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Recreation Creek Watershed Analysis

Prepared for

Pelican Butte Corp.
U.S. Forsest Service

Prepared by

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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 Recreation Creek watershed (Pelican Butte 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).

The focus of this watershed analysis was to characterize the physical and biological processes and interactions of the Recreation Creek 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 Tribe, U.S. Forest Service (USFS), U.S. 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 appendices and accompanying GIS analysis files should provide sufficient detail for resource managers to facilitate a more site-specific analysis (i.e., National Environmental Policy Act [NEPA] planning).

A watershed analysis is recognized as an iterative process that evolves as information gathering and analysis techniques are refined. The initial analysis of Recreation Creek was based on existing and available data, providing a framework on which to build future analyses.

The Recreation Creek watershed analysis was conducted by the following interdisciplinary team of professional resource specialists:

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1.0 STEP 1 – CHARACTERIZATION

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

1.1 Physical Characteristics

The Recreation Creek watershed, also commonly known as the Pelican Butte watershed, has a drainage area of approximately 10.9 square miles (approximately 6,950 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 (see General View Map, 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 which 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 4,100 feet to 8,000 feet near Pelican Butte summit (approximately 0.25 meter below summit). Most of the watershed (97%) is located on USFS lands, administered by the Klamath Ranger District of the WNF. Tracts of private land, totaling nearly 195 acres, are located primarily along the lower portion of the watershed bordering Recreation and Crystal Creeks. The Recreation Creek watershed is bordered on the east side by the Upper Klamath Wildlife Refuge, administered by the U.S. Fish and Wildlife Service (USFWS). A small resort, Rocky Point Resort, is located near the mouth of Recreation Creek at Rocky Point. It provides housing, boating, and canoeing opportunities for tourists, fisherman, and hunters on a year-round basis.

Road density in the Recreation Creek watershed is considerably lower (2.78 miles/square mile) than the average road density on the WNF (4.29 miles/square mile) (USDA, et al., 1993). Many roads on the eastern side of Pelican Butte are closed seasonally (January 7 to August 31) to protect wildlife in the watershed. 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).

Snowy, cold winters and dry, hot summers typify the climatic regime for the Recreation Creek watershed. Available weather data indicates that most of the annual precipitation falls in December and January, with less than 12% falling during the summer months. The Recreation Creek watershed accumulates greater than average snow depth due to the eastern 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). 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 Recreation Creek 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 intermittent 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 rates of the volcanics that form Pelican Butte result 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 Recreation Creek 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 from isolated springs at lower elevations provides most of the flow within Recreation Creek (Bunker, pers. comm., 1997).

The dominant hydrologic (flow) characteristics for the watershed include rapid infiltration of spring snowmelt and lack of perennial stream channels which 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 within the upper slopes of the Recreation Creek watershed most likely have changed little through time. Due to residential development at lower elevations in the watershed, however, the historic groundwater flow regime may be altered. 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 flow regimes have been altered. Alteration of the historic flow regime most likely is confined to increases in withdrawals at lower elevations for human uses resulting in depression of the local aquifer storage volume. Road building associated with logging within the Recreation Creek watershed also may have altered the historic flow paths. Due to the geologic nature of the area, including porous material and steep slopes, it is unlikely that logging has significantly altered the flow regime currently present within the watershed.

FEMAT classifies Pelican Butte (Recreation Creek) 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.

Two types of Key Watersheds were identified, Tier 1 and Tier 2. A total of 162 Key Watersheds were identified, including 139 Tier 1 and 23 Tier 2 (USDA, et al., 1993). Tier 1 Key Watersheds were identified as those directly contributing to conservation of at-risk fish species, specifically anadromous salmonids, bull trout, or resident fish species. Tier 2 Key Watersheds (Pelican Butte) were selected for their importance as sources of high quality water, these watersheds may not necessarily contain at-risk fish stocks (Tuchmann, et al., 1996).

Watershed analyses are required on Key Watersheds prior to implementation of 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 not net increase in amount of roads in Key Watersheds (USDA and USDI, 1994b).

The 1996 303(d) list of streams designated by the Department of Environmental Quality (DEQ) does not specifically list Recreation Creek as water quality limited; however, Agency Lake and Upper Klamath Lake, contiguous with Recreation Creek, are listed (DEQ, 1996). As designated in the Oregon Administrative Rules (OAR), official uses for the Klamath Basin waters including Crystal and Recreation 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.

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, pers. comm., 1997).

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).

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 (approximately 1,551 acres; 22% of the watershed) at the toe of the butte that are perennially inundated and constitute a portion of Upper Klamath Lake's western shore.

The "miscellaneous landtypes" (approximately 236 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 (5,112 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, generally tend to be more sensitive and regenerate and grow slower than those below 6,000 feet.

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

Inherent Fertility	Acres	Percent of Watershed
Not applicable (marsh lands)	1,551	22
Low	303	4
Moderate	184	3
High	4,861	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 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 it's resilience to recover from those impacts and resume functioning at it's 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 (Figure 7). Again, these soil types occur at the higher elevations along the shoulder slopes, ridge tops, and summit of the butte.

Table 2. Forest Soil Sensitivity to Disturbance

Inherent Sensitivity	Acres	Percent of Watershed
Not applicable (marsh lands)	1,551	22
Low	94	1
Moderate	5,211	76
High	43	1

1.2 Biological Characteristics

Vegetation within the Recreation Creek 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 Recreation Creek watershed follow an elevation gradient, rising through four vegetation zones (Franklin and Dyrness, 1973) from the Klamath Lake Basin to 0.25 mile 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. A variety of plant communities lie within these vegetation zones (Hopkins, 1979) which provide localized ecological classification and management inferences. The plant community map and Appendix Table 1 show the location and acreage of plant communities and vegetation zones.

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, is an important influence. Nevertheless, disturbance factors such as fire, wind, insects, diseases, and timber harvest have had greater influence on development of much 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.

Four different forested vegetation zones occur in the watershed (see Vegetation Community Type Map, Figure 8). Each zone contains more than one locally recognized plant association as described by Hopkins (1979). Non-forested communities occur on rock outcrops, talus and scree slopes.

Unique vegetation communities or special habitats occur in the Recreation Creek watershed. These generally are associated with Recreation and Crystal Creeks and the forest marsh interface of Upper Klamath Lake and the talus slopes, and rock outcroppings that occur in upper elevations of the watershed. There are no known sites that support Threatened, Endangered, and Sensitive plant species.

The scope of this analysis can not address all species that occur or are suspected to occur, therefore, only Threatened and Endangered, Candidate, Forest Service Region 6 Sensitive Species, and Survey and Manage species will be included. In addition, the watershed supports recreationally important species such as Rocky Mountain elk, mule deer, cougar, and black bear (Table 3).

Table 3. Federal and State Listed Wildlife Species Potentially Occurring in the Recreation Creek Watershed.

Species (common name)	Scientific Name	Status	Presence	Inventory
Northern spotted owl	*Strix occidentalis caurina*	FT	K	4
Bald Eagle	*Haliaeetus leucocephalus*	FT	K	4
Peregrine Falcon	*Falco peregrinus*	FE	S	1
Spotted Frog	*Rana pretiosa*	FC	U	3
Fisher	*Martes pennanti*	FC	K	2
Northwestern pond turtle	*Clemmys marmorata marmorata*	FS	S	3
California Wolverine	*Gulo gulo*	FS	U	1

Species (common name)	Scientific Name	Status	Presence	Inventory
Common Loon	*Gavia immer*	FS	K	1
American White Pelican	*Plecanus occidentalis*	FS	K	1
Ferruginous Hawk	*Buteo regalis*	FS	S	1
Greater Sandhill Crane	*Grus canadensis*	FS	K	1
Long-billed Curlew	*Numenius americanus*	FS	K	1
Tri-colored Blackbird	*Agelaius tricolor*	FS	U	1
Yellow Rail	*Coturnicops noveboracensis*	FS	S	2
Preble's Shrew	*Sorex preblei*	FS	U	N
Great gray Owl	*Strix nebulosa*	RS	K	1
Flammulated Owl	*Otus flammeolus*	RS	K	1
White-headed Woodpecker	*Picoides albolarvatus*	RS	K	4
Black-backed Woodpecker	*Picoides arctus*	RS	K	4
Pygmy Nuthatch	*Sitta pygmaea*	RS	K	4
Bats	*Various species See Section 3.2.2 Bats*	Various	K	4
Northern goshawk	*Accipiter gentilis*	MIS	K	1
Pileated Woodpecker	*Dryocopus pileatus*	MIS	K	2
American Marten	*Martes americana*	MIS	K	1
Northern Three-toed Woodpecker	*Picoides tridactylus*	MIS	S	2
Elk	*Cervus elaphus roosevelt*	MIS Game	K	1
Mule deer	*Odocoileus hemionus*	MIS Game	K	1
Bear	*Euarctos americanus altifrontalis*	Game	K	1
Cougar	*Felis concolor*	Game	K	1
Mollusks	*Various species See Section 3.2.2 Mollusks*	Various	K	4
Western Toad	*Bufo boreas*	SS	K	3
Horned Grebe	*Podiceps auritus*	SS	K	4
Red-necked Grebe	*Podiceps grisegena*	SS	K	1
Least Bittern	*Isobrychus exilis*	SS	K	1

Species (common name)	Scientific Name	Status	Presence	Inventory
Snowy Egret	*Bubulcus ibis*	SS	K	1
Barrow's Goldeneye	*Bucephala islandica*	SS	K	1
Bufflehead	*Bucephala albeola*	SS	K	1
Swainson's Hawk	*Buteo swainsoni*	SS	S	1
Upland Sandpiper	*Bartramia longicauda*	SS	U	N
Northern Pygmy Owl	*Glaucidum gnoma*	SS	K	1
Common Nighthawk	*Chordeiles minor*	SS	K	1
Lewis' Woodpecker	*Melanerpes lewis*	SS	K	1
Willianson's Sapsucker	*Sphyrapicus thyroideus*	SS	K	1
Olive-sided Flycatcher	*Contopus borealis*	SS	K	4
Willow Flycatcher	*Empidonax traillii*	SS	K	4
Purple Martin	*Progne subis*	SS	S	4
Bank Swallow	*Riparia riparia*	SS	S	4
Loggerhead Shrike	*Lanius ludovicianus*	SS	S	4
Yellow-breasted Chat	*Icteria virens*	SS	S	4
Vesper Sparrow	*Pooecetes gramineus*	SS	U	4
Western Bluebird	*Sialia mexicana*	SS	S	4
Western Gray Squirrel	*Sciurus griseus*	SS	K	N

Key:

Status
FT = Federal Threatened
FE = Federal Endangered
FC = Federal Candidate
FS = Forest Service Sensitive
RS = ROD Species
MIS = Management Indicator Species
SS = State Sensitive

Inventory
4 = Surveys to Protocol
3 = Structured surveys not to protocol
2 = Structured spot surveys
1 = Casual, unstructured surveys
N = No surveys completed

Presence
K = Known
S = Suspected
U = Unknown

Federally listed wildlife species that are known to occur in the watershed include the threatened Northern spotted owl *(Strix Occindentalis)* and bald eagle (*Haliaeetus leucocephalus*).

There are three spotted owl activity centers representing three pairs located in the watershed. Private lands and developed areas within the watershed provide limited or no spotted owl nesting or roosting habitat and are not expected to provide this habitat in the future.

Recreation Creek is located within bald eagle Management Zone 22 (Klamath Basin) as described in the Pacific Bald Eagle Recovery Plan (USDI, 1986). There are two known bald eagle territories centered in the watershed, with another two overlapping into the watershed. These territories contain 11 nest sites and represent four pairs of nesting bald eagles. The WNF designates a large portion of the lower watershed as bald eagle habitat (USDA, 1981).

The great gray owl (*Strix nebulosa;* GGO) is identified in the Northwest Forest Plan as a Protection Buffer Species (USDA and USDI, 1994a). GGOs are most common in lodgepole pine forest areas adjacent to meadows, however, they also are found in other coniferous forest types. Some shelterwood harvesting systems found in the watershed may have created suitable habitat for the species by opening up otherwise closed-canopy cover for foraging. There are no known GGO pairs within the watershed, however, occasional sightings of single birds have been documented within the watershed. There is no other information on abundance or distribution of GGOs or their habitat in the Recreation Creek watershed.

Various bat species also have been identified as Forest Service Sensitive (USDA, 1990). There are 12 bat species that have ranges that include Pelican Butte.. Bats breed and roost in cavities in large trees and snags, including cracks and deep fissures of bark. Caves, pit mines, and bridges also provide habitat. There are no pit mines or known caves in the watershed.

Recreationally important species such as elk, mule deer, mountain lion, and black bear are all known to occur within or in close vicinity to the Recreation Creek watershed. Specific surveys for these species have not been conducted by the WNF in the watershed.

The Northwest Forest Plan identifies the following management areas within the watershed area (Table 4):

- 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 and the bald eagle. There are approximately 3,120 acres of lands designated as LSR within the Recreation Creek watershed.

- 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 both the LSR and Matrix designated lands within the Recreation Creek watershed area (see Land Allocation Map, Figure 4).

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

    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.

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

- 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.

- Areas designated as Semi-primitive Recreation, Developed Recreation, and Timber Production also are located within the watershed area.

Table 4. Acres of Federal Land Allocation Within the Pelican Butte Watershed Analysis Area.

LAND ALLOCATION	ACRES
LSR	3,123
Matrix	2,482
Bald Eagle Nest Habitat	585
Bald Eagle Nest Replacement Habitat	2,081
Bald Eagle Winter Roost Habitat	168
Riparian Reserves	10
Semi-primitive Recreation	1,330
Developed Recreation	337
Private Lands	167

Geographic isolation, formed by tectonic plate activity, has resulted in habitat with diverse speciation in the Klamath basin. A total of 37 fish species are known to inhabit the Upper Klamath basin, 17 of which are native, and 8 of which are endemic. The remaining 20 fish species have been introduced to the watershed (Logan and Markle, 1993). In addition, the Miller Lake lamprey, a fish species once endemic to the basin, is now considered extinct.

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 mouth of Upper Klamath Lake in 1919 (USDA, 1993). The lower dams do not allow fish passage, and have consequently extirpated anadromous fish runs to the Upper Klamath basin (including Recreation Creek).

Four anadromous fish species historically inhabited the Klamath basin, including steelhead (*Oncorhynchus mykiss*), bull trout *(Salvelinus confluentus)*, chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). Although rainbow trout are still present in the basin today, they are the result of ODFW stocking programs. Remnant populations of bull trout also are found in the basin, with known populations occurring in Threemile Creek and Wood River (Kann, pers. comm., 1997). There are no known records documenting the existence of bull trout in Recreation or Crystal Creeks.

Two endangered fish species and three Species of Concern currently inhabit the Upper Klamath watershed (adjacent to the Recreation Creek watershed). The Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*) were listed as endangered by the USFWS in 1988 (USDI, 1988). Although never documented, it is suspected that these suckers may have historically spawned in Crystal and/or Recreation Creeks. Fish Species of Concern in the basin include the Klamath largescale sucker (*Catostomus snyderi*), Pacific lamprey (*Lampetra tridentata*) and the slender sculpin (*Cottus tenuis*).

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, aquatic and terrestrial vegetation are the dominant forms of cover for fish in these systems. Although many pieces of large woody debris (LWD) were noted in the channel, most were small, single pieces, partially embedded in the substrate, providing little cover for fish (Shapiro & Associates, Inc., 1997a).

The spring-fed water conditions in Recreation Creek provide cooler temperatures and better water quality for fish avoiding undesirable summer and fall conditions in Upper Klamath Lake.

The hypereutrophic nature of Upper Klamath Lake contributes to periodic outbreaks of a bacterial gill infection, *Flexobacter columnaris*, which was the causative agent for a massive fish kill in 1971. Approximately 15 million fish were killed during this outbreak, most were Tui chub but some suckers and trout also were affected. Several other fish die-offs were reported to have taken place in the lake since 1971 (U.S. Bureau of Reclamation, 1992, 1996; Beuttner, 1997), although none as severe . The latest die-off associated with this infection was recently observed in 1997 (Kann, pers. comm., 1997).

Salmonid specific protozoan parasites (*Ceratomyxa shasta*) are also present, and parasitic zooplankton (*Copepod spp.*) infest the lake system (ODFW, 1981). Past stocking strategies designed to increase rainbow trout populations in the lake have not always proved successful, possibly due to the presence of the various fish pathogens. In addition, microcytin, a potent liver toxin, has recently been found in algae products from the lake.

A survey was conducted on July 31, 1997 for rare, threatened and endangered aquatic invertebrates in the Recreation Creek watershed (Wisseman, 1997). Species surveyed for included the Shuh's Homoplectran caddisfly (*Homoplectra schuhi*; Species of Concern), Alsea micro caddisfly (*Ochrotricha alsea*; Sensitive), Fischer's caddisfly (*Lepidostoma fischeri*; Candidate), and Cascades apatanian caddisfly (*Apatania [radema] tavala;* SOC/S). No habitat that would be remotely suitable for any of the above listed species was found in Recreation Creek.

2.0 ISSUES AND KEY QUESTIONS - STEP 2

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 Recreation Creek watershed are:

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

The watershed analysis will attempt to answer questions developed for each issue.

2.1 Water Quantity And Quality

Water quantity and quality are important issues for the Recreation Creek 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 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 productivity)?
- Is surface erosion a problem in the watershed? What are the locations of surface erosion in the watershed?
- What is the windthrow potential?

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 150 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 (e.g. age, species composition).

2.2.3 Forest Fragmentation

- Is habitat fragmentation (functional and structural) an issue in the Recreation Creek watershed?

2.2.4 Rare plants

- What Threatened, Endangered, and Sensitive species, Species of Concern, 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?

2.3 Terrestrial Wildlife

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

2.3.1 Late Successional Forest Habitat

- What species of wildlife are associated with late successional forest habitat?
- What forest stands are providing adequate snag numbers? Coarse Woody Debris?
- What is the relationship of LSR habitat in this watershed with surrounding LSR habitat?

2.3.2 Late Successional Dependent Species

- How many spotted owls occur within the watershed?
- How many acres of spotted owl nesting, roosting, and foraging (NRF) habitat are in the watershed? What is the distribution of spotted owl NRF habitat in the watershed? What percentage of the watershed does this represent?
- What is the location, current condition and distribution of bald eagle NRF habitat in the watershed? What percentage of the watershed does this represent?
- How many GGO occur in the watershed? What is the quality of GGO habitat?

2.3.3 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?

2.3.4 Special Habitats

- What are the locations of special habitats, such as springs, seeps, meadows and scree slopes?
- Which species are dependent on these special habitats?

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 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?

2.5 Biological Diversity

- How have wildlife and plant habitats been altered by timber harvest, fire suppression, and diking/draining of wetlands?
- What is unique about this watershed in terms of biological diversity?
- How is the watershed currently functioning in terms of providing biological diversity?
- How is it expected to function in the future?

3.0 CURRENT AND REFERENCE CONDITION - STEPS 3 AND 4

Step 3, 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.

Step 4, 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 Recreation Creek 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. Even before logging began in the forests surrounding Pelican Butte, many of the timber stands were open or patchy, particularly on the lower slopes. As a result, snow interception by the tree canopy would have varied greatly. 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 (USDA, 1993).

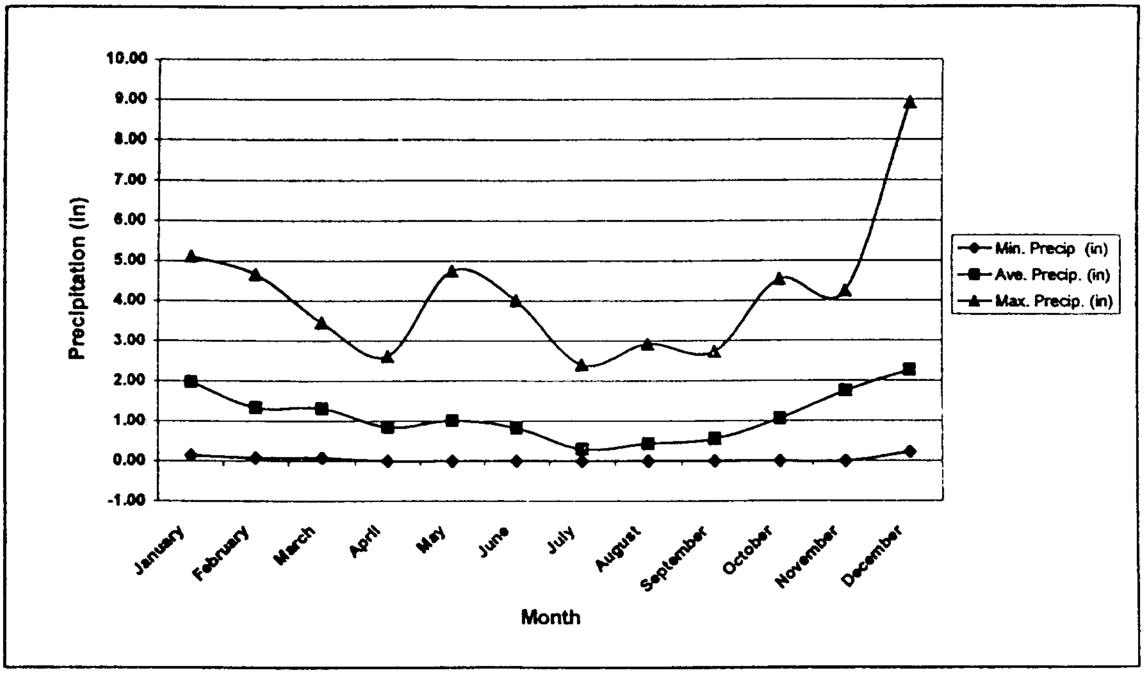
The geology of Pelican Butte influences the surface hydrology within the Recreation Creek watershed. The porous nature of the butte results in rapid infiltration of spring melt that results in little or no hillslope fluvial processes. As a consequence there is no evidence of flowing surface waterbodies 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 Recreation Creek 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 southeast of the Recreation Creek watershed and may represent a different climatic zone than Pelican Butte. The 69-year period of recorded weather data (1928-1997) shows that most of the annual precipitation falls in December and January, with less than 12% falling during the summer months (Graphic1). Within the Recreation Creek 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 Recreation Creek watershed accumulates greater than average snow depth due to the eastern 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).

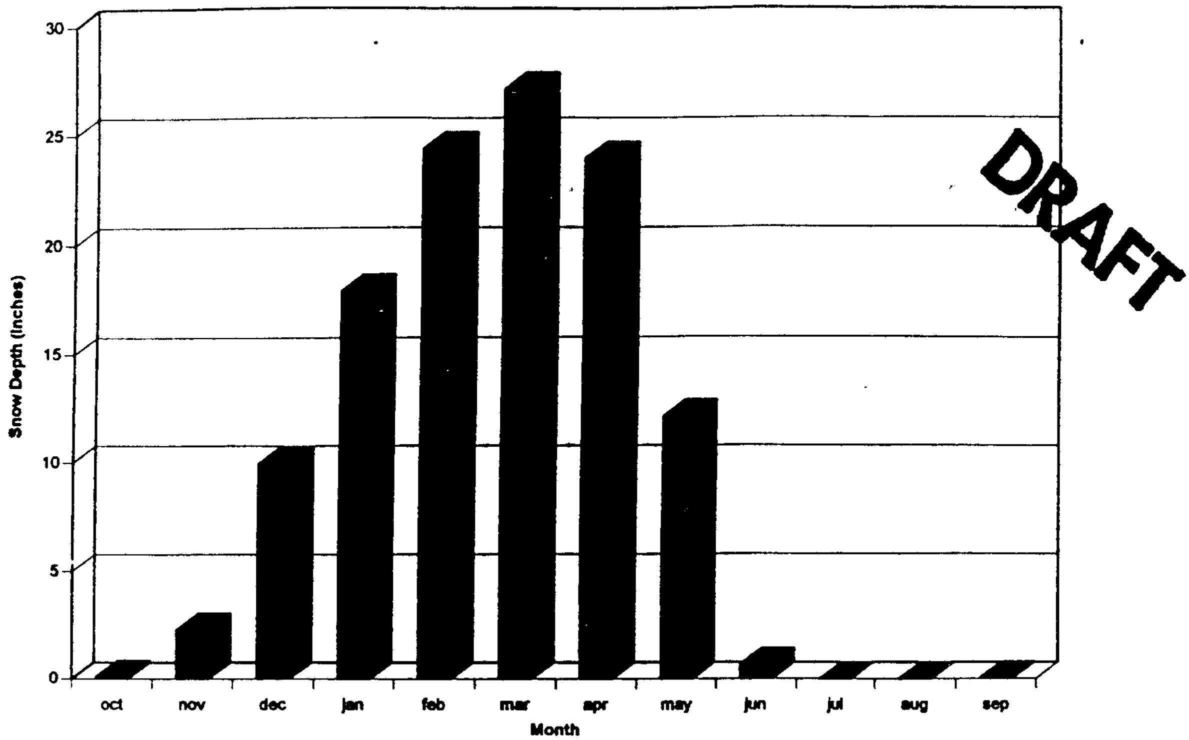
Lower amounts of precipitation concurrent with high air temperatures occur during the summer months. Frequent thunderstorms also accompany the summer months. Due to the rain shadow effect of the Cascades, annual precipitation decreases from the crest of Pelican Butte to the lower elevations. Average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

Graphic 1. Precipitation for Klamath Falls, Oregon (1928-1997)



Snowtel data from the northwestern side of Pelican Butte at Cold Springs 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). The timing and duration of spring rains heavily influence the timing of 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 Recreation Creek watershed. Infiltrated spring melt recharges the deep aquifers and eventually discharges as baseflow within Recreation Creek and from perennial springs within the watershed. There is one mappedperennial spring located within the watershed (Malone Spring, approximate elevation 4,100 feet) and a series of 12+ unnamed springs at bottom of watershed.

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



Based on preliminary data (Bunker, pers. comm., 1997) there are two basic groundwater systems: a locally perched groundwater system reflected in the intermittent lakes on the Butte; 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 direct precipitation and snowmelt with 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 dam that has altered the base level elevation of the Upper Klamath Lake. This human alteration may have resulted in a higher and more constant water level within Recreation and Crystal Creeks. Logging within the Recreation Creek watershed included the clearing of land predominantly at lower elevations. This is expected to have had little influence on hydrology due to the lower precipitation rates at these elevations and a 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 and 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 Recreation Creek watershed. 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 of Water in Recreation Creek and its Tributaries

<u>Beneficial Uses Established by the State of Oregon</u>

The 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 waters identified in the Recreation Creek watershed; those that occur on USFS lands; and those that are potentially negatively affected by USFS management activities. Beneficial uses occurring in the Recreation Creek watershed and on USFS lands were determined through discussion with USFS staff, examination of water rights categories, and field observations.

Table 5. Beneficial Uses of Surface Water in the Recreation Creek Watershed

Beneficial Uses of Klamath Basin Waters Including Recreation Creek	Beneficial Use Occurs in Recreation Creek Watershed	Beneficial Use Occurs on USFS Lands	Beneficial Uses in Recreation Creek Watershed Potentially Affected by USFS Activities
Water Supply - Public, Private, and Industrial	Y	Y	Y
Irrigation and Livestock Watering	Y	N	N
Salmonid Fish Rearing and Spawning	Y	Y	Y
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

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).

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

Water Quality Parameter	Primary Beneficial Use Protected
Dissolved Oxygen	Fisheries and Aquatic Life
Bacteria	Water Contact Recreation
pH	Fisheries and Aquatic Life
Temperature	Fisheries and Aquatic Life
Turbidity	Fisheries and Aquatic Life
Total Dissolved Gas	Fisheries and Aquatic Life
Total Dissolved Solids	Drinking Water
Toxic and/or Carcinogenic Compounds	Drinking Water, Fisheries, and Aquatic Life

Additional beneficial uses protected by these standards include aesthetics, livestock watering, wildlife, and irrigation water supply.

Numeric water quality standards established by DEQ for the Klamath Basin (OAR 340-41-962) that are applicable to the watershed are shown in Appendix Table 2, located in the appendix of this report. These water quality standards were adopted by the EQC and became effective July 1, 1996.

State Reporting on Status of Water Quality

The DEQ reports on the condition of State waters in the *Biennial Water Quality Status Assessment Report*, also known as the 305(b) report, because section 305(b) of the Clean Water Act requires the state to produce and submit the report to the Environmental Protection Agency (EPA) every two years. In the 305(b) report, Oregon tracks its progress toward the goals of the Clean Water Act, describes activities and accomplishments of the DEQ Water Quality Program, and discusses water quality problems that need to be addressed. The most recent 305(b) report was issued in April 1994.

When existing required pollution controls are not stringent enough to achieve the State's water quality standards, section 303(d) requires the State to identify those water bodies. 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). The final 303(d) list of "water quality limited" streams for the 1994 305(b) report was issued in July 1996. Recreation Creek and Crystal Creek are not listed as "water quality limited." Upper Klamath Lake is listed as "water quality limited." The listing and the lake's water quality are discussed more fully in a subsequent section.

Water Quality Data and Characterization

Quantitative Water Quality Data

No water quality data is available for waterbodies within the boundary of the watershed analysis. The U.S. Bureau of Reclamation collected water quality data at two locations downstream from and outside of the watershed analysis boundary in 1991 and 1992 as part of an Upper Klamath Lake Wetlands Study (Sartoris, et al., 1991, 1992). The data has not been extrapolated to the Recreation Creek watershed analysis because of uncertainty about the effects of Upper Klamath Lake water quality on the water quality of the lower portion of Crystal Creek, where the monitoring occurred. The Bureau of Reclamation data shows that water quality in Crystal Creek near Upper Klamath Lake 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.

Other Sources Contacted for Water Quality Data

The following additional agencies and sources were contacted regarding existing water quality data:

Larry Caton, DEQ Environmental Specialist (pers. comm., 1996) was supplied with geographic coordinates of a polygon encompassing the Recreation Creek watershed. A search of the EPA STORET database, based on the polygon, revealed that no stations or data exist within the watershed. STORET is the main national database for water quality data and contains data from EPA, U.S. Geological Survey, and other federal and state agencies, including Oregon DEQ.

Mike Berg, U.S. Bureau of Reclamation (pers. comm., 1996) was unaware of the availability of any water quality data for Recreation and Crystal Creeks other than that collected by the Bureau of Reclamation (Sartoris, et al. 1991, 1992) and discussed previously.

Characterization of Water Quality in the Upper Klamath Basin

Crystal and Recreation Creeks are not monitored as part of the DEQ ambient water quality monitoring network and are not reported on in the 305(b) report.

Several waterbodies in the Upper Klamath Lake watershed are listed as "water quality limited" in the DEQ's 1996 303(d) list. Those waterbodies are: 1) Agency Lake, listed as water quality limited for chlorophyll a in summer, dissolved oxygen for cool water aquatic life in summer, and pH in summer; 2) Rock Creek, water quality limited for habitat modification and temperature in summer; 3) Threemile Creek, water quality limited for habitat modification; and 4) Upper Klamath Lake, listed as water quality limited for chlorophyll a in summer, dissolved oxygen for cool water aquatic life in summer, and pH in summer.

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 Recreation Creek and Upper Klamath Lake. Recreation Creek 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).

Conditions of Beneficial Uses and Associated Parameters

No data is available to evaluate water quality related to any of the beneficial uses within the Recreation Creek watershed. However, the USFWS has identified Recreation Creek as important refugia habitat for fish during stressful summer conditions (USDI, 1994b).

Conclusions

As discussed previously, no data is available to evaluate water quality related to the designated beneficial uses. However, it is important to note again 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 likely 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 wetland and riparian vegetation, and homebuilding, may have impacted water quality in the creeks.

USFS management activities within the watershed may potentially affect the beneficial uses of surface water within the watershed and on USFS lands.

3.1.3 Soils and Erosion Processes

Reference Condition

Erosion and Sediment Regime 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 Recreation Creek 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 6,950-acre watershed are described and mapped in the WNF's Soil Resource Inventory (SRI) prepared by Carlson (1979; Figure 5). The inventory provides an 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 also 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 6), even on slopes greater than 20%. 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 current, primary, <u>reference</u> sediment producing processes in this watershed (Swanson, et al., 1982). Consequently, current reference surface erosion and sediment production rates are low.

Additionally, 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 <u>surface</u> 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 also 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)	1,551	22
Low	4,549	65
Moderate	388	6
High	462	7

<u>Mass Wasting Potential</u>

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 Klamath marsh, presumably during the wet season.

Windthrow

Windthrow potential is dependent on a variety of factors, including:

1. Topography and Storm Patterns. The watershed is generally on the leeward side of the prevailing wind and storm tracks that originate from a south-to-southwest quadrant. Occasional east winds or erratic winds associated with thunderstorm activity can have minor effects.
2. Tree or Stand Location. Trees in exposed ridgetop locations in this watershed have generally developed windfirm characteristics. Timber stands in other locations are generally protected from stormtrack winds, due to the generally east aspect.
3. Root Disease. Trees affected by root disease are highly susceptible to windthrow. In the Recreation Creek watershed, white fir stands comprise the highest risk.
4. Stem Decay. Stem decay also predisposes trees to failure from breakage. Again, white fir is the most susceptible species.
5. Tree Form. Many trees that have developed within dense timber stands have small diameters in relation to their height, poorly developed root systems, and short, narrow crowns. If these trees are exposed to high winds, they are susceptible to windthrow. Conversely, whitebark pines and mountain hemlocks on exposed ridgetop locations have developed tree forms that deflect wind over the canopy. Such trees are seldom windthrown.
6. Soil. Rooting depth also affects windthrow potential. Rooting depth is a function of depth to water table, depth to root restricting layers, soil moisture content, and the amount of rock in the soil. In the Recreation Creek watershed, total soil depth and the amount of rock in the soil are generally the most restrictive elements.

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 30.3 miles (approximately 116 acres) of roads in the watershed, equating to a road density of 2.78 miles of road per square mile (Table 8), lower than the Forest wide standard and guideline identified by the Land and Resource Management Plan for the Winema National Forest (LRMP; USDA, 1990). Most were constructed more than 10 years ago for forest management access (USDA, 1994). All of the roads are below 6,000 feet, most (19 miles, 63%) are constructed on the mid sideslopes and footslopes of the butte, while approximately 11 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 the lake shore. The majority of miles in the watershed are native surfaced roads that are closed to vehicle traffic for 9 months in most years. 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.

Table 8. Road Miles by Surface Type and Use, Classifications by WFPB (1995)

Erodibility of Soil Type	Surface Type								
	Native (Total = 19.8 mi)			Gravel (Total = 3.7 mi)			Paved (Total = 6.8 mi)		
Level of Use	NM	NS	NI	GM	GS	GI	AM	AS	AI
High	0	0	2.6	0	0	0	0	0	0
Moderate	0	0	14.5	0	0	1.9	5.1	0	0
Low	0	2.5	0.2	0	1.4	0.4	0	1.7	0
Totals	0	2.5	17.3	0	1.4	2.3	5.1	1.7	0

Key: A = asphalt, G = gravel, N = native/dirt
M = Active Mainline, S = Active Secondary, I = Inactive or Abandoned

Level of Use:
High: Road is actively used and maintained for log haul traffic. Receives log haul traffic more than 50% of the time during the year.
Moderate: Road receives log haul traffic up to 50% of the time. These are typically well-maintained major spur roads that provide access to larger areas.
Low: Traffic limited to pick-up traffic the majority of the time, with occasional log truck traffic This will usually be a spur road accessing areas that rarely have log haul.

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 (USDA, 1994). The amount of sediment (usually crushed pumice) deposited is unknown, however, little if any of the sediment is anticipated to enter a water coarse 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 (up to 1 ton per year, <1 cu. yd.) sediment is transported offsite to water sources (Table 9). Consequently, the sediment budget has changed little (Table 10). 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. Sediment Yield from Roads (tons per year*, WFPB, 1995)

Erodibility of Soil Type	Surface Type								
	Native			Gravel			Paved		
Level of Use	NM	NS	NI	GM	GS	GI	AM	AS	AI
High	0	0	0	0	0	0	0	0	0
Moderate	0	0	0	0	0	0	0	0	0
Low	0	0.35	0	0	0	0	0	0.14	0
Totals	0	0.35	0	0	0	0	0	0.14	0

Key: A = asphalt, G = gravel, N = native/dirt
M = Active Mainline, S = Active Secondary, I = Inactive or Abandoned

*Sediment yield from landings and skid trails not calculated, delivery potential to water bodies from these sediment sources is presumed negligible.

The affect 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.

Table 10. 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	6.5 to 7.5	7 to 8

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, those 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).

Ground-based timber harvest activities have occurred on 1,699 acres (24%) of the watershed, affecting long-term site productivity, generally where roads, landings, and skid-trails occur. Currently, approximately 371 acres (5% of watershed) of roads, landings, and skid trails (estimated 116 acres of road, 255 acres of landings and skid trails) are in a detrimentally compacted condition, reducing the potential of the soil to support forest vegetation.

None of these human-induced detrimental soil impacts exist on sensitive soil types. Approximately 285 acres (4% of watershed) have been harvested on soil types with a moderate to high surface erosion potential, conversely, 1,114 acres have been harvested on soil types with a moderate to low potential for surface erosion. Timber harvest has occurred on 79 acres of soil types with moderate inherent fertility, while 1,620 acres have been harvested on soil types with a higher relative fertility.

Soil quality can be characterized as being relatively moderate to high throughout the watershed, although forest management practices have negatively affected inherent soil productivity on a small proportion of the watershed (Table 11). It is estimated that 5% of the mapped soil types in the watershed are estimated to be in a low to moderate quality condition. About 90% of the soil resources in the watershed are considered to be in good condition. Approximately 5 % of the watershed is scree and talus.

Table 11. Soil Quality (marshland acreage excluded)

High to Moderate Quality		Low to Moderate Quality	
Acres	% of watershed	Acres	% of watershed
4,809	90	539	5

3.2 Biological Characteristics

3.2.1 Vegetation

Reference Condition

The Recreation Creek 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 itself, 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. The plant communities within the watershed are described in Appendix Table 1, and specific locations are shown on the Vegetation Community Type map, Figure 8.

The largest plant community, the mixed conifer/snowbrush-snowberry, occupies about one third of the entire watershed. When combined with the mixed conifer/snowberry/strawberry plant community, the entire mixed conifer complex covers 46% of the watershed (Table 12). Expanded data describing land classification for size/structure and plant association are shown in Appendix Table 1.

Table 12. Size and Structural Classes for Plant Associations

PLANT ASSOCIATION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Grand Total
SIZE/STRUCTURE										
Seed-Sap-Pole	33	0	0	0	0	0	0	0	0	33
Pole-Sm	45	5	5	0	36	1	0	0	0	92
Sm-Med	8	0	11	0	0	1	0	0	0	20
Pole/MS+	804	79	12	38	43	8	29	6	10	1030
Sm/MS-	939	450	251	132	292	147	16	9	16	2251
Sm/MS+	[illegible]	248	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sm/MS++	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Med/MS+	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pole/MSLD	113	2	0	1	4	14	14	10	0	157
Sm/MSLD	208	19	16	14	8	40	9	7	0	321
Rock-Sparse Veg	2	0	4	1	1	36	0	0	0	44
Shrub	10	0	0	0	0	0	8	0	0	18
Tule Mdw	4	0	0	0	0	3	1282	173	0	1462
Water	0	0	0	0	0	0	46	0	0	46
Grand Total	2395	855	778	525	465	289	1403	208	27	6946
Percent	34%	12%	11%	8%	7%	4%	20%	3%	0%	100%

Notes: Data in shaded cells would meet old growth definitions, using classifications derived from USDA Forest Service. Column totals may differ due to numerical rounding.

Historically, the forests within the watershed were affected by countervailing 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 or golden 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, it tended to reduce stocking of true firs, maintain pine stands, and create gaps within the forest canopy.

Although wind has been 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 in the watershed was associated with white fir infected with annosus root disease. The greatest concentrations were on northeastern slopes between Snow Lakes and Rock Creek.

Forest stands in the watershed were not characterized in the past by vast stretches of undisturbed old-growth trees. Although *in-situ* reference data are not available, the fire regimes and other disturbance factors would have tended to create patchy conditions over much of the landscape, with stands commonly ranging from 20 to 40 acres. Nevertheless, late successional characteristics appear to have been at a higher level prior to introduction of logging.

Current Condition

Disturbance regimes in the watershed have been substantially altered in this century. Fire suppression and logging have affected species composition, stand structure, disease and insect susceptibility, and fire regime.

Because of the fire suppression policies, few ignitions in the past half century have resulted in burns of more than several acres. A compilation of data from the last 36 years shows virtually no wildfire effects in the watershed (Table 13). As a result, fire-sensitive species such as white fir and Shasta red fir have increased dramatically throughout much of the area (Harvest History/Fire Location maps, Figures 9a and 9b).

Table 13. Fire Occurrence, Cause, and Size in the Recreation Creek Watershed (1961-1966)

YEAR	CAUSE	SIZE (Acres)
61	Lightning	<0.25
66	Miscellaneous	<0.25
67	Lightning	<0.25
67	Lightning	<0.25
69	Miscellaneous	<0.25
72	Lightning	<0.25
73	Lightning	<0.25
73	Lightning	<0.25
73	Lightning	<0.25
74	Lightning	<0.25
75	Lightning	<0.25
77	Lightning	<0.25
77	Lightning	<0.25
77	Lightning	0.25 - 9
78	Lightning	<0.25
81	Smoking	<0.25
87	Lightning	<0.25
87	Lightning	<0.25
87	Lightning	<0.25
92	Lightning	<0.25
93	Lightning	<0.25
95	Campfire	<0.25
96	Lightning	<0.25

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 - the classic "high-risk" trees.

Timber harvest began early in the century with logging of high-value ponderosa pines on the lower slopes. Although the reason often given for this species preference is the higher economic value of the pines, another important factor was the increasing amount of "high-risk" trees. In these situations, sanitation-salvage logging was a preferred method of capturing imminent mortality and high-value logs.

In the 1970's, regeneration harvests began in earnest. For the most part, shelterwoods were used, and clearcutting was not a predominant practice in the watershed. In more recent times, timber harvest objectives have shifted to an emphasis on maintaining large ponderosa pines and reducing fuel loading.

Removal of the pines gave further impetus to the true firs, and many timber 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 14, most of the logging in the watershed was confined to the lower slopes, and was concentrated in the mixed conifer/snowbrush-bearberry plant association, where ponderosa pine was prevalent. A total of 58% of the mixed conifer/snowbrush-bearberry and 44% of the white fir/snowberry/strawberry plant associations were harvested. Much of this area was covered by more than one timber sale or timber management activity. In combination, a total of 55% of these two vegetation types were affected.

Table 14. Harvest Area and Percent by Plant Association

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Area Harvested (acres)	1417	376	140	0	0	0	0	0	1933
Total Area in Type	2422	855	778	525	465	289	1403	208	6946
Percent of Veg Type Harvested	58%	44%	18%	0%	0%	0%	0%	0%	28%
Total % White Fir Type Harvest	55%								

Note: No data available for harvest on private land.

In contrast, only a minor amount of logging has been done in the forested plant associations on the upper slopes. Only 18% of the Shasta red fir-white fir/chinquapin-prince's pine/long-stolon sedge type has been logged. There is no record of logging in either the Shasta red fir-mountain hemlock/pinemat manzanita/long-stolon sedge or mountain hemlock/grouse huckleberry types. In total, less than one third of the watershed has been logged or directly affected by timber management activities.

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 reveals the marked reduction in the amount of area that would meet the old growth or late successional characteristics (Table 15). Areas with late successional structure have declined from about 61% historically, to about 29% currently.

Table 15. Comparison of Current and Historic Vegetation

Structural Category	Size and Structure Code	Historic Vegetation			Current Vegetation		
		Acres	Percent	Old Growth	Acres	Percent	Old Growth
Single Sized	Seed-Sap-Pole				33	1%	
	Pole-Sm	10	0%		91	2%	
	Sm-Med	1	0%		19	0%	
	Subtotal	11	0%		143	3%	
Multi-Sized	Pole/MS+	570	12%		976	20%	
	Sm/MS-	286	6%		2,063	41%	
	Sm/MS+	128	3%	3%	1,054	21%	21%
	Sm/MS++		0%		370	7%	7%
	Med/MS-	458	10%	10%		0%	
	Med/MS+		0%		5	0%	
	Lg/MS-	2,255	48%	48%		0%	
	Subtotal	3,697	79%		4,468	89%	
Multi-Sized Low Density	Pole/MSLD		0%		119	2%	
	Sm/MSLD	404	9%		266	5%	
	Med/MSLD	12	0%			0%	
	Lg/MSLD	552	12%			0%	
	Subtotal	968	21%		385	8%	
	Total	4,676	100%	61%	4,996	100%	29%

Note: Column totals may differ due to numerical rounding.

The most striking change has been in the loss of stands with large, scattered ponderosa pines intermixed with smaller trees, predominantly white fir (the "Large/Multi-Sized Minus" category). Removal of the large pines allowed the remaining trees, mostly white fir, to dominate the site, often in overstocked conditions. Some of these areas (21%) appear to meet old growth mapping criteria, and have late successional forest characteristics. The increase in true fir species composition has resulted in creation of continuous vertical fuels (the so-called *ladder fuels*) in many stands. This structural change, combined with accumulations of fuels from fire exclusion, has modified the fire regime over much of the watershed. Instead of supporting low-intensity ground fires, stand replacement fires are now a distinct risk.

Higher up in the watershed, fewer changes from the past are apparent. In the mountain hemlock zone, little logging has taken place, and the incidence of other 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 a large extent.

Although the amount of late successional forest habitat has been reduced substantially by logging in the lower portions of the watershed, it appears that patch sizes and complexity are much the same as in the past. The historic pattern of 20- to 40- acre stands resulting from fire is similar to the stand sizes in the present day forest landscape.

Special Status Plant Species

Reference Condition

There is no information on the historic occurrence or distribution of Special Status Plant (SSP) species within the watershed area. Historically there was a mosaic of well-distributed habitat types throughout the watershed. These habitats likely provided for a variety of species including some of those currently considered SSP species.

Current Condition

SSP species identified in the Recreation Creek watershed include species classified as State Sensitive, Forest Service Sensitive, Forest Plan MIS, Survey and Manage species, and Threatened and Endangered species, including Candidate.

Field surveys for SSP species were conducted within the Recreation Creek watershed in 1987 (City of Klamath Falls, 1989) and 1997 (Shapiro, 1997b). These surveys primarily were botanical investigations in support of the proposed Pelican Butte winter sports site and other resource programs such as timber management, wildlife and fisheries enhancement, and recreation.

Under the Record of Decision (ROD) of the Presidents Northwest Forest Plan (USDA and USDI, 1994b), implementation of the standards and guidelines for Survey and Manage species will be required. These guidelines require management for many vascular and nonvascular plants and fungi. Lack of information on distribution, abundance, and habitat needs makes it difficult to predict the potential occurrence of these species. The only Survey and Manage species suspected to occur within the watershed are the candystick plant (*Allotropa virgata*) and the bryophyte Pacific fuzzwort (*Ptilidium californicum)*. These species were not found during the 1989 and 1997 field surveys.

Candystick plant is a non-green mycotrophic species, requiring an association between it, a fungus, and another vascular plant (usually a tree or shrub species) for establishment and survival. Its range is from British Columbia to southern Sierra Nevada in California (Pojar and Mackinnon, 1994). While the species is widespread, it is rare throughout its range. The species is known to occur in closed canopy pole, mature and old-growth forests in Douglas-fir, western hemlock, grand fir, Pacific silver fir (*Abies ammabillis*), and lodgepole pine (*Pinus contorta*) vegetation series (Mayrsohn, pers. comm., 1996,). On the Klamath District of the WNF it is known to occur in the Shasta red fir-mountain hemlock (CR-S1-12) and mountain hemlock (CM-S1-11) plant associations. It does not appear to tolerate competition and typically occurs where there is little understory. Populations are highly isolated, raising questions of gene flow in the species. Due to small, short-lived seeds and its obligate mycorhizzal relationship, large and relatively unfragmented habitat areas may be important to maintain species viability and promote gene exchange between populations. Candystick plant may not flower or emerge above ground every year. The old flowering stems may persist for several years, making surveying possible. During its growing season, the plant is very distinctive and easily identified.

Little is known about the response of candystick plant to stand management. Populations where the overstory was harvested appear to have been extirpated (Mayrsohn, pers. comm., 1996). It is unknown whether the species can re-establish following ground-disturbing activities, or how it is affected by post-harvest burning. Potential habitat for the species occurs throughout the watershed, probably wherever the Shasta red fir-mountain hemlock (CR-S1-12) and mountain hemlock (CM-S1-11) plant associations occur. This species exists in large populations in Shasta red fir and mountain hemlock stands in the Threemile and Sevenmile drainages located to the north of Recreation Creek (USDA, 1996)

The bryophyte Pacific fuzzwort (*Ptilidium californicum*) is known to occur in mesic forest system on the boles of trees in white fir/red fir forest stands in northern California. Limited research has been conducted on the exact habitat requirements of this species. Pacific fuzzwort is known to occur in a narrow elevational band between 3,000 and 5,000 feet. This species was not found in an inventory of bryophytes conducted in nearby Cherry Creek (Wagner, 1997). Habitat for this species potentially exists within the watershed within the Shasta red fir/white fir (CR-S3-11) and mixed conifer (CW- C2-15) plant associations.

Noxious Weeds

Noxious weeds are defined in *Noxious Weed Strategy for Oregon and Washington* (BLM/OR/WA Pt-94+4220.9) as "Plant species designated by federal or state law as generally possessing one or more of the characteristics of being aggressive and difficult to manage, parasitic, and carrier of a host of serious insects or disease, and being non-native, new or not common to the United States."

The noxious weed St. Johnswort (*Hypericum perforatum*) occurs along 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, therefore, it is likely that it occurs within the Recreation Creek watershed.

3.2.2 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. 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 very complex.

Based on the amount and distribution of mature forests in 1949 (based on 1949 to 1956 aerial photographs), habitat for late-successional dependent species was well distributed throughout the watershed. Although forest fires and logging had occurred, a majority of the watershed was in a late seral condition in 1949. Uncut stands at lower elevations were probably dominated by large diameter ponderosa pine with lesser amounts of Douglas-fir and sugar pine. While quality or "condition" of the forest can not fully be known, it is thought that these forests provided suitable habitat for late-successional dependent species through natural succession.

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

Current Condition

<u>Threatened and Endangered Species</u>

Northern Spotted Owl

There are three spotted owl activity centers representing three pairs located within the watershed. In addition, the activity center of a territorial single spotted owl overlaps into the watershed. All three of the owl pairs and the territorial single occur within the LSR designated lands. This comprises 7.5% of the known spotted owls on the Klamath Ranger District.

The watershed contains approximately 2,460 acres (35% of the watershed) of suitable spotted owl NRF habitat (see Spotted Owl NRF Map, Figure 10). Approximately 73% of the NRF habitat (1,794 acres) is located within the LSR and 17% (414 acres) located in Matrix. An additional 10% (251 acres) of the NRF habitat is located in semi-primitive and developed recreation-designated lands. The portion of the LSR located within the watershed is comprised of 57% NRF, slightly above the 50% minimum recommended in the LSR Assessment (USDA, 199_). Spotted owl dispersal habitat is abundant in the watershed; however, data necessary to calculate acreages of dispersal habitat are currently not available.

NRF habitat is concentrated in the lower two-thirds of the watershed and habitat connectivity is relatively good. Although dispersal habitat is still present in most areas, past timber harvest has narrowed the connection of the NRF habitat between the north and south portions of the LSR. The upper slopes of the watershed outside of the LSR are lacking NRF habitat (e.g., areas above tree line) as a result of natural features and conditions, rather than past timber management. Private lands along West Side Road provide limited or no spotted owl habitat. Spotted owl habitat is absent to the east of the watershed due to the presence of Upper Klamath Lake.

Bald Eagle

A total of 2,820 acres of the Recreation Creek watershed are designated as bald eagle habitat management areas (see Eagle Habitat Management Area Map, Figure 11). These management areas consist of bald eagle nesting habitat, replacement habitat, and winter roosting habitat (Table 16). Approximately 60% of the designated bald eagle habitat is located within the LSR, with approximately 40% occurring on Matrix designated lands.

Table 16. Acres of bald eagle habitat by land designation

HABITAT TYPES	LSR	MATRIX
Nesting Habitat	253	325
Replacement Habitat	1,361	714
Winter Roosting Habitat	112	56
Total	**1,726**	**1,095**

There are two bald eagle territories centered within the watershed and two territories that overlap into the watershed. These territories represent four bald eagle pairs and contain 10 nest sites (seven nests inside the watershed and three nests outside 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 to the north of the watershed in 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, 199__ LSR Assessment). 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. Furthermore, past timber management and fire suppression have resulted in a lack of 50-100 year old trees throughout the majority of the watershed. This has reduced or eliminated an entire age class from the watershed that would have provided potential replacement nest trees in the future.

Bald eagle foraging habitat within the watershed occurs in Crystal and Recreation Creeks, Pelican Bay, and Upper Klamath Lake. 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. These large open water and marsh land areas have been significantly reduced by diking and draining for conversion to agriculture with natural vegetation filling in open water areas (USDI, 1993). In addition, waterfowl distribution and abundance has been significantly reduced due to in-basin and out-of-basin alterations to habitat.

Peregrine Falcon

DRAFT

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

Federal Candidate Species

Fisher

Fishers were reintroduced into several locations in Oregon after being nearly extirpated. Fishers from Minnesota were released west of Crater Lake National Park, and the population has been expanding from that area. In 1996, two radio collared male fishers were tracked from the Rogue River National Forest to the Winema National Forest. One of the two made its home just south of Crater Lake National Park. The other fisher was followed to the north side of Pelican Butte. It was found dead in that area in early 1997.

Potential habitat for fishers occurs throughout the Recreation Creek watershed. Fishers however, are not known to occur within the watershed. Human distrubance along Westside Road may likely proclude fishers from this portion of the watershed.

Forest Service Region 6 Sensitive Species

California Wolverine

Wolverines have not been documented in the vicinity of the Recreation Creek 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. Recreation Creek watershed does contain suitable habitat for wolverines and is well connected to other potential habitat in wilderness areas and Crater Lake National Park. Therefore, it is quite possible that Recreation Creek watershed could be occupied by wolverines at any time. The home range of wolverines is larger than the Recreation Creek watershed.

Common Loon

Common loons have been sighted on Recreation Creek within the watershed boundary. They occupy parts of Klamath County during the nesting season and are suspected to nest on Miller Lake.

American White Pelican

White pelicans nest on Upper Klamath Lake near the Recreation Creek watershed. The only habitat for pelicans within the watershed is on Recreation and Crystal Creeks.

Ferruginous Hawk

Ferruginous hawks are large hawks that prefer open country. There is no nesting habitat within the Recreation Creek watershed, but these birds may pass by or roost there during their spring and fall migration.

Greater Sandhill Crane

Greater sandhill cranes often are seen in the wet meadows south and east of Recreation Creek, and may use these areas for nesting. Much of the potential nesting habitat is on or adjacent to private land.

Long-billed Curlew

long-billed curlews are seen occasionally around Upper Klamath Lake. There are no records of long-billed curlews nesting within Recreation Creek watershed, however, some of the meadows in this area may provide suitable nesting habitat.

Tri-colored Blackbird

Tri-colored blackbirds nest in marsh habitat with tules or cattails. Upper Klamath Lake contains many acres of that habitat adjacent to Recreation Creek. The nearest known tricolored blackbird 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. They have been located at 26 sites in Klamath County and 2 sites in Lake County.

The marsh land associated with Recreation and Crystai Creeks and Upper Klamath Lake contain habitat that appears suitable for yellow rails, although there are no documented observations in this area. Yellow rails have been documented nesting 3 miles northeast of the watershed.

Preble's Shrew

No suitable habitat for Preble's shrew occurs within Recreation Creek.

ROD Species

Great Gray Owl

The great gray owl is classified as a low-density species on the WNF. There is no information on abundance or distribution of great gray owls within the watershed. No observations of GGOs were made during spotted owl surveys conducted within the watershed in 1987 and 1988 (City of Klamath Falls, 199_). Occasional sightings of GGOs have occurred in this watershed (Hardy, pers. comm., 1997). Clearcuts and heavily thinned forest stands in the lower portions of the watershed may approximate GGO preferred meadow hunting habitat. Although this species may occur in the planning area, the habitat generally lacks the type of meadow edge or openings favored by GGOs. Natural openings that do occur in the upper elevations of the watershed are limited to scree slopes and talus slopes that provide only limited foraging habitat.

With very little GGO habitat in the watershed, determining trends is not very applicable. GGO habitat does occur in the Rock, Cherry, Nannie, and North Fourmile Creek watersheds located to the north, west, and south of Recreation Creek.

Flammulated Owl

Flammulated owls are secondary cavity nesters and use cavities, in snags and live trees, created by woodpeckers or, less often, that occur naturally. Flammulated owl habitat occurs within the Recreation Creek watershed, and flammulated owls are known to occur there. No nests have been documented, but it is assumed that these owls nest within the watershed. No specific surveys for flammulated owls have been conducted within the watershed. They occasionally respond to spotted owl or great gray owl calls during surveys.

Little is known about the size of the flammulated owl population in the Recreation Creek watershed. They have been found in most of the forest areas in the vicinity of the watershed. They are being studied because they are associated with large ponderosa pine habitat which has declined significantly over the last 100 years.

White-headed Woodpecker

White-headed woodpeckers excavate their nest cavities in moderately decayed ponderosa pine snags averaging 31 inches in diameter. The Forest Plan recommends that 0.60 snag per acre at least 15 inches in diameter be provided in soft decay stages. Home ranges on the Winema National Forest average 524 acres in contiguous habitat and 845 acres in fragmented habitat.

White-headed woodpecker habitat occurs within the Recreation Creek watershed. This species has been documented in the watershed and is presumed to nest there; no nests however, have been documented. White-headed woodpeckers are associated with large ponderosa pine habitat, which is declining.

Black-backed Woodpecker

Black-backed woodpeckers prefer old lodgepole pine stands, utilizing snags with heartrot for their nests (Goggans, 1988). The Forest Plan recommends that 0.12 hard snag per acre at least 17 inches in diameter be provided in stands of mixed conifer and lodgepole pine. Black-backed woodpeckers forage almost exclusively on wood boring beetle larvae. Black-backed woodpecker nesting habitat is present within the Recreation Creek watershed but no nests have been documented in recent years.

Black-backed woodpecker populations are known to increase rapidly following a mortality event such as fire, windthrow, or bark beetle outbreak. Most of the time, this is a species of low density, found on only 1% of breeding bird atlas sites in Washington State and 12% of breeding bird survey routes in Oregon (Marshall, 1992).

Pygmy Nuthatch

Pygmy nuthatches use habitat very similar to that used by white-headed woodpeckers. The ROD states that provision of snags for white-headed woodpeckers will provide for the needs of pygmy nuthatches. Pygmy nuthatches are known to occur within the Recreation Creek watershed, but no nests have been documented. Pygmy nuthatches are associated with large ponderosa pine habitat, which is declining.

Management Indicator Species

Northern Goshawk

There is no information on historic abundance and distribution of northern goshawk in the watershed. Historically there was a significant, well-distributed amount of northern goshawk nesting and foraging habitat throughout the watershed. The portions of the watershed above timberline have never provided goshawk habitat.

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, pers. comm., 1997). Suitable habitat for goshawks within the watershed is likely concentrated within the LSR. Timber removal has reduced the amount of suitable goshawk habitat within the watershed.

Pileated Woodpecker

Pileated woodpeckers are an old-growth forest indicator species on the Winema National Forest (LRMP: pg. 4-128). Pileated woodpecker habitat occurs throughout the majority of the watershed below 6,500 feet in elevation. No surveys to protocol have been conducted for this species within the watershed.

Pileated woodpeckers are common within the Recreation Creek watershed, although the size of their territories keeps them from being abundant. Pileated woodpecker populations are declining in much of their range because they require plentiful, large diameter snags for nesting and foraging. Many managed timber stands no longer provide that type of habitat.

American Marten

American martens are an indicator species in the Winema Forest Plan for mature mountain hemlock and high-elevation lodgepole pine ecosystems, with multi-canopied stands containing a high diversity of understory plant species

Suitable habitat for American martens does occur within the Recreation Creek watersehd above 6, 000 feet in elevation. American martens have been sighted within the vicinity of the watershed. No surveys to protocol have been conducted for this species within the watersehd. With no good survey data, it is hard to estimate population trends however, the marten population does appear to be doing well at the present time.

Northern Three-toed Woodpecker

Northern three-toed woodpeckers are a management indicator species for mature lodgepole, mountain hemlock, and subalpine fir habitat in the Winema Forest Plan. Northern three-toed woodpeckers prefer old lodgepole pine stands, utilizing snags with heartrot for their nests (Goggans, 1988). The Forest Plan recommends that 0.12 hard snag per acre at least 17 inches in diameter be provided in stands of mixed conifer and lodgepole pine.

Northern three-toed woodpecker nesting habitat is present, within the Recreation Creek watershed, but no nests have been documented in recent years.

Elk and Deer

The Recreation Creek 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, pers. comm., 1997). Currently the elk and deer population is below the current management objective for the area. Recreation Creek watershed likely will always support only a small deer population due to a limited forage base as result of the small number of shrubs 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.

Four habitat variables that affect the availability (or effectiveness) of these habitats to elk: sizing and spacing of forage and cover areas; density of roads open to motorized vehicles; cover quality; and forage quality.

There are approximately 30.26 miles of road in the Recreation Creek watershed, which equates to road density of approximately 2.8 miles/square miles. By comparison, ODFW management target levels are 1.5 miles of road per square mile. (ODFW, 1992). Currently, the majority of the road miles within the watershed are closed to public access from January 1 through August 31 for protection of bald eagles and bald eagle habitat.

Recreation Creek primarily provides elk summer range habitat. Some areas along West Side Road and in adjacent Rock Creek drainage provide elk calving areas. Elk migrate out of the Pelican Butte area to winter in the lower elevation forests west of the Cascade

Crest (Collom, pers. comm., 1997).

Game Species

Bears and Cougars

There is no inventory information for bear or cougars within the watershed area. ODFW (1993a) provided the most recent density estimates for eastern Oregon at 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 (Johnson and Strickland, 1992; ODFW, 1993). 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, pers. comm., 1997).

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 potential den sites for bears, and management of the area limits human disturbance most of the year.

Bats

Bats are recognized as an important component of forest ecosystems. They are a main predator of nocturnally active adult forms of many forest insect pests. At least two species of bats depend on trees primarily present in old-growth stands for roosts. Many other bat species rely on old-growth trees for roost sites when other structures (cliffs, caves, mines, buildings) are absent. Distribution of individual bats and bat species in forests is non-random and the primary factor appears to be roost limitation (Perkins and Cross, 1988). There are five species of bats that have the potential to inhabit the Recreation Creek watershed (Hardy, pers. comm., 1997)

There are 12 bat species that have habitat ranges that include the Recreation Creek watershed (Cross, 1997; Table 17) Six species are listed as sensitive by the State of Oregon and five of those receive additional protection in the ROD. A bat inventory was completed in 1997 in the adjacent Rock Creek and Fourmile Creek watersheds (Cross, 1997). This inventory sampled bats using mist-netting over areas of open water following the methodology outlined by Cross (1986). A total of nine species of bats were documented during this and other study (Cross, 1995, 1997; Table 17).

Table 17. Species of Bats Potentially and Known to Occur within the Vicinity of the Pelican Butte Watershed (Cross, 1995, 1997)

Species	Scientific Name	Status	Documented in Vicinity
California myotis	*Myotis californicus*	None	Rock, Fourmile
Long-eared myotis	*Myotis evotis*	ROD, State	Rock,
Little brown myotis	*Myotis lucifugus*	None	Rock, Fourmile
Fringed myotis	*Myotis thysanodes*	ROD, State	Fourmile
Long-legged myotis	*Myotis volans*	ROD, State	Rock
Yuma myotis	*Myotis yumanensis*	State	Rock, Fourmile
Hoary bat	*Lasiurus cinereus*	None	Rock, Fourmile
Silver-haired bat	*Lasionycteris noctivagans*	ROD, State	Rock, Fourmile
Big brown bat	*Eptesicus fuscus*	None	Rock
Townsend's big-eared bat	*Corynorhinus townsendii*	FS	Likely
Pallid bat	*Antrozous pallidus*	ROD, State	No
Brazilian free-tailed bat	*Tadarida brasiliensis*	None	No

KEY:
FS= listed on the Pacific Northwest Region sensitive list
ROD = additional protection provided in ROD
State = sensitive status, State of Oregon.
Rock = Rock Creek Watershed
Fourmile = Fourmile Creek Watershed

The surveys found relatively high densities of some species of bats in the Rock Creek and Fourmile watersheds (Cross, 1994, 1997). Silver-haired bats, big brown bats, hoary bats, California myotis, and Yuma myotis were found in this analysis area. Fringed myotis, long-eared myotis, and long-legged myotis have been located within 5 miles of the watershed. Pallid bats and Townsend's big-eared bats occur in Klamath County and also may occur in the analysis area.

There are no caves or known bat roosts within the Recreation Creek watershed. Several of the bat species which occur in the vicinity of the watershed (silver-haired bat, fringed myotis, long-eared myotis, and long-legged myotis) have a 250-foot protection buffer around known sites (USDA, USDI, 1994b). One species of bat that was not captured during the surveys but that is potentially in the watershed is the Townsend's big-eared bat (Cross, 1997).

The only open water areas for bats to forage within Recreation Creek watershed are Recreation and Crystal Creeks. Snags and older deformed trees as well as the rural homesites along Westside Road, likely provide suitable roosting sites for several bat species. One limited habitat feature that probably limits the abundance of bats is caves. One species in particular, Townsend's big-eared bat, roosts during both day and night in caves or cave-like structures. Other species use caves or cave-like structures as night roosts (Cross, 1997).

Herptofauna

There is no information on the historic distribution and abundance of herptofauna within the Recreation Creek watershed. It can be assumed that the open water and marshland areas of Recreation Creek likely provided suitable habitat for several aquatic-based herptofauna species. Scientific research has provided evidence that on a large scale both population sizes and geographical ranges are diminishing for many amphibian species (Blaustein and Wake, 1990). In addition, construction of the Linkeville Dam in 1919 which raised the water level of Klamath Lake by 3.3 feet may have altered shoreline and emergent habitat features along Recreation Creek.

Surveys for herptofauna were conducted in Recreation Creek in 1997 (SHAPIRO, 1997). Recreation Creek provides the only aquatic habitat within the Pelican Butte watershed. Pacific chorus frog (*Hyla regilla*) and Western terrestrial garter snake (*Thamnophis elegans*) were the only species observed during the field survey. Northwestern pond turtles (*Clemmys marmorata marmorata*) are known to occur in Upper Klamath Lake, however none were observed during the survey of Recreation Creek.

Additional herptofauna species potentially occurring within Recreation Creek include spotted frog (*Rana pretiosa*; USFWS Candidate Species), Cascade frog (*Rana cascadae* USFWS Species of Concern), long-toed salamander (*Ambystoma macrodactylum*), western toad (*Bufo boreas*), northern alligator lizard (*Elgaria coerulea*), Klamath garter snake (*Thamnophis elegans biscutatus*), and rough skinned newt (*Taricha granulosa*).

There are three Sensitive Species (Cascade Frog, Northwestern pond turtle, and spotted frog) that have the potential to occur within the watershed. Descriptions of these species, and their habitat distribution within the watershed are described in detail below.

Cascades frog (USFWS Species of Concern) was not observed during field surveys. Populations of Cascade frogs may be more difficult to find than historically (Blaustein, et al., 1995). Fellers and Drost (1993) reported that Cascades frog populations in northern California have exhibited a sharp decline for many years. Corkran and Thoms, (1996), however, stated that "although declines in some local populations have been noted, the Cascades frog is still a common species within its range."

During field surveys conducted by the City of Klamath Falls between 1985 and 1988, a single Cascades frog was observed at the 7,900-foot elevation level near the Pelican Butte summit (City of Klamath Falls Report, 1989). It is unknown if this observation occurred inside or outside of the watershed boundary. Cascades frog breeding habitat would occur only in Recreation and Crystal Creeks. Cascades frogs are a montane species that generally occurs above 2,600 feet in meadows, marshes, and ponds (Blaustein, et al., 1995). They often are found in relatively small bodies of water such as ephemeral pools or potholes without vegetation, marsh-like areas that are overflows of larger lakes, lakeshore alcoves, and along creeks (Nussbaum, et al., 1983)

Northwestern pond turtle (USFWS Species of Concern) was not observed during field surveys. The upper elevational limit for Northwestern pond turtles is approximately 4,500 feet in elevation, although a few records exist for sites up to 6,700 feet (Holland, 1994). This species is known to occur in rivers, streams, lakes, ponds, permanent and ephemeral wetland habitats, and altered habitats such as reservoirs (Holland, 1994). In the Klamath basin, the majority of records are from the Klamath and Lost Rivers and the Klamath Lakes. 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 (Blaustein, et al., 1995). Movements into upland habitat may extend up to 1,640 feet from the waters edge (Holland, 1994).

Because no occurrences of Northwestern pond turtles have ever been reported from the study area, no information about their historic abundance and distribution exists. The historic condition and distribution of potential habitat also are unknown. Construction of the Linkeville Dam in 1919, which raised the water level of Klamath Lake by 3.3 feet, may have altered shoreline and emergent habitat features along Crystal and Recreation Creeks.

Spotted frog (USFWS Candidate Species) was not observed during field surveys. Spotted frogs are known to occur in Grass Lake in the Sky Lakes Wilderness Area located approximately 8 miles northwest of the watershed. 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). This species also is known to occur in a few high Cascade lakes in Oregon. Within the watershed, spotted frogs could potentially occur in Recreation and Crystal Creeks.

There is no information on the historic distribution and abundance of spotted frogs within the watershed. Over the past 50 years, the spotted frog has been extirpated from much of its former range in western Oregon and Washington (Leonard, et al., 1993). Extirpation coincides with the introduction and spread of bullfrogs which prey on spotted frog tadpoles and adults (Marshall, 1996). The presence of bullfrogs is likely an indication of the absence of spotted frogs from the same area. There is no information on the distribution or abundance of bullfrogs within the watershed.

Mollusks

Both terrestrial and freshwater mollusks are known to or could potentially occur within the Recreation Creek watershed. Freshwater mollusks can inhabit permanent water bodies of all sizes and a few can tolerate conditions in temporary or seasonal situations as well (Frest and Johannes, 1995). Flowing water situations are generally favored by most species, but lakes, in particular river influenced lakes or spring-influenced water bodies such as Upper Klamath Lake may support a great diversity of species (Frest and Johannes, 1995). Little research has been completed to date on terrestrial mollusk species in the Upper Klamath Basin area (Frest, pers. comm., 1997). New mollusk species are being discovered and described therefore, little is known regarding the historic distribution and composition of most species.

Freshwater mollusk surveys have been conducted at several locations along the eastern base of Pelican Butte within the watershed (Frest and Johannes, 1995, 1996). 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. A list of freshwater mollusk species that are known to occur within the watershed is contained in Table 18.

There is no information on terrestrial mollusk species for the watershed, however, they could occur anywhere within the watershed. A list of all potential mollusk species (freshwater and terrestrial) that could occur within the watershed is contained in Appendix Table 3.

Table 18. Mollusk Species Known to Occur Within and/or Adjacent to the Recreation Creek Watershed (Frest and Johannes, 1995, 1996)

Location	Species	Type	ROD Status
Rocky Point Resort	*Fulminicola* n. sp 1.	Freshwater Gastropoda	SM
	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	SM
	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	

3.2.3 Fisheries and Aquatic Habitat

Reference Condition

Cope (1884) 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. Eight 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, 1992), 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 Recreation or Crystal Creeks 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 (LWD) entering 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). Due to similarities in channel form and the lack of LWD present instream, it could be speculated that Recreation Creek also may have been dredged.

Prior to dredging and installment of the Linkville 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 LWD, terrestrial and aquatic vegetation for cover.

Current Condition

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 wide, 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 deep. Substrate is almost entirely comprised of silts and organics, with isolated pockets of larger substrate artificially placed near boat landings and docks (SHAPIRO, 1997a).

At summer low flow, Crystal Creek averages approximately 50 to 75 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 to 10 feet, averaging approximately 5½ - to 6-feet deep. Substrate is entirely 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 entire Recreation Creek watershed.

Fish Habitat

Due to lack of flowing surface water in the Recreation Creek 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 Linkville 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 to patches of rooted aquatic vegetation, primarily yellow pond lilly (*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 LWD 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 LWD appeared to have cut ends, with no natural pieces observed in the system. It is likely that many pieces of LWD originally found in these systems were removed during dredging activities to facilitate boat passage.

Land ownership to the east of Recreation and Crystal Creeks is part of the Upper Klamath Wildlife Refuge, administered by the USFWS (Figure 3). Land ownership on the west bank is a combination of private residential resort, and WNF. Lands under USFS ownership are primarily old-growth, mixed conifer stands, with small groves of cottonwood, aspen and marsh interspersed. Much of the private land has already been cleared, removing terrestrial vegetation for houses and clearing wetland vegetation for boat access to Recreation or Crystal Creeks. This has effectively reduced vegetation that may have historically provided cover for fish and lowered the potential for LWD recruitment from this streambank.

Fish Presence and Distribution

The Recreation Creek watershed historically supported both resident and anadromous fish species. A total of 35 fish species are known to inhabit the Upper Klamath Lake basin, 17 of which are native, and 8 of which are endemic. The remaining 20 fish species have been introduced to the watershed (Logan and Markle, 1993), primarily as game fish. A 38th species, the Miller Lake lamprey, once endemic to the basin, is now considered extinct. Table 19 summarizes fish species known to inhabit the Upper Klamath Lake basin.

Table 19. Fish Species Historically Found within the Upper Klamath Lake Basin and Potentially the Recreation Creek Watershed

SPECIES	SCIENTIFIC NAME	ORIGIN	STATUS	KNOWN DISTRIBUTION	REFERENCE
Black crappie	*Pomoxis nigromaculatus*	I	-	UKL	Logan, 1993
Blue chub	*Gila coerulea*	NE	-	UKL and all Tribs.	Logan, 1993
Bluegill	*Lepomis macrochirus*	I	-	C	Logan, 1993
Eastern brook trout	*Salvelinus fontinalus*	I	-	ROC	Logan, 1993
Brown bullhead	*Ictalurus nebulosus*	I	-	AL, UKL	Logan, 1993
Brown trout	*Salmo trutta*	I	-	A, CH, UKL, W	USDA, 1993
Bull trout	*Salvelinus confluentus*	N	PE	T, W	Logan, 1993
Chinook salmon	*Oncorhynchus tshawytscha*	N/I	-	***Extirpated from Basin***	Logan, 1993
Coho salmon	*Oncorhynchus kisutch*	N/I	C	***Extirpated from Basin***	Logan, 1993
Cutthroat trout	*Oncorhynchus clarki*	I	-	Unknown	Logan, 1993
Fathead minnow	*Pimephales promelas*	I	-	AL, UKL and all tribs.	Logan, 1993
Green sunfish	*Lepomis cyanellus*	I	-	Lost R., Not in UKL	Logan, 1993
Klamath Lake sculpin	*Cottus princeps*	NE	-	AL, UKL	Logan, 1993
Klamath River lamprey	***Lampetra similis***	NE	-	UKL	Logan, 1993
Klamath largescale sucker	*Catostomus snyderi*	NE	SoC	UKL	USDA, 1993
Klamath smallscale sucker	*Catostomus rimiculus*	N	-	Trinity, Klamath, and Rogue Rivers.	USDA, 1993
Kokanee (sockeye salmon)	*Oncorhynchus nerka kennerlyi*	I	-	CS, F, UKL	Logan, 1993
Lake whitefish	*Coregonus clupeaformis*	I	-	Stocked in UKL, but did not take	Logan, 1993
Largemouth bass	*Micropterus salmoides*	I	-	Unknown	USDA, 1993

SPECIES	SCIENTIFIC NAME	ORIGIN	STATUS	KNOWN DISTRIBUTION	REFERENCE
Lost River sucker	*Deltistes luxatus*	NE	LE	UKL	USDA, 1993
Marbled sculpin	*Cottus klamathensis*	NE	-	AL, UKL	Logan, 1993
Miller Lake lamprey	*Lampetra minima*	**NE**	**E**	Extinct	Logan, 1993
Pacific lamprey	*Lampetra tridentata*	N	SoC	Klamath River	Logan, 1993
Pit-Klamath brook lamprey	*Lampetra lethophaga*	N	-	Klamath River	USDA, 1993
Pumpkinseed	*Lepomis gibbosus*	I	-	AL, UKL, C	Logan, 1993
Rainbow trout (Redband)	*Oncorhynchus mykiss*	N/I	-	Wide Distribution	USDA, 1993
Sacramento perch	*Archoplites interruptus*	I	-	UKL	Logan, 1993
Shortnose sucker	*Chasmistes brevirostris*	NE	LE	UKL	USDA, 1993
Slender sculpin	*Cottus tenuis*	NE	SoC	UKL	Logan, 1993
Smallmouth bass	*Micropterus dolomieui*	I	-	UKL	Logan, 1993
Speckled dace	*Rhinichthys osculus klamanthensis*	N	-	Widely Distributed	USDA, 1993
Tiger trout	*Salmo trutta* x *Salvelinus fontinalis*	I	-	UKL, W	Logan, 1993
Tui chub	*Gila bicolor*	N	-	UKL	Logan, 1993
White crappie	*Pomoxis annularis*	I	-	Lost River, UKL	Logan, 1993
White sturgeon	*Acipenser transmontanus*	I	-	UKL	Logan, 1993
Yellow perch	*Perca flavescens*	I	-	UKL, Pelican Bay	Logan, 1993

Origin: *N – Native, NE – Native Endemic, I – Introduced* ***Status:*** *PE – Proposed Endangered, LE – Listed Endangered, SoC – Species of Concern, C – Candidate Species, E - Extinct*
Distribution: *AL – Agency Lake, C – Crystal Ck., CH – Cherry Ck., CS – Crystal Springs, F – Fourmile Ck., REC – Recreation Ck., ROC – Rock Ck., T – Threemile Ck., UKL – Upper Klamath Lake, W – Wood River.*
Shaded Species have been extirpated or are now extinct in the basin.

Six of the species listed in Table 19 can be eliminated from consideration in terms of inhabiting the Recreation Creek watershed, including the chinook salmon, coho salmon, lake whitefish, common carp, goldfish and Miller Lake lamprey. As previously mentioned, Miller Lake lamprey are now thought to be extinct, and chinook and coho salmon runs have been extirpated from the basin. Approximately 400,000 lake whitefish were introduced into Upper Klamath Lake by the U.S. Fish Commission in 1889. Sampling since 1896 has failed to collect any lake whitefish from the lake indicating that this introduction was unsuccessful. Goldfish and common carp were introduced into Devils Lake and Lake of the Woods, but neither species has been observed in the Upper Klamath Lake basin (Logan and Markle, 19^3).

Four anadromous fish species historically inhabited the Klamath basin, including steelhead, bull trout, coho salmon, and chinook salmon. Anadromous fish runs were extirpated from the Upper Klamath watershed upon completion of the Copco dam on the Klamath River in California (1917). Although rainbow trout are still present in the basin today, the anadromous form (steelhead) has been extirpated along with the other anadromous species (Logan and Markle, 1993). Remnant populations of bull trout can still be found in the Upper Klamath basin, with known populations occurring in Threemile Creek and Wood River (Kann, pers. comm., 1997). No bull trout have been recorded in Recreation or Crystal Creeks.

Two federally listed endangered fish species and three Species of Concern inhabit the Upper Klamath watershed and potentially the Recreation Creek watershed. The Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) were listed as endangered species by the USFWS in 1988 (USDI, 1988). Although not documented, it is suspected 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, pers. comm., 1997).

Approximately 4.51 square miles (2,888 acres) of proposed critical habitat have been identified within the Recreation Creek 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 of Concern in the basin include the Klamath largescale sucker (*Catostomus snyderi*), Pacific lamprey (*Lampetra tridentata*) and the slender sculpin (*Cottus tenuis*).

Over 20 fish species have been introduced into the Upper Klamath basin over the past century (see Table 19). Many of these species are game fish that were legally introduced by federal or state governments. In addition to the attempted lake whitefish stocking effort, records indicate that the U.S. Fish Commission stocked six species in Upper Klamath Lake and most of its tributaries from 1922 to 1932. Species stocked included rainbow trout, brook trout, brown trout, chinook salmon, coho salmon, and kokanee (landlocked sockeye salmon).

Largemouth bass, crappie, yellow perch, carp, and brown bullhead were introduced to the system by the ODFW in the late 1930's to diversify the fishery in the region. The ODFW continued to stock rainbow trout, brook trout, brown trout, and kokanee from 1948 to 1968. Between 1968 and 1972, brook trout and brown trout stocking was terminated in all water bodies with direct connection to Upper Klamath Lake. Cutthroat trout and tiger trout were stocked in Wood River in 1972. Rainbow trout stocking ended in 1980 when it was determined that stocking was unsuccessful as introduced strains were highly susceptible to *Ceratomyxa shasta* (Logan and Markle, 1992).

Species such as the fathead minnow are thought to have been introduced by the public, probably by fishermen as escaped bait fish. The fathead minnow was first found in Upper Klamath Lake in 1982, it is now present in all lake tributaries and is the most common fish in Upper Klamath and Agency Lakes (Logan and Markle, 1992).

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 many 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).

Table 20 summarizes species found in Crystal Creek proper, and at the mouth of Crystal Creek during a sampling study by Logan and Markle in 1992. Due to connectivity and similarities in habitat, it is expected that these species also would likely be found in Recreation Creek. In addition to the species listed in Table 20, kokanee also have been documented in Crystal Creek where anglers recently reported catching them at Crystal Springs (Logan and Markle, 1992).

High water quality in these spring-fed streams appears to be appealing to a multitude of fish species. Rainbow trout, yellow perch, and brown bullhead have shown seasonal migration patterns to the northern marsh and spring areas of the lake (Vincent, 1968; Stubbs and White, 1993). This migration is apparently related to poor water conditions throughout the rest of the lake, where during summer and fall months, pH levels have been reported as high as 10 and dissolved oxygen levels reported as low as 1 milligram per liter in portions of the lake (BOR, 1992).

The hypereutrophic nature of Upper Klamath Lake contributes to periodic outbreaks of a bacterial gill infection, *Flexobacter columnaris*, which was the causative agent for a massive fish kill in 1971. As reported by Beuttner (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, 1992; BOR 1996; Beuttner, 1997; see Table 21), although none as severe as the one in 1971 in terms of total fish kill.

Table 20. Numbers and Location of Fish Sampled by Logan and Markle (1992) in Crystal Creek

Survey Date (1992)	Location/ Method	Shortnose Sucker	Lost River Sucker	Tui Chub	Blue Chub	Fathead Minnow	Brown Bullhead	Pumpkinseed	Bluegill	Yellow Perch	Pacific Lamprey	Marbled Sculpin	Klamath Lake Sculpin	Slender Sculpin	Rainbow Trout	Brook Trout
03/31/92	C/E										3	10	1	2	1	
04/10/92	M/E										1	12		11	9	2
04/10/92	C/E										1			36	7	13
05/07/92	M/T	3	1	12	57	4	4	5		15	5	4	1	1		
06/17/92	M/P															
06/18/92	M/P															
07/07/92	M/P													3		
07/08/92	M/P													2		
07/08/92	C/E													16	1	35
07/09/92	M/P															
07/10/92	M/P													1		
07/21/92	M/T	3		13	6		431	5		19						
07/22/92	M/T	1		10			369	7	1	2						
07/23/92	M/T						5	3				1				

Location: C – Crystal Creek Proper, Crystal Creek @ Mouth **Method**: E – Electrofishing, P – Push Net (larval sampler), T – Trap Net

Table 21. Reported Fish Kills Associated with *Flexobacter columnaris* in Upper Klamath Lake Between 1971 and 1997 (BOR 1996; Perkins, 1996; Beuttner, 1997).

	Year						
	1971	1986	1988	1994	1995	1996*	1997**
Lost River Suckers	25	190	33	10	378	2,213	867
Shortnose Suckers	-	22	8	-	124	1,912	1,264
Unidentified Sucker Species ***	-	-	-	-	-	1,924	224
Rainbow Trout	-	-	-	-	-	-	89

- No numbers reported for blank cells
*** Perkins, 1996**
**** Beuttner, 1997**
***** Carcasses not identifiable to species level**

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 (Beuttner, 1997). It is important to note that these figures probably represent only a portion of the fish actually killed during the outbreak, with some carcasses consumed by fish eating birds, sinking to the lake bottom, and/or becoming concealed in shoreline vegetation (Beuttner, 1997).

The 1997 die-off was reported as the second largest documented fish-kill in Upper Klamath Lake. Blue and tui chubs were hardest hit, with suckers, rainbow trout, sculpin, and yellow perch also noted. This was reported to be the first year that substantial numbers of rainbow trout (89) were documented in the fish kill (Beuttner, 1997).

Because of the long history of algal blooms and poor water quality in Upper Klamath Lake, it can be expected that additional fish kills other than those specified in Table 21 also have occurred in other years. Fish kills involving non-game fish such as suckers may not have historically been reported to the public, while large populations of fish eating birds may also have quickly consumed carcasses erasing evidence of the fish kills (BOR, 1996).

<u>Aquatic Invertebrates</u>

Rare, threatened or endangered aquatic invertebrate species potentially present in the vicinity of the Recreation Creek 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).

4.0 SYNTHESIS AND RECOMMENDATIONS - STEPS 5 AND 6

Step 5 of the watershed analysis is an attempt to explain how physical and anthropogenic processes may have contributed to changes in the Recreation Creek 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. These processes, both natural and anthropogenic, are described briefly below, and in more detail in Sections 4.2 and 4.3 of this report.

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 Recreation Creek watershed was altered during this century by fire suppression. This 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 Recreation Creek 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 Recreation Creek watershed for agriculture and housing. Native upland vegetation was replaced with grass and ornamental trees and shrubs, while wetland vegetation was replaced by crops and upland vegetation. 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 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 Recreation Creek watershed since the turn of the century. Dam placement on the Klamath River and the outlet to Upper Klamath Lake have 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 Recreation Creek watershed.

Timber management within the Recreation Creek watershed has led to an increase in the amount of cleared land. The most significant result of timber harvesting within the Recreation Creek 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 30 miles of roadway within the Recreation Creek watershed (including paved, unimproved, and improved).

Agriculture has potentially effected 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 lead to an increase in the depletion of the area's aquifer storage volume.

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

Recommendations

Specific data documenting the surface and subsurface hydrologic regime of the Recreation Creek watershed is needed. Site specific infiltration data may be provided by the installation of lysimeters within the watershed that may yield specific snow accumulation measurements. In the meantime, efforts to protect surface waters/springs in the watershed should continue. < sp.

4.2.2 Soils And Erosion Processes

Of the processes described at the beginning of this section, timber management has been the dominant process affecting soils and erosion processes in the Recreation Creek watershed. Overall, a long-term (persistence >20 years) loss of maximum inherent soil productivity has occurred on approximately 371 acres (5% 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.

Recommendations

Considering the WNF Land and Resource Management Plan (LRMP) standards and guidelines pertaining to soil productivity, and the thresholds for the acceptable areal 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.

There are no roads in the watershed that impart an adverse impact on aquatic species or habitat in the watershed. Furthermore, none of the roads in the watershed is perceived as being in a condition not meeting Aquatic Conservation Strategy objectives, or that is contrary to ROD standards and guidelines for road conditions in riparian reserves.

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 spread of annosus root rot and outbreaks of bark beetles in overstressed stands. Because of major changes in fuel loading and stand structure, 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 late successional 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.

In recent years, timber stand treatments have been focused on forest restoration. A primary emphasis has been in fostering the growth and development of ponderosa pine in the mixed conifer vegetation zone. A secondary emphasis is reduction of stocking density in overstocked stands of white fir. Major treatments include:

- Precommercial and commercial thinning, emphasizing retention of ponderosa pines in mixed stands and density reduction in white fir stands.
- Planting of ponderosa pine to provide future replacement stands.
- Emphasis on retention of ponderosa pine and removal of white fir in partial cutting prescriptions.

Recommendations

Continue the emphasis on density management and other activities that foster the growth and development of ponderosa pine. Continue to emphasize fuel reduction and related treatments in areas with high fire 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

Continue to implement silvicultural prescriptions and other stand treatments that emphasize the growth and development of early seral species. Identify opportunities where the use of prescribed fire, usually in conjunction with timber harvest, would reduce excessive fuels and reduce the stocking of white fir.

Lack of Large Trees

The reduction in stands of large trees, particularly those with characteristics of late successional forest, 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 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 Recreation Creek 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.

Intensive 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 Recreation Creek watershed. Logging, both thinning and stand replacement harvest methods, now occur 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 (2.8 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 few remaining old-growth stands in the LSR and interior forest stands 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 Recreation Creek watershed for agricultural and rural residential housing has resulted in long-term exclusion of forest habitat from approximately 200 acres (3%) 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 West Side 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 has been reduced in extent or eliminated. Movement of less mobile upland forest species to the marshlands may be blocked by West Side Road and other smaller access roads. In addition, general habitat alteration and increased levels of disturbance has 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 Northwestern 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. Wildlife depredation on crops and/or residential landscaping may result in the removal (usually fatal) of animals from 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 through out the portion of the watershed below approximately 5,000 feet elevation. The white fir 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 partial shelterwood and thinning likely have resulted in the conversion of nesting/foraging habitat to dispersal habitat. Logging also has removed a high percentage of the large diameter ponderosa pine and Douglas-fir trees that were suitable for nesting. Some portions of the watershed have been thinned at a level reducing canopy coverage below the percentage required for dispersal habitat. Stands thinned to levels below that required for dispersal may prevent spotted owl from moving through otherwise suitable habitat.

Currently, spotted owl NRF habitat is well distributed in the watershed and connectivity to other watersheds is good. Due to past timber management within the watershed, however, 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. Loss or significant distruption 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 has out competed 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.

Foraging areas for bald eagles within the watershed are limited to Recreation and Crystal Creeks and portions of Upper Klamath Lake. The majority of eagles that nest and/or roost within the watershed likely forage in lake and wetland habitats located 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 (USDI, 1992); 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 Recreation Creek 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.

Recommendations

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. Due to the limited timber operations within the watershed, it is likely road density could be reduced to ODFW target levels.
- Control exotic species (plants and animals) that are harmful to native biota.

Spotted Owl/Bald Eagle

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 Recreation Creek 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 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.

Compare the effects of the current road closure policy with pre-road closure conditions on bald eagle nesting survival.

During management activities, retain all large pine and Douglas-fir snags where feasible. Manage stands to grow large recruitment trees to provide bald eagle nest and roost sites.

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) and species composition (noxious weeds), 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 four species extirpated, one species extinct, two endangered, and three others listed as Species of Concern.

Habitat loss and degradation in the Recreation Creek watershed can be attributed to, but may not be limited to, damming, decreasing water quality, exotic species introduction, and lack of instream cover complexity. These deficiencies can be linked to the processes identified at the beginning of this chapter, primarily including timber management, non-timber, 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, removal of riparian vegetation, livestock grazing, and agricultural practices (Stubbs and White, 1993).

Timber management in the Recreation Creek watershed began early this century. Although it is unclear how much timber was actually removed from the Recreation Creek watershed during this time, early efforts were probably focused on removal of large individual conifers (high-grading of large ponderosa pine). These trees often were removed directly from riparian zones; however, besides Recreation and Crystal Creeks, there are no riparian zones impacting fish populations within the watershed. Impacts associated with removal of riparian vegetation appear to have been limited to the lower slopes of Pelican Butte. Since this time, regulations designed to retain trees within riparian zones have been established for both federal and private lands. Federal lands bordering these stream systems are now restricted from harvest and are set aside as Riparian Reserve, LSR, Eagle Habitat, and Critical Sucker Habitat (see Land Allocation Map, Figure 4).

Road building is an anthropogenic process directly related to timber management activities. Roads can affect the landscape by increasing erosion and sediment loading, altering channel morphology, and changing runoff patterns (Furniss, et al., 1991). Sediment delivered from roads is typically highest for several years following actual construction, but continues throughout the life of the road. Sediment delivered to a stream system will vary depending on surface type, drainage design, and road use

(WFPB, 1995). Increased sediment loads often have negative impacts on fish species and their habitat. However, sediment delivery does not appear to be a major concern in the Recreation Creek watershed. Twenty-three miles of non-paved road exist in the watershed, resulting in a non-paved road density of 2.15 miles per square mile. The lack of flowing surface water and a corresponding lack of drainage ditches and culverts, combined with the porous nature of soils within the watershed limit deliverability of sediment to Recreation and/or Crystal Creeks. The potential for sediment delivery is further limited by restricting road use, with seasonal road closures in the watershed taking place between January 1 and August 31.

As discussed in the Current Conditions section of this report, Crystal Creek was dredged in 1909 to facilitate passage for tourists traveling to Crater Lake. These dredged channels were used for barging and log rafting, providing indirect impacts from timber management activities outside of the Recreation Creek watershed. Due to similarities in channel form, the lack of LWD present instream, and its current use for canoeing and boating, it could be speculated that Recreation Creek also may have been dredged. Prior to dredging and construction of the Linkeville 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.

Agricultural and residential development (non-timber processes) also have affected habitat conditions in the Recreation Creek watershed. Vegetation was cleared from the floodplain and riparian zones as the lower portion of the watershed was developed. The floodplain 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 zones 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 annual problems in the Upper Klamath basin. Although Recreation and Crystal Creeks are known to have better water quality than found in the lake, data in Crystal Creek shows that standards for temperature, pH, and dissolved oxygen have been violated for resident fish and aquatic life one or more times. Nutrient production was naturally high in the basin; 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. 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).

DRAFT

Management of Upper Klamath Lake has had significant impacts on fisheries in the Recreation Creek watershed, including water level and fisheries management. In 1917, dam construction began within the Klamath River basin, resulting in a tremendous loss of fish habitat. Dams extirpated all anadromous fish runs from 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, theODFW began stocking largemouth bass, crappie, yellow perch, carp, and brown bullhead to diversify the fishery (Logan and Markle, 1993).

Thirty-seven fish species currently inhabit the Upper Klamath basin, only 17 of which are native. A total of 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 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 lakes 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.

Recommendations

Management direction for fisheries and riparian zones on the Klamath District of the Winema National Forest was provided in the *1990 Winema National Forest Land and Resource Management Plan* (USDA, 1990) as amended by the *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (ROD; USDA and USDI, 1994b).

According to the ROD, the Aquatic Conservation Strategy (ACS) was developed to maintain and restore ecosystem health at the watershed and landscape scales, to protect habitat for fish and other riparian dependent species and resources, and to restore currently degraded habitats. Fish and riparian zones will be managed according to Riparian Reserve Standards and Guidelines and ACS Objectives (USDA and USDI, 1994b). A complete list of ACS objectives has been included in the appendix of this report.

Standards and Guidelines for Riparian Reserves prohibit or regulate activities in Riparian Reserves that would retard or prevent attainment of ACS objectives. These objectives were designed to define the context for agency review and implementation of management activities. In order to comply with ACS Objectives, an agency must manage the riparian-dependent resources to either ~~maintain the existing condition~~ meet or implement actions to restore conditions. Watershed analysis is used as the tool to develop the baseline from which to assess maintaining or restoring the condition. Management actions that do not ~~maintain or improve the existing conditions~~ in the long-term would ensure that ACS objectives are met

~~not meet the intent of the~~ ACS, ~~and~~ should ~~therefore~~ not be implemented (USDA and USDI, 1994b).

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Since fish distribution and abundance can be directly linked to habitat complexity and quality, enhancement opportunities in the watershed should focus on restoration of these components. Attempts should be made to reverse or stabilize negative habitat trends in the Recreation Creek watershed. Efforts should concentrate on improving the habitat deficiencies outlined in Steps 3 and 4 of this report. This activity should work toward meeting Objectives 1 and 2 of the ACS: to maintain or restore the distribution, diversity, and complexity of watershed features; and to maintain or restore spatial and temporal connectivity within the watersheds.

Without removal of downstream dams or improvements in upstream passage past these dams, it will be difficult to restore the spatial and temporal connectivity between watersheds as called for in ACS Objective #2; however, it is possible to restore some of the complexity of watershed features outlined in ACS Objective #1. To avoid reducing habitat complexity, it is recommended that future clearing of marsh vegetation and dredging of Recreation and Crystal Creeks or their springs be limited. In addition to partially addressing Objective #1, this also begins to address ACS Objective #3 which directs that management restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

As a component of the ACS, FEMAT classified Pelican Butte (Recreation Creek) as a Tier 2 Key Watershed (OF-105) (USDA, et al., 1993). Tier 2 watersheds (Pelican Butte) were designated for their importance as sources of high quality water.

ACS Objective #4 is intended to maintain or restore water quality to a level necessary to support a healthy ecosystem. It also mandates that water quality remain in a range that benefits the survival, growth, reproduction, and migration of individuals composing aquatic communities. 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 extremely important for fish refuge in the late summer months as water quality conditions decline in Upper Klamath Lake. The importance of this watershed to water quality and survival of certain aquatic species (such as the endagered suckers and rainbow trout) in Upper Klamath Lake could center around the maintenance of water quality in this watershed.

Management direction specific to Key Watersheds states that no new roads will be built in roadless areas, and 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 not net increase in amount of roads in Key Watersheds (USDA and USDI, 1994b). ACS Objective #5 is designed to maintain or restore the sediment regime to a level consistent with which aquatic systems evolved. Currently, there are approximately 32 miles of road in the watershed, representing a road density of approximately 2.8 miles/square mile. The average road density for the entire WNF was reported as 4.29 miles/square mile. This density is slightly higher than that for all lands administered by the Forest Service and the BLM within the range of the northern spotted owl (3.38

miles/square mile) (USDA, et al., 1993).

To meet ACS Objective #5, management should look at reducing road density in the watershed. Roads deemed necessary for management objectives should remain seasonally closed, while unnecessary roads should be permanently closed or obliterated. Because sediment delivery to stream channels within the watershed is almost non-existent, the priority for actual road closure should be low.

To monitor changes in the quality of aquatic habitat and the abundance and distribution of fish, a series of baseline studies are recommended for implementation in the basin. Very little information exists on fish population or distribution in the Recreation Creek 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 data in Recreation and Crystal Creeks and Malone Springs.
- Conduct fish population surveys.

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6.0 GLOSSARY

Anadromous – Applied to the migratory nature of fish that spend the majority of their lives at sea, but then migrate to freshwater to spawn.

Anthropogenic – Of, relating to, or influenced by the impact of man on nature.

Critical Habitat – Under the Endangered Species Act, 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 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

Disturbance regime - A natural interference process characteristic of a geographic area or ecological condition. Examples include insects, diseases, wind, fire, landslides, and volcanism.

Endemic – A plant or animal species that occurs naturally in a certain region and whose distribution is relatively limited to a particular locality.

Eutrophic – Applied to nutrient-rich waters with high primary production. Typically, eutrophic lakes are shallow, with a dense plankton population and well developed littoral vegetation. The high organic content may mean that in summer, when there is stagnation caused by thermal stratification, oxygen supplies in the hypolimnion become limiting for some aquatic species.

Exotic – A plant or animal species introduced from a distant place; not native to the area.

Extirpated – Localized disappearance of a species from an area.

Hypereutrophic – Excessively eutrophic.

Intermittent Stream – A stream that flows only at certain times of the year when it receives water from other streams or from surface sources such as melting snow.

Lentic – Applied to a freshwater habitat characterized by calm or standing water (e.g. lakes, ponds, swamps, and bogs).

Lotic – Applied to a freshwater habitat characterized by running water (e.g. springs, rivers, and streams).

Watershed – The region draining not a river, river system, or body of water.

Appendix Table 1. (Continued)

Ecoclass	Map Code	Scientific Name	Common Name	Dominant Tree Species
CW-C2-15	ABCO/CEVE-SYAL	*Abies concolor/Ceanothus velutinus-Symphoricarpos albus*	Mixed conifer/snowbrush-bearberry	White fir - ponderosa pine - Douglas-fir
CW-S3-12	ABCO/SYAL/FRVIP	*Abies concolor/Symphoricarpos albus/Fragaria virginiana platypetala*	White fir/snowberry/strawberry	White fir - ponderosa pine - Douglas-fir
CR-S3-13	ABCO-ABMAS/ CACH-CHUM/CAPE5	*Abies concolor-Abies magnifica shastensis/Castanopsis chrysophylla-Chimaphila umbellata/Carex pennsylvanica*	Shasta red fir-white fir/chinquapin-prince's pine/long-stolon sedge	White fir - Shasta red fir - Douglas-fir - western white pine
CR-S1-12	ABMAS-TSME/ ARNE/CAPE5	*Abies magnifica shastensis-Tsuga mertensiana/Arctostaphylos nevadensis/Carex pennsylvanica*	Shasta red fir-mountain hemlock/pinemat manzanita/long-stolon sedge	Shasta red fir - mountain hemlock - western white pine
CM-S1-13	TSME/VASC	*Tsuga mertensiana/Vaccinium scoparium*	Mountain hemlock/grouse huckleberry	Mountain hemlock - Shasta red fir - subalpine fir
--	--	--	Talus with scattered conifer	Variable (zone-dependent)
--	--	--	Tule meadow	N/A

Reference: Hopkins, W.E., 1979. Plant associations of South Chiloquin and Klamath Ranger Districts - Winema National Forest. USDA Forest Service, Pacific Northwest Region. Publ. R6-Ecol-79-005.

Appendix Table 2. Numeric Water Quality Standards Related to Beneficial Uses

	Beneficial Use			
Parameter	**Resident Fish & Aquatic Life**	**Salmonid Spawning & Rearing**	**Water Contact Recreation**	**Water Supply**
Dissolved Oxygen (minimum)	Not less than 8.0 mg/L. Where barometric pressure, altitude, and temperature preclude attainment of 8.0 mg/L DO levels shall not be less than 90% saturation (cold water life). See OAR 340-41-965 for details.	Spawning to fry emergence; not less than 11.0 mg/L unless intergravel DO is greater than 8.0 mg/L then not less than 9.0 mg/L. Where conditions of barometric pressure, altitude, and temperature preclude attainment of 11.0 mg/L or 9.0 mg/L standard, DO shall not be less than 95% saturation. Intergravel DO shall be greater than 6.0 mg/L. See OAR 340-41-965 for details.	No DEQ standard	No DEQ standard
Bacteria (maximum)	No DEQ standard	No DEQ standard	30-day log mean of 126 E. coli organisms per 100 mL, minimum of five samples. No single sample greater than 406 organisms per 100 mL.	No DEQ standard
pH (acceptable range)	6.5 - 9.0 Cascade Lakes above 5,000' 6.0-8.5	6.5 - 8.5	No DEQ standard	No DEQ standard
Temperature (maximum)	Spawning to fry emergence: not less than 11.0 mg/L unless intergravel DO is greater than 8.0 mg/L, then not less than 9.0 mg/L. Where conditions of barometric pressure, altitude, and temperature preclude attainment of 11.0 mg/L or 9.0 mg/L standard, DO shall not be less than 95% saturation. Intergravel DO shall be greater than 6.0 mg/L.	No measurable surface water temperature increase from anthropogenic activities: in basins where salmonid fish rearing is a designated beneficial use and surface water temperatures exceed 64 F; and in waters and periods of the year determined by DEQ to support native salmonid spawning, egg incubation, and fry emergence in a basin which exceeds 55 F.	No DEQ standard	No DEQ standard
Turbidity (maximum)	No more than 10% cumulative increase above background level.	No DEQ standard	No DEQ standard	No DEQ standard
Total Dissolved Gas (maximum)	110% saturation	110% saturation	No DEQ standard	No DEQ standard
Total Dissolved Solids (maximum)	Standard only for Klamath R. from Klamath Lake to Oregon-California border. Standard for that reach is specific conductance less than 400 micromhos at 77 F.	Standard only for Klamath R. from Klamath Lake to Oregon-California border. Standard for that reach is specific conductance less than 400 micromhos at 77 F.	No DEQ standard	No DEQ standard
Toxic Substances (maximum)	Varies (see OAR 340-41, Table 20)	Varies (see OAR 340-41, Table 20)	No DEQ standard	Varies (see OAR 340-41, Table 20)

Appendix Table 3. Mollusk Species Known or Likely to Occur in the Upper Klamath Lake Drainage Which Could Potentially Occur in the Recreation Creek Watershed (Frest and Johannes, 1995 and 1996)

SPECIES	STATUS					
	NSO[1]	ROD[2]	ICB[3]	UKL[4]	ARI[5]	NWM[6]
FRESHWATER GASTROPODA						
Pyrgulopsis archimedis Berry, 1947	Sp, E	-	S, E	S, E	-	S, E
Pyrgulopsis n. sp. 1 Frest & Johannes, 1995a	Sp, E	-	S, E	S, E	-	S, E
Pyrgulopsis n. sp. 2 Frest & Johannes, 1995a	-	-	S, E	S, E	-	S, E
Lyogyrus n. sp. 3 Frest & Johannes, 1995a	Sp, E	-	S, E	S, E	S, E	S, E
Lyogyrus n. sp. 4 Frest & Johannes, 1995a	Sp, E	-	S, E	S, E	-	S, E
Lyogyrus n. sp. 5 Frest & Johannes, 1995a	Sp, E	-	S, E	S, E	-	S, E
***Fluminicola* n. sp. 1 F. & J., 1995a**	**Sp, E**	**yes**	**S, E**	**S, E**	**S, E**	S, E
***Fluminicola* n. sp. 2 F. & J., 1995a**	**Sp, E**	**yes**	**S, E**	**S, E**	**S, E**	S, E
***Fluminicola* n. sp. 3 F. & J., 1995a**	**Sp, E**	**yes**	**S, E**	**S, E**	**S, E**	S, E
Fluminicola n. sp. 7 Frest & Johannes, 1995a	-	-	S, T	S, T	-	S, T
Fluminicola n. sp. 8 Frest & Johannes, 1995a	-	-	S, E	S, E	-	S, E
Fluminicola s. sp. 27 Frest & Johannes, 1996	-	-	-	S, E	-	S, E
Fluminicola n. sp. 28 Frest & Johannes, 1996	-	-	-	S, E	-	S, E
Flumnicola n. sp. 29 Frest & Johannes, 1996	-	-	-	S, E	-	S, E
Fluminicola n. sp. 30 Frest & Johannes, 1996	-	-	-	S, E	-	S, E
Fluminicola n. sp. 31 Fret & Johannes, 1996	-	-	-	S, E	-	S, E
Stagincola (Hinkleyia) montanensis (Baker, 1913)	-	-	W	-	-	-
Lanx alta (Tryon, 1865)	Sp, T	-	S, E	-	-	-
Lanx klamathensis Hannibal, 1912	Sp, E	-	S, E	-	-	-
Helisoma (Carinifex) newberryi newberryi (Lea, 1858)	Sp, E	-	S, E	-	-	-
Vorticifex effusus dalli (Baker, 1945)	Sp, E	-	S, E	-	-	-
Vorticifex effusus diagonalis (Henderson, 1929)	Sp, E	-	S, E	-	-	-
Vorticifex klamathenisis klamathenisis (Baker, 1945)	Sp, E	-	S, E	-	-	-
Vorticifex klamathensis sinitsini **(Baker, 1945)**	**Sp, E**	**yes**	S, E	S, E	S, E	S,E

SPECIES	STATUS					
	NSO[1]	ROD[2]	ICB[3]	UKL[4]	ARI[5]	NWM[6]
TERRESTRIAL GASTROPODA						
Discus shimeki cockerelli (Pilsbry, 1898)	-	-	-	C2	-	?
Mondenia (Monadenia) n. sp. 1 Frest & Johannes, 1995a	-	-	S, E	S, E		S, E
***Preistiloma arcticum* ? Crateris Pilsbry, 1946**	**Sp, T**	**yes**	**S, T**	**S, T**	**S, T**	**S, T**
***Prophysaon coeruleum* Cockerell, 1890**	-	**yes**	-	-	-	**S, E**
***Prophysaon dubium cockerell*, 1890**	-	**yes**	-	-	-	**S, E**
Prophysaon n. sp. 1 Frest & Johannes, 1996	-	-	-	-	S, E	S, E
Vespericola sierranus (Berry, 1921)	**Sp, T**	**yes**	**S, T**	**S, T**	**S, T**	**S, T**

SPECIES	S~ATUS					
	NSO[1]	ROD[2]	ICB[3]	UKL[4]	ARI[5]	NWM[6]
FRESHWATER BIVALVIA						
Anodonta californiensis Lea, 1852	Sp, E	-	S, T	C2	-	S, E
Anodonta oregonensis Lea, 1838	-	-	-	-	-	-
Anodonta wahlametensis Lea, 1838	Sp, E	-	S, E	-	-	S, E
Gonidea angulata (Lea, 1838)	-	-	W	-	-	Watch
Margaritifera falcata (Gould, 1850)	-	-	W	-	-	Watch
Pisidium (C.) ultramontanum Prime, 1865	Sp, E	-	S, E	C2	-	S, E
Pisidium (C.) n. sp. 1	-	-	S, E	-	-	S, E

EXPLANATION:

C2 = Federal ESA category 2 candidate: see USFWS (1994)
E = Recommended for federal ESA listing as Endangered; see Frest & Johannes (1993, 1995, 1996, 1997)
S = Sensitive species; see Frest & Johannes (1995, 1996, 1997)
Sp = Species of Special Concern; see Frest & Johannes (1993, 1996, 1997)
T = Recommended for federal ESA listing as Threatened; see Frest & Johannes (1993, 1995, 1996, 1997)
W = Watch List; see Frest & Johannes (1995, 1997)

1 = Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl (Frest & Johannes, 1993)
2 = Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management of Habitat for Late-Successional and old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (ROD, 1994)
3 = Interior Columbia Basin Mollusk Species of Special Concern (Frest & Johannes, 1995a)
4 = Frest & Johannes (1996) Freshwater Mollusks of the Upper Klamath drainage, Oregon
5 = Frest & Johannes (1996) Additional Information on Certain Mollusk Species of Special Concern Occurring Within the Range of the Northern Spotted Owl
6 = Frest & Johannes (1997, in press) Northwestern US Mollusk Species of Special Concern

Appendix Table 3. Mollusk Species Known or Likely to Occur in the Upper Klamath Lake Drainage Which Could Potentially Occur in the Recreation Creek Watershed (Frest and Johannes, 1995 and 1996)

SPECIES	STATUS					
	NSO[1]	ROD[2]	ICB[3]	UKL[4]	ARI[5]	NWM[6]
FRESHWATER GASTROPODA						
Fluminicola n. sp. 32 F. & J., 1997	-	-	-	-	-	S, E
Fluminicola n. sp. 33 F. & J., 1997	-	-	-	-	-	S, E
Fluminicola n. sp. 34 F. & J., 1997	-	-	-	-	-	S, E

SPECIES	STATUS					
	NSO[1]	ROD[2]	ICB[3]	UKL[4]	ARI[5]	NWM[6]
TERRESTRIAL GASTROPODA						
Monadenia fidelis celeuthia berry, 1937	-	yes	-	-	-	S, E
Vespericola sierranus (Berry, 1921)	Sp, T	yes	S, T	S, T	S, T	S, T
Pristiloma articum? Crateris Pilsbry, 1946	Sp, T	yes	S, T	S,T	S, T	S, T
Prophysaon coeruleum Cockerell, 1890	-	yes	-	-	S, E	S, E
Prophysaon dubium Cockerell, 1890	-	yes	-	-	S, E	S, E
Prophysaon n. sp. 1 Frest & Johannes, 1996	-	-	-	-	S, E	S, E

EXPLANATION:

C2 = Federal ESA category 2 candidate: see USFWS (1994)
E = Recommended for federal ESA listing as Endangered; see Frest & Johannes (1993, 1995, 1996, 1997)
S = Sensitive species; see Frest & Johannes (1995, 1996, 1997)
Sp = Species of Special Concern; see Frest & Johannes (1993, 1996, 1997)
T = Recommended for federal ESA listing as Threatened; see Frest & Johannes (1993, 1995, 1996, 1997)
W = Watch List; see Frest & Johannes (1995, 1997)

[1] = Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl (Frest & Johannes, 1993)
[2] = Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management of Habitat for Late-Successional and old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (ROD, 1994)
[3] = Interior Columbia Basin Mollusk Species of Special Concern (Frest & Johannes, 1995a)
[4] = Frest & Johannes (1996) Freshwater Mollusks of the Upper Klamath drainage, Oregon
[5] = Frest & Johannes (1996) Additional Information on Certain Mollusk Species of Special Concern Occurring Within the Range of the Northern Spotted Owl
[6] = Frest & Johannes (1997, in press) Northwestern US Mollusk Species of Special Concern

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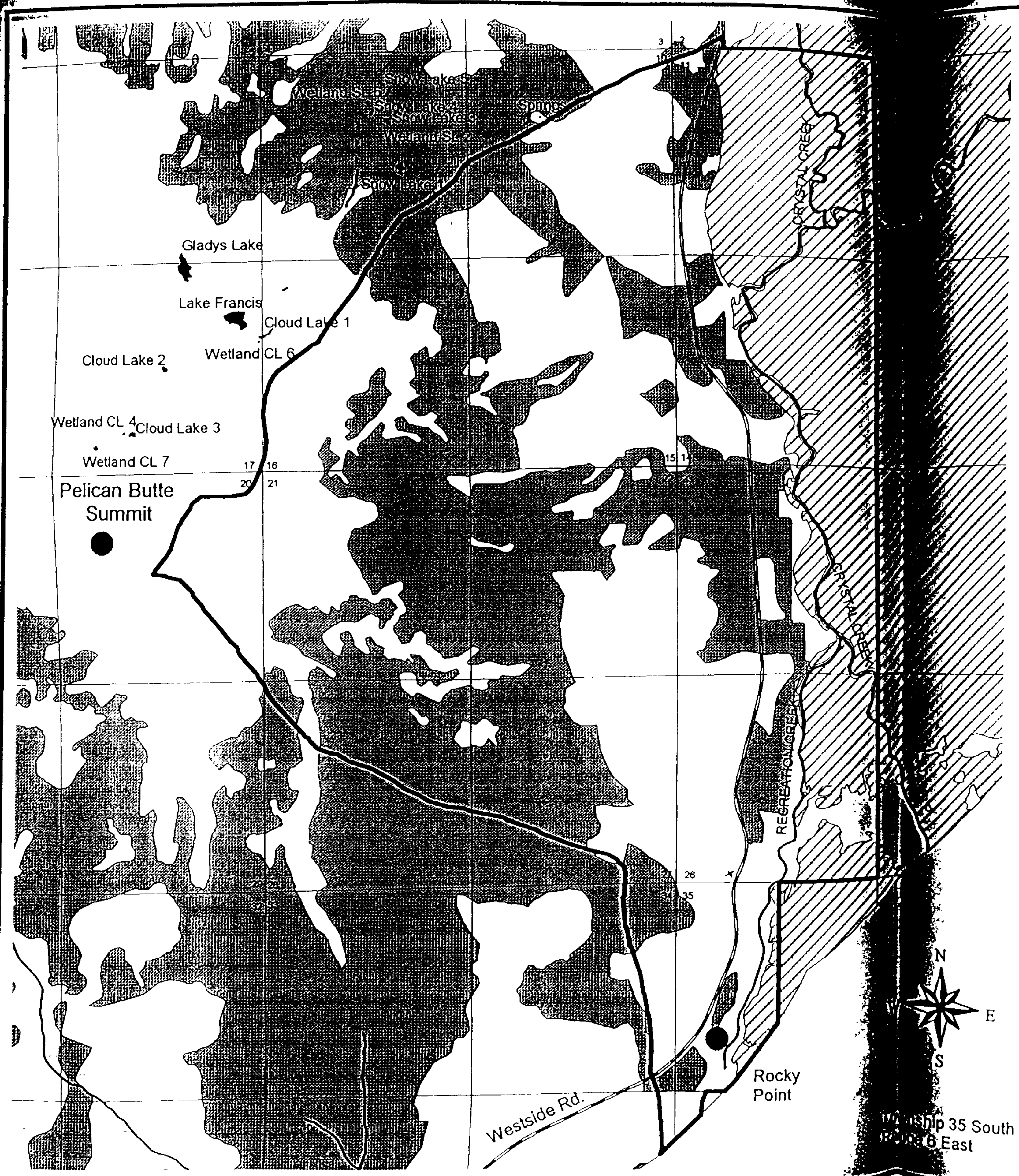

Rec
Wat

SP
ROOSTIN

Legend

- RECREATION CREEK WATERS
- CREEKS
- LAKES
- WETLANDS
- UPPER KLAMATH MARSH

SPOTTED OWL NESTING/ROOSTING

- NRF
- Non-Habitat

0.5 0 0.5 1

3000 0 3000 6000

SCALE: 1 : 36,000

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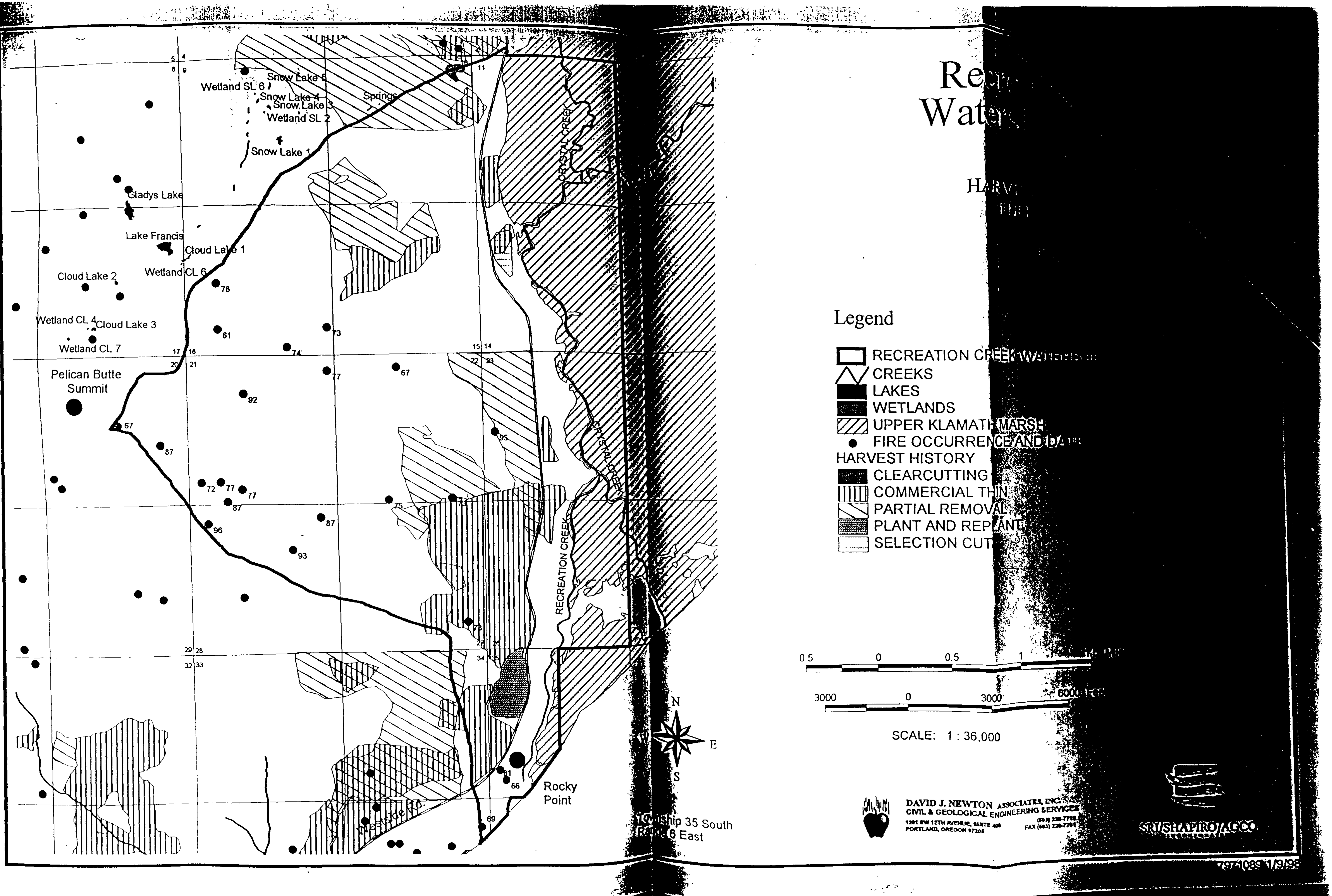
Recr
Wate
HARV
Legend
RECREATION CREEK WATERSHED
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
FIRE OCCURRENCE AND DATE
HARVEST HISTORY
CLEARCUTTING
COMMERCIAL THIN
PARTIAL REMOVAL
PLANT AND REPLANT
SELECTION CUT
0.5
0
0.5
1
3000
0
3000
6000
SCALE: 1 : 36,000
Snow Lake 6
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Springs
Snow Lake 1
Gladys Lake
Lake Francis
Cloud Lake 1
Wetland CL 6
Cloud Lake 2
Wetland CL 4
Cloud Lake 3
Wetland CL 7
Pelican Butte
Summit
CRYSTAL CREEK
RECREATION CREEK
Rocky
Point
Westside Rd.
Township 35 South
Range 6 East
N
W
E
S
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PORTLAND, OREGON 97205
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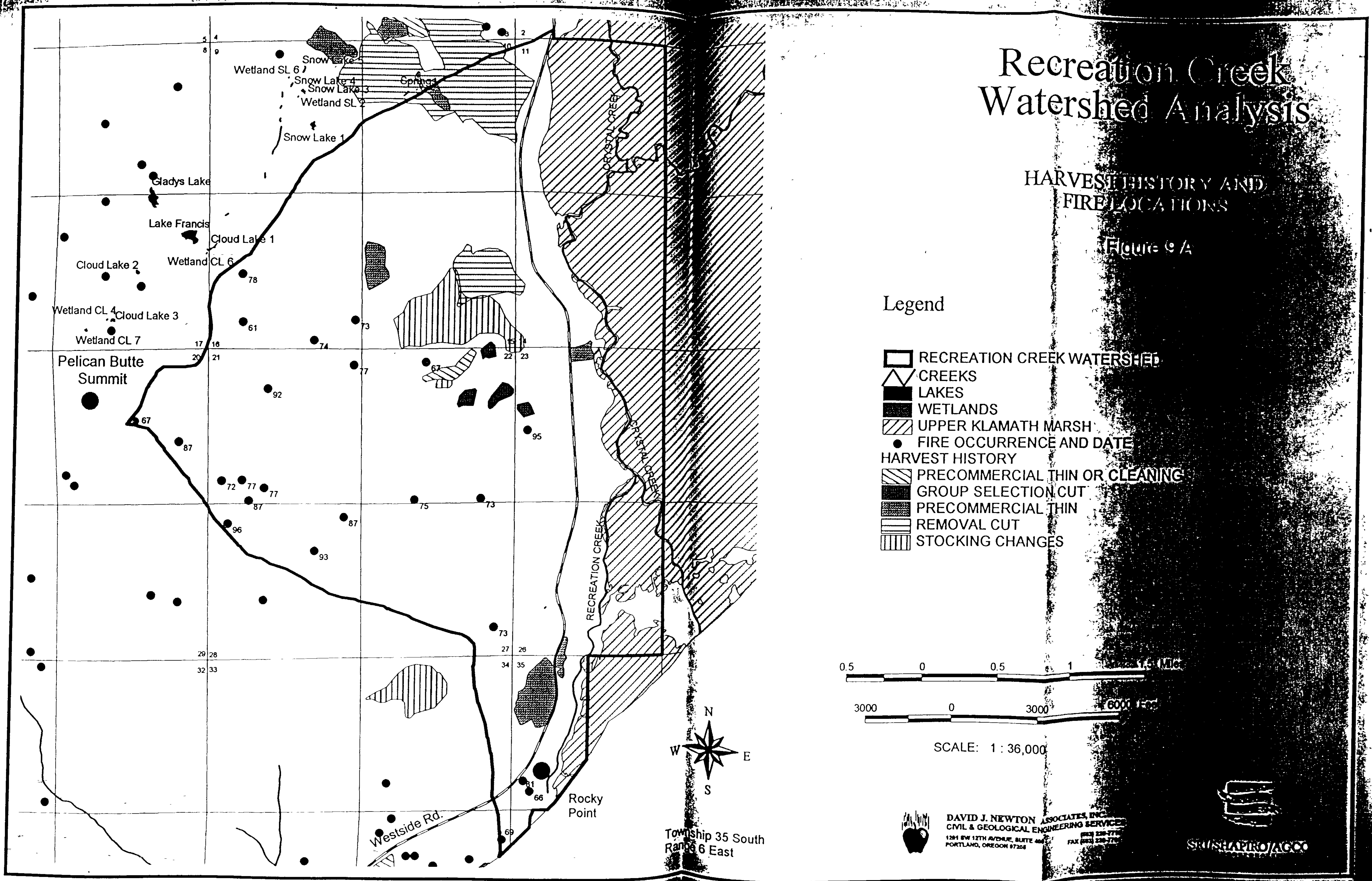
Recreation Creek
Watershed Analysis
HARVEST HISTORY AND
FIRE LOCATIONS
Figure 9 A
Legend
RECREATION CREEK WATERSHED
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
FIRE OCCURRENCE AND DATE
HARVEST HISTORY
PRECOMMERCIAL THIN OR CLEANING
GROUP SELECTION CUT
PRECOMMERCIAL THIN
REMOVAL CUT
STOCKING CHANGES
0.5 0 0.5 1 1.5 Miles
3000 0 3000 6000 Feet
SCALE: 1 : 36,000
N
W
E
S
Township 35 South
Range 6 East
Snow Lake 5
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Snow Lake 1
Spring 1
Gladys Lake
Lake Francis
Cloud Lake 1
Cloud Lake 2
Wetland CL 6
Wetland CL 4
Cloud Lake 3
Wetland CL 7
Pelican Butte
Summit
CRYSTAL CREEK
RECREATION CREEK
Rocky
Point
Westside Rd.
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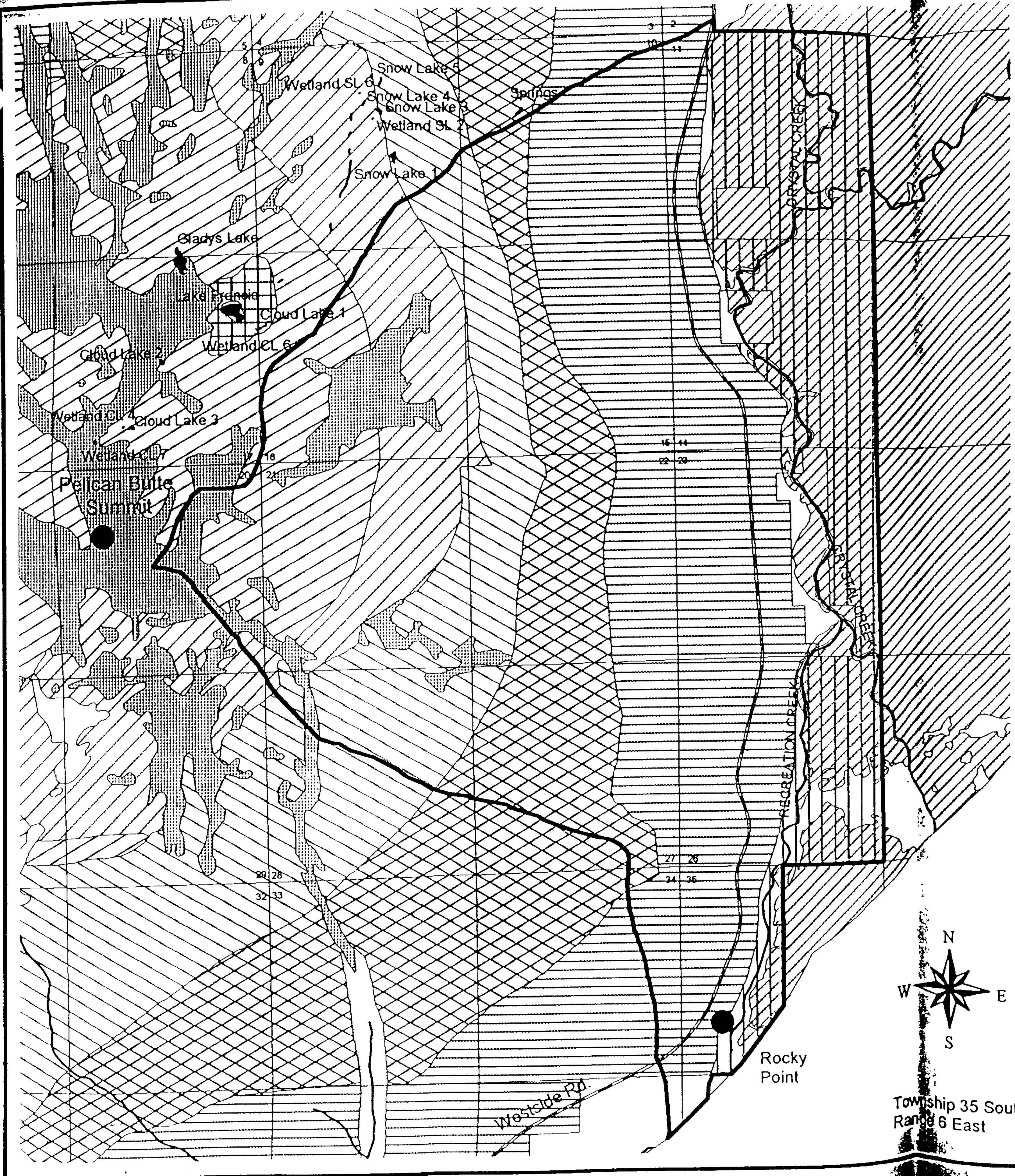
CIVIL & GEOLOGICAL ENGINEERING SERVICES
1201 SW 12TH AVENUE, SUITE 400
PORTLAND, OREGON 97205
SRI/SHAPIRO/AGCO



Recre
Watersh

VEGETATION

Legend

- RECREATION CREEK WATERSHED
- CREEKS
- LAKES
- WETLANDS
- UPPER KLAMATH MARSH

VEGETATION COMMUNITY TYPES

- Lodgepole/grouse huckleberry/long-stolon sedge
- Mixed conifer/snowbrush-bearberry
- Mountain hemlock/grouse huckleberry
- Shasta red fir-mtn hemlock/pinemat manzanita
- Shasta red fir-white fir/chinqapin-princes pine
- Tallus with scattered conifers
- White fir-alder/shrub meadow
- White fir/snowberry/strawberry
- Tule Meadow

0.5 0 0.5 1

3000 0 3000 6000 Feet

SCALE: 1 : 36,000

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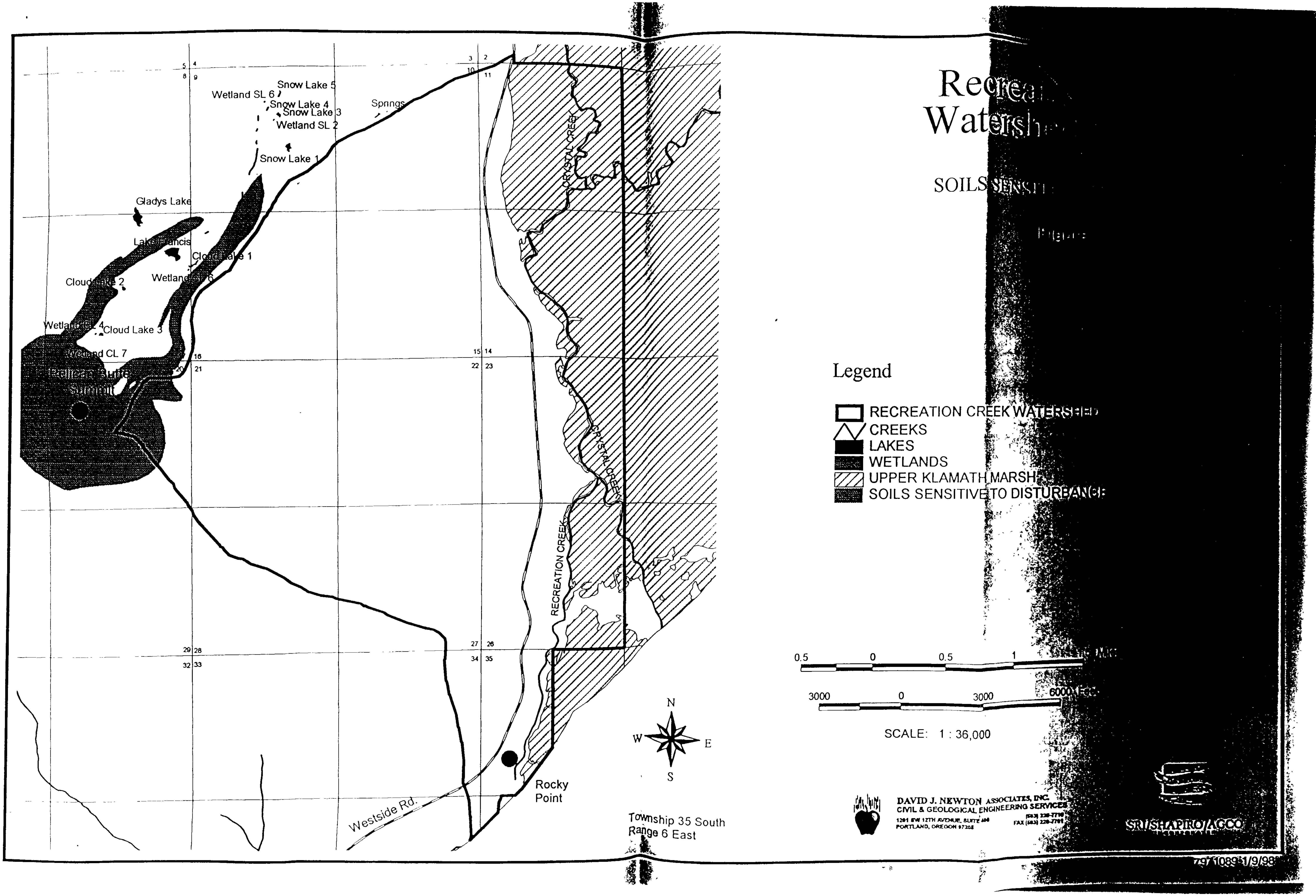
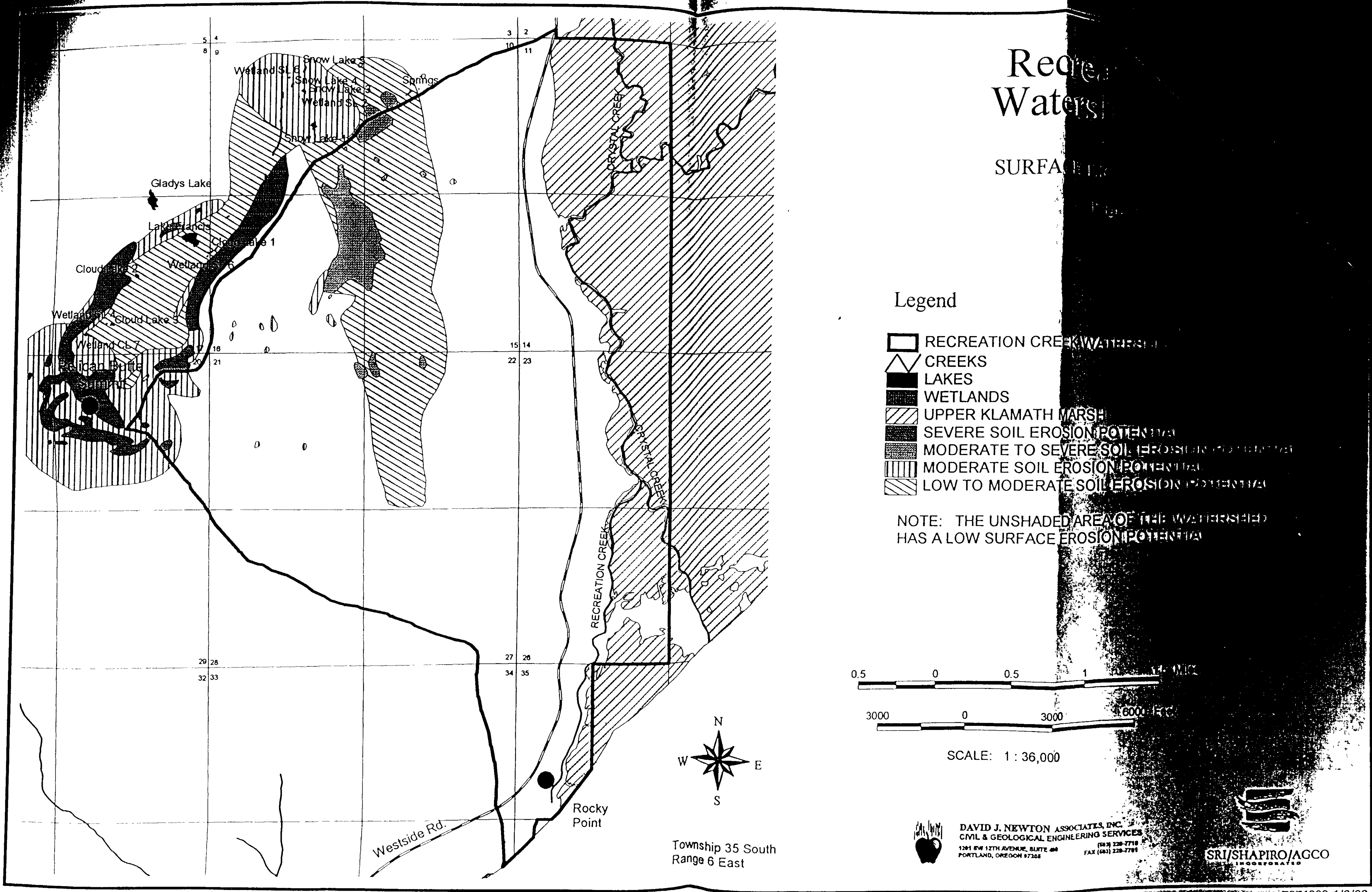


Rec
Wat
SOILS
Legend
RECREATION CREEK
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
SOILS SENSITIVE TO DISTURBANCE
0.5 0 0.5 1
3000 0 3000 6000
SCALE: 1 : 36,000
DAVID J. NEWTON ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
SRI/SHAPIRO/AGCO
Snow Lake 5
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Snow Lake 1
Springs
Gladys Lake
Cloud Lake 1
Cloud Lake 2
Cloud Lake 3
Wetland CL 7
CRYSTAL CREEK
RECREATION CREEK
Rocky Point
Westside Rd.
N
W
E
S
Township 35 South
Range 6 East



Rec
Water
SURFA
Legend
RECREATION CRE
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
SEVERE SOIL EROSION POTEN
MODERATE TO SEVERE SOIL
MODERATE SOIL EROSION POTEN
LOW TO MODERATE SOIL EROSION
NOTE: THE UNSHADED AREA OF THE WATERSHED
HAS A LOW SURFACE EROSION POTENTIAL
SCALE: 1 : 36,000
Gladys Lake
Lake Francis
Cloud Lake 1
Cloud Lake 2
Cloud Lake 3
Wetland CL 7
Pelican Butte Summit
Snow Lake 5
Snow Lake 4
Snow Lake 3
Snow Lake 1
Springs
CRYSTAL CREEK
RECREATION CREEK
Westside Rd.
Rocky Point
Township 35 South
Range 6 East
N
S
E
W
DAVID J. NEWTON ASSOCIATES, INC.
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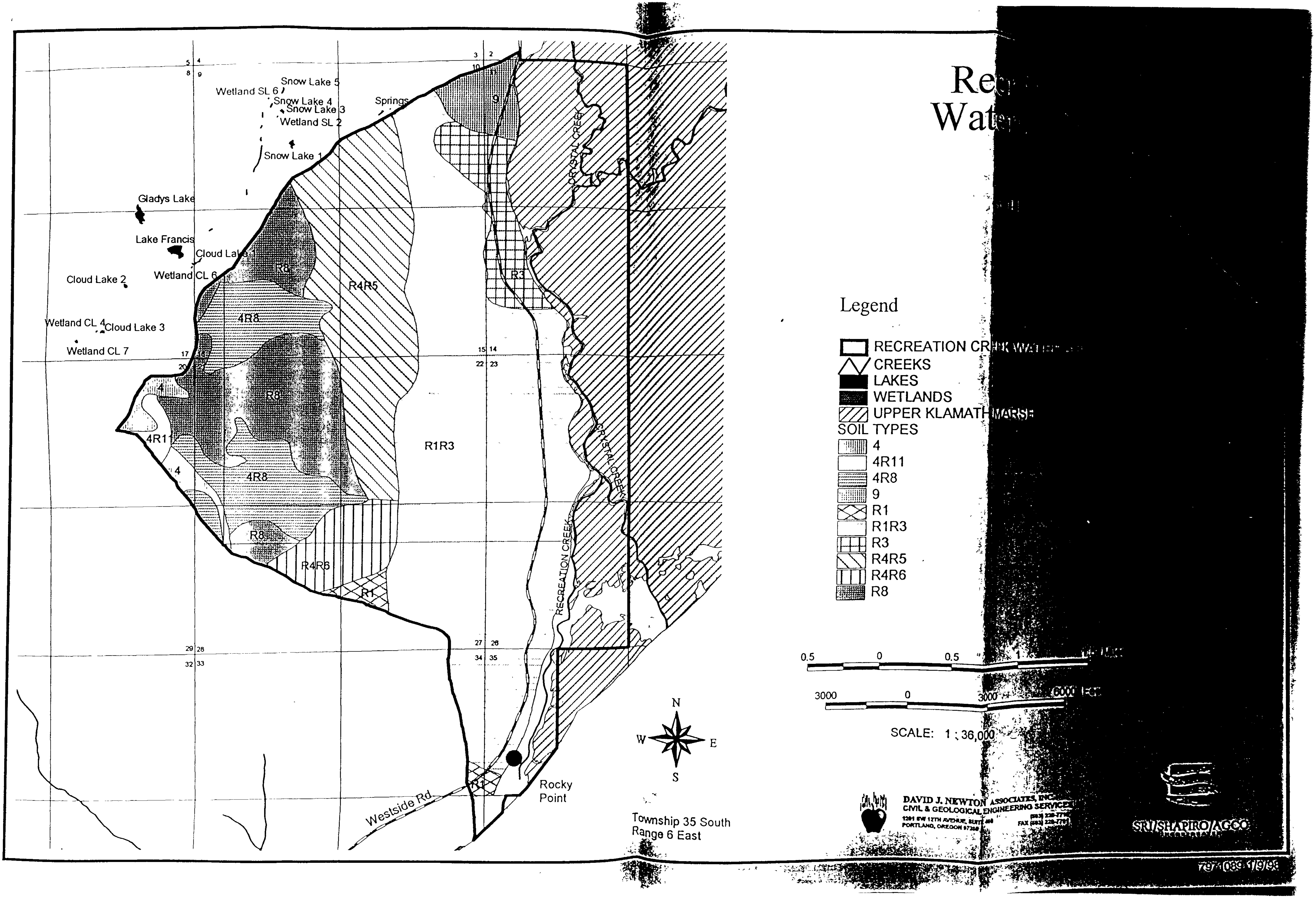
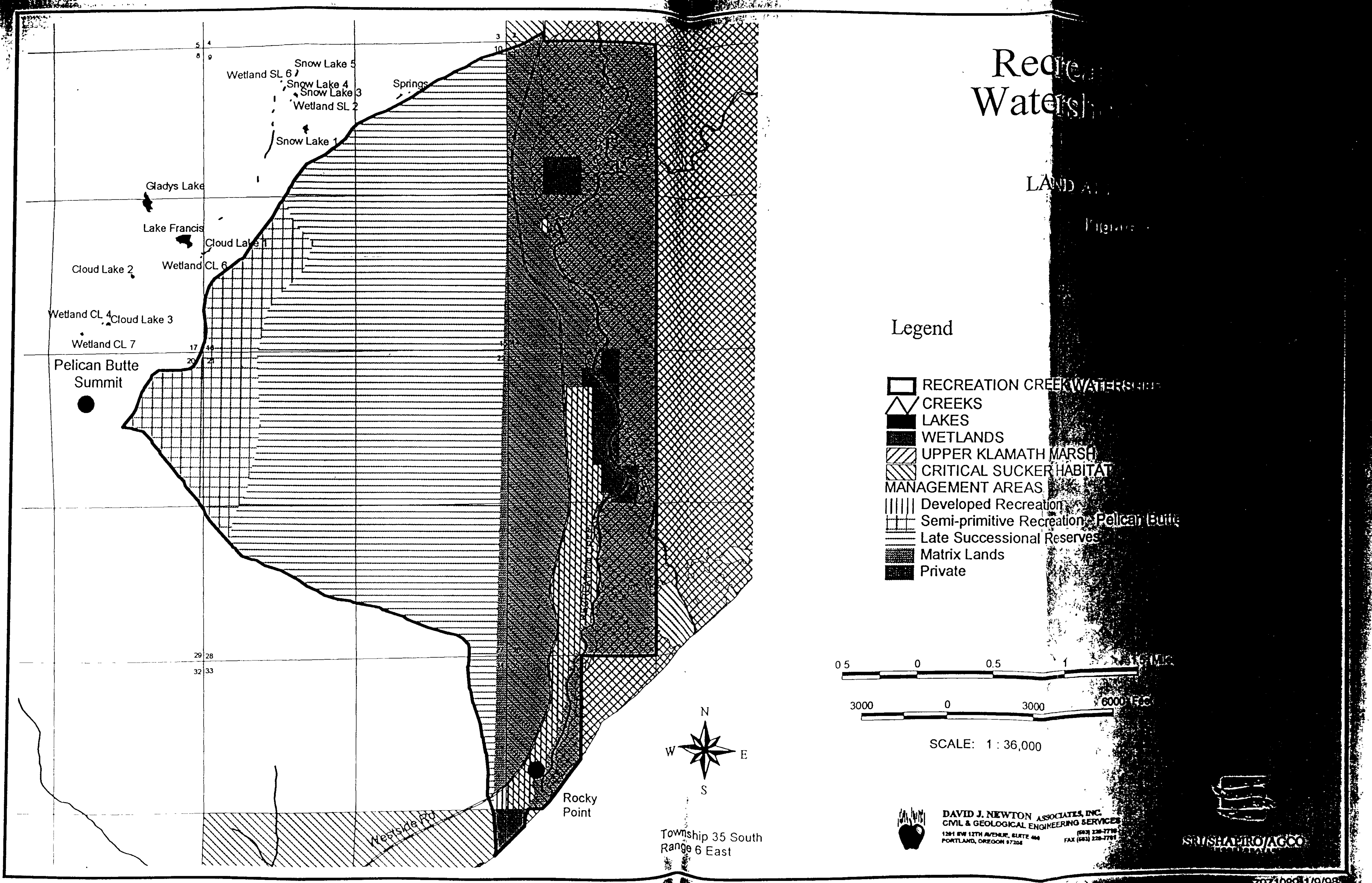


Re
Wat
Legend
RECREATION CR
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
SOIL TYPES
4
4R11
4R8
9
R1
R1R3
R3
R4R5
R4R6
R8
0.5
0
0.5
3000
0
3000
6000
SCALE: 1 : 36,000
N
S
E
W
Township 35 South
Range 6 East
DAVID J. NEWTON ASSOCIATES, INC.
CIVIL & GEOLOGICAL ENGINEERING SERVICES
SRI/SHAPIRO/AGCO
Snow Lake 5
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Snow Lake 1
Springs
Gladys Lake
Lake Francis
Cloud Lake 2
Wetland CL 6
Wetland CL 4
Cloud Lake 3
Wetland CL 7
CRYSTAL CREEK
RECREATION CREEK
Rocky Point
Westside Rd.
R4R5
R1R3
4R8
4R11
R8
R3
R4R6
R1
9
4



Snow Lake 5
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Springs
Snow Lake 1
Gladys Lake
Lake Francis
Cloud Lake 1
Cloud Lake 2
Wetland CL 6
Wetland CL 4
Cloud Lake 3
Wetland CL 7
Pelican Butte Summit
Rocky Point
Westside Rd
Township 35 South
Range 6 East
Legend
RECREATION CREEK WATERSHED
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
CRITICAL SUCKER HABITAT
MANAGEMENT AREAS
Developed Recreation
Semi-primitive Recreation - Pelican Butte
Late Successional Reserves
Matrix Lands
Private
SCALE: 1 : 36,000
N
S
E
W
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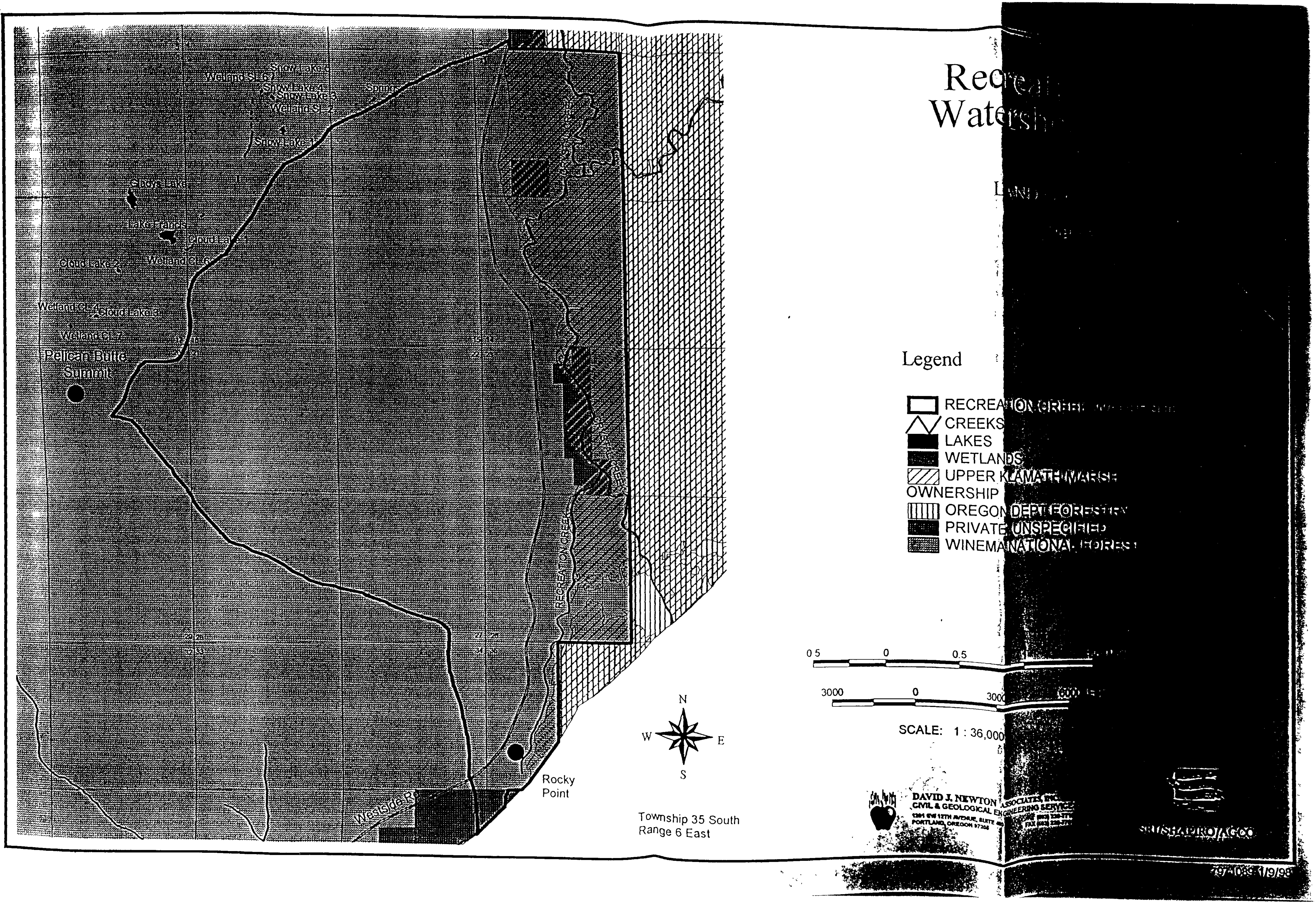

Snow Lake 4
Snow Lake 3
Snow Lake 1
Lake Francis
Cloud Lake 2
Cloud Lake 3
Pelican Butte Summit
Rocky Point
Westside Rd
RECREATION CREEK
N
W
E
S
Township 35 South
Range 6 East
Legend
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
OWNERSHIP
OREGON DEPT FORESTRY
PRIVATE UNSPECIFIED
WINEMA NATIONAL FOREST
0.5
0
0.5
3000
0
3000
SCALE: 1 : 36,000
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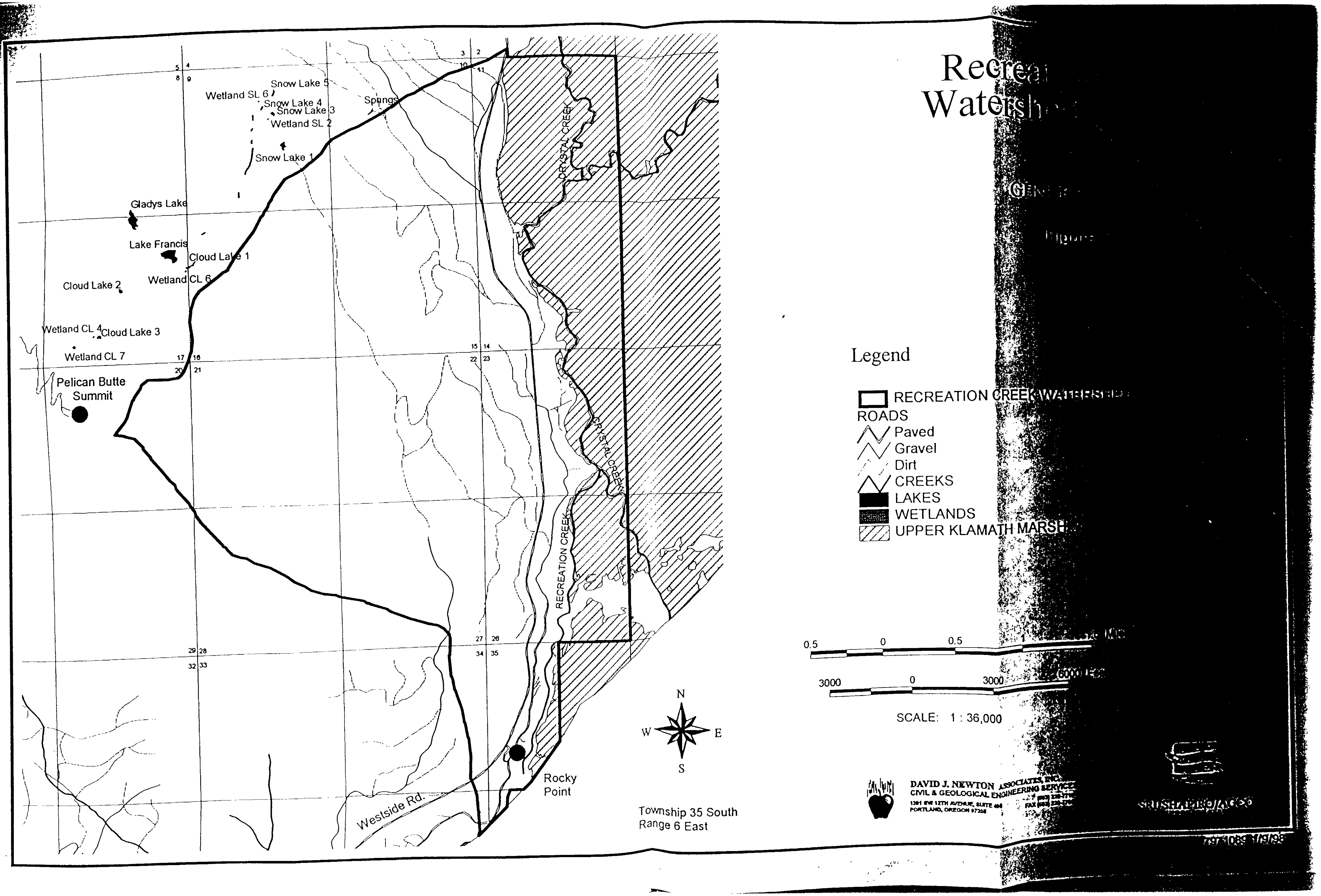

Recrea
Watersh
Legend
RECREATION CREEK WATERSH
ROADS
Paved
Gravel
Dirt
CREEKS
LAKES
WETLANDS
UPPER KLAMATH MARSH
SCALE: 1 : 36,000
Snow Lake 5
Wetland SL 6
Snow Lake 4
Snow Lake 3
Wetland SL 2
Snow Lake 1
Springs
Gladys Lake
Lake Francis
Cloud Lake 1
Wetland CL 6
Cloud Lake 2
Wetland CL 4
Cloud Lake 3
Wetland CL 7
Pelican Butte Summit
CRYSTAL CREEK
RECREATION CREEK
Westside Rd.
Rocky Point
Township 35 South
Range 6 East
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