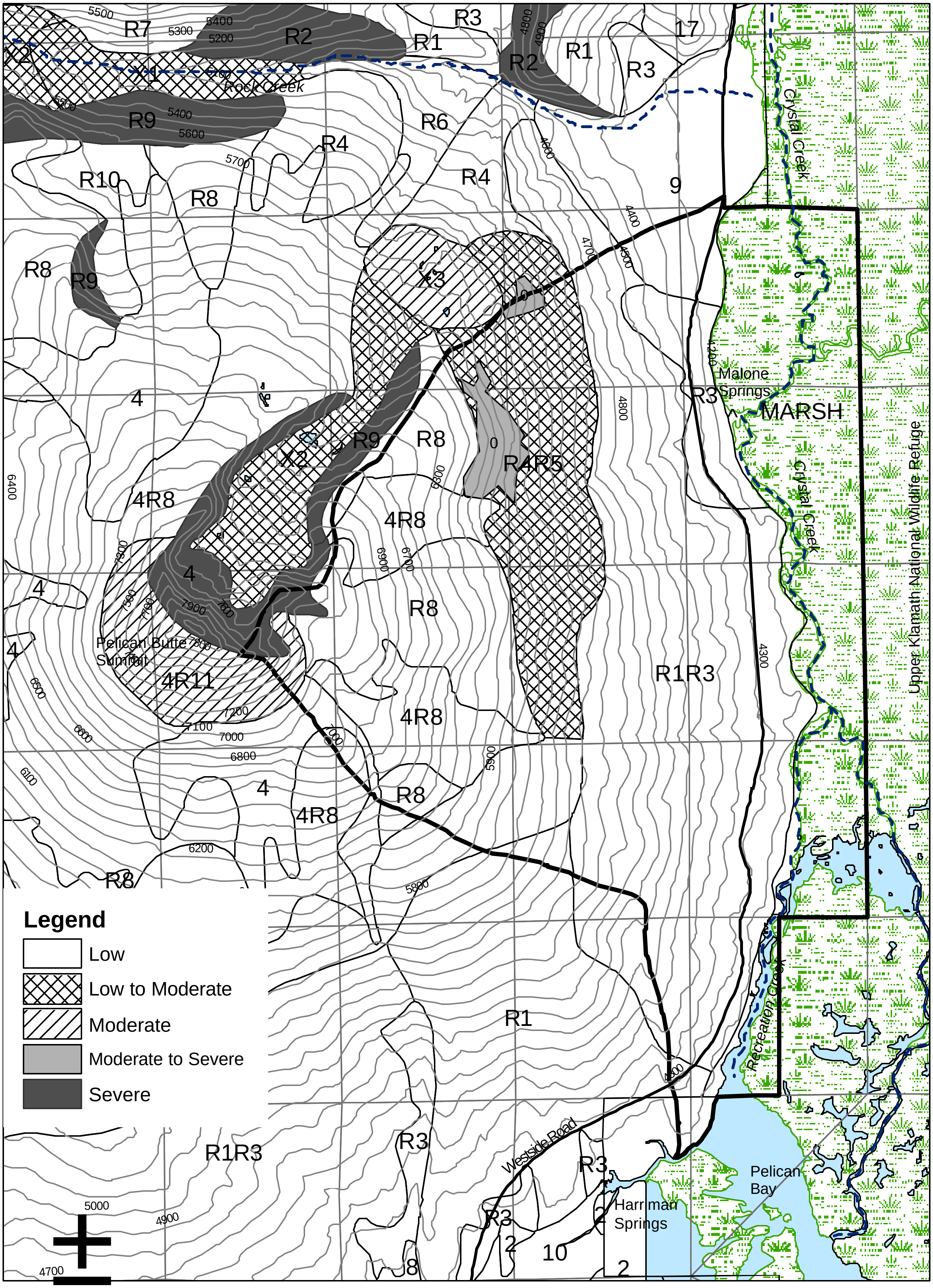
There are no tributary surface streams or channels on the slopes of the butte within the watershed; therefore, fluvial erosion is lacking, and the reference sediment delivery potential from fluvial and surface erosion processes to Crystal and Recreation Creeks is negligible. In periglacial times, several channels draining alpine glaciers were carved into the east face of the mountainside, routing sediments to Upper Klamath Lake below; however, since the retreat of those glaciers, the channels have filled in and become swales of accumulated and stored sediment.

The predominant inherent annual surface erosion processes in this watershed are raindrop splatter, dry ravel, and, to a minor degree, wind erosion. These processes primarily occur at the higher elevations on bare, exposed, pumiceous and ash like soils near the ridgetop and summit area. Sediment production and delivery by these processes is considered nominal in the watershed. Most of the sediment in the watershed is in storage as the soil mantle that blankets the lower half of Pelican Butte's sideslopes, footslopes, and toeslopes.

Table 7. Inherent Surface Erosion Potential (bare soil conditions; Carlson, 1979)

Surface Erosion Potential	Acres	Percent of Watershed
Not Applicable (marsh lands)	1,550	22
Low	4,432	64
Low - Moderate	770	11
Moderate	40	<1
Moderate - Severe	107	1
Severe	46	<1

Figure 8. Surface Erosion Potential in the Pelican Butte Key Watershed



Township 35 South
Range 6 East

Mass Wasting Potential

Unstable slopes, in terms of episodic mass wasting events such as debris slides, debris flows, translational slides, slump blocks, and rotational failures, are not commonly encountered in this watershed. Small rockfall failures occasionally occur in a few locations at isolated ridgetop locations. The dominant slope process occurring in the watershed is soil and talus creep, the slow downhill movement of soil particles and rock fragments by a variety of forces (Swanson, et al., 1982). Soil creep is the primary sediment transport mechanism in the watershed. Rates of soil creep in the watershed have not been previously investigated. A calculation of soil creep, using a methodology defined in Washington State's Department of Natural Resources watershed analysis guide (WFPB, 1995), results in an estimate of approximately 6 to 7 tons (approximately 8 cu. yd.) of reference sediment yielded per year from the watershed. This relatively small amount of sediment yield is delivered to Recreation and Crystal Creeks in minute, invisible quantities at the margin between Pelican Butte's toeslope and the waterline of Upper Klamath marsh, presumably during the wet season.

Current Conditions

Current Erosion Processes and Sediment Yields

Road construction, logging activities, and development on private land have altered the reference sediment regime. Sediment production is the background sediment regime component most altered. Changes in sediment production are due to: 1) a higher incidence of accelerated sheet erosion and dry ravel, both surface erosion processes that now occur where once they did not; and 2) the removal of effective ground cover that has exposed bare soil at sites previously protected by forest litter and canopy covers. Some upland forested sites (approximately 371 acres; 5% of watershed) that did not produce sediment now do, mainly where roads, landings, and skid trails occur.

There are approximately 35.8 miles (135 acres) of roads in the watershed (Table 8 and Figure 9), equating to a road density of 3.3 miles of road per square mile. County maintained paved roads total 7.2 miles and include the Westside Road, which accesses the Forest west of Upper Klamath Lake, and the Rocky Point Road, which accesses the resort and some of the recreation residences in the watershed.

Forest roads were constructed over 10 years ago for forest management access (USDA, 1994). Although log haul may resume at some point, timber sales have not occurred in the watershed since the early 1990’s, and current use of Forest Service roads in the area is primarily for recreation, hunting, and fire suppression. Most Forest Service roads are native surface; 3.9 miles are improved with gravel. The majority of Forest Service roads in the watershed which do not access developed recreation areas receive low use. Several roads are closed to vehicle traffic for 8 months of the year to protect nesting bald eagles. Aside from clearing of vegetation, they receive very little road maintenance. Maintenance of road drainage structures is not a frequent or essential action in this watershed.

All of the roads are located below 6,000 feet elevation; the upper portion of the watershed lies in the Sky Lakes B Roadless Area. Most roads (22.5 miles, 63%) are constructed on the mid sideslopes and footslopes of the butte, while approximately 13.3 miles (37%) exist on the toeslope of the butte. There are approximately 2.5 miles of native or gravel surfaced road within 200 feet of Crystal and Recreation Creeks.

Table 8. Road Miles by Surface Type, Use, and Soil Surface Erosion Potential

Soil Surface Erosion Potential	Surface Type								
	Native			Gravel			Paved		
Use	*High*	*Med*	*Low*	*High*	*Med*	*Low*	*High*	*Med*	*Low*
Severe	0	0	0	0	0	0	0	0	0
Moderate-Severe	0	0	.70	0	0	0	0	0	0
Moderate	0	0	0	0	0	0	0	0	0
Low-Moderate	0	0	4.5	0	0	0	0	0	0
Low	0	0	19.5	0	3.9	0	5.3	1.9	0
Totals	0	0	24.7	0	3.9	0	5.3	1.9	0

High = Active Mainline, Med = Active Secondary, Low = Inactive or Abandoned

Accelerated erosion occurring on road surfaces in the watershed produces sediment. The primary sediment producing mechanisms occurring on roads are sheet erosion, raindrop splatter, and dry ravel. These processes can commonly be observed on road cut-banks and the treads of non-paved roads where bare soil particles are exposed to the elements. Additionally, sediment is transported to the paved roads in the watershed by road sanding crews in the winter. The amount of sediment (usually crushed pumice) deposited is unknown; however, little if any of the sediment is anticipated to enter a water course to be transported to Recreation or Crystal Creeks.

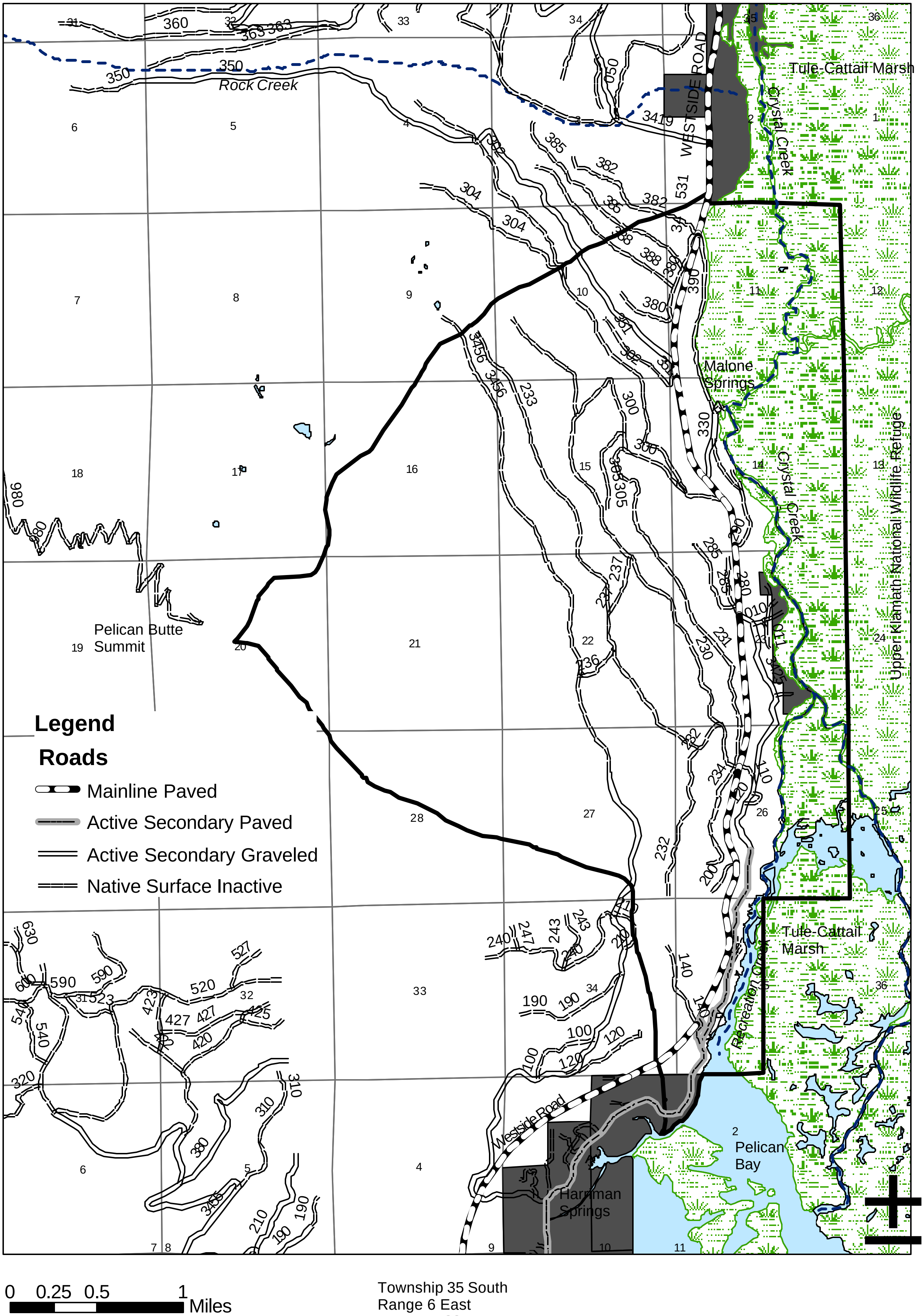
Visual evidence suggests that most of the sediment produced on roads and skid trails is only transported short distances by sheet flow to storage elements on adjacent hillslopes. Road intercepted snowmelt and precipitation runoff has resulted in very few observable gullies and rills of any significance (width and depth <1", length <5', number of gullies or rills observed <5). Since there are no streams that intersect road surfaces on the butte, little if any sediment is transported offsite to water sources. Sediment yield from roads is estimated to be less than 1 ton per year, or less than 1 cubic yard.

Consequently, the sediment budget has changed little (Table 9). While sediment production (input) has increased to a degree, sediment yield (output) has not changed much. Most of the sediment produced from human disturbances, such as roads, is contributed back to storage.

Table 9. Comparison of Reference and Current Sediment Yield

Reference (tons/yr)	Road Related (tons/yr)	Total (tons/yr)	Percent Relative Increase
6 to 7	0.5 to 1	6.5 to 8	8 to 14

Figure 9. Roads in the Pelican Butte Key Watershed



The effect that roads have had on soil creep, the primary sediment transport mechanism in the watershed, and a type of mass wasting process, is considered nominal. Observed road segments did not appear to potentially increase the rate of creep on the butte. Surface runoff intercepted by roads and potentially concentrating water to slopes was not observed to overload the soils by increasing per volume mass that could accelerate creep rates. Nor did any of the roads constructed on the steeper slopes in the watershed appear to seriously undercut the soil mantle, potentially destabilizing it by removing foundation material; therefore, soil creep rates in the watershed are conjectured to be unchanged. Extensive study to validate or refute this observation would not seem prudent, as sediment production and delivery in the watershed is relatively quite low.

Soil Condition (Soil Quality)

Detrimental soil impacts that exist in the watershed have affected soil productivity to some degree. Mainly caused by road building and past logging activities, the detrimental impacts observed were compaction, accelerated erosion, and excess removal of organic material (litter and duff layers). Evaluating the extent and severity of those impacts and then comparing them to inherent soil productivity, results in an assessment of soil condition termed soil quality. A soil has a high quality if it can: 1) recycle and store essential nutrients and elements; 2) store and release water to plants, streams, and groundwater; 3) promote and sustain root and soil biotic habitat; and 4) positively respond to soil management practices and yet resist degradation (Bennett, 1994).

Inherent soil quality can be characterized as being moderate to high throughout the watershed (see Table 10). Most of the area with low to moderate quality consists of rocky rubble lands (talus and scree).

Table 10. Inherent Soil Quality (marshland acreage excluded)

High to Moderate Quality		Low to Moderate Quality	
Acres	**% of watershed**	**Acres**	**% of watershed**
4856	90	539	10

Forest management practices have negatively affected inherent soil productivity on a small proportion of the watershed. Ground-based timber harvest activities have occurred on 1,933 acres (28%) of the watershed, affecting long-term site productivity, generally where roads, landings, and skid trails occur. Currently, approximately 390 acres (6% of watershed) of roads, landings, and skid trails do not support forest vegetation to the maximum inherent capability of the soil.

3.2 VEGETATIVE DIVERSITY

3.2.1 Vegetation

Reference Condition

The Pelican Butte Key watershed is dominated by forest vegetation. The four vegetation zones - white fir, Shasta red fir, mountain hemlock, and whitebark pine - provide an elevation transect from Recreation Creek to the rock and scree slopes near the summit of Pelican Butte.

These zones provide a broad classification of vegetation. A more localized classification was developed to describe the plant associations representative of the area (Hopkins, 1979). These plant associations are based on dominant tree, shrub and grass/forb vegetation layers. (See Figure 5.)

Historically, the forests within the watershed were affected by opposing forces of natural succession and periodic disturbance. In the upper elevations, mountain hemlock and whitebark pine, the successional climax species, occupied sites for very long periods without major disturbance. Although fire played an important role in these forests, other factors, such as snow avalanches, windthrow, diseases and insect outbreaks often were more significant.

In the white fir and Shasta red fir vegetation zones, fire played a dominant role in forming the structure and composition of the forest stands. The average return interval of fire appears to have varied from 10 to 40 years in the lower elevations and dry slopes, to an average of 40 to 60 years in the Shasta red fir zone further upslope (Agee, 1993). Low intensity burns, particularly at low elevations in the white fir zone, helped to perpetuate early seral species such as ponderosa pine, and mid-seral species, such as Douglas-fir. Fire favored these species not only by the creation of suitable seedbeds for germination and early growth, but also by reduction of competition from shade tolerant trees. Both ponderosa pine and Douglas-fir are fire resistant, particularly in maturity, while the true firs are highly susceptible to fire damage and mortality in all stages.

Fire in the mid-slope areas within the Shasta red fir zone favored the establishment and growth of western white pine and lodgepole pine, often creating stands of mixed composition.

The pattern of stand development was directly affected by fire intensity and frequency. In the lower elevations and on dry slopes, fires tended to be both more frequent and less intense than further upslope. This created larger, more uniform stands with low to moderate stocking density.

Where fires occurred less often, the accumulation of fuels resulted in hotter fires, but tended to create small stands or large gaps rather than landscape-scale stand replacement. Following wildfire, many of these areas reverted to brushfields of snowbrush ceanothus, manzanita, or chinquapin. Because of competition from dense shrub stands, these areas were often resistant to establishment of conifers. As a result, tree regeneration often took many decades, and it is likely that the brushfields were a semi-permanent landscape feature in parts of the watershed.

In historic times, stand structure and species composition in the watershed were strongly affected by native insects and diseases. Bark beetles periodically killed or damaged most species, decimating overstocked stands and those with poor vigor. Root rot affected some species, such as white fir, more than others, notably ponderosa pine. As a result, root rot tended to reduce stocking of true firs, maintain pine stands, and create gaps within the forest canopy.

Although wind can be an important disturbance factor affecting the development of forest stands and landscapes, broad areas of windthrow have not been found in the watershed. Instead, localized patches of blowdown appear to have been the general condition, often affected by high stand density, incidence of root rot, and topographic position. Most of the blowdown observed recently in the area occurred in white fir stands infected with annosus root disease. The greatest concentrations were on the northeastern slopes between Snow Lakes and Rock Creek.

Historically, forest stands in the watershed were not characterized by vast stretches of undisturbed old-growth. Fires and other disturbance factors, along with rocky openings and topographic features, would have tended to create patchy conditions over much of the landscape. Patches were variable, and generally ranged from 20 to a few hundred acres in size.

Current Condition

Disturbance regimes in the watershed were substantially altered beginning in the early 1900's. Fire suppression and logging have affected species composition, stand structure, disease and insect susceptibility, and fire regime.

Because of fire suppression policies, few ignitions in the past 50 years have resulted in burns of more than a few acres. A compilation of data from 1961-1999 shows virtually no wildfire effects in the watershed (Table 11), although a number of fire starts have occurred (Figure 10). As a result, fire-sensitive species, such as white fir and Shasta red fir, have increased dramatically throughout much of the area.

As these species increased, they competed with early seral species for moisture and growing space. Without the competitive advantage of fire, ponderosa pine declined in vigor throughout much of the landscape. Many of the old-growth pines became increasingly susceptible to bark beetle attack.

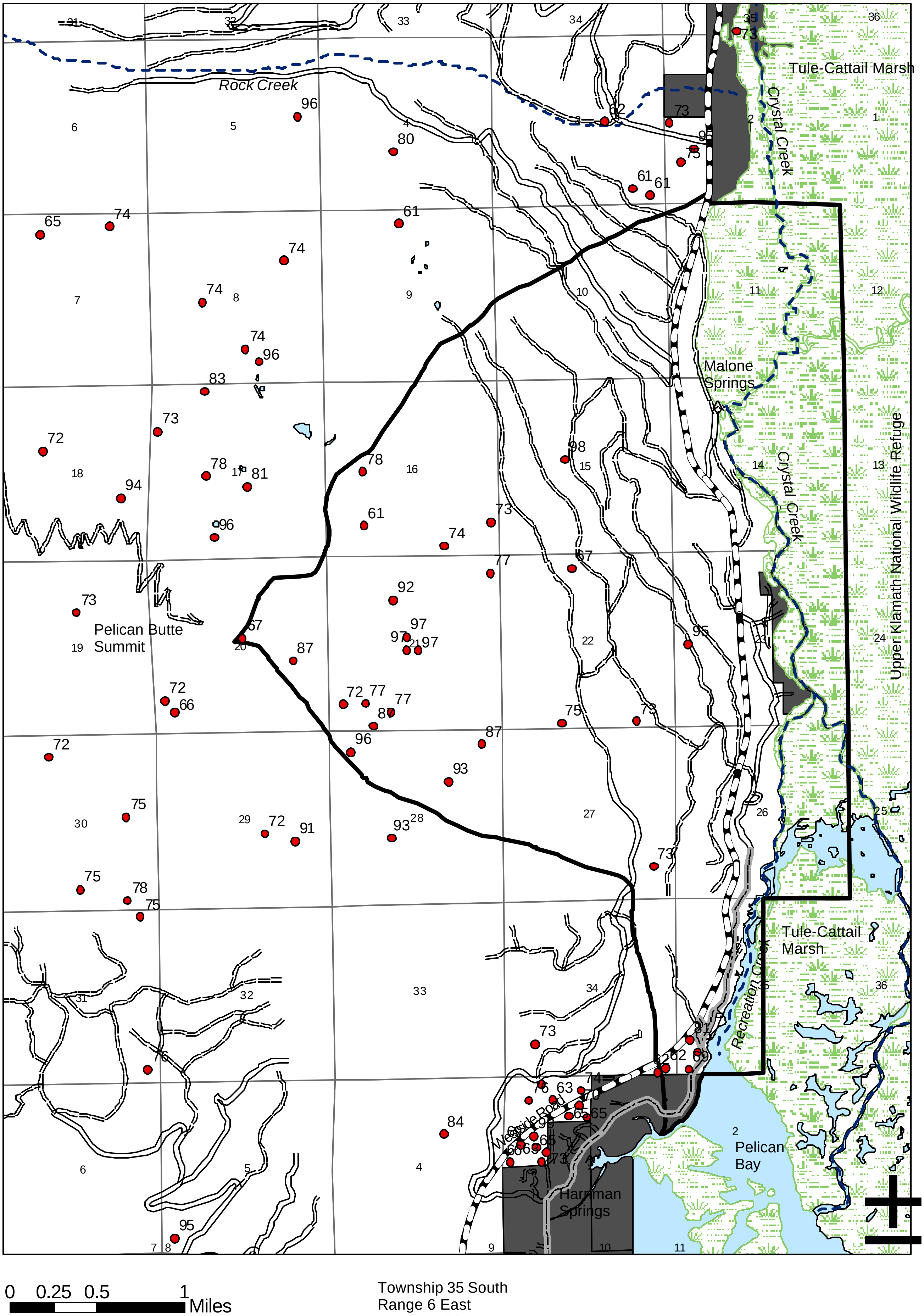
Timber harvest began early in the 20^{th} century with logging of high-value ponderosa pines and Douglas-fir on the lower slopes. Although the reason often given for this species preference is the higher economic value, another important factor was the increasing amount of "high-risk" ponderosa pine trees. In these situations, sanitation-salvage logging was a preferred method of capturing imminent mortality and high-value logs. High grading likely occurred over most of the accessible areas of the watershed during the first half of the century.

Figure 11 shows logging by decade in the watershed since the 1960's. Most prescriptions were various thinning and partial overstory removal cuts, which focused on removal of the larger trees. Regeneration cuts included shelterwood and group selection cuts; large-scale clearcutting did not occur in the watershed. Two of the plantations in the watershed, including the Rocky Point plantation near the resort, resulted from reforestation of old wildfires in the 1960's. These are not shown as regeneration harvest in Figure 11. Timber harvest has not occurred in the watershed since the early 1990's.

Table 11. Fire Occurrence, Cause, and Size in the Pelican Butte Key Watershed 1961-1999.

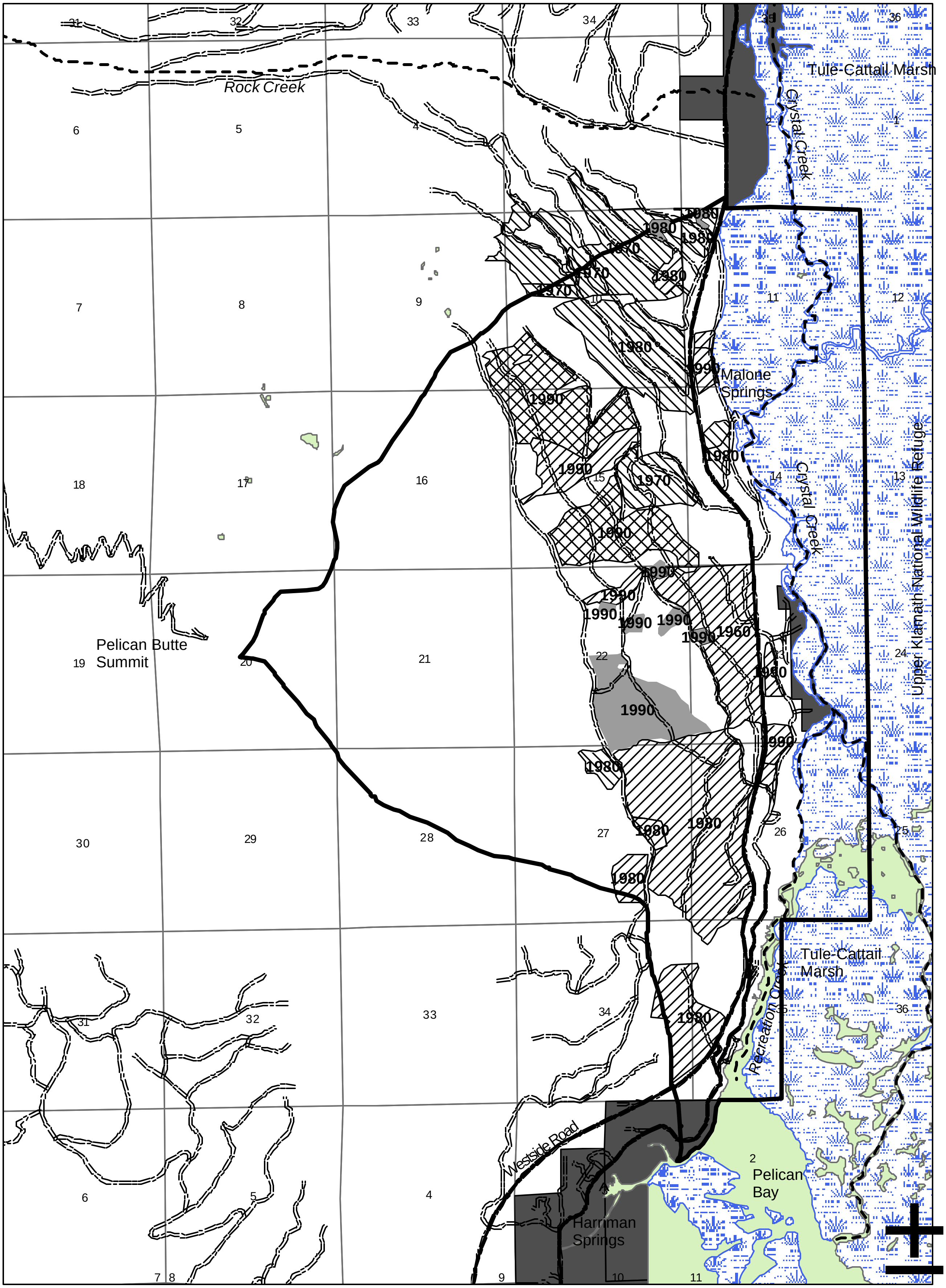
Year	Cause	Size (Acres)
1961	lightning	<0.25
1962	human caused	<0.25
1966	human caused	<0.25
1967	lightning	<0.25
1967	lightning	<0.25
1969	human caused	<0.25
1972	lightning	<0.25
1973	lightning	<0.25
1973	lightning	<0.25
1973	lightning	<0.25
1974	lightning	<0.25
1975	lightning	<0.25
1977	lightning	<0.25
1977	lightning	<0.25
1977	lightning	.025-9.0
1978	lightning	.<.025
1981	human caused	<0.25
1987	lightning	<0.25
1987	lightning	<0.25
1987	lightning	<0.25
1992	lightning	<0.25
1993	lightning	<0.25
1995	human caused	<0.25
1996	lightning	<0.25
1997	lightning	<0.25
1997	lightning	<0.25
1997	lightning	<0.25
1998	lightning	<0.25

Figure 10. Location of Fire Starts by Year in the Pelican Butte Key Watershed



Township 35 South
Range 6 East

Figure 11. Timber Harvest in the Pelican Butte Key Watershed by Decade.



0   0.25   0.5   1 Miles

Township 35 South
Range 6 East

Commercial Thin
Commercial Thin/Partial Overstory Removal
Partial Overstory Removal

Removal of pines and Douglas-fir accelerated conversion to true firs, and many stands of overstocked white fir developed in areas formerly dominated by ponderosa pine. These fir stands, in turn, were host to additional problems. For example, it is likely that Armillaria root rot has increased in recent decades along with stocking of white fir. The fir engraver beetle has also multiplied, especially during prolonged periods of drought.

As shown in Table 12 and Figure 11, most of the logging in the watershed was confined to the lower slopes, where ponderosa pine was prevalent and stands were less steep and more accessible. Approximately 59% of the mixed conifer/snowbrush-pinemat manzanita plant association and 44% of the white fir/chinquapin-boxwood plant association was harvested. Much of this area had more than one harvest entry. In contrast, only a minor amount of logging has been done in the forested plant associations on the upper slopes. In total, less than one third of the watershed has been logged or directly affected by timber management activities.

Table 12. Acres Harvested by Plant Association in the Pelican Butte Key Watershed

	mt hemlock-grouse huckleberry	Shasta red fir-mt hemlock/ pinemat manzanita/ long-stolon sedge	Shasta red fir-white fir/chinquapin-princes pine/long-stolon sedge	white fir/chinquapin-boxwood	tule-cattail marsh	mixed conifer/ snowbrush-pinemant manzanita	private land	Talus with scattered conifers	Total
Area Harvested (acres)	0	0	140	376	0	1417	0	0	1933
Total Area in Veg Type	465	524	778	855	1429	2395	208	289	6945
Percent of Veg Type Harvested	0	0	18	44	0	59	0	0	28

Logging and fire suppression have changed the structure of the forest at both the stand and landscape levels. A comparison between current and historic conditions estimated from historical (1940-1950's) aerial photos reveals a marked reduction in the amount of area with old growth structure (Table 13). Areas with old growth structure have declined from about 61% historically, to about 29% currently.

The most striking change has been the loss of multistoried stands dominated by large overstory trees (large/multisized -) and an increase of stands dominated by small trees with or without scattered large overstory trees (small/multisized +, small multisized -). This largely reflects the removal of large pine and Douglas-fir in the watershed. At the same time, the increase in true fir in the absence of fire resulted in increased stand density and creation of continuous vertical fuels or *ladder fuels*. Less than 10% of the watershed was in a low density condition in the 1990's, compared to 20% in 1940/1950. Instead of supporting low-intensity ground fires, the lower elevation stands are now at risk of stand-replacement fires.

Table 13. Comparison of Current and Historical Vegetation Structure

		Historical Vegetation			Current Vegetation		
Structural Category	**Size/Structure**	**acres**	**percent**	**% old growth structure**	**acres**	**percent**	**% old growth structure**
Single Story	seed-sap-pole	0	0	0	33	1	0
	pole-small	10	<1	0	91	2	0
	small-medium	1	<1	0	19	<1	0
Multistory	pole/multisized +	570	12	0	976	20	0
	small/multisized -	286	6	0	2063	41	0
	small/multisized +	128	3	3	1054	21	21
	small/multisized ++	0	0	0	370	7	7
	medium/multisized -	458	10	10	0	0	0
	medium/multisized +	0	0	0	5	<1	<1
	large multisized -	2255	48	48	0	0	0
Multistory Low Density	pole/multisized low density	0	0	0	119	2	0
	small/multisized low density	404	9	0	266	5	0
	medium/multisized low density	12	<1	0	0	0	0
	large/multisized low density	552	12	0			

Low Density indicates crown closure <40%

Higher up in the watershed, fewer changes from the past are apparent. In the mountain hemlock zone, no logging has taken place, and the incidence of natural disturbance may be within the range of historic norms. Closer to timberline, the introduction of white pine blister rust has resulted in dead and dying whitebark pine. Although there is only scattered mortality, change is apparent. Nevertheless, it appears that genetic resistance to the disease is buffering the impacts to some extent.

Although the amount of forest with old growth structure has been reduced in the watershed, patch size and complexity are much the same as in the past, with stands varying from 20 to a few hundred acres in size.

3.2.2 Riparian Reserves and Riparian Condition

Riparian reserves in the Pelican Butte Key watershed are limited to the Upper Klamath Lake/Marsh wetlands which include Recreation and Crystal Creeks and a band along the shoreline which totals approximately 350 acres. No other perennial or intermittent streams are located in the watershed. Riparian reserves along the shoreline were designated by using the Northwest Forest Plan interim width of 2 site potential tree lengths. In this area, the distance used is 320 feet.

Reference Condition

Historically, the lakeshore riparian zones were a mix of hardwoods (aspen, cottonwood), shrubs (willow, dogwood, spiraea, snowbrush, serviceberry) and conifers (white fir, Douglas-fir, ponderosa pine). In the past, periodic fires may have promoted more hardwood and shrub regeneration than currently occurs today.

Current Condition

Little timber harvest has occurred in the shoreline riparian reserve. Some clearing has been done for development of the Rocky Point boat launch, resort, and residences along Recreation Creek and on private land. Approximately 4.3 miles of road have been constructed in the shoreline reserve. Currently, approximately 25% of the shoreline reserve is in a late successional condition, 25% in a mid seral condition, and the rest in an open or early seral condition. Much of this area is considered a high fire risk, because of the presence of ladder fuels, decadent brush, and dead/down accumulation in close proximity to residences.

3.2.3 Special Status Plant Species

Reference Condition

There is no information on the historic occurrence of Special Status Plant (SSP) species within the watershed area. It is likely that the species currently present were also present historically.

Current Condition

SSP species analyzed in the Pelican Butte Key watershed include species classified as Forest Service Sensitive (Table 14), and Survey and Manage (Table 15). No Federally listed Threatened and Endangered plant species have habitat in the watershed. Although not plants, fungi are also considered here.

Field surveys for SSP species were conducted within the Pelican Butte Key watershed in 1987 (City of Klamath Falls, 1989), 1997 (Shapiro, 1997b) and in 1999-2000 by Forest personnel in support of the proposed Pelican Butte winter sports site. Additional surveys have been done in the area during analysis of timber sales and other projects.

To date, no sensitive plant species have been found in the Pelican Butte Key watershed. Two species have been located on Pelican Butte outside of the key watershed area. A large population of *Arnica viscosa* occurs on open talus slopes along the main west ridge and a single site of *Scirpus subterminalis,* proposed for inclusion on the sensitive list in 2003, has been found at one of the Snow Lakes.

The Survey and Manage list is updated annually. Only a few survey and manage species that currently require pre-disturbance surveys have potential habitat on the Forest (Table 15). These include Category A and C species. During previous surveys, 2 sites of the Category D fungus *Mycena overholtsii*, and 59 sites of the Category F fungus *Collybia bakerensis* were

Table 14. Region 6 Sensitive Plant Species Documented or Suspected to Occur on the Winema National Forest

R6 Sensitive Species Suspected or Documented on Winema NF 1999	Range	Local Habitats	Potential Habitat in Pelican Butte Key Watershed
Arabis suffrutescens var. horizontalis	Endemic to Klamath Co, OR. Few sites in Crater Lake NP	high elevation open sites with coarse pumice.	yes
Arnica viscosa	Deschutes, Klamath, Douglas Co, OR; CA. On Winema, found at a few sites in wilderness along the Cascade Crest and on Pelican Butte.	high elevation, open rocky sites	yes
Asplenium septentrionale	Klamath and Douglas Co, OR; CA. Rogue River, Umpqua and Winema NF. On Winema, found in southwest part of Chemult RD.	basalt rock outcrops	possibly
Astragalus peckii	Endemic to Klamath and Deschutes Co, OR. Deschutes and Winema NF. Limited to pumice zone.	openings in lodgepole pine, ponderosa pine, or juniper communities. pumice or ash soils	no
Botrychium lanceolatum	OR, WA. Suspected on the Winema	well-drained floodplains, moist meadows and openings in mesic forest	no
Botrychium pumicola	South-Central Oregon. Deschutes, Winema, Fremont NF and Crater Lake NP. On Winema, found on Chemult RD, and northern Chiloquin RD east of HWY 97.	alpine peaks and lodgepole basins in pumice zone	possibly
Calochortus longebarbatus var. longebarbatus	South-Central Oregon and adjacent Northern California, South-central Washington and adjacent north-central Oregon. Includes Winema, Fremont, and Modoc NF's. On Winema, found in Sprague, and Sycan watersheds with one site in Williamson River watershed.	Poa/Danthonia/ Deschampsia moist meadows located in pine habitats	no

Carex stenophylla	Sporatic occurrence in the west. Two historic sites in Oregon, including 1 site in Klamath County. Suspected to occur on the Winema	wet meadows	no
Castilleja chlorotica	Endemic to Deschutes, Klamath and Lake Co, OR. On Winema, found at one site near northeast corner of the Forest	shrub openings on exposed well-drained slopes and summits in sagebrush, bitterbrush, or pine communities	no
Cicuta bulbifera	ID, WA, OR. Historic site in Klamath County	Wetlands, lake and stream margins	possibly
Collomia mazama	Endemic to southern Oregon Cascades. Umpqua, Rogue, and Winema NF, Crater Lake NP. On Winema, found in Lost Creek, Horse Creek, Rock Creek and Cherry Creek drainages, Klamath RD	true fir/lodgepole pine forest, meadows, and meadow edges	yes
Eriogonum prociduum	Endemic to Klamath and Lake Co, OR; northeast CA; and NW Nevada. On Winema NF limited to SE Chiloquin RD.	Areas of barren rocky or gravelly volcanic soils within juniper or sagebrush habitat.	no
Gentiana newberryi	Oregon Cascades and Northern CA. On Winema found on Klamath RD.	Deschampsia/Carex wet meadows and meadow edges, generally 5,000' and above	no
Hazardia whitneyi var. discoideus	Oregon Cascades and Northern CA. On Winema few sites found along Cascade Crest in wilderness.	Rocky, open forested slopes at high elevation.	yes
Iliamna bakeri	Southern OR and Northern CA. On Winema, few sites in southeast Chiloquin RD.	Open pine and juniper forest. Often burned areas.	no
Lycopodiella inundata	Cicumboreal extending to California in the Pacific Northwest. On Winema one site in Yoss Creek drainage on Chiloquin RD.	bogs, muddy depressions, pond margins	no

Mimulus evanescens	Idaho, central and eastern Oregon to northern CA. Only two known extant populations: Lake Co, OR and Lassen Co, CA. Suspected to occur on the Winema.	vernally moist sites along perennial and intermittent streams; receding margins of lakes, ponds, and reservoirs within juniper/sagebrush habitats.	no
Mimulus tricolor	California, Willamette Valley and south Central Oregon. Winema and Fremont NF. On Winema, found in Sycan River watershed.	Seasonally flooded depressions, channels, and streambanks located in openings in pine and sagebrush habitats. Relatively heavy soils.	no
Penstemon glaucinus	Endemic to Klamath and Lake Co, OR. On Winema, few sites found located east of HWY 97.	Openings in mid to high elevation pine, fir, and mt. hemlock communities. Well-drained volcanic soils along rocky points and ridges.	yes
Perideridia erythrorhiza	Endemic to Klamath, Jackson, Josephine, Douglas Counties in Oregon. Known locations may represent 2 different species. Siskiyou and Winema NF, Roseburg and Medford BLM. On Winema, found near Upper Klamath Lake on Klamath RD.	Poa/Deschampsia moist meadows, forest edges below 4500'	no
Rorippa columbiae	Columbia River Region; Klamath, Lake and Harney Co, OR; Modoc Co, CA. Winema NF, Lakeview, Klamath and Burns BLM. On Winema, few sites found in southeast part of Chiloquin RD.	along intermittent and perennial streams and lakeshores: banks, sandbars, vernal pools, lakebeds, ditches.	no
Scheuchzeria palustris	WA, OR, CA, ID. Sites along the Cascades in OR. On Winema, few sites found on Klamath RD.	wetlands and lake margins	yes
Thelypodium brachycarpum	Southern OR and Northern CA. Historic site on Klamath RD, near Upper Klamath Lake	alkaline flats, lake margins in shrub steppe and at edge of pine forests.	no

found in the watershed. Category D species require management of high priority known sites. Site management is not required for Category F species. Both of these species are saprophytes that occur on logs and produce sporocarps in the spring during snowmelt. It is likely that more sites of these species occur in the watershed.

The fungus *Chromosera cyanophylla* was also found at 13 sites within the watershed. This species has been removed from the Survey and Manage list, but is currently being reviewed for inclusion on the sensitive species list. *Chromosera* is another spring saprophyte that occurs on large logs and stumps and is likely to occur throughout the watershed.

Table 15. Category A and C Survey and Manage Plant Species Known or Suspected to Occur on the Winema National Forest.

Species Known or Suspected to occur on Winema Requiring Predisturbance Surveys	Known Sites On/Near Forest	Suitable Habitats	Potential Habitat in Pelican Butte Key Watershed
Schistostega pennata	found near Diamond and Odell Lakes	blowdown root wads in riparian areas and wetlands	possibly
Cypripedium montanum	found on Chiloquin District	White fir mixed conifer below 5000’	yes

3.2.4 Noxious Weeds

Noxious weeds are defined as "those plant species designated as noxious weeds by the Secretary of Agriculture or by the responsible State official. Noxious weeds generally possess one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host of serious insects or disease and being native or new to or not common to the United States or parts thereof." (FSM 2080). In the reference condition, no noxious weeds were present.

Noxious weeds are currently limited to disturbed sites, such as roadsides and landings, in the watershed and are currently uncommon in the area. The noxious weed St. Johnswort (*Hypericum perforatum*) occurs along some of the roadsides and landings in the watershed. Bull thistle (*Cirsium vulgare*) is currently present in small amounts. Spotted knapweed (*Centaurea maculata*) and dalmation toadflax (*Linaria dalmatica*) occur along Westside Road. Canada thistle (*Cirsium arvense*) is known to occur in the adjacent Rock, Cherry, and Nannie Creeks watershed area, and may also occur within the Pelican Butte Key watershed.

3.3 TERRESTRIAL WILDLIFE

Reference Condition

Prior to European settlement, the watershed contained a high degree of habitat diversity that provided for a diversity of wildlife species. Habitats ranged from marsh and open water associated with Upper Klamath Lake to low elevation ponderosa pine forests to mid elevation true fir forests to high elevation mountain hemlock and white bark pine forests and open talus slopes.

Historically, forest wildlife occupied a landscape that consisted of burned and unburned forest that resulted in a shifting mosaic of age classes and species composition, depending on elevation, aspect, fire frequency, fire intensity, and disease and insect infestations. Wildlife species abundance and distribution likely shifted with the changing landscape patterns created by the natural disturbances. Forest habitats within this landscape probably were structurally and vegetatively complex.

Based on aerial photographs from 1940-1956, the majority of the watershed had late successional/old growth structure in 1940/1950. Uncut stands at lower elevations were dominated by large diameter ponderosa pine with lesser amounts of Douglas-fir, sugar pine, and white fir. While quality or condition of the forest cannot fully be known, these forests generally appeared to be more open, and to have a greater proportion of large trees and less understory development than in the current condition. Upper elevation stands, where little timber harvest has occurred, were similar to the current condition, although it is likely that fire suppression has also contributed to more continuous and denser stands in this area as well.

The forest-marsh interface, where the slopes of Pelican Butte meet the extensive marshlands of Upper Klamath Lake, historically had a high degree of habitat and species diversity.

Current Condition

Over 290 wildlife species are known or suspected to occur in the Pelican Butte Key watershed. The majority of these are associated with Recreation and Crystal Creeks and the vast marshlands of Klamath Lake National Wildlife Refuge. Table 16 lists wildlife species addressed in this analysis and their current management status.

3.3.1 Late Successional Habitat

Spotted owl nesting/roosting/foraging habitat was used as an approximation of late successional forest conditions in this analysis. The watershed contains approximately 2,219 acres of NRF habitat (Figure 12). This is approximately 41% of the watershed excluding marsh lands. Most of the NRF habitat (1,707 acres) in the watershed is located within LSR #R0227.

Despite past timber harvest, NRF habitat is fairly evenly distributed throughout the watershed and habitat connectivity is relatively good. The upper slopes of the watershed are lacking NRF habitat as a result of natural features and conditions. Private lands and developed areas along Westside Road provide limited or no NRF. NRF is absent to the east of the watershed due to the presence of Upper Klamath Lake/marsh.

The portion of LSR #R0227 in the watershed comprises approximately 5% of the total LSR lands on the Klamath District. LSR within the watershed is approximately 52% NRF habitat, slightly above the 50% minimum recommended in the LSR Assessment (USDA, 1997).

The lower half of the LSR in the watershed is within bald eagle habitat and is managed under the Recovery Plan for the Pacific Bald Eagle. As stated in the Northwest Forest Plan (page C-11), activities required by recovery plans for listed threatened and endangered species take precedence over Late-Successional Reserve standards and guidelines. Managing this area for more open stand conditions to maintain or promote development of large pines and Douglas-fir meets bald eagle recovery plan direction and also better fits historical conditions and site potential than managing for dense true fir stands.

Most of the LSR in the zone above bald eagle habitat has never been harvested and remains roadless. This area generally provides dense canopy, high levels of large trees, and abundant snags and woody debris.

Table 16. Terrestrial Wildlife Species Addressed in the Pelican Butte Key Watershed Analysis.

Common Name	Scientific Name	Status	Presence	Inventory
Northern spotted owl	*Strix occicentalis caurina*	FT, CH	K	3
Bald eagle	*Haliaeetus leucocephalus*	FT	K	3
Canada lynx	*Lynx canadensis*	FT	U	N
Yellow-billed cuckoo	*Coccyzus americanus*	FC	N	N
Oregon spotted frog	*Rana pretiosa*	FC, S	U	2
Northwestern pond turtle	*Clemmys marmorata marmorata*	S	U	N
Horned grebe	*Podiceps auritus*	S	U	N
Red-necked grebe	*Podiceps grisegena*	S	K	1
Least bittern	*Ixobrychus exilis*	S	K	1
Bufflehead	*Bucephala albeola*	S	U	1
Harlequin duck	*Histrionicus histrionicus*	S	U	1
American peregrine falcon	*Falco peregrinus anatum*	S	N	N
Yellow rail	*Coturnicops novebracensis*	S	N	1
Tricolor blackbird	*Agelaius tricolor*	S	U	1
Pacific pallid bat	*Antrozous pallidus pacificus*	S	U	1
Pacific fringe-tailed bat	*Myotis thysanodes vespertinus*	S	U	1
California wolverine	*Gulo gulo*	S	N	3
Pacific fisher	*Martes pennanti*	S	U	N
Great gray owl	*Strix nebulosa*	SM	K	1
Northern goshawk	*Accipiter gentilis*	SC	K	N
Elk	*Cervus canadensis*	SC	K	N
Deer	*Odocoileus hemionus*	SC	K	N

Key

Status:
FT=Federal Threatened
FC=Federal Candidate
CH=Critical habitat designated
S=R6 Sensitive
SM=Survey & Manage
SC=Species of management concern

Presence:
K=Known
S=Suspected
U=Uncertain
N=Not present

Inventory:
N=No surveys done
1=Unstructured suveys
2=Structured surveys not to protocol
3=Surveys to protocol

3.3.2 Threatened, Endangered, and Candidate Species

Northern Spotted Owl (threatened)

There are three spotted owl activity centers located within the watershed. All three of the activity centers occur within LSR. These activity centers comprise 7.5% of the known spotted owls on the Klamath Ranger District. Table 17 gives the results of monitoring of these activity centers in 2002 (Andrews, 2002).

Table 17. Northern Spotted Owl Sites and Status in the Watershed (2002).

Site Number	Site Name	Status
2239	Rocky Point	Pair + 2 young
2387	Cloud Lakes East	Male auditory; repro unknown
2757	Eagles Roost	Male; repro unknown

Spotted owl NRF habitat is discussed above. Spotted owl dispersal habitat is abundant throughout the watershed and comprises about 70% of the landscape, excluding marsh (Figure 12).

Bald Eagle (threatened)

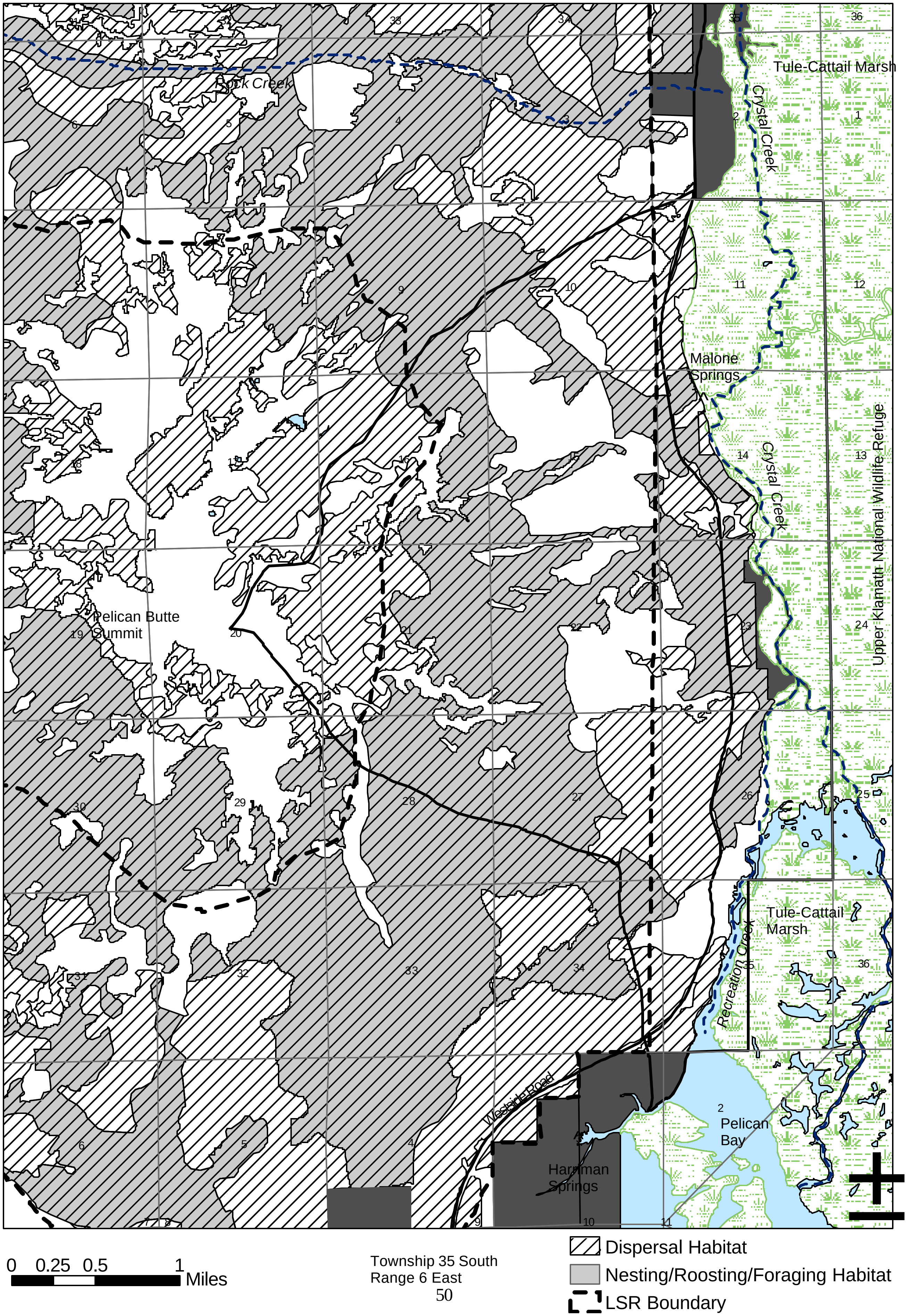
A total of 2,828 acres of the Pelican Butte Key watershed are designated as bald eagle habitat management areas (Figure 6, Table 5). These management areas consist of bald eagle nesting habitat, replacement habitat, and winter roosting habitat. Approximately 60% of the designated bald eagle habitat is located within LSR. The watershed is located within bald eagle Management Zone 22 (Klamath Basin) as described in the Pacific Bald Eagle Recovery Plan (USDI, 1986).

There are two bald eagle territories centered within the watershed and two territories that overlap into the watershed. These territories comprise 27% of all known bald eagle territories on the Klamath Ranger District. In addition, a bald eagle winter roost is located at the north end of the watershed and extends into the adjacent Rock Creek drainage.

Within the watershed, and throughout the Klamath Ranger District, bald eagles nest almost exclusively in live ponderosa pine, Douglas-fir, and sugar pine trees (USDA, 1997). These tree species also are the preferred roost tree species and are generally the largest and tallest trees in the area (Dellasala, 1987). These tree species are located primarily along the lower and mid-slopes of the watershed. Historic timber harvest activities on the Klamath Ranger District concentrated on the selective logging of large diameter ponderosa pine, sugar pine, and Douglas-fir (USDA, 1995). As a result, the number of suitable nest trees within the watershed likely has been reduced.

Bald eagle foraging habitat within the watershed occurs in Crystal and Recreation Creeks and the Upper Klamath Lake National Wildlife Refuge to the east. The most important fish prey species from these foraging areas are tui chub, blue chub, and suckers (Frenzel, 1984). Other important prey includes waterfowl, small mammals, and carrion. Eagle foraging areas in the Upper Klamath Basin have been reduced by diking and draining for conversion to agriculture

Figure 12 Spotted Owl Habitat in the Pelican Butte Key Watershed



(USDI, 1993). In addition, waterfowl distribution and abundance has been significantly reduced due to in-basin and out-of-basin alterations to habitat.

Canada Lynx (threatened)

Based on current information on Canada lynx occurrence and habitat, lynx are not considered to be present on the Winema National Forest. There are no sightings or suitable habitat for this species within or near the watershed. The area has potential secondary habitat for lynx, but it is presently fragmented and occupied by other predators, such as coyotes, bobcats, and mountain lions.

Yellow-billed Cuckoo (candidate)

Yellow-billed cuckoos require blocks of riparian forest (willow-cottonwood) greater than 10 hectares in size for nesting habitat. Large blocks of this habitat are not present in the watershed and yellow-billed cuckoos are not expected to occur.

Oregon Spotted Frog (candidate)

Spotted frogs are most likely to be found at marshy edges of ponds or lakes, or in algae-grown overflow pools of streams (Nussbaum, et al., 1983). The spring and marsh area on the east side of the watershed has been surveyed for spotted frogs, and none were found. Spotted frogs were found in a ditch at Jack Springs and Fourmile Spring/Creek north of the watershed.

3.3.3 Forest Service Sensitive Species

Peregrine Falcon

Pelican Butte does not have any cliff habitat that appears suitable for peregrine falcon nesting. The nearest known nest is 24 miles away near Crater Lake. Much of the habitat around the butte is suitable foraging habitat for peregrine falcons. Peregrine falcons have been observed on Pelican Butte several times.

Least Bittern

Least bittern inhabit emergent vegetation in fresh water marshes. They build their nests out of vegetation usually near or over water. Bitterns are known to occur in Upper Klamath Marsh adjacent to the analysis area.

Bufflehead

Bufflehead are cavity nesters, using either natural or woodpecker-excavated (especially flicker) cavities. Their nests are usually found within 650’ of water. Their diet consists of aquatic insects, seeds from aquatic vegetation, crustaceans, snails, and other mollusks. Fish is important to their diet in the wintertime. Bufflehead have been observed in Recreation Creek, but there are no known nest sites within the Pelican Butte Key watershed.

Harlequin Duck

Harlequin ducks inhabit forested mountain streams with fast moving water. They usually nest under shrubs within 60-90' of water. The Pelican Butte Key watershed is not within the known range of the species, and harlequin ducks have not been observed in the watershed.

Horned and Red-necked Grebe

Horned and red-necked grebes are found in shallow, freshwater lakes with marshy edges that have reeds and sedges. The grebes build floating nest structures in shallow water that are anchored by reeds or other emergent vegetation. Red-necked grebes have been observed nesting in marsh areas just east of Rocky Point. Horned grebes have been observed on Upper Klamath Lake near the watershed.

Tri-colored blackbird

Tri-colored blackbirds nest in marsh habitat with tules or cattails. Upper Klamath Lake/Marsh contains many acres of suitable habitat adjacent to Recreation Creek. The nearest known nests are located 7 miles from the watershed.

Yellow Rail

Once thought to be extirpated from Oregon, yellow rails were "rediscovered" in Klamath County in 1982. Rails have been located at 26 sites in Klamath County and 2 sites in Lake County. The marsh land associated with Recreation and Crystal Creeks contain habitat that appears suitable for yellow rails, although there are no documented observations in this area. Nest sites have been documented 3 miles north of the watershed.

Bats

Open water areas along Recreation and Crystal Creeks provide foraging habitat in the watershed. Bats breed and roost in cavities in large trees and snags, including cracks and deep fissures of bark. There are no caves, mines, abandoned buildings, or wooden bridges in the area which would require protection under the Northwest Forest Plan.

Twelve bat species have habitat ranges that include the Pelican Butte Key watershed (Table 18). A bat inventory was completed in adjacent Rock Creek (north) and Fourmile Creek (south) watersheds in 1997 (Cross, 1997). A total of nine species were documented during this survey. Many of these species are likely to occur in the Pelican Butte Key watershed. Two species of bats on the sensitive species list could occur in the watershed. Pacific fringe-tailed bats were located at Fourmile Creek, and Pallid bats are known to occur in Klamath County.

California Wolverine

Wolverines have not been documented in the vicinity of the Pelican Butte Key watershed for many years. They have been documented, however, in other parts of Oregon and California, and may be re-occupying much of their former range. The home range of wolverines is larger than the Pelican Butte Key watershed. The watershed does contain suitable habitat for wolverines and is well connected to other potential habitat in wilderness areas and Crater Lake National Park. Surveys for wolverines on Pelican Butte are in progress.

Table 18. Species of Bats With Ranges Which Include the Pelican Butte Key Watershed.

Species	Scientific Name	Status	Documented in Vicinity
California myotis	*Myotis californicus*		Rock, Fourmile
Long-eared myotis	*Myotis evotis*		Rock
Little brown myotis	*Myotis lucifugus*		Rock, Foumile
Pacific fringe-tailed bat	*Myotis thysanodes vespertinus*	S	Fourmile
Long-legged myotis	*Myotis volans*		Rock
Yuma myotis	*Myotis yumanensis*		Rock, Fourmile
Hoary bat	*Lasiurus cinereus*		Rock, Fourmile
Silver-haired bat	*Lasionycteris noctivagans*		Rock, Fourmile
Big brown bat	*Eptesicus fuscus*		Rock
Townsend's Big-eared bat	*Corynorhinus townsendii*		Likely to occur
Pallid bat	*Antrozous pallidus*	S	No
Brazilian free-tailed bat	*Tadarida brasiliensis*		No

Fisher

Fishers prefer dense stands with 70-80% canopy closure. They den in cavities in the ground, under logs, or in large live trees. Potential habitat for fishers occurs throughout the Pelican Butte Key watershed. Fishers, however, are not known to occur within the watershed. Human disturbance along the Westside Road may preclude fishers from this portion of the watershed.

Northwestern Pond Turtle

This species is known to occur in rivers, streams, lakes, ponds, permanent and ephemeral wetland habitats, and altered habitats such as reservoirs (Holland, 1994). Northwestern pond turtles generally require emergent basking sites such as partially submerged logs, vegetation mats, rocks, or mud banks (Nussbaum, et al., 1983). Although these turtles are found almost exclusively in or near water, they use terrestrial habitats for nesting, overwintering, and dispersal. Movements into upland habitat may extend up to 1,640 feet from the water's edge. Pond turtles are not documented to occur in the watershed, but potential habitat is present along Crystal and Recreation Creeks.

3.3.4 Survey and Manage Species

Great Gray Owl

Surveys for great gray owls were conducted on Klamath District in 1995-1996. No nest sites were detected on the District. Occasional sightings of great gray owls have occurred in the Pelican Butte Key watershed (Hardy, 1997, pers. comm.). Clearcuts and heavily thinned forest stands in the lower portions of the watershed may provide foraging habitat. However, the watershed generally lacks the type of meadow edge or openings favored by great gray owls.

Terrestrial Mollusks

Two terrestrial mollusk species currently on the Survey and Manage list have potential habitat in the Pelican Butte Key watershed. The Crater Lake tightcoil (*Pristiloma arcticum crateris*) occurs in mossy areas and organic material near small springs and seeps. The evening field slug (*Deroceras hesperium*) has been found on large woody debris at Blue Springs located at the north end of Klamath District. Surveys were conducted at various locations throughout the watershed for survey and manage terrestrial mollusks, but neither of these species was located. A number of sites of bludgray taildropper (*Prophysaon coeruleum*) were found. This species is no longer on the survey and manage list in Oregon.

3.3.5 Other Management Indicator Species

Cavity Nesters, Pileated Woodpeckers

Cavity nesters, such as pygmy nuthatches, flammulated owls, black-backed woodpeckers, pileated woodpeckers and white-headed woodpeckers, occur in the watershed. These species require large snags. Black-backed woodpeckers also require beetle infested trees for foraging. Loss of large diameter trees from past timber harvest has likely reduced habitat for woodpeckers. Fire suppression has also reduced beetle-infested trees for foraging habitat.

Northern Goshawk

There is no information on the current distribution or abundance of northern goshawks within the watershed. Goshawks have been sited within the watershed but nesting has not been documented (Hardy, 1997, pers. comm.). Suitable habitat for goshawks within the watershed is likely concentrated within the LSR. Timber management, including regeneration and selective logging, has reduced the amount of suitable goshawk habitat within the watershed.

American Marten

Marten are indicator species for mature mountain hemlock and high-elevation lodgepole pine ecosystems. Marten have been observed in the watershed, but surveys have not been conducted. High elevation forests in the watershed have changed little from reference conditions.

3.3.6 Game Species

Elk and Deer

The Pelican Butte Key watershed falls within the ODFW Keno Wildlife Management Unit. There are no specific population estimates for the watershed. Elk and deer occur primarily in the lower and mid-slopes of the watershed (Collom, 1997, pers. comm.). Currently the elk and deer population is below the current management objective for the area. The reduced deer population is likely due to a limited forage base as result of the limited shrub growth in the understory. The elk population in this area has been increasing over the past 10 to 15 years. This trend has been occurring throughout the Klamath Basin.

The watershed primarily provides summer range habitat. Some areas along Westside Road and in adjacent Rock Creek drainage provide calving and fawning areas. Elk migrate out of the

Pelican Butte area to winter in the lower elevation forests west of the Cascade Crest (Collom, 1997, pers. comm.).

Bear and Cougar

There is no inventory information for bear or cougar within the watershed. The most recent (1993a) ODFW estimates for eastern Oregon are one black bear per 1.1 square miles. Average cougar density for Oregon has been estimated at 7.5-7.8 cougars per 100 square miles (ODFW, 1993b). In general, the population of these species is stable or increasing within the Klamath Basin. This trend of population increase is occurring state wide as result of recent legislation that prohibits the use of dogs in the hunting of these species. (Collom, 1997, pers. comm.)

The populations of deer and elk within the watershed likely provide an adequate forage base for cougars. The late-successional forest stands within the watershed provide numerous den sites for bears, and the remoteness of the area limits human disturbance most of the year.

3.4 AQUATIC HABITAT AND FISHERIES

Reference Condition

In 1884, Cope noted that Upper Klamath Lake supported a great population of fishes, and was more prolific in animal life than any other water body known to him at the time. Fish such as the Lost River sucker were present "in incredible numbers", and were one of the most important food sources for the Klamath and Modoc Indian tribes (Stubbs and White, 1993). Rainbow trout also were described by Cope as abundant in Upper Klamath Lake tributaries (Thomas and Ford, 1993). The Upper Klamath Basin supported at least 17 native fish species, represented by both resident and anadromous life history strategies. Nine of these species are endemic to the Klamath Basin. Blue chub (*Gila coerulea*), an endemic species, was the most common species found in the lake (Logan and Markle, 1993).

Upper Klamath Lake was a eutrophic system even prior to European settlement (BOR, 1996), leading to the possibility that fish may have historically used Recreation and/or Crystal Creeks for refuge during warm periods or periods of poor water quality. It is not known which or how many of these species actually used these systems at that time. It can be assumed that many of these species used these systems at least temporarily, probably during migration or for temporary refuge, holding, or rearing. Springs feeding Recreation and Crystal Creeks (Malone and Crystal Springs) have been present for hundreds of years and may have historically been used as spawning areas for suckers.

No information describing historic habitat and channel conditions could be located for either system during preparation of this report; however, habitat in these systems likely was similar to what exists today: open channel bordered by flooded tule marsh to the east and old-growth mixed forest to the west. Large woody debris recruited from the west bank likely was located throughout both systems, creating complex in-channel habitat.

It is known that Crystal Creek was dredged beginning around 1909 to facilitate steamboat passage for tourist travel to Crater Lake. The improved access in turn encouraged large-scale logging activities, floating barges and log rafts down Crystal Creek to the towns of Klamath Falls, Algoma, and Shippington (USDA, 1994). Recreation Creek may have also been dredged; it has a channel form similar to Crystal Creek and also is low in woody debris.

Prior to dredging and installment of the Link River Dam, these channels historically would have been shallower, held water at elevated levels for a shorter duration, and probably had less of a defined channel than what is found today. Habitat likely was more complex, having less deep, open water, and more large woody debris and terrestrial and aquatic vegetation for cover.

Current Condition

3.4.1 Channel Morphology

Recreation and Crystal Creeks are spring fed systems, more typical of a lentic system than the implied lotic stream system. These marsh creeks are better characterized as palustrine wetlands, with little observable gradient or flow. Palustrine wetlands are described as nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 5 parts per thousand (Cowardin, et al., 1979).

At summer low flow, Recreation Creek ranges in width from 50 to 200 feet, with a more typical width ranging between 50 to 75 feet. The creek is widest near its confluence with Pelican Bay, tapering off as it proceeds upstream. At high flow, Recreation Creek is contiguous with Upper Klamath Lake and lacks a defined channel. Depths range from 3 to 12 feet, averaging approximately 6 feet. Substrate is almost entirely comprised of silts and organics, with isolated pockets of larger substrate artificially placed near boat landings and docks.

At summer low flow, Crystal Creek averages approximately 50-70 feet wide. Like Recreation Creek, at high flow, it is also contiguous with Upper Klamath Lake and lacks a defined channel. Depths range from 2-10 feet, averaging approximately 5.5-6 feet deep. Substrate is enitrely comprised of silts and organics (Shapiro, 1997a).

Streambanks are comprised primarily of silts and organics, with fine sediment tightly interwoven around organic root masses (for example, tule, willow). Bank stability is excellent in both systems, with root masses anchored well enough to withstand daily and seasonal wind and wave erosion.

Runoff from the east side of Pelican Butte occurs almost exclusively through groundwater seep, with no overland flow or defined stream channels located within the Pelican Butte Key watershed.

3.4.2 Fish Habitat

Due to lack of flowing surface water in the Pelican Butte Key watershed, fish habitat is limited to Recreation and Crystal Creeks. During winter and spring high-flow, habitat spreads beyond the active channel into the marsh and is actually contiguous with the lake. During summer and fall low-flow, habitat is constrained within the active channel as water levels recede. Water in these stream systems is currently influenced by the Link River Dam, maintaining water at flooded levels for longer periods of time than under natural conditions.

Summer fish habitat was assessed by boat on July 24, 1997 (Shapiro, 1997a). Recreation and Crystal Creeks are both spring fed, flowing through a low gradient, U-shaped channel. Habitat in these channels is glide-like, with uniform depth and a poorly defined thalweg. Fish cover is mainly provided by water depth, aquatic vegetation, and overhanging terrestrial vegetation. Most fish observed during the site visit were closely associated with patches of rooted aquatic vegetation, primarily yellow pond lily (*Nuphar polysepalum*) and floating-leaved pondweed (*Potamogeton natans*). Few fish were observed in areas of open water devoid of aquatic vegetation.

Although many pieces of woody debris were present instream, the majority of pieces were small, single pieces partially embedded in fine substrate and providing little cover for fish. All pieces of instream large woody debris appeared to have cut ends, with no natural pieces observed in the system. It is likely that many pieces of large woody debris originally found in these systems were removed to facilitate boat passage during dredging activities.

Land ownership to the east of Recreation and Crystal Creeks is part of the Upper Klamath Wildlife Refuge, administered by the USFWS. Land ownership on the west bank is a combination of private residential, resort, and Winema National Forest. Lands under USFS ownership are primarily mid and late successional mixed conifer stands, with small groves of cottonwood and aspen interspersed. Much of the private land has been cleared, removing terrestrial vegetation for houses and clearing wetland vegetation for boat access to Recreation or Crystal Creeks. This has reduced vegetation that may have historically provided cover for fish and the potential for large woody debris recruitment from the streambank.

Fish use in Recreation and Crystal Creeks appears to be limited to migration, holding, refuge and rearing. The lack of suitable spawning substrate eliminates spawning potential for most species. High water quality in spring-fed streams of the Klamath Basin are important to a multitude of fish species, which migrate to spring-fed areas during summer and fall months. This migration is apparently related to poor water conditions in Upper Klamath Lake and Agency Lake; pH levels have been reported as high as 10, and dissolved oxygen levels reported as low as 1 mg/l in portions of the lake (BOR, 1996).

3.4.3 Fish Presence and Distribution

The Pelican Butte Key watershed historically supported both resident and anadromous fish species. Numerous fish species are known to inhabit the Upper Klamath Basin, 17 of which are native, and 9 of which are endemic. At least 18 fish species have been introduced to the watershed (Logan and Markle, 1993), primarily as game fish.

Tables 19 and 20 display native and introduced fish in the Upper Klamath Basin. Table 21 shows fish that are found in Upper Klamath/Agency Lakes and in Crystal and Recreation Creeks (ODFW, 1997).

Anadromous species that were historically found in the Upper Klamath Basin, but are not currently found in either Upper Klamath and Agency Lakes or Crystal and Recreation Creeks include chinook (*O. tshawytscha*) and coho salmon *(O. kitsutch*), and steelhead (the anadromous form of rainbow trout). These species were extirpated from the Upper Klamath Basin with construction of Copco Dam in 1917.

It is suspected that bull trout once had a much wider distribution in the Klamath Basin, but now are found only in the headwaters of a few isolated spring-fed streams. Bull trout require high

Table 19. Native Fish Species in the Upper Klamath Basin.

Native Species		Endemic to Upper Klamath Basin	Status
Tui chub	*Gila bicolor*		
blue chub	*Gila coerulea*	X	R6
bull trout	*Salvelinus confluentus*		T, PCH
Coho salmon	*Onchorynchus kitsutch*		extirpated
redband trout	*Onchorhynchus mykiss*		R6
Chinook salmon	*Onchorynchus tshawytscha*		extirpated
marbled sculpin	*Cottus klamathensis*	X	
Klamath Lake sculpin	*Cottus princeps*	X	
slender sculpin	*Cottus tenuis*	X	R6
Pit-Klamath-brook lamprey	*Lampetra lethophaga*		R6
Miller Lake lamprey	*Lampetra minima*	X	
Klamath River lamprey	*Lampetra similis*	X	R6
Klamath largescale sucker	*Catostomus snyderi*	X	R6
Klamath smallscale sucker	*Catostomus rimiculus*		
shortnose sucker	*Chasmistes brevirostris*	X	E,PCH
Lost River sucker	*Deltistes luxatus*	X	E,PCH
speckled dace	*Rhinichthys osculus klamathensis*		
R6=USFS Region 6 sensitive species, **T**=Threatened, **E**=Endangered, **PCH**=Proposed Critical Habitat			

Table 20. Introduced Fish Species in the Upper Klamath Basin.

		Introduced into Upper Klamath Lake
white crappie	*Pomoxis annularis*	
black crappie	*Pomoxis nigromaculatus*	
green sunfish	*Lepomis cyanellus*	
pumpkinseed	*Lepomis gibbosus*	X
bluegill	*Lepomis macrochirus*	
Eastern brook trout	*Salvelinus fontinalus*	
lake trout	*Salvelinus namaycush*	
German brown trout	*Salmo trutta*	
rainbow trout	*Onchorynchus mykiss*	X
Kokanee	*Onchorynchus nerka kennerlyi*	
brown bullhead	*Ictalurus nebulosus*	X
fathead minnow	*Pimephales promelas*	X
largemouth bass	*Micropterus salmoides*	X
Sacramento perch	*Archoplites interruptus*	
yellow perch	*Perca flavencens*	X
goldfish	*Carassius auratus*	
mosquito killifish	*Gambusia* spp.	
white sturgeon	*Acipencer transmontanus*	X
carp	*Cyprinus carpio*	

Table 21.

General distribution of fish species in Klamath and Agency lakes; Crystal and Recreation creeks			
Native Species		**Klamath and Agency lakes**	**Crystal and Recreation creeks**
Tui chub	*Gila bicolor*	x	x
blue chub	*Gila coerulea*	x	x
redband trout	*Onchorhynchus mykiss*	x	x
marbled sculpin	*Cottus klamathensis*	x	x
Klamath Lake sculpin	*Cottus princeps*	x	**?**
slender sculpin	*Cottus tenuis*	x	x
Pit-Klamath-brook lamprey	*Lampetra lethophaga*	**?**	**?**
Klamath River lamprey	*Lampetra similis*	x	x
Klamath largescale sucker	*Catostomus snyderi*	x	**?**
shortnose sucker	*Chasmistes brevirostris*	x	x
Lost River sucker	*Deltistes luxatus*	x	x
speckled dace	*Rhinichthys osculus klamathensis*	x	**?**
Introduced Species			
pumpkinseed	*Lepomis gibbosus*	x	
brown bullhead	*Ictalurus nebulosus*	x	
fathead minnow	*Pimephales promelas*	x	**?**
largemouth bass	*Micropterus salmoides*	x	
yellow perch	*Perca flavencens*	x	x

quality, cold water for spawning and heavy cover for rearing. These conditions are currently not found in Crystal or Recreation Creeks. The Klamath River population segment of bull trout (*Salvelinus confluentus*) was listed as threatened in 1998 (USDI, 1998) and critical habitat proposed in 2002. Recreation Creek is included within "Subunit I, Upper Klamath Lake" as proposed critical habitat for bull trout (USDI, 2002).

Recreation Creek is within Unit 4 of the proposed critical habitat for Lost River (*Deltistes luxatus*) and shortnose suckers (*Chasmistes brevirostris)*, which were listed as endangered by the USFWS in 1988 (USDI, 1988). Critical habitat was proposed, but not designated in 1994. Approximately 2,888 acres of proposed critical habitat have been identified in the Pelican Butte Key watershed for the endangered sucker species (USDI, 1994a).

Critical habitat is defined as: (1) the specific areas within the geographic area occupied by a federally listed species on which are found physical and biological features essential to the conservation of the species, and that may require special management considerations or protection; and (2) specific areas outside the geographic area occupied by a listed species, when it is determined that such areas are essential for the conservation of the species (USDA and USDI, 1994a).

Fish species inhabiting the Upper Klamath Basin that have been identified as sensitive by the Forest Service are Pit-Klamath-Brook lamprey (*Lampetra lethophaga*), Klamath River lamprey (*Lampetra similis*), Slender sculpin (*Cottus tenuis*), Blue chub (*Gila coerulea*), Klamath largescale sucker (*Catostomus snyderi*), and redband trout (*Onchorhynchus mykiss* ssp.). The Klamath smallscale sucker is native only to the Klamath River and Spencer Creek (ODFW, 1997).

Of the numerous fish species that have been introduced into the Upper Klamath Basin, Table 21 above shows five introduced species that currently exist in Upper Klamath and Agency Lakes. Little information exists detailing fish species found specifically within Recreation or Crystal Creeks; therefore, due to connectivity with the lake, similarities with lake habitat, and better water quality conditions than found in the lake, it is reasonable to assume that fish species found in the lake have the potential to at least seasonally utilize Recreation and/or Crystal Creeks. At high flow, the marsh tributaries are interconnected with the lake, allowing free migration throughout the marsh, lake, and tributaries (Light, et al., 1996). Yellow perch (*Perca flavencens*) is known to occur in Recreation Creek (ODFW, 1997).

The hypereutrophic nature of Upper Klamath Lake contributes to periodic outbreaks of a bacterial gill infection *Flavobacter columnare*, which was the causative agent for a massive fish kill in 1971. As reported by Buettner (1997), "Columnaris is a naturally occurring bacteria that thrives under warm water conditions and is associated with fish that are stressed or in poor health." Approximately 15 million fish were killed during this outbreak; most were tui chub, but some suckers (27 Lost River suckers) and trout were also impacted. Several other fish die-offs were reported to have taken place in the lake since 1971 (BOR, 1996; Buettner, 1997), although none as severe as the one in 1971 in terms of total fish kill.

Fish kills were highest for the endangered suckers in recent years, with 6,049 carcasses collected in 1996 (Perkins, 1996) and an additional 2,355 carcasses collected in 1997 (Buettner, 1997). It is important to note that these figures probably represent only a portion of the fish actually killed during the outbreaks, with some carcasses consumed by fish eating birds, sinking to the lake bottom, and/or becoming concealed in shoreline vegetation.

3.4.4 Aquatic Invertebrates

Rare aquatic insect species potentially present in the vicinity of the Pelican Butte Key watershed include the Shuh's Homoplectran caddisfly, Alsea micro caddisfly, Fischer's caddisfly, and Cascades apatanian caddisfly. To assess presence/absence of these species, habitat and invertebrates in Recreation Creek were examined from a canoe on July 22, 1997. No habitat remotely suitable for any of the above listed species was found in Recreation Creek during this field visit (Wisseman, 1997).

Two small springs were found in the Pelican Butte Key watershed. These were small seeps emerging from the ground and flowing for a short distance before going subsurface again. These springs were sampled qualitatively on July 31, 1997. Few aquatic invertebrates were collected from the two isolated springs found in the Recreation Creek basin. Taxa encountered included: Nematoda, Oligochaeta, Ostracoda, *Zapada columbiana* (stonefly), Corydalidae (hellgramite), *Lepidostoma-sand case* (caddisfly), *Lepidostoma verodum* (caddisfly), *Psychoglypha* (caddisfly), *Rhyacophila*-early instar (caddisfly), *Dicranota* (cranefly), and chironomid midges. No sensitive or rare aquatic invertebrates were identified.

Freshwater mollusk surveys were conducted at several locations along the eastern base of Pelican Butte within the watershed (Frest and Johannes, 1998). These surveys were conducted at Malone Spring and at the Rocky Point Resort on Recreation Creek. A total of 15 freshwater mollusk species (12 gastropods and 3 bivalves) were found (Table 22). None of these species are currently on the Survey and Manage list.

Table 22. Mollusk Species Indentified in the Pelican Butte Key watershed.

Location	Species	Type
Rocky Point Resort	*Fluminicola* n. sp 1.	Freshwater Gastropoda
	Helisoma (C.) *newberryi*	Freshwater Gastropoda
	Lymnaea stagnalis appressa	Freshwater Gastropoda
	Menetus (M.) *callioglyptus*	Freshwater Gastropoda
	Physella (physella) gyrine	Freshwater Gastropoda
	Pisidium idahoense	Freshwater Bivalvia
	Sphaerium striatinum	Freshwater Bivalvia
	Valvata humeralis	Freshwater Gastropoda
	Vorticifex k. klamathensis	Freshwater Gastropoda
Malone Springs	*Fulminicola* n. sp 1.	Freshwater Gastropoda
	Helisoma (C.) *newberryi*	Freshwater Gastropoda
	Lanx klamathensis	Freshwater Gastropoda
	Lymnaea stagnalis appressa	Freshwater Gastropoda
	Lyogyrus n. sp5	Freshwater Gastropoda
	Musculium raymondi	Freshwater Bivalvia
	Physella (physella) gyrine	Freshwater Gastropoda
	Planorbella (P.) *subrenata*	Freshwater Gastropoda
	Stagnicola (H*.) caperata*	Freshwater Gastropoda
	Vorticifex effusus effusus	Freshwater Gastropoda

4.0 STEPS 5 AND 6 - SYNTHESIS AND RECOMMENDATIONS

Step 5 of the watershed analysis is an attempt to explain how physical and anthropogenic processes may have contributed to changes in the Pelican Butte Key watershed over time. The process synthesizes and interprets, using an interdisciplinary approach, data gathered during the previous four steps. Current and reference conditions are compared for key ecosystem elements identifying significant changes, causes (natural or anthropogenic), and trends.

Step 6 brings the results of the previous steps to conclusion by focusing on management recommendations that respond to watershed processes previously identified. Enhancement opportunities, monitoring, and research studies that respond to issues and key questions are suggested. Data gaps and limitations of the analysis also are addressed.

4.1 DOMINANT PROCESSES AFFECTING THE WATERSHED AT THE LANDSCAPE LEVEL

During preparation of Steps 1 through 4 of the watershed analysis, it became evident that several processes were responsible for the majority of changes that have affected the watershed on a landscape level. Due to the complexity of ecosystems, it is unlikely all processes involved in forming the watershed's current condition have been identified. The dominant processes, both natural and anthropogenic, are described briefly below.

4.1.1 Fire

Historically, wildfire was the dominant disturbance process in landscapes of the Pacific Northwest. Natural fire regimes have varied greatly across the region, from infrequent, episodic stand-replacement fires to frequent underburns of low intensity. Similar to other areas in the region, the historic fire regime in the Pelican Butte Key watershed was altered during this century by fire suppression. This may have resulted in major changes affecting the entire ecosystem. Interrelationships between fire, wind, insect and disease infestations, human activities and natural succession continue to determine the shape of the landscape.

4.1.2 Timber Management/Harvest

Timber harvest has occurred in the Pelican Butte Key watershed since early in this century, beginning with logging of high-value ponderosa pine in the lower elevations. Today, the harvest has shifted to an emphasis on forest health, often through silvicultural prescriptions that emphasize restoration of ponderosa pine and other large trees that provide important benefits to fish and wildlife. Road building is an anthropogenic process directly related to timber management activities. Roads can affect the landscape by increasing erosion and sediment loading and affecting migration patterns of wildlife (such as elk and mollusks).

4.1.3 Non-timber (Agricultural and Rural/Residential)

Agricultural and rural/residential development plays a minor role in formation of the watershed landscape. Low-lying forest was cleared and wetland/marshes were diked and drained in and around the Pelican Butte Key watershed for agriculture and housing. Placement of rural/ residential homesites has occurred along the Crystal and Recreation Creeks, altering the wetland/forest interface, an important area for diversity of wildlife species. Nutrient-rich runoff from agricultural crops throughout the Klamath Basin has contributed to the decline of water quality in Upper Klamath Lake and its tributaries including Crystal and Recreation Creeks.

4.1.4 Management of Upper Klamath Lake

Management of Upper Klamath Lake has impacted the Pelican Butte Key watershed since the turn of the century. Dam placement on the Klamath River and the outlet to Upper Klamath Lake has prevented upstream passage of fish species since 1917, changing species composition native to the Upper Klamath Basin. Stocking programs employed by federal and state government agencies have further impacted species composition in the watershed by introducing a multitude of exotic fish species. Lake level management has impacted vegetative communities in the watershed by raising lake levels approximately 3.3 feet above the normal high water level.

4.2 PHYSICAL CHARACTERISTICS

4.2.1 Hydrology

Fire likely affected the amount of area cleared that may have resulted in greater accumulations of snow pack and increases in peak flow, quick flow, delayed flow and total storm hydrograph volume within the watershed; however, large-scale fires have not been documented in recent history within the Pelican Butte Key watershed.

Timber management within the Pelican Butte Key watershed has led to an increase in the amount of cleared land. The most significant result of timber harvesting within the Pelican Butte Key watershed can be most likely attributed to an increase in roads. Clearing for roadways can result in the increase in impervious area by the compaction of fine soils. Based on current conditions, there are approximately 36 miles of roadway within the Pelican Butte Key watershed (including paved, unimproved, and improved).

Agriculture has potentially affected the hydrologic regime of Recreation Creek by increasing withdrawals and alteration of the Klamath Basin base level with the installation of dams. Diversion of flows for agricultural purposes may have led to an increase in the depletion of the areas aquifer storage volume.

Residential development is not a dominant form of landscape alteration within the upper portions of the Pelican Butte Key watershed; however, it may have influenced the lower elevations adjacent to Upper Klamath Lake.

<u>Recommendations</u>

Specific data documenting the surface and subsurface hydrologic regime of the Pelican Butte Key watershed is needed. Lysimeters may assist in identifying the amount of snowmelt that infiltrates in the watershed and snow courses within the watershed may yield specific snow accumulation measurements. In the meantime, efforts to protect surface waters/springs in the watershed should continue, through the use of riparian reserve management and application of the Aquatic Conservation Strategy Objectives.

4.2.2 Soils And Erosion Processes

Timber management and road construction have been the dominant activities affecting soils and erosion processes in the Pelican Butte Key watershed. Overall, a long-term (persistence >20 years) loss of maximum inherent soil productivity has occurred on approximately 390 acres (6% of watershed) due to road building and timber harvest activities. Approximately 63 of these acres (1% of the watershed) are paved, gravel, and native surfaced roads that can be considered to be semi-permanently out of timber production. The resultant loss in economic value due to decreased timber yields on these acres has not been calculated; however, considering the percentage of the watershed affected, the reduction appears quite low.

Recommendations

Considering the WNF Land and Resource Management Plan (LRMP) standards and guidelines pertaining to soil productivity, and the thresholds for the acceptable aerial extent of detrimental soil impacts mandated there, it appears that effects to soil resources from timber harvest activities are being minimized in this watershed. Thus, it can be recommended that future timber management efforts continue to limit ground disturbances that often result from ground-based tree harvest activities by enforcing the existing LRMP standard and guideline #12-5.

In addition, the Aquatic Conservation Strategy suggests that watershed restoration focus on removal or upgrading of roads; therefore, it is recommended that roads not needed for long-term management be sub-soiled and returned to forest production.

4.3 BIOLOGICAL CHARACTERISTICS

4.3.1 Vegetation

Vegetative changes in the watershed have been caused by complex interactions between a series of factors. Logging of ponderosa pine and exclusion of wildfire have increased the composition of white fir and, to a lesser extent, Shasta red fir. This, in turn, has increased the susceptibility of the forest to insect mortality in overstressed stands. Because of major changes in fuel loading and stand structure in the white fir zone, fire regimes have changed from historic times, with the possibility of stand-replacement fires increasing substantially. Many decades of logging also have reduced the acreage and density of large trees that contribute to old growth stand structure.

Sustainability of Vegetation

Much of the forest in the watershed is overstocked. High stand density has created stress on the trees, making them more susceptible to insects, diseases, and other mortality agents. Past mortality has resulted in accumulations of dead fuel in many areas. This includes both standing snags and down wood. High accumulation of fuels increases the probability of catastrophic, landscape-scale fire. Recent timber sales in the area have concentrated on thinning and partial harvests designed to lower stand density, increase tree growth and vigor, and reduce mortality.

Recommendations

Increase the emphasis on stand density management. Include both commercial and precommercial thinning as priorities. Emphasize treatment of key areas that have excess density or fuel accumulations, or areas with greater fire ignition risk.

Stand Structure and Composition

The increase in late seral species, primarily true firs, is beyond historic ranges. Multiple-layered canopies are much more prevalent today than in the past, increasing the probability of crown fires.

Recommendations

Design thinning and other stand management practices to emphasize growth and development of early seral species, especially ponderosa pine. Remove or reduce the stocking of true firs where this would liberate the pines or Douglas-firs. Identify stands where use of prescribed fire (usually in conjunction with timber harvest) would be feasible.

Lack of Large Trees

The reduction in stands of large trees, is an important change affecting wildlife. For example, eagles nesting near Upper Klamath Lake are dependent on large pines or Douglas-firs with flat tops or structures. Replacement of the existing nest trees could be a problem in the future, unless recruitment is planned for.

Recommendations

Emphasize thinning to accelerate growth of ponderosa pine and Douglas-fir in areas where large trees are important features. This includes stands identified as Late Successional Reserve or Eagle Habitat. Selectively remove excessive stocking of white fir.

4.3.2 Terrestrial Wildlife

The watershed contains habitat for several species listed as threatened, endangered, Forest Service Sensitive, and/or Survey and Manage. Aside from spotted owls and bald eagles, there is very little biological data on other wildlife species that are either known or have the potential to occur within the watershed. This makes it difficult to understand and properly manage resource programs in a way that is compatible with all biological resources, in addition to assessing the effects of ecological functions and processes.

The changing landscape patterns resulting from land management practices of the last century have had dramatic effects on the ecology of forests in the Pelican Butte Key watershed. Historically, fires likely created a mosaic of different age class stands that provided a variety of habitat types within the watershed. These habitat types moved spatially and temporally across the watershed in an approximately 20 to 60 year cycle. Fire killed trees, creating snags and coarse woody debris.

Forest management and modern fire suppression techniques have allowed for the control of fires at their ignition point, substantially limiting natural- and anthropogenic-caused fires in the Pelican Butte Key watershed. Logging, both thinning and stand-replacement harvest methods, has occurred in the place of fires. These changes have altered forest structure, ecosystem function, and wildlife habitats. As a result, fire currently plays a much smaller role in shaping the landscape within the watershed.

The road network (3.3 miles/square mile) can serve as a conduit for introduction of exotic plant and animal species into the forest landscape. Exotic species compete with, and sometimes outcompete, native flora and fauna. This is especially a problem for the remaining late successional stands in the LSR where interior forest species already are vulnerable to reduction in numbers.

Roads, whether gated or not, provide increased human access that could lead to wildlife poaching, or accidental or purposeful wildlife harassment, and could provide potential access for human-caused fires. Roads affect wildlife habitat by fragmenting it and providing avenues for non-native species. Roads that bisect the LSR reduce the effectiveness of these areas as connectivity corridors and increase the amount of edge, thereby reducing value of the areas for certain wildlife species. Additionally, roads may act as barriers to less mobile species, diminishing their ability to move through otherwise suitable habitat.

Management of lands within the Pelican Butte Key watershed for rural residents has resulted in long-term exclusion of forest habitat from approximately 200 acres of the watershed. This primarily has occurred along the forest/marsh interface area along the eastern boundary of the watershed. The construction of homes and access roads, including Westside Road, has likely altered species movements between these two distinct habitat types. Upland areas that may have provided a necessary habitat for certain life stages of aquatic-based species may no longer be accessible or have been reduced in extent. Movement of less mobile upland forest species to the marshlands may be blocked by the Westside Road and other smaller access roads. In addition, general habitat alteration and increased levels of human disturbance have reduced the value of this area to a variety of wildlife species.

Changes in hydrology caused by diking, dredging, and flooding has altered water flow and possibly water quality in Recreation and Crystal Creeks. Aquatic species, such as mollusks, spotted frog, and western pond turtle, may have been affected.

Rural homesites and recreationally managed lands may act as a barrier to less mobile species and/or a corridor for exotic species to enter the watershed. Domestic dogs can cause serious impacts on wildlife. Dogs prey on a wide variety of animals, from big game to rodents and birds. The presence of barking dogs can result in reduced use or avoidance of an area by wildlife. Domestic cats prey on small mammals, birds, and snakes. Repeated hunting by cats in the same area can result in locally reduced populations of some small bird and mammal species.

Spotted Owl

Fire suppression activities over the last century may have actually increased the amount and connectivity of spotted owl habitat within the watershed. Due to fire suppression, white fir has increased in acreage and age class throughout the portion of the watershed below approximately 5,000 feet elevation. The white fir zone has developed closed canopies in stands that historically contained low canopy coverage, thus allowing spotted owls to use these areas. In addition, the increase in white fir has created a greater amount of connectivity between prime habitat areas that were historically separated by non-habitat. Furthermore, the reduction of fire has allowed forests to develop a greater number of late successional forest attributes. Snags and downed logs persist over longer periods of time, and a greater percentage of the forest is made up of closed canopy stands.

Logging within the watershed has offset some of the increases in spotted owl habitat from fire suppression. Regeneration harvests have effectively removed all habitat from certain areas while thinning has likely resulted in the conversion of nesting/foraging habitat to dispersal habitat. Logging also has removed large diameter ponderosa pine and Douglas-fir trees that were suitable for nesting. Stands harvested to levels below that required for dispersal may prevent spotted owls from moving through otherwise suitable habitat.

Currently, spotted owl NRF habitat is well distributed in the watershed, and connectivity to other watersheds is relatively good. As a result of past timber management within the watershed, some portions of the NRF habitat occur as narrow corridors through areas of non-habitat. These narrow corridors are vulnerable to catastrophic events such as fire, disease, and/or insect outbreaks. Severing of these habitat corridors could result in a loss of connectivity between otherwise suitable NRF habitat.

Bald Eagle

Historic timber harvest activities within the watershed concentrated on the selective logging of the large diameter trees used by bald eagles for nesting. Fire suppression has resulted in an increase in the amount of white fir that competes with ponderosa pine, sugar pine, and Douglas-fir--trees most often selected by eagles for nesting. Currently, there are enough suitable nest trees to support the local bald eagle population; however; these trees are not being replaced as quickly as they die. Continued stand prescriptions to accelerate the recruitment of large pine and Douglas-fir trees likely will be necessary to increase the number of bald eagles nesting within the watershed.

Foraging areas for bald eagles are located in lake and wetland habitats outside of the watershed boundaries. Loss of foraging areas around Upper Klamath Lake and the reduction in the prey base is a concern. Prey availability is believed to be the primary limiting factor for eagle populations in the Klamath Basin; therefore, it can be assumed that the reduction in the number of waterfowl and open water foraging areas has reduced the number of eagles that could potentially occur within the Pelican Butte Key watershed. If additional reductions in the number of waterfowl and open water foraging areas continue, the maximum number of eagles that can be supported within the watershed will decline, even if an abundance of high quality nesting and roosting habitat is available.

<u>Recommendations</u>

General

Decommission, where possible, roads that occur within, or bisect, the LSR; promote revegetation and reduce fragmentation of these areas.

Close and/or decommission roads in an attempt to reduce overall road density. This will improve habitat quality for wildlife species sensitive to human activity.

Control exotic species (plants and animals) that are harmful to native biota.

Spotted Owl

Where conflict exists between management for bald eagle and spotted owl habitat in the LSR, the following issues should be considered:

- The health and status of the bald eagle population in the Klamath Basin and in the Pacific Northwest compared to the health and status of spotted owl populations on the District and in the Pacific Northwest.

- The availability of spotted owl habitat corridors between the Pelican Butte Key watershed and adjacent watersheds.

- The sustainability of spotted owl habitat in bald eagle management areas.

In areas where spotted owl NRF habitat occurs in narrow corridors, manage adjacent stands to provide NRF habitat in the near future. In addition, through stand management, attempt to connect areas of NRF habitat that are severed by non-habitat to increase habitat connectivity within and through the watershed. This will reduce the likelihood of the loss of NRF habitat connectivity from catastrophic events.

Bald Eagle

During management activities, retain all large pine and Douglas-fir snags where feasible. Manage stands to grow large recruitment trees.

Continue stand prescriptions to accelerate the recruitment of large pine and Douglas-fir trees to increase the number of bald eagles nesting within the watershed.

Forest/Marsh Interface

There is not adequate information to make recommendations for restoring wetlands and uplands along Crystal and Recreation Creeks and the shoreline of Upper Klamath Lake. Because of the changes in lake hydrology (3.3 feet lake level rise), presence of residential areas, and the number of roads, both private and public, reversing impacts of past management may not be possible in many cases. In addition, portions of the forest/marsh interface area are influenced by conditions on private land where restoration efforts would likely conflict with current uses.

Restoration activities should be broad scale and take into consideration impacts from outside the area. Other Klamath Lake shoreline restoration projects (for example, Williamson River and Running Y Resort) should be reviewed for successes and failures.

4.3.3 Aquatic Habitat and Channel Condition

Habitat loss and degradation have been identified as two of the leading factors influencing the decline of both anadromous and resident fish species in the Pacific Northwest since the turn of the century (USDA, et al., 1993). These factors appear to have led to the decline of native fish species in the Upper Klamath Basin, with three species extirpated, two endangered, one threatened, and six others listed as USFS Region 6 Sensitive.

Habitat loss and degradation in the Pelican Butte Key watershed can be attributed to, but may not be limited to, damming, decreasing water quality, exotic species introduction, and lack of instream cover complexity. Except for instream cover complexity, these deficiencies result from basin-wide influences and can be linked to the processes identified at the beginning of this chapter, including timber management, non-timber (agricultural and residential) uses, and management of Upper Klamath Lake.

Many of these processes were identified in the final listing for the endangered suckers as reasons for the overall decline of sucker populations in the Upper Klamath Basin. These reasons included damming of rivers, instream flow diversions, hybridization, competition and predation by exotic species, restricted range of habitat, dredging and draining of marshes, and water quality problems associated with timber harvest, removal of riparian vegetation, livestock grazing, and agricultural practices (Stubbs and White, 1993).

The Pelican Butte Key watershed comprises less than 1% of the Upper Klamath Basin and has contributed little to the basin-wide decline of aquatic habitat. Timber management in the Pelican Butte Key watershed has had a limited impact on aquatic habitat in Crystal and Recreation Creeks. Riparian zones on Federal lands bordering these stream systems are now restricted from harvest. Sediment delivery from road building does not appear to be a major concern in the Pelican Butte Key watershed. The lack of flowing surface water combined with the porous nature of soils within the watershed limit deliverability of sediment to Recreation and/or Crystal Creeks.

Crystal Creek was dredged in 1909 to facilitate passage for tourists traveling by ferry to Crater Lake. These dredged channels were used for barging and log rafting, providing indirect impacts from timber management activities outside of the Pelican Butte Key watershed. It is likely that Recreation Creek also was dredged, due to similarities in channel form, the lack of large woody debris present instream, and its current use for canoeing and boating. Prior to dredging and construction of the Link River Dam, these channels would historically have been shallower, held water at elevated levels for a shorter duration, and probably had less of a defined channel than what is found today. Habitat likely was more complex, having less deep, open water and more LWD, terrestrial and aquatic vegetation for cover.

Recreation and residential development (non-timber processes) have affected habitat conditions in the Pelican Butte Key watershed. In places, the riparian zone was converted from its natural state to conditions suitable for houses, yards, and the Rocky Point Resort. In addition, wetland vegetation was cleared, opening up views and passages to facilitate boat and canoe access to the waterways. This effectively reduced the riparian zone's potential for LWD recruitment into Recreation and Crystal Creeks, while also reducing the buffering capacity of the wetland vegetation. Disturbing marshland tends to aerate soils, increasing pH, phosphate releases from the peat, and aerobic decomposition of nitrogen (Stubbs and White, 1993).

Water quality poses one of the most significant threats to fish and other aquatic biota in the watershed. High water temperatures, low dissolved oxygen, and elevated pH levels (>10) are an annual problem in Upper Klamath Lake. Although Recreation and Crystal Creeks are known to have better water quality than found in the lake, data shows that standards for temperature, pH, and dissolved oxygen have been violated for resident fish and aquatic life in lower Crystal Creek. Nutrient production is naturally high in the basin; however, agricultural runoff appears to contribute the bulk of the nutrients to lake eutrophication. Studies in 1967 and 1982 reported that agricultural input from pumps and canals account for 31% of the phosphorous entering the lake, despite only 12.4% of the lake's inflow. High nutrient levels produce blue-green algal blooms during the summer which coincide with high water temperatures and fluctuating dissolved oxygen levels. The high production and die-off of this algae are the cause of the drastic fluctuations observed in dissolved oxygen and pH in the lake (Stubbs and White, 1993).

Management of Upper Klamath Lake, including water level and fisheries management, has had significant impacts on fisheries in the Pelican Butte Key watershed. In 1917, dam construction began within the Klamath River Basin, resulting in a tremendous loss of fish habitat. Dams prevented all anadromous fish runs from returning to the Upper Klamath Basin, while providing migration barriers to resident fish species.

To compensate for losses to the anadromous fishery in the basin, a basin-wide fish stocking practice was deployed by state and federal governments. Initial introductions were made by the Oregon Fish Commission and were limited primarily to salmonids (rainbow, brook trout, brown trout, chinook, coho, and kokanee). Beginning in the 1930s, the ODFW began stocking largemouth bass, crappie, yellow perch, carp, and brown bullhead to diversify the fishery (Logan and Markle, 1993).

Of the numerous fish species that currently inhabit the Upper Klamath Basin, only 17 are native. Nearly 20 fish species have been introduced to the watershed since the turn of the century. The introduction of exotic fish species has significantly changed the aquatic ecosystem in the Upper Klamath Lake and Recreation Creek basins. Exotic species compete with native species through predation and/or competition for habitat and food resources. Blue chub were once the lake's most numerous fish species; today the illegally introduced fathead minnow has become the most common fish in the lake.

Since fish abundance and distribution can be directly linked to habitat complexity and quality, enhancement opportunities should focus on restoration of habitat complexity and water quality in the watershed. Management direction should focus on objectives described under the Aquatic Conservation Strategy (USDA and USDI, 1994b).

Recommendations

Recommendations specific to the Pelican Butte Key watershed include:

To increase habitat complexity, and restore the physical integrity of the aquatic system, limit future clearing of riparian and marsh vegetation and dredging of Recreation and Crystal Creeks and their springs.

Since water temperature, dissolved oxygen levels, and pH already have been identified as critical components to survival of aquatic species, they should be monitored on a regular basis. Seasonal monitoring studies would allow the District to better monitor water quality in the watershed. These spring-fed systems appear to be important for fish refuge in the late summer months as water quality conditions decline in Upper Klamath Lake.

Management direction specific to Key Watersheds states that no new roads will be built and efforts shall be made to reduce existing system and non-system road mileage outside roadless areas. Roads deemed unnecessary for management should be closed or decommissioned.

To monitor changes in the quality of aquatic habitat and the abundance and distribution of fish, a series of baseline studies are recommended. Very little information exists on fish population or distribution in the Pelican Butte Key watershed. Seasonal fish sampling surveys should be performed in Recreation Creek, Crystal Creek, and Malone Springs to confirm which species use these systems, and the timing and life stage of that use. Spawning, refuge, and rearing studies should be performed to identify areas critical to fish production in the watershed.

Data Needs

Monitor water quality in Recreation and Crystal Creeks and at Malone Springs.

Conduct fish population surveys.

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