Mazama Watershed Analysis

Prepared for
Chemult Ranger District

by
Analysis Team

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Mazama Watershed Team

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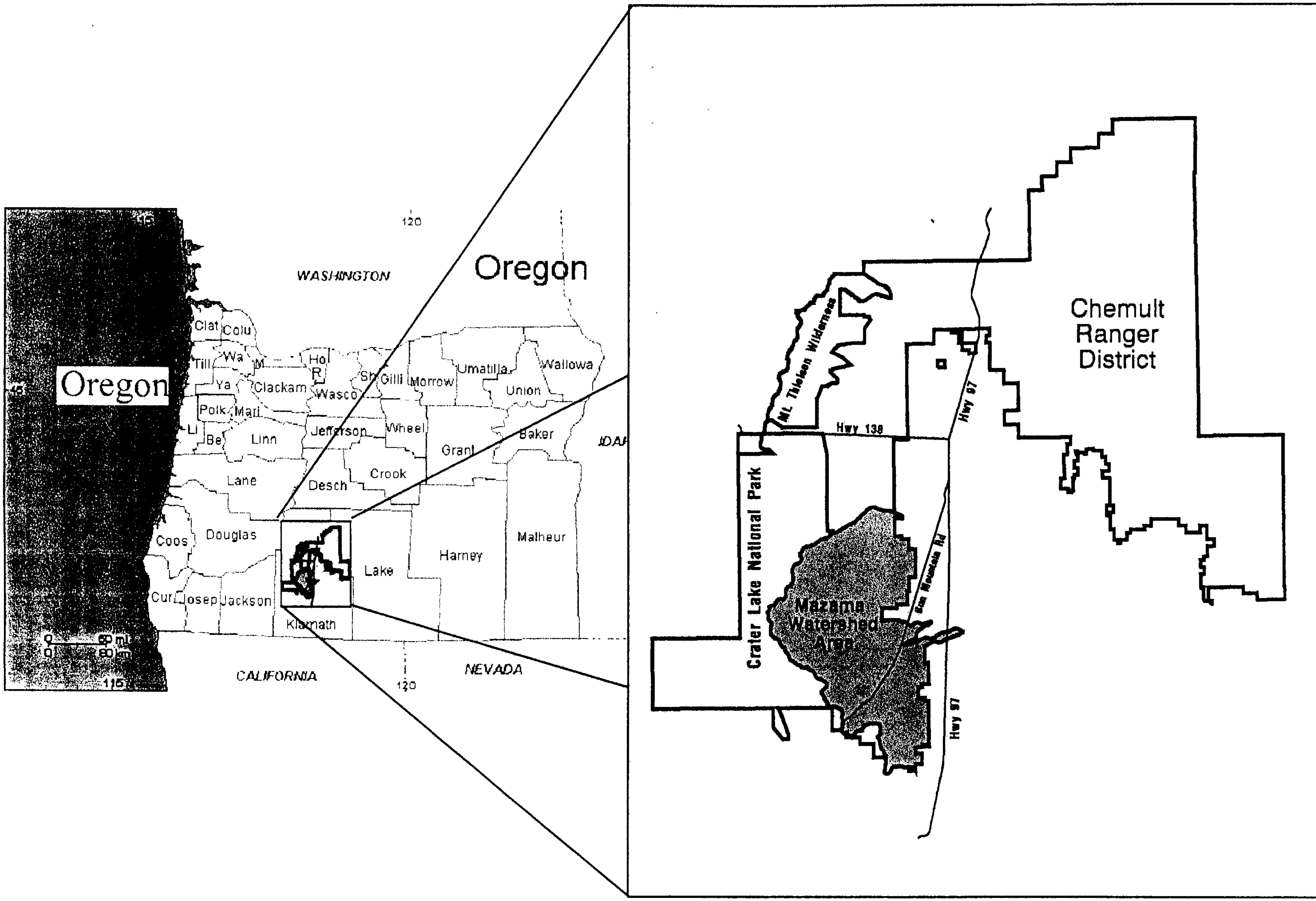

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Crater Lake National Park
Mazama Watershed Area
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EXECUTIVE SUMMARY

Mazama Watershed

Chemult Ranger District

June, 1996

The Mazama Watershed Analysis is written to help guide project planning during the implementation of the *President's Forest Plan* (also known as the *Northwest Forest Plan*) on the Chemult Ranger District of the Winema National Forest. The analysis area includes the upper reaches of 7 subwatersheds: Sand Creek, Scott Creek, Pothole Creek, Bear Creek, Cavern Creek, Lost Creek and Wheeler Creek. These subwatersheds encompass all District lands within the range of the northern spotted owl.

The purpose of this analysis is to review existing information and develop conceptual strategies to sustain viable ecosystems. Analysis was completed using the *Federal Agency Guide for Watershed Analysis, version 2.2.* This 6 step process melds social values, biological capabilities, and physical characteristics of the landscape at the watershed level. The 6 steps are: characterization of dominant features and processes, identification of issues and key questions, description of current conditions, description of historic conditions, synthesis and interpretation of information, and management recommendations responsive to issues. The *Odell Pilot Watershed Analysis* (Crescent Ranger District, 1994) was used extensively in the development of this analysis as an example of how to present the process and for its information relevant to this watershed.

Five core topics that represent the major and common ecological elements and processes were identified from issues and addressed in this analysis: erosion processes, including geology and soils, aquatic habitats, including stream condition, hydrology and water quality, vegetation, species and habitat, and historic human uses.

Issues were identified for each of the core topics. A) erosion: heavy sediment loads are clogging diversion ditches and culverts in the lower stream reaches, B) aquatics: water for domestic use, loss of riparian hardwood, systems vulnerable to disturbance, road influence, C) vegetation: conversion of ponderosa pine to mixed conifer, overstocking, shift in fire regime to larger, more destructive fires, declining populations of *Allotropa virgata,* D) species and habitat: population declines of several wildlife species, and E) human uses: sustain high quality water for domestic use, access to Crater Lake National Park for illegal hunting and mushroom gathering activities.

The synthesis and interpretation section identifies 11 trends. Eight trends are influenced primarily by management activities and three primarily by natural processes. These trends result from factors , which, over time, influence change on a portion of the ecosystem. The trends are categorized as either red, yellow or green. Red implies an urgency for intervention to prevent further deterioration of a resource. Yellow indicates something should be done soon to prevent the resource from becoming a red trend. Green indicates no great urgency is needed or the trend maintains or enhances ecosystem sustainability and should continue.

Red flag trends include change in the fire regime for ponderosa pine, reduction of large tree dominated stands, shift in species composition, and beetle threat in lodgepole pine. Yellow flag trends include shift in stream zone vegetation, erosion from roads contributing sediments to streams, increase in disease, increase in soil compaction, and slow regeneration in frost pockets. Green flag trends include sparse pool development and high water quality.

Recommendations for management activities respond to issues and key questions and are separated into four categories: management opportunities, management recommendations, research opportunities and monitoring needs. Management opportunities include development and implementation of a fire/silviculture strategy that mimics historic stand maintenance fire effects for the watershed, commercial and precommercial harvest, implementation of the Riparian Reserve Strategy and subsoiling unnecessary roads. Recommendations are common to all proposed activities and include the following: buffering the Pinnacles Canyon wall, minimizing fragmentation and developing silvicultural prescriptions to maintain or enhance old growth characteristics. Research opportunities exist to develop a feasibility study to introduce bull trout into Sand and Scott Creeks, and gather more information on the distribution of two sensitive insect species. Monitoring is necessary to detect contamination of domestic water supply downstream from the Scott Creek campground and to update the *Allotropa virgata* Conservation Strategy.

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Chapter 1. Introduction

Characterization

The eruption of Mt Mazama 7,000 years ago buried the watershed in pumice and ash to depths varying from 65 - 121 feet. The resulting pumice and ash soils are very young and undeveloped with low productivity. Water erosion hazards are very low due to rapid infiltration and permeability rates, except on road surfaces. These soils are unstable and prone to displacement, especially on steep slopes (>40%). Frost heaving may hinder seedling establishment, especially in cold air basins.

The aquatic ecosystems of the Mazama Panhandle analysis area are mainly small to medium sized perennial streams (Sand Creek, Scott Creek, Bear Creek, Lost Creek, Pothole Creek, Cavern Creek and Wheeler Creek) which generally flow from west to east. A small number of unnamed intermittent streams feed into the perennial systems in the upper reaches of Sand Creek and its tributaries Wheeler and Cavern Creek as well as the upper reaches of Scott Creek. The area has a low drainage density. The streams in the system (with the exception of Sand Creek) tend to have simple drainage patterns with few or no tributaries and relatively small watershed areas. Historically streams likely connected to the Klamath Marsh and Williamson River in wet years. Now diversions draw off enough water to dry up all overland flows before any creeks reach the river.

Thick pumice deposits overlaying older dense lava and areas of glacial till define hydrologic function. The upper pumice layers allow high infiltration rates. As a result, intermittent streams are relatively rare in the area (15.21 miles of intermittent channel and 68.63 miles of interrupted perennial). The underlying lava tends to be much less permeable to water and creates areas of perched water below elevations of 6500 feet (Frank and Harris 1969). These perched water tables create numerous springs which feed the creeks in the analysis area. Other aquatic habitats such as wet lands, lakes and ponds are rare or nonexistent in the analysis area.

The highly unstable, low bulk density pumice soils slough from steep canyon walls and contribute large sediment loads of sand and gravel sized materials into portions of Sand and Scott Creeks (Dambacher et al., 1993). The gradient of the streams decrease as they flow from west to east resulting in deposition in the flatter eastern portion of the analysis area (Frank and Harris, 1969). The water has low mineral content, low concentrations of nutrients and water quality is high (USGS unpublished data).

Streams have low to moderate amount of structure necessary to maintain habitat diversity and channel stability. Natural limitations and harvest of large trees in riparian zones contribute to this.

Five plant association groups (PAG) were identified: dry lodgepole pine, dry ponderosa pine, dry mixed conifer, wet mixed conifer and mountain hemlock. Disturbance regimes are distinct for each PAG, and vary by agents involved, their periodicity, intensity and magnitude of the area affected. Low intensity, high frequency disturbances such as insect and disease pockets modify the ecosystem much less dramatically than high intensity, low frequency disturbances such as stand replacement fires (Bennett et al, 1994). Fire suppression and other management activities have been the most significant disturbance agents for the past 80 years. Collectively, these agents have changed a large percentage of the vegetative landscape.

The ponderosa pine fire regime has changed dramatically. Fire suppression efforts have nearly eliminated frequent, low intensity stand maintenance fires that historically occurred. This has led to increased stocking, increased fire hazard and a species composition shift away from ponderosa pine.

Management activities outside Crater Lake National Park (heareafter referred to as the Park) have shifted seral composition and landscape patterns. Harvest activities have reduced late and old seral structural composition and increased mid and early seral structural composition. The pattern of openings (mid and early stands) has shifted from numerous small patches (1-5 acres in size) with very few large openings greater than 100 acres, to numerous medium size openings (20-100 acres) uniformly distributed across the landscape.

There are 191 wildlife species known or suspected to occur within the watershed. Of these, 39 species are declining or extirpated from parts of their ranges. Sixteen factors are identified that contribute to declines within the watershed. The most significant are: loss or degradation of late and old seral habitat; fewer large diameter trees, snags and down logs; increased fragmentation and edge influence; disturbance; and degraded riparian habitat.

Early human use of the area was limited. Few aboriginal hunters and gatherers used this area because of its limited wildlife and edible plants in comparison to more productive areas to the east. The Klamath Tribes considered Crater Lake a place of great power and made occasional spiritual visits. The Treaty of 1864 included reservation lands along the eastern edge of the watershed.

Crater Lake was the most significant feature to draw early visitors. Prospectors passing through in the 1850's spread tales of the most incredible blue lake they saw. They were soon followed by outdoor enthusiasts seeking this wondrous lake. Through their efforts, Crater Lake National Park was established in 1902 and is today considered a natural wonder of the world.

Perhaps the greatest historic impacts to this watershed were those associated with the railroad logging era in the early 1900's. Large scale logging began after Congress passed the Indian Omnibus Act of 1910. Nearly 1 billion board feet of large ponderosa pine were harvested over a period of 15 years. Railroad lines, spurs and branches, with the associated logging camps, accessed the enire area. Stumps, railroad grades and camps are still somewhat apparent after 70 years of recovery.

Current uses are quite variable. The Park management strategy promotes natural succession processes while minimizing human disruption to these processes. Conversely, management strategies on National Forest, State and private ownership regulate numerous and varied uses that are dictated by public need for resources.

Issues and Key Questions

Issues were identified through the public scoping effort and by resource specialists. Key questions focus the analysis on the relevant management, public and resource concerns. The following issues and key questions are the basis of the Mazama Watershed Analysis.

Issue: Clean water for domestic use.
Key questions:
1. Are there water quality problems within the watershed?
2. Are the Scott Creek Campground toilets and wastewater sumps affecting water quality in Scott Creek?

Issue: Diversions may have disconnected streams in the watershed from the Williamson River.
Key questions:
1. What native fish were present?
2. Were there migratory fish?
3. Were bull trout and redband trout present?
4. Is there currently acceptable habitat for bull trout?

Issue: Riparian hardwoods and other unique riparian habitat are disappearing.
Key questions:
1. Is riparian habitat disappearing?
2. Why is it disappearing?
3. What did these areas look like historically?

4. Were there beavers in this watershed?
5. Are current riparian conditions contributing to declining species or decreased water quality?

Issue: Stream systems are very vulnerable to disturbance.
Key questions:
1. What effects are harvest and other management activities having on these systems?
2. What effects are natural processes having on these systems?

Issue: Roads are influencing hydrologic function.
Key questions:
1. Are roads changing timing and duration of flow, altering channels and contributing to increased sediments?
2. To what extent are roads influencing hydrologic function?

Issue: Vegetative health and sustainability are at risk in parts of the watershed. Parts of the area are overstocked, leading to a stressed condition making these areas more susceptible to insects and disease. High natural fuel loads have made some areas vulnerable to stand replacement fires. Fire suppression and past harvest have caused changes in vegetative composition and structure.
Key questions:
1. What vegetation changes have occurred?
2. What caused these changes?
3. Which areas are at risk?
4. What changes are contributing to the decline of *Allotropa virgata*?

Issue: Populations of several wildlife species are declining.
Key questions:
1. Which species are at risk?
2. Which changes are contributing to declining populations?
3. What is causing these changes?
4. Are any species increasing?
5. What habitat types and structure can be provided and maintained?
6. Are late and old habitat elements such as snags, down wood, connectivity present?
7. What are the changes in the late and old structure and habitat?
8. What is the difference between historic fragmentation and human- influenced fragmentation?

Issue: Roads provide access to Crater Lake National Park for illegal hunting and mushroom picking.
Key question:
1. Can any roads within 1 mile of the Park be closed to minimize access?

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Chapter 2. Current condition

Erosion Processes

The most significant event in recent geologic history was the eruption of Mount Mazama about 7,700 years ago. Prior to eruption, the Cascade Crest running through the upper reaches of the watershed was a high plateau of basaltic lava cones and andesitic volcanoes. Mazama was the most prominent volcano. After the eruption of Mazama began, pumice , ash and hot gases spewed out for nearly 100 years. Pumice and ash covered the area to the northeast for hundreds of miles. The majority of the flows were confined to canyons along Mazama's lower slopes. When eruptions finally ended, Mazama was partially gone and pumice covered the watershed to depths from 65' to 121'. The deeper deposits are in the northern portions of the watershed. Dacite domes (Lookout, Pothole, Dry, and other unnamed buttes) with craggy outcrops and cinder cones (Boundary Butte and other unnamed cones) rise above the pumice deposits (Williams, 1942). See the geology map.

The soils in the watershed are derived from pumice and ash from the eruption of Mazama. These soils are geologically very young. The upper soil horizons show very little development and tend to be less productive than older, more developed soils. Refer to the maps of soils and fallout/deposition.

The high water holding capacity of pumice and ash soil, in combination with its thermal properties, create ideal conditions for frost heaving. Frost heaving can cause soil loosening and displacement. Tree seedlings and other plants are often left with their roots either broken or exposed on the soil surface causing them to die.

Pumice and ash soils are water repellent during the driest part of the summer. Repellency is usually due to either wildfire, overly hot prescribed fire, terpines and resins produced by pines or fungal mycelia. Stronger repellency under litter and the general lack of fire in the area indicates that the repellency in pumice and ash soils is likely caused by terpines, resins, and fungal mycelia. The effect of repellency is rapid water runoff during high intensity summer storms. Some surface soil erosion and sometimes severe erosion on roads and fills can occur during these storms. Management activities that stir up the litter layer and surface to 3 or 4 inches deep break up this repellent layer. On the other hand, maintenance of the litter layer may provide enough detention, interception and roughness to mitigate effects of overland flow.

Pumice and ash soils have low aggregate stability because they contain very little clay and organic matter to cement particles together. Soil particles are easily detached and displaced. Thus, soils are highly susceptible to erosion when subjected to surface flows. Displacement becomes more pronounced on steep slopes. Dry ravel can occur on steep (over 40%) slopes. This is very evident in the steep canyons along Scott and Sand Creeks.

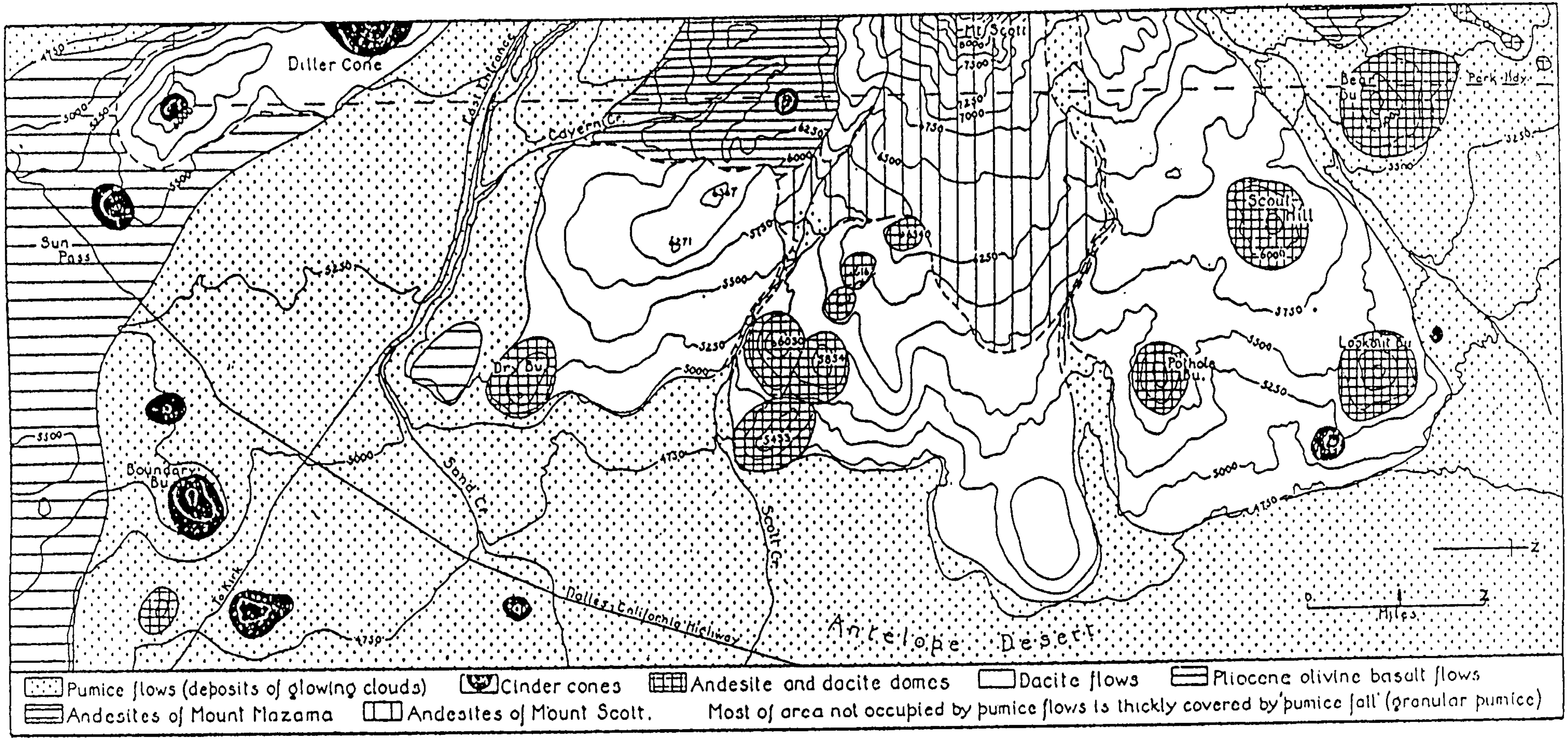
Pumice and ash soils have rapid infiltration and permeability rates except when they are dry and water repellent. These characteristics decrease water erosion hazards to a low level despite the low aggregate stability. Occasionally heavy rains fall on snow and frozen ground and may result in flash floods that scour stream channels. In July, 1994, such an event washed out the 2308 road crossing at Bear Creek. Channel debris and sediments were flushed downstream and deposited in the flats above the 70 Road at the lower end of the creek. A similar event occurred in the spring of 1964. Crossings were not designed to handle these intense flows. Lesser degrees of channel scouring has occurred in the higher gradient stream reaches in the watershed.

The soils in the watershed are moderately susceptible to compaction depending on the soil texture, soil moisture, the amount of cobbles and stones, and the amount of carbon in the top layers. Frost heaving, root movement, worms and other natural phenomena alleviate compaction in the top 4-6 inches. Below that depth, however, these soils have a low to moderate ability to restore infiltration and aeration features after compaction has occurred. Thus compaction effects persist for a long time due to the lack of ameliorating factors.

Geology Map

MAP 1 THE GEOLOGY OF CRATER LAKE NATIONAL PARK

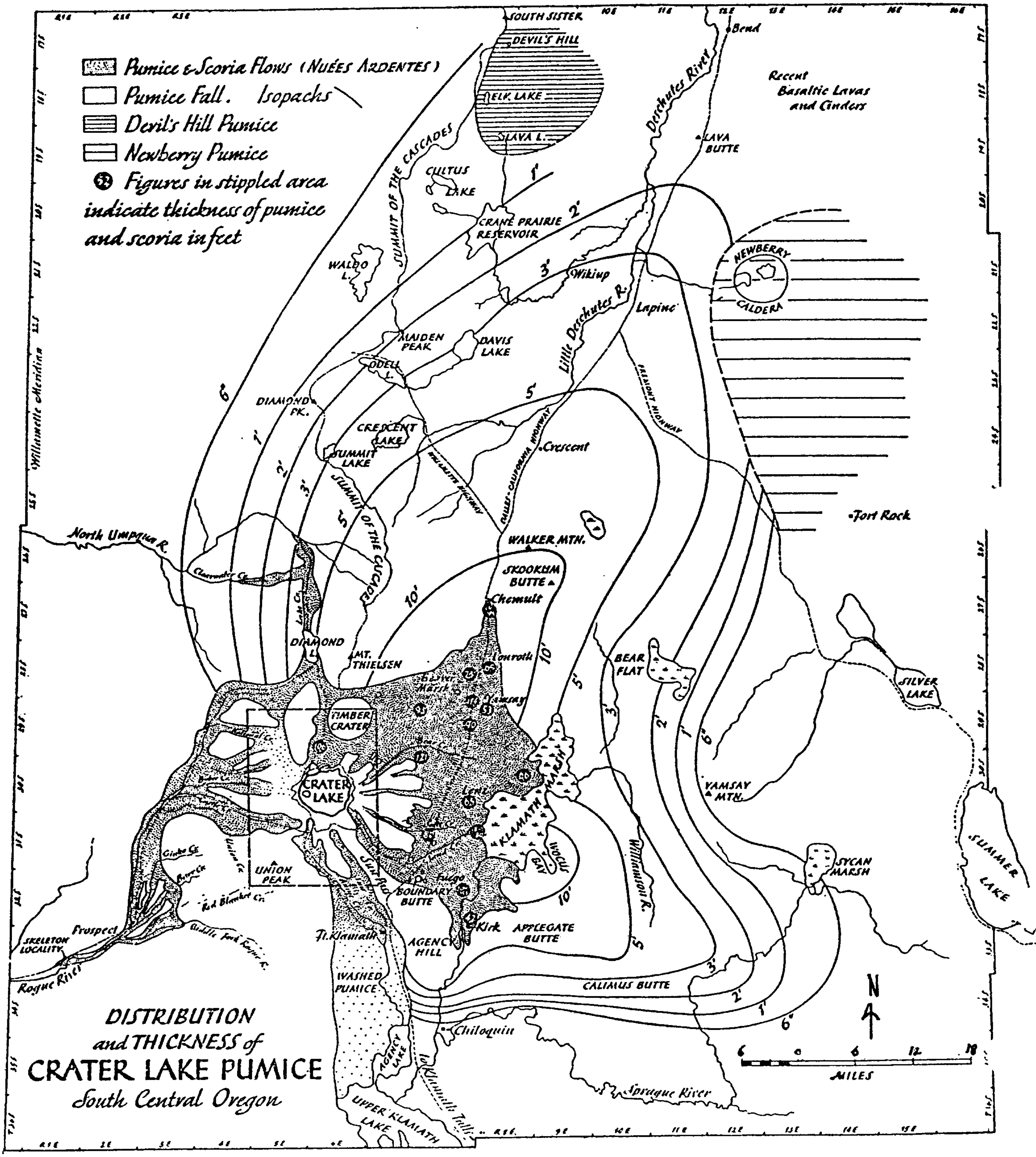
WILLIAMS & HOWELL, 1942



Map of the region east of Crater Lake National Park

MAP 2

WILLIAMS & HOWELL, 1942



DISTRIBUTION and THICKNESS of CRATER LAKE PUMICE South Central Oregon

Map showing distribution and thickness of Crater Lake pumice. (Drawn by A. W. Severy.)

TLS, MAY 1996

Aquatic Habitats

The upper portions of the watershed are in the Park and have had very little human influence. These areas are high in the watershed and represent the smaller upstream ends of the stream systems. Of the 83.84 miles of perennial and intermittent stream in the analysis area, 48.77 miles (58%) are on National Forest. The eastern portion of the watershed (National Forest and private lands) has been altered by roading, logging and diversions. Riparian Reserves Standards and Guidelines in the Northwest Forest Plan (NWFP) are appropriate for riparian areas within the National Forest.

Stream surveys to assess aquatic habitat condition and function were conducted by Forest Service personnel on Sand Creek in 1992 and Scott Creek in 1995 and 1991. Surveys were limited to the National Forest. In 1989 similar surveys were conducted in the Park by Park Service personnel on Scott Creek, Sand Creek and Bear Creek.

Stream surveys on Scott Creek counted all large wood in the stream (large wood was considered to be >12 inches in diameter and > 25 feet long). Average values for each stream reach ranged from 19.3 to 40 pieces of large wood per mile. Large woody material is important to the structure and function of stream systems, especially the creation of pools, stabilization of banks, creation of cover for fish and regulation of sediment transport. The values encountered range from very low to moderate for forested streams such as Scott Creek. Stumps of varying age were noted on the banks of the creek and throughout the riparian zone.This suggests past logging in and near the stream may be partially responsible for the low amounts of wood present in the stream. Large flood events in 1964 may have also flushed some wood from the system.

Scattered large and mature trees were observed along most of Scott Creek. The larger trees tend to be white fir at lower elevations and red fir or mountain hemlock at higher elevations while the stumps tend to be ponderosa pine. Woody material needs should be sufficient in the stands along the streams if large remnant trees are left to eventually die and fall.

Although scattered large trees remain, stands along Scott Creek tend to be dominated by earlier seral stages. During the survey, the inner (within 20 feet of the stream) and outer (between 20 and 100 feet from the stream) riparian zones were classified by dominant seral stage based on percent cover. The inner riparian zone tended to be dominated by the grass/forb stage with areas of shrub/sapling and lesser amounts of small trees near the Park boundary. The outer riparian zone was almost entirely dominated by the small tree seral class. The suppression of fire in the area may have allowed the canopy to become more dense and the number of young trees in the stand to increase. This could result in a higher percentage of cover by the younger seral classes and a resultant bias in the data towards the younger seral classes.

Number of pools per mile is a good measure of stream condition and fish habitat quality. Pools per mile were recorded during the Scott Creek stream survey. Values ranged from 4.7 per mile (extremely poor) to 50.7 per mile (marginal habitat quality). Few large boulders of resistant rock are available in the system to create pools. This leaves the stream dependent on large woody material for the creation of pools. In areas with little wood, few pools were observed.

Dominant and subdominant stream bed substrates were estimated during the Scott stream survey. Gravel sized pumice is the dominant substrate in all but one low gradient reach that is dominated by sand. Gravel and sand are subdominant in all but two high gradient reaches with some cobble sized pumice present in those.

The low pool frequency and habitat suitability in Scott Creek are exacerbated by the high amount of sand and gravel sized material being eroded in the upper reaches and transported through the system. High sediment loads from ravelling and erosion are characteristic of stream geomorphology and dominance of pumice soils within the upper reaches. To a much lesser degree, human impacts including sediment from logging and roading, removal of wood inputs by logging, and other hydrologic modifications may influence what is likely an already naturally low number of pools.

The 1992 survey of Sand Creek revealed a pattern similar to Scott Creek. However, Sand Creek and its tributary Wheeler Creek have cut deep canyons into deep pumice which had filled a pre Mazama eruption glacial canyon (Frank and Harris, 1969). These steep walled canyons in the Pinnacles area lack vegetation and provide large inputs of small pumice material to the stream. In comparison, management activities are contributing small amounts of sediment. Stream survey records show much larger amounts of wood than Scott Creek (5.2, 222.3 and 623.9 pieces per mile for the three reaches surveyed). Pools per mile ranged from 4.5 to 9.6. These numbers are extremely low especially considering the amount of large wood present. The width to depth ratio, considered a good measure of proper hydrologic function was measured as ranging from 6.4 to 7.34. This is well within the range of a healthy stream channel. The substrate of the channel was dominated by sand with some limited amounts of gravel sized pumice which the survey crew noted floated when disturbed.

The highly unstable nature of the deep pumice probably is the cause of the extreme dearth of pools in the surveyed reaches of Sand Creek. Dambacher et al. (1993) conducted a similar survey on Sand Creek in 1989 in the Park. Gravel sized substrate in lower reaches and gravel in higher reaches was reported. This indicates that large inputs of sand are occurring in the steepest part of the canyon below the National Forest / National Park boundary or that gradients in the Park are steeper and more effectively move sediment.

Little information is available about the other streams in the analysis area. The tributaries of Sand Creek, Wheeler Creek and Cavern Creek as well as the nearby Lost Creek are in relatively undisturbed areas of Crater Lake National Park and are probably at natural or near natural condition.

Currently none of the streams in the analysis area have surface connections to the Klamath Marsh or the Williamson River. Pothole Creek and Bear Creek become subsurface flows in the pumice soils west of Highway 97. Sand Creek and Scott Creek are diverted into the Sand Creek Canal west of Highway 97 and used for irrigation west and north of Klamath Marsh.

Some anecdotal evidence exists which supports the idea that Sand and Scott Creeks may have had surface connections to the Klamath system annually (Mosby, 1988, Bond, 1949). Klamath Basin Adjudication records indicate the construction of diversions and associated canals on Sand Creek were built in 1919 and 1920. Diversions from Scott and Sand Creeks likely occurred at this time. Diverting water from the streams for agriculture may have severed any connections between streams and the Williamson system.

The Oregon Natural Heritage Program records report bull trout in Wood River and Klamath Lake. Cope (year) reported bull trout in the Williamson River. If streams in the analysis area had at least occasional connectivity to the Williamson River / Klamath Marsh system these populations of bull trout could have colonized these systems and migratory individuals which reared in the Williamson River or Klamath Lake could have used these creeks for breeding. Rainbow trout and other native fishes capable of living in cold water systems may have also colonized the Sand and Scott Creek systems.

Large portions of the watershed are heavily roaded. A total of 452.62 miles of open roads are present in the analysis area. The average density of roads in the analysis area is 3.44 miles of road per square mile. This number is much higher in some areas due to averaging over the entire watershed, including areas in the Park which have few or no roads. The number of road crossings per mile of creek was estimated at 0.29 crossings per stream mile. Road drainage is poor.

Impermeable road surfaces increase surface runoff and concentrate it in road ditches. However, ditches rarely carry water due to pumice soil high permeability and infiltration rates. Personal observations suggest surface runoff and sediments from roads and ditches within 300 feet of streams may get into streams. However, beyond 300 feet, ditch water percolates into the soil and drops sediment loads without ever reaching streams. There is no evidence to indicate that these flows and sediment loads are destabilizing stream morphology. Sediment loads may have a small influence on aquatic organisms immediately downstream from road crossings: Sand Creek crossings- Sun Mountain road, 1 private road, Silver Lake Road, Scott Creek crossings- 2308, 2308-150, 2308-063, 2308-065, 2308-110.

The drainage density in the watershed is .64 miles of perennial and intermittent stream channel per square mile. Roads act as intermittent channels by intercepting and channeling surface water. The effects of adding 3.44 miles of roads per square mile to the natural drainage density is minimized by the high permeability and infiltration rates of pumice soils. It is not clear how much influence the high road density is having on hydrologic function. There is no evidence to suggest a significant impact.

The streams derive most of their volume from spring flows and snow melt in the spring. Summer rain storms are rare in the area, but may occasionally flush hydrophobic soils down slopes. Frank and Harris (1969) estimated that seepage from Crater Lake provided no more than 10% of the water in the watersheds surrounding the Lake. Most springs are cold with low mineral content (Frank and Harris, 1969). Nutrients tend to be low in the streams (table 3). Wisseman (1991, 1992) reported that the insect taxa collected in the analysis area were indicative of good water quality. Forest Service personnel collected temperature data on Scott Creek in 1995 and Sand Creek in 1993 with automated data collectors. Overall water quality is good in the two streams which have been monitored. It is likely that other streams in the area have similar water qualities.

TABLE 1. Water quality data from Sand and Scott Creeks.

Stream name	Total Organic Nitrogen	Phosphorus	Mineral Content	Maximum Temperature
Sand Creek	0.05 mg / L[1]	0.04 mg / L[1]	Some springs high in mineral content.[2] Low in most of stream.[1]	10 C[3]
Scott Creek	0.03 mg / L[1]	0.02 mg / L[1]	Low[1]	16 C but most days did not exceed 13 C[3]

.1.) USGS unpublished data. Measurements taken near eastern border of USFS lands.
2.) Wisseman, 1992
3.)Collected by USFS using automated temperature recorders in 1993 on Sand Creek and 1995 on Scott Creek.

Scott Creek campground is located on Scott Creek near the eastern boundary of the Winema National Forest. Two vault toilets, a wastewater dump, several picnic tables and several fire rings are located in the riparian zone. The vault toilets are old and the integrity of the vaults is unknown (R. Frost USFS pers. com.). The south bank of the creek in and around the campground has little vegetation (except for large trees) apparently due to foot traffic along the bank. The impact of campground users appears to be limited to the immediate area of the campground with the possible exception of down stream water quality impacts resulting from the toilets and wastewater dump. Many dispersed camping areas were found along Scott Creek during the 1995 stream survey. Most appear to have been out of use for several years. Roads leading to most of the camps have been closed. Impacts from these camps probably range from minimal to zero. Other recreational impacts on aquatic systems are unknown but most likely minor.

Vegetation

Vegetative plant association groups (PAG) were identified by comparing Pacific Meridian Resource satellite imagery (PMR data) to the Winema National Forest Plant Association Guide (Hopkins, 1988). Seral classes were determined by grouping sizes/structure from PMR data and comparing to ponderosa pine successional patterns (Hopkins, ?). Size/structure groupings can be found in Appendix A.

Vegetation was analyzed using the concept of "historic range of variability" of successional stages. A pivotal assumption is that an element or process that is outside the range of natural variability cannot be sustained naturally. Native species have adapted to the natural disturbance events of the past 7,700 years and require those conditions for their survival (Bennett et. Al. 1994). The vegetative condition that existed prior to European settlement (1820-1900) represents a reasonable point of reference to assess natural change as well as human modification (Subregional Report, 1993).

There are 5 plant association groups (PAG) within the watershed: dry ponderosa pine - 18,382 acres (22%), dry lodgepole pine - 24,454 acres (29%), dry mixed conifer - 24,338 acres (29%), mountain hemlock - 1,750 acres (2%) and wet mixed conifer 791 acres (<1%). An additional 10,224 acres are comprised of a mix of species in which all species make up <25% of the canopy. Grass, rocks and shrubs make up 4,962 acres (6%).

The watershed span from the Cascade crest to the toe of the Cascade slope shows dramatic changes in elevation and climate that influence vegetation. Mountain hemlock grows highest in elevation near the east rim of Crater Lake. Dry lodgepole pine grows in well-drained, ashy, low productivity soils. It occurs either mixed in with other PAG's or in pure stands. Pure lodgepole pine stands grow most often on flat or concave ground at both high and low elevations. Dry mixed conifer extends from the Sky Lakes Wilderness into the southwest portion of the watershed and can also be found on buttes and north facing slopes. Dry ponderosa pine grows at the lower elevations on well-drained, sandy soils, on slight rises, and south slopes of buttes. Wet mixed conifer grows in only a few places on Sand, Scott, and Wheeler Creeks. Refer to the PAG map.

The current percentage of early, mid, and late seral classes in lodgepole pine, mixed conifer and ponderosa pine are compared to the historic range of variability. Lodgepole pine is well above in the late seral class and well below in the early /mid seral classes. Mixed conifer is well above in the mid seral class and well below in the early seral class. Ponderosa pine is well above in the mid seral class and below in both the early and late seral classes. The greatest seral composition sustainability concern lies with the late seral lodgepole pine because of the need for and lack of short term replacement habitat.

Table 2. Historic range of variability for Plant Association Groups (PAG) within the Mazama Watershed.

Plant Association Group	ACRES in WAA	% Of WAA	%Early seral class		%Mid seral class		%Late seral class	
			CUR-RENT	**HIST-ORIC**	**CUR-RENT**	**HIST-ORIC**	**CUR-RENT**	**HIST-ORIC**
Mixed Conifer	24,338	29	3	46-69	52	0-8	45	23-70
Lodgepole pine	24454	29	18	33-56	**	0-37	82	7-21
Ponderosa pine	18382	22	3	8-18	53	0-14	43	74-96
Hemlock	1750	2	3	NDA	22	NDA	74	NDA
<25% of any tree species	10224	11	49	NDA	31	NDA	20	NDA
Other (grass, rock or, shrub)	4962	6	NA	NA	NA	NA	NA	NA
TOTAL	84,110							

**Early and mid seral classes are combined in the lodgepole PAG.
WAA=Watershed Analysis Area, NA=Not Applicable, NDA=No Data Available

The mountain hemlock PAG is comprised of primarily mountain hemlock with smaller amounts of lodgepole pine and/or whitebark pine. There is very little ground cover vegetation. This PAG has developed slowly over thousands of years. Trees are stunted in growth and form and can be described as "bonsai". The extreme weather conditions (short growing season, cold, poor soils) cause this "krumholtz" growth pattern. This PAG is considered unsuitable for timber production. Very little manipulation has occurred and it is within the historic range of variability.

Wet mixed conifer is a unique PAG comprised of Engelmann spruce and other conifers. There are also wet conifer areas around seeps and springs in the watershed (<700 acres).The deciduous hardwood component appears to be diminishing.

Disturbance regimes are distinct for each PAG. Regimes vary by agents involved, their periodicity, intensity, and magnitude of the area affected. Agents within this watershed are fire, weather, activities associated with timber harvest, insects, and disease. Weather events such as windstorms, floods, and drought have been insignificant since our historic point of reference. Insects and diseases are increasing. However, harvest activities and fire suppression have had the most significant influence on processes and structure within the watershed.

Each PAG once had its own distinct fire regime. These regimes varied in intensity and return intervals. Low intensity fires (stand maintenance fires) killed small trees, brush, and larger trees intolerant of fire. High intensity fires (stand replacement or wildfires) killed everything, including fire tolerant species. Fires were the main vegetation shaping force in the mixed conifer, lodgepole pine and ponderosa pine. They thinned stands, defined species composition and seral class composition, reduced shrub growth and fuel loads, and helped check the spread of insects and diseases.

Table 3. Fire size, interval, and intensity by Plant Association Groups (Agee, ??).

PAG	FIRE SIZE (Acres)	RETURN INTERVAL (YRS.)	INTENSITY	RESULT
Ponderosa pine	>1000	5-15	low	stand maintenance
Ponderosa pine	<100	very rare	high	stand replacement
Lodgepole pine	>1000	80-120	high	stand replacement
Lodgepole pine adjacent to Ponderosa pine	50-1000+	20-30	high	stand replacement
Mixed conifer	variable	30	variable	combination
Hemlock	>1000	500	high	stand replacement

Fire suppression efforts for the past 80 years have virtually eliminated these shaping factors. As a result, shifts are occurring in stocking, species composition and structure that are outside the historic range of variability. Stand exam data available for National Forest lands are compared to stocking curves (Cochran) to determine stand risk. Overstocking is common in lodgepole pine, mixed conifer, and ponderosa pine. Multi-story structure is developing in the ponderosa pine, creating ladder fuels to once fire-resistant canopies. True firs and lodgepole are invading ponderosa pine sites and out competing the ponderosa in mixed stands.

These shifts in turn compound the watershed's susceptibility to stand replacement fires. Overstocking contributes heavy fuel loads, multi-story structure improves fire's ability to spread through the crowns. The result is the higher probability of more intense, larger stand replacement fires.

Insects in the watershed include mountain pine beetle, western pine beetle, tussock moths, spruce budworms, and fir engraver beetles. Insect activity is probably higher than occurred historically because overstocked stands provide an abundance of stressed, low vigor trees that are more susceptible to insect attack. This is especially true in the late seral lodgepole pine stands. The large acreage of overstocked late seral lodgepole stands in close proximity to each other makes a significant percentage of this PAG more likely to experience a large scale mountain pine beetle outbreak and resulting high mortality.

Armillaria and annosus root diseases, Indian paint fungus, dwarf mistletoe, and white pine blister rust are found throughout the watershed. Mortality is usually precipitated by other agents such as stress, insects, and blowdown. Fire historically disrupted development, growth and proliferation of diseases in various ways. These diseases are now probably more prevalent because of fire suppression.

Harvest activities have significantly influenced seral composition and structure in mixed conifer and ponderosa pine. Late seral ponderosa pine is below the historic range in variability due to harvest of large ponderosa pine. Harvest preference for large diameter ponderosa (primarily during the railroad logging era) has decreased the average tree diameter in late seral stands and reduced the numbers of large ponderosa pine per acre in both mixed conifer and ponderosa stands.

Table 4. Timber harvest activity on state, federal and private land from the 1960's through the 1980's. The numbers represent acres harvested by plant association group (PAG).

PAG	OWNERSHIP	DECADE			
		1960'S	1970'S	1980'S	1990'S
Ponderosa pine	National Forest	5428	1261	3756	0
	State	0	2000	2000	0
	Private	0	3261	5756	0
	TOTAL	5428	6522	12012	0
Mixed conifer	National Forest	7156	1663	2549	0
	State	NA	NA	NA	0
	Private	NA	NA	NA	0
	TOTAL	7156	1663	2549	0
Lodgepole pine	National Forest	3024	203	2099	0
	State	0	1000	1000	0
	Private	0	1000	1000	0
	TOTAL	3024	2203	4099	0

PAG=Plant Association Group, NA=Not applicable (State and private lands do not contain any mixed conifer plant associations)
NOTE 1: In the 1990's there was no timber harvested from the Watershed Analysis Area.
NOTE 2: This table does not reflect the millions of board feet harvested in the railroad logging era. Refer to Tonsfeld map of the early railroad logging sale location.

In the summers of 1992 & 1995 portions of the watershed had floristic surveys completed. There are currently no known sensitive plant populations within this planning area. However, plants on the Region 6 Sensitive list that have potential habitat in the watershed include the following:

Table 5. Sensitive plants considered within the Mazama Watershed.

Agoseris elata	Documented on Deschutes NF
Allium campanulatum	Suspect on Winema NF
Arabis suffrutescens var. horizontalis	Documented on Winema NF
Arnica viscosa	Documented on Winema NF
Aster gormanii	Suspect on Deschutes NF
Astragalus peckii	Documented on Winema NF
Botrychium pumicola	Documented on Winema NF
Bortychium simplex	Documented on Winema NF
Carex buxbaumii	Undocumented on Winema NF
Castillleja chlorotica	Documented on Deschutes NF
Collomia mazama	Documented on Winema NF
Gentiana newberryi	Suspect on Winema NF
Haplopappus whitneyi var. discoideus	Undocumented on Winema NF
Hieracium bolanderi	Undocumented on Winema NF
Melica stricta	Documented on Winema NF
Mimulus jepsonii	Documented on Winema NF
Penstemon glaucinus	Documented on Winema NF
Silene nuda ssp. insectivora	Documented on Winema NF

Information is thoroughly lacking regarding occurrence, distribution, and abundance of non vascular plants. None are known to occur within the watershed. However, there is potential habaitat for many of these species.

Allotropa virgata (candy stick or sugar stick) is the only vascular plant identified in the Northwest Forest Plan that is known to occur in the watershed. However, there is potential habitat for many of these species. Numerous populations of candy stick have been located. Candy stick, a "survey & manage" species (ROD, C-3 list) requires the use of survey strategies 1& 2, to manage known sites and survey prior to ground-disturbing activities.

Candy stick can be referred to as a mycotroph, a plant that obtains necessary nutrients and carbon componds from a fungus associated with its roots. This is actually a three way symbiosis because the fungus is connected with a photosynthesizing plant, commonly a coniferous species. Its preferred habitat is decayed down wood in late and old seral conifer stands, but it is can also be found in other habitat types. Opening stands, disturbing soils, and removing down wood disrupt interactions in the three way relationship necessary to maintain *Allotropa*. The influence of fire is not completely understood.

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COMMENTS

Species and Habitat

There are 191 species of birds, mammals, amphibians and reptiles that are known or suspected to occur in the watershed. A list of these species was derived from the Habscapes program and can be found in Appendix B. Forty species (2 insects, 2 amphibians, 24 birds, and 12 mammals) are considered species of concern. (SOC). SOC include all federal and state listed species, federal proposed and candidate species, federal species of concern, state sensitive species and Oregon Natural Heritage listed species (The Nature Conservancy, December, 1995, USFWS, September, 1995, USFWS, March 20, 1996). SOC are so designated because of significant population declines across their respective ranges. Types of habitat modifications that are known to cause population declines in other areas are assumed to cause declines within this watershed also.

Table 6. Common Name of Species of Concern Found or suspected in Mazama Panhandle Watershed Analysis Area.TLS, May, 1996.

Amphibians & Insects	Mammals	Birds
	*American marten	*flammulated owl
cascades frog	*hoary bat	*great gray owl
western toad	*long-eared myotis	*northern spotted owl
Schuh's homoplectran	*long-legged myotis	*pygmy nuthatch
Cascades Apatonian	*silver-haired bat	*white-headed woodpecker
Caddisfly	California wolverine	American peregrine falcon
	gray wolf	short-earred owl
	fringed bat	black-chinned hummingbird
	Yuma bat	bald eagle
	pallid bat	bank swallow
	western gray squirrel	Lewis' woodpecker
	*lynx	merlin
		northern goshawk
		pileated woodpecker
		purple martin
		black-backed woodpeckers
		northern pygmy owl
		Red-breasted sapsucker
		Rufous hummingbird
		Vaux's swift
		Williamson's sapsucker

*SOC with standards and guidelines found in the Northwest Forest Plan.

Species are associated with five plant association group (PAG) habitat types in the East Cascades Ecoregion. Refer to the vegetation section for percentage of each habitat type. Appendix C lists habitat types where each species is likely to occur. Appendix D lists species likely to occur in each of the PAG's (Habscapes).

Table 7. Habitat Components of Species of Concern. TLS, May, 1996.	
Cascades frog	Mixed conifer habitats of meadows, marshes, bogs, streams and ponds.
western toad	Most common near marshes; is nocturnal and spends the day under woody debris, in other animals burrows, or buried in the soil
marten	Use late seral lodgepole, mountain hemlock and mixed conifer stands and other areas with high concentrations of down wood.
fisher	Use patches of closed canopy, late seral forests with high amounts of large-diameter fallen woody debris.
wolverine	Prefer large tracts of relatively undisturbed diverse areas with an abundance of quality food. Use fallen logs, tree roots, or protruding rocks as den sites.
lynx	Use early seral forests for foraging and late seral forests that contain cover for denning.
gray wolf	Inhabit forest wilderness
western gray squirrel	Inhabit forested areas of mountains and lowlands, usually among oak-pine forests.
pallid bat	Prefer late-seral ponderosa pine forests. Roost and hibernate in crevices in caves, snags, and broken-top trees.
Yuma bat	Inhabit rather open areas. Colonize and roost singly in caves or little-used buildings.
fringed bat	Occur in mixed-conifer and mixed-evergreen forests with relatively dry moisture regimes. Forage at or within forest canopy, and use cave crevices, trees, snags, and old wooden bridges or buildings for hibernation and roosting sites.
silver-haired bat	Use old- growth forests for foraging and roosting; day and maternity roosting occur in crevices of large snags and decadent trees.
long-legged myotis	Prefer ponderosa pine forests and forage in streams and drainages. Hibernate and roost in trees, snags, and rock crevices.
long-eared myotis	Inhabits thinly forested and semidesert areas. Forage in riparian zones; roost and hibernate in snags, trees, and cave crevices. Require small water sources in forest clearings.
hoary bat	Strongly associated with mature forests for roosting and foraging; solitary, hang in trees and shrubs by day.
flammulated owl	Favor late seral ponderosa with patches of dense mixed conifer for roosting.
great gray owl	Use vacant nests built by other raptors in mid-late seral lodgepole adjacent to meadows.
spotted owl	
pygmy owl	Use numerous forests types and age classes; most common along the edges of clearings and meadows. Nest in tree cavities created naturally or by other creatures.
pygmy nuthatch	Use mature old-growth ponderosa pine in open stands with less than 70% canopy. Nest in cavities that are 20 or more feet high, usually located in decadent trees. Forages in young ponderosa pine.

Table 7. Habitat Components of Species of Concern. TLS, May, 1996.	
white-headed woodpecker	Inhabit ponderosa pine forests and forage on the trunks of living conifers and in the crowns of conifers. Nest in dead trees having heartrot; standing and leaning snags are used.
Lewis' woodpecker	Typically nest in tree cavities located in snags, within mid-late seral mixed conifer and ponderosa PAG.
black-backed woodpecker	Nest primarily in tree cavities located in snags and hollow live lodgepole and occasionally in mixed conifer and mountain hemlock. Require mid-old seral sizes
Williamson's sapsucker	Use large tree cavities in late seral stages of ponderosa, mixed conifer, mountain hemlock and conifer wetlands.
pileated woodpecker	Use late seral mixed conifer. Require high numbers of large snags and down wood for foraging and nesting.
peregrine falcon	
bald eagle	Nest in large ponderosa and mixed conifer near water.
goshawk	Use late seral ponderosa, mixed conifer, lodgepole and mountain hemlock PAG.
merlin	
black-chinned hummingbird	
bank swallow	Burrow in banks near water.
purple martin	Typically occur along bodies of water, but also found in old burns in forests and in urban situations. Require airspace that is free of obstruction, and nest in cavities such as old woodpecker holes and artificial nest boxes.

Species of Concern habitat information was obtained from Oregon statistics, wildlife biologists and literature.

The SOC have a common link. They show declining population trends because of very low habitat versatility. Many are dependent on a very specific habitat component or combination of habitat components and are easily outcompeted and/or predated upon by other species. Conversion of late and old stands to young stands, loss of large trees, reduced decadence, smaller patch sizes, loss of riparian habitat and introduction of non-native species are the most significant factors contributing to population declines in this watershed.

Table 8. Factors Contributing to Species of Concern Population Declines within the Mazama Watershed. TLS, May, 1996.

Conversion of late and old seral stands to younger seral stands.

Great gray owls, flammulated owls, pygmy owls, boreal owls, spotted owls, white-headed woodpeckers, black-backed woodpeckers, Lewis' woodpeckers, Williamson's sapsucker, pileated woodpecker, goshawk, merlin, yuma bat, pallid bat, fringed bat, silver-haired bat, long-legged myotis, long-eared myotis, hoary bat, marten, fisher, western gray squirrel, pygmy nuthatch

Decrease in the numbers of >20" dbh mixed conifer trees and snags.

Flammulated owl, pygmy owl, spotted owl, white-headed woodpecker, Lewis' woodpecker, Williamson's sapsucker, pileated woodpecker, goshawk, yuma bat, pallid bat, fringed bat, silver-haired bat, long-legged myotis, long-eared myotis, hoary bat, marten, fisher, western gray squirrel, pygmy nuthatch

Decrease in the numbers of >20" dbh ponderosa pine trees and snags.

Flammulated owl, pygmy owl, white-headed woodpecker, Lewis' woodpecker, Williamson's sapsucker, yuma bat, pallid bat, fringed bat, silver-haired bat, long-legged myotis, long-eared myotis, hoary bat, western gray squirrel, pygmy nuthatch

Fragmentation: smaller habitat patches, more habitat edge, longer dispersal distances between patches, more openings within patches.

Spotted owl, Williamson's sapsucker, pileated woodpecker, goshawk, merlin, yuma bat, pallid bat, fringed bat, silver-haired bat, long-legged myotis, long-eared myotis, hoary bat, wolverine, marten , fisher, pygmy nuthatch

Degraded riparian habitat: loss of large tree and down wood structure.

Great gray owl, Lewis' woodpecker

Introduction of, competition by and predation from non-native species.

Lewis' woodpecker, purple martin, bank swallow, black-chinned hummingbird

Decrease in the amount of large, down wood.

Pileated woodpecker, wolverine, marten, fisher

Plant species composition shift from ponderosa to fir.

Flammualted owl, white-headed woodpecker, Lewis' woodpecker

Disturbance: rural homes, roads, logging, people, etc.

Great gray owl, peregrine falcon, yuma bat, pallid bat, fringed bat, silver-haired bat, long-legged myotis, long-eared myotis, hoary bat, wolverine, bank swallow

Trapping, bait poisoning and predator hunts.

Wolverine, marten, fisher, gray wolf, lynx

Riparian migration barriers: water diversion, roads, high culverts, large openings, etc.

Cascades frog, western toad

Dependent on others for cavity construction.

Flammulated owl, pygmy owl, boreal owl, purple martin

Table 8. Factors Contributing to Species of Concern Population Declines within the Mazama Watershed. TLS, May, 1996.

Poaching. Deer, elk
Extirpated. Gray wolf, lynx, grizzly bear
Naturally small population size. White-headed woodpecker, peregrine falcon, purple martin

Three listed species are known to occur: spotted owls, bald eagles and peregrine falcons. Several pairs of spotted owls are known to nest in the southern part of the watershed. Bald eagles and peregrines nest inside the caldera immediately west of the watershed and do some foraging within the watershed. Eagles feed along Sand and Scott Creeks and peregrines feed in the open areas near the lake. Primary forage areas for eagles and peregrines are outside the watershed. There is no eagle nesting habitat potential within the watershed. However, there may be a few rocky points on Mt Scott and in the Pinnacles area of the Park that provide peregrine nesting habitat.

The majority of the watershed is within the spotted owl range line. The 50-11-40 concept (50% of a quarter township must have stands that average at least 11 inches in diameter and have at least 40% canopy closure) describes traditional suitable habitat. Approximately ?? acres meet 50-11-40 and are considered suitable habitat. Nearly all suitable habitat on the National Forest falls within 3 Late Successional Reserve areas (R0231, RO232, RO233).

Spotted owl habitat within this watershed consists of a peninsula of mixed conifer that extends from the Sky Lakes Wilderness to the northeast. It is a transition zone of at best marginal habitat that represents the eastern most extension of the owl's range. Habitat degradation, isolation, little interaction and fragmentation problems (predation, high energy expense, competition) compound the difficulties in trying to maintain breeding pairs in this area.

Many of these mixed conifer stands along the eastern edge historically were open, ponderosa pine dominated stands. Fire suppression has allowed more firs to establish and contributed to heavier stocking and higher canopy closures. The decadence and increased canopy closure associated with firs increases owl habitat suitability in these historic pine sites. However, the high risk of wildfire or the high maintenance costs reduce the probability that these stands can be maintained. Refer also to the habitat suitability and LSR map.

Mule deer, elk and antelope are common. An occasional black-tailed deer wanders through from the west side of the Cascade crest. The southern portion of the watershed is an important elk staging area. The Sun Pass Road Closure minimizes disturbance to congregated elk during key times in spring and fall. The closure is in effect from November 1 through June 30. There is no big game winter range within the watershed.

There are several years of survey data available for spotted owls, goshawks, pileated woodpeckers and furbearers on the National Forest (district files). Several years of owl data is also available for the Park. Regional protocols were followed for goshawks and owls to find as many birds as possible and determine reproductive status. The pileated woodpecker protocol detected birds, but did not have reproductive visits (Bull, ?). Snowtracking was used to get a general idea of the distribution and abundance of marten, fisher and wolverine in the area. These survey efforts also made numerous detections of pygmy owls, flammulated owls and white-headed woodpeckers.

Survey efforts over the past 10 years for these species suggest that their current distribution is similar to those given in historic accounts (Mazamas 1897, Farner 1952, ONHP 1995, Wallis 1947). It is assumed that SOC are less abundant than they were historically because of declines in key habitat components.

Table 9. Mazama Wildlife Survey Summary. TLS, May, 1996.

Species	Survey Years	Distribution	Abundance
spotted owls	1989-1996	mixed conifer	4 pairs
**flammulated owls	n/a	ponderosa, mixed conifer	common
**pygmy owl	n/a	ponderosa, mixed conifer	common
goshawk	1991, 1995,1996	all PAG	few
pileated woodpecker	1991-96	ponderosa, mixed conifer	common
white-headed woodpecker	n/a	ponderosa, mixed conifer	few
marten	1989-92	lodgepole, mixed conifer	common
fisher	1989-92	lodgepole, mixed conifer	very few
wolverine	1989-92	mt hemlock, mixed conifer, lodgepole	very few

**detections made during spotted owl surveys.

The results of fisheries surveys are summarized in table 10. No rainbow trout were found in any survey. Fish stocking records are summarized in table 11.

TABLE 10. Results of several fisheries surveys conducted in the Mazama Panhandle Watershed Analysis area. RN, 4/96.

Stream Name	Surveyed by	Brook Trout	Brown Trout
Sand Creek	USFS 1992 Klamath Tribe 1990 USPS 1989	Present throughout	Present
Scott Creek	USFS 1991, 1995 Klamath Tribe 1990	Present throughout	Present in lower reaches near eastern boundary of USFS lands
Lost Creek	USPS 1989	Numerous small, stunted individuals present throughout	Not present
Wheeler Creek	USPS 1989	Present in the lower reaches	Not present
Cavern Creek	USPS 1989	Present in the lower reaches	Not present
Bear Creek	USPS 1989	High densities from 1.0 km above park boundary to 1.4 km from park boundary. Upstream colonization limited by human made dam	Not present

TABLE 11.) Fish stocking histories of the Mazama Panhandle Watershed Analysis Area as summarized by Thomas and Ford (1993), Oregon Department of Fish and Wildlife and U.S. National Park Service records. RN, 4/96.

Stream Name	Brook Trout	Brown Trout	Rainbow Trout
Scott Creek	1965, 1968, 1971	1925	1971
Sand Creek	1937 to 1940 on USPS lands and 1940 to 1969 on USFS lands	Unknown (Wallis, 1948 reports finding them in 1947)	1955

Thomas and Ford (1993) found no records of fish in the analysis area prior to the introduction of exotic fish. However, no systematic inventories or surveys were conducted in the analysis area prior to fish introductions. Some evidence exists which indicates that native species of fish may have been present in the analysis area prior to fish introductions. Charles Phillips (Wenatchee N.F.) reported speaking with a long time Chiloquin resident who reported catching bull trout in Sun Creek, Scott Creek, Sand Creek as well as other locations. Sun Creek which is just outside the analysis area has an extant population of bull trout partially substantiating this record (Dambacher et al., 1993). The flows in Sand Creek are approximately twice those of Sun Creek. Water temperature and other habitat variables in Sand Creek measured in the National Forest stream survey (1992) appear suitable for bull trout. While no conclusive data has been discovered regarding the status of bull trout, a potential exists that bull trout may have inhabited the streams of the analysis area. Other native fish may have been present in these streams but cold water temperatures may have precluded use of these habitats by most species (Bond, 1949).

The infrequent surface flow connection to the Klamath Marsh would severely limit any migrant fish populations which use these creeks as spawning areas and isolate any resident populations. Human modifications, consequences that befall small, isolated populations and lack of connectivity for recolonizing likely caused native fishes to become extirpated. The only fish present in the systems are exotic species which have been planted.

Introduced brown trout, rainbow trout and brook trout have been associated with the decline of bull trout populations (Rieman and McIntyre, 1993). Reiman and McIntyre (1993) report that hybridization with brook trout is apparently a problem for isolated, remnant populations of bull trout. Leary et al. (1983) documented extensive hybridization in conjunction with displacement of bull trout by brook trout. Brook Trout are more tolerant of habitat modification (especially increases in water temperature) than the bull trout and are believed to have restricted the distribution of bull trout in Sun Creek, adjacent to the analysis area. Efforts have been made to remove brook trout from the Park portion of Sun Creek for the protection of the bull trout population (Morris and Buktenica, 1992). The introduction of brook trout, brown trout and rainbow trout into stream reaches within the watershed may have been the fatal blow to bull trout populations already struggling due to isolation, small population size and habitat modification.

Declines and population extinctions have been documented for the Cascade frog (*Rana cascade*) by several authors (see Stebbins and Cohen, 1995 for a review). Suggested causes of the decline include the introduction of non-native predatory fish, drought, and the loss of open meadows due to fire suppression (Stebbins and Cohen, 1995). The populations in the Sky Lakes Wilderness immediately south of Crater Lake National Park may represent the functional southeast extent of the species current range. These populations are small compared to other locations in the Cascades and Olympic Mountains (R. Nauman USFS unpublished data). These small populations at or near the edge of the range of this species may be vulnerable to extinction. Cascade frogs use ponds, lakes and still water sections of streams for breeding. They may also use ephemeral wetlands with sufficient hydro periods for breeding. These habitats are extremely rare in the analysis area, most likely due to the highly permeable nature of the pumice soils found in the area.

Western toads (*Bufo boreas*) have not been documented in the analysis area but do occur in other nearby areas. The lack of still water habitat in the analysis area may limit the suitability of the habitat for western toads.

While the upper reaches of the aquatic systems are in near natural condition in the Park, the lower reaches on Forest and private ownerships are degraded due to sedimentation, irrigation diversions.

Surveys for aquatic macroinverebrates have been conducted by Wisseman (1991, 1992) on Lost Creek and Sand Creek in Crater Lake N.P. and Scott Creek and Sand Creek on the Chemult Ranger District, Winema National Forest. Overall densities for invertebrates were low to moderate. Molluscs were absent and crustaceans were represented only by ostrocods. The species richness of Scott Creek was much greater than Sand Creek and Scott Creek had double the standing crop of insects that Sand had. The densities of insects in both Scott and Sand was extremely low (Sand; 696.8 and Scott; 1307.6 insects / m^2) compared to other midsized, forested, montane streams in the Pacific Northwest which typically have 5000 to 10,000 insects / m^2. Unstable pumice substrate, few large structures, few pools, scouring during high water events and introduction of non-native fish serve to limit insect productivity and diversity.

Most of the insect taxa found by Wisseman (1991, 1992) are commonly occurring and broadly distributed taxa with winged adults which have fair to excellent dispersal capability. This is a logical pattern considering the short time (approximately 7,000 years) since the eruption of Mt. Mazama which would certainly have eliminated any insects present in the creek at that time. Although the post eruption period has been relatively short for the recolonization of the streams, several taxa of interest were discovered by Wisseman (1991, 1992). The federally listed category 2 caddisfly *Apatania tavala* was discovered in Lost and Sand Creeks between 4400 and 6200 feet elevation.

An unknown species of caddisfly from the genus *Farula* was collected n the spring head segment of Lost Creek. Only ten species of this genus are known, all from Western North America. Most species are found in cold, isolated spring habitats at mid to high elevations in the Sierra Nevada and Cascades. Some of the species are endemic to one or several springs in a limited geographic area.

Two other species of interest were collected in streams near the analysis area. A undescribed species of caddisfly (*Psychoglypha* n. sp.) was collected at 5600 feet elevation in a small first order channel which is a tributary to Annie Creek. An undescribed mayfly (*Caudatella* n. sp.) was collected above 6000 feet elevation on Sun Creek.

Spotted Owl Habitat and LSR Map

Human Uses

Paleoenvironmental studies have shown that the eruption of Mount Mazama drastically changed the watershed, but the influence on the plants, animals, and people of the region overall were minimal. Although the pumice landscape supports a variety of vegetation and wildlife -- the climate, altitude and soil conditions of Crater Lake and its immediate vicinity was responsible for the limited supply of edible foods and other biota causing this area to be a suboptimal habitat for aboriginal hunters and gatherers.

The western portion (Cascade Range) of the Klamath territory was well-forested; the eastern area mostly a semi-desert. With the exception of several fertile areas along permanent water sources (such as the Klamath Marsh, Agency/Klamath lakes, Williamson/Sprague rivers), most of the ethnographic Klamath territory was not desirable for habitation. Thus, the Klamath Indians used the lakes, rivers, and marsh environment for their subsistence rather than the forest-clad mountains, which they firmly believed, "invite only the solitary seeker after power (Spier 1930)."

Although the watershed was claimed as part of the Klamath territory, ethnographic studies have shown that the Indians rarely visited this area because it was believed to be a place of great supernatural powers and was thus considered a very dangerous place --- best to be avoided. In the "old days" only a "very strong man" would dare approach this area (Davis 1964). While the Klamath Indians may have feared Crater Lake, they did visit the area on certain occasions, particularly for power, strength, and luck (Barrett 1910).

According to ethnographic data, the Klamath and the people of the Rogue River drainage were not at all friendly and this was another reason for not venturing beyond the crest of the range. On occasion, however, the Klamath's hunted in this region but only in large parties. They also gathered berries in the area west and northwest of Crater Lake.

The Mazama Watershed can be roughly divided into thirds; the westernmost third being the Park, the remaining two thirds being the Chemult District of the Winema National Forest. The eastern most third portion is located within the former Klamath Indian Reservation. The Klamath Reservation was formed during the signing of the Treaty of 1864, and passed into private and public ownership with the Klamath Termination Act of 1954. The reservation lands and transferred lands from neighboring forests were brought together to form the Winema National Forest in 1961.

Non-Indian use in the watershed area began in the 1850s, when a group of gold mining prospectors from the Jacksonville area of southern Oregon (near Medford) ventured into the Crater Lake vicinity. When the prospectors discovered there was no gold, they left. However, hearing about the wondrous "blue lake," other prospectors trickled into the area.

It was not until the 1880's when the Crater Lake area amassed increasing public interest. William G. Steel, known as the "Father of Crater Lake," began a 17 year campaign to preserve Crater Lake as a national scenic wonder. Steel, an outdoor enthusiast, founded the Oregon Alpine Club in 1887, and a much more exclusive group called the "Mazamas", to support the preservation of Crater Lake as a National Park. The Mazamas and a number of Klamath Indians gathered for a meeting at the Lake in 1896 and succeeded in convincing Congress to preserve the Lake. These efforts also initiated scientific studies of the Lake and the establishment of Crater Lake as a National Park in 1902 (Williams and Mark 1995).

Another prominent figure in the establishment of the park was Judge John B. Waldo of the Willamette Valley. Waldo was also an outdoor enthusiast, who spent many summers camping and hiking in the Cascades. He proposed a forest reserve along the crest of the Oregon Cascade range, 12 miles on either side of the divide, to be managed by a joint state and federal commission. By 1893, the area around the Lake had received partial protection when it became the Cascade Range Forest Reserve (Williams and Mark 1995). However, there was great opposition by sheep owners, who felt that a reserve would eliminate sheep grazing from alpine meadows. In 1897, the Secretary of Interior shut off grazing in all forest reserves which angered sheep owners - this measure resulted in sheep grazing studies. The first study was completed by Frederick Coville (USDA Botanist) in 1898. Coville concluded that sheep grazing was a danger to the forest only if it was unregulated. Livestock grazing was then regulated, and livestock allotments were assigned through grazing permits. A sheep allotment was assigned, in the area of the watershed, in the early 1900's. The Bear Creek Sheep and Goat Allotment was under the administration of the Klamath District of the Rogue River National Forest. In 1961, with the formation of the Winema National Forest, the permit was transferred.

Because of the remoteness of this region, industrial-scale timber extraction did not begin until 1909 when Southern Pacific railroad constructed its line to connect Klamath Falls, Oregon, to Weed, California. By 1911, the railroad ended its line at the town of Kirk which became a center for railroad logging activities. According to Tonsfeldt (1995), the lands reserved by Klamath Treaty of 1864 included "some of the best ponderosa pine forest in the United States" (p. 33). Under the treaty law prior to 1910, timber from the reservation was generally not sold to lumber manufacturers so as to prevent exploitation of Indian resources. Only timber damaged by fire or dead from other causes were allowed to be sold (Kinney 1950). Selling timber from industrial scale logging on reservation lands was not made legal until Congress passed the Indian Omnibus Act in 1910 (Tonsfeldt 1995). The first significantly large timber sales that occurred within the watershed are the Middle Mt. Scott and North Mt. Scott/Bear Creek sales.

The Algoma lumber company of Klamath County purchased timber within what is referred to as the "Middle Mt. Scott Sale" in 1917. The Algoma lumber company logged approximately 316,879,370 board feet of timber between 1918-1930 in this sale. Initially, the lumber company used various equipment (including a donkey engine, a slide, an Ohio crane, a McGiffert, and one tractor of four sets of horse-drawn high wheels) and struggled to cut 200,000 feet/day. Shortly thereafter, they discovered the effectiveness of high-wheel logging which increased timber production of up to 300,000 feet/day. This logging method required fewer personnel as well. Currently 87% of the grades in the Middle Mt. Scott area have been converted into roads (Tonsfeldt 1995).

In 1914, the Pelican Bay Lumber Company of Klamath Falls negotiated with Crater National Forest to purchase timber north of the Middle Mt. Scott Sale. This sale, the North Mt. Scott/Bear Creek Sale complex (officially known as, the November 4, 1914 sale) yielded nearly 600 million board feet of timber and is reportedly the most extensive on the Winema National Forest (Tonsfeldt 1995). To reach the timber, 17 miles of rail access from Kirk needed to be constructed. Though the National Forest declined to help with the costs, the company persuaded the Indian Service to sell a unit of Klamath Reservation timber (Tonsfeldt 1995). In 1924, there were three sales near Bear Creek: the Crater National Forest Sale, the Klamath Reservation sale, and a unit of private timber in sections 31, 32, 33, T. 28S.,R. 7E and sections 4, 5, 6, T. 29S.,R. 7E.

The North Mt. Scott tract is within the watershed and the former Klamath Indian Reservation. This unit was harvested from 1917-1927 and produced 138,876,580 board feet of timber. Logging involved both wheels and skidder methods. Though the North Mt. Scott sale has a number of complex features, Tonsfeldt (1995) believes the system does not exhibit geographical coherence and thus does not have adequate integrity. Conversely, the southernmost portion of the Bear Creek tract which is also within the watershed (from Lookout Butte to Bear Creek), is an important historic site and is considered eligible to the National Register of Historic Places.

By far, the most observable changes to the landscape are related to early railroad logging activities. Branch and spur lines followed drainages into the hills. A number of camps were constructed in remote areas, on-site and preferably near water sources, for example, for the loggers and their families, industrial and construction sites for railroad related maintenance.

As the timber industry boomed, so did the realization that timber was an economically valuable resource. This realization thus led to development of organized fire protection plans. Fire lookouts were sporadically built beginning in the 1920s but the Civilian Conservation Corps (CCC) constructed a network of lookouts and guard stations throughout the Pacific Northwest during the 1930s. These structures were established predominantly in remote areas, depending upon the local topography (for views) and adjacency to water(for personal use). Communication via telephone lines linked the lookouts to guard stations and railroads.

There is a remnant of a steel tower lookout on Boundary Butte that was constructed during the 1930s. Although we lack the precise measurement of this tower, it may have ranged in height from 35 to 175 feet, with a superstructure roughly seven by seven feet. The superstructure would have housed a fire finder and telephone (Kresek 1985). A cabin associated with the lookout measured 12 by 16 feet and served as the residence of the watchman (Rose 1988). Other buildings associated with lookouts were outhouses, sheds, and sometimes root cellars for cold storage.

Current human uses center around hunting, dispersed recreation, mushroom harvesting, forest management and wood cutting. Klamath Tribes retain treaty rights to hunt and gather on former reservation lands.

3

Chapter 3 Synthesis and Interpretation

Trend Descriptions

A trend is a result of factors which over time influence change on a given element or portion of the ecosystem. Natural trends are distinguished from management trends. The significant influences on natural trends are from system functions, while human activities are the significant influences on management trends. It is assumed that if causal factors driving trends are stopped, the trend will stop or change positively. Trend descriptions, causes, ecological processes involved and resources affected follow:

Each trend is ranked according to its sensitivity (susceptibility, the ability to resist a change in properties, and resiliency, the ability to self-restore) and risk, and was then identified as being a red, yellow, or green trend. The colors indicate a combination of the level of risk and sensitivity. Red implies an urgent need for something to be done, such as management activities or intervention to prevent further deterioration of that resource, threatened species, or species viability. Yellow indicates that something needs to be done soon to prevent the resource from becoming a red trend. Green indicates that management opportunities exist within that trend, but that the urgency is not great or that the trend is good and should continue.

Management Trends

Trend 1: Change in fire regimes for ponderosa pine from frequent, low intensity fires to large, stand replacement fires. **Causes**: Nearly total fire suppression and unmanaged stands has resulted in the development of complex fuel profiles, overstocking and understory ladder fuels make the risk of stand replacement fires very high. **Ecological processes:** Vegetative succession including shifts in structure, composition, age, health and vigor. Increased competition for water and nutrients. Regeneration. Nutrient cycling.

Increased influence from insect and disease disturbance regimes. The distribution of successional stages has and will continue to move outside the HRV if the trend is allowed to continue. **Resources affected:** Increased fire suppression costs. Increased economic loss of large trees and old growth habitat loss. **Rating: Red flag.**

Trend 2: Reduction in large tree dominated ponderosa pine and mixed conifer stands, with corresponding increase in poles and seedling/sapling dominated stands and increased fragmentation. (Applies to all stands outside the Park.) **Causes:** Fire suppression and past harvest. The large ponderosa pine component within the watershed has been severely reduced from past harvest and competition, and within stand structural diversity is in danger of being lost due to the significant risk of disturbance activities. This risk is due, in part, to the complex fuel structure that has resulted from the exclusion of low intensity fires. **Ecological processes:** More extreme fire behavior with larger fires and higher economic loss. See also ecological processes in Management Trend 1. **Resources affected:** Short term and long term reduction of large tree component, especially ponderosa pine, which provide a valuable economic resource and important wildlife habitat structure. Decrease in the brush/ forb composition that provides big game forage. Seral composition shift favoring early successional wildlife species over late. The distribution of successional stages has and will continue to move outside the HRV if the trend is allowed to continue. **Rating: Red flag.**

Trend 3: Shift in species composition, structure and canopy closure away from ponderosa pine toward mixed conifers. **Causes:** Past harvest activities have removed primarily ponderosa because of their high economic value. Fire suppression efforts have eliminated low intensity understory fires that favor establishment of ponderosa pine. **Ecological processes:** Succession and competition. Fire intolerant species such as white fir and lodgepole pine now successfully compete with ponderosa pine. Shift in disturbance regimes resulting in higher catastrophic fire risk, and increased insect and disease infestations. **Resources affected:** Economic loss of high value ponderosa pine. Loss of high value habitat for numerous species of wildlife such as white-headed woodpeckers, flammulated owls, pygmy nuthatch and bats. The distribution of successional stages has and will continue to move outside the HRV if the trend is allowed to continue. **Rating: Red flag.**

Trend 4: High probability of mountain pine beetle outbreak with high mortality in late seral lodgepole pine. **Causes:**: Large acreage of overstocked, low resiliency, late seral lodgepole pine, and endemic populations of mountain pine beetle with a preference for large lodgepole pine make it highly susceptible. **Ecological processes:** Fire and insect disturbance regimes, competition, succession of lodgepole pine. **Resources affected:** Economic loss of large lodgepole pine and habitat loss for species such as great gray owls, goshawks, martens, fishers, merlin, three-toed woodpeckers and black-backed woodpeckers. **Rating: Red flag.**

Trend 5: There is a shift in stream zone vegetation structure and composition from a few large trees to many sapling and pole size conifers and fewer deciduous hardwoods. Woody litter is increasing at the expense of the more valuable, large, structural wood. **Causes:** Past harvest removed many of the large trees that are needed for long-term stream structure input. Fire suppression and lack of understory management has allowed dense stands of young conifers to become established. **Ecological processes:** Shift in fire regime and succession, competition, hydrologic function. **Resources affected:** Conifers out compete the deciduous hardwoods, which results in a loss of unique habitat highly valued by a large variety of wildlife species including neotropical migratory birds and stream invertebrates. Quality of riparian and aquatic habitats decline from lack of sustainable, long term inputs of large down wood. **Rating: Yellow flag.**

Trend 6: Roads within 300' of stream channels are contributing sediment to streams. **Causes**: Poor road location, poor road drainage, compaction on roads. **Ecological processes:** Erosion, hydrologic function. **Resources affected:** Water quality. Little is known about aquatic species in this watershed. Sediment deposits degrade or destroy their habitat. **Rating: Yellow flag.**

Trend 7: Diseases are more prevalent. **Causes**: Fire suppression limits natural control. Overstocking increases stress and reduces resistance to disease. The shifting tree species composition due to fire suppression is less resistant to native diseases. **Ecological processes:** Shift in fire regime, competition, succession. **Resources affected:** Economic loss from slowed growth and increased mortality. **Rating: Yellow flag.**

Trend 8: Increase in soil compaction. **Causes**: Roads, use of equipment for harvest activities and fuels treatment. **Ecological processes:** Potential long-term impacts on soil productivity, vegetative diversity and growth rates. **Resources affected:** Soil and water quality. Economic loss due to slower growth rates. **Rating: Yellow flag.**

Natural Trends

Trend 1: Frost pockets are prone to excessive frost heaving. **Causes:** Result from the combination of cold air settling in the low spots and low aggregate stability of pumice soils. This situation is aggravated by removing all overstory trees and down wood that provide microsite protection. **Ecological processes:** Regeneration and vegetative succession. **Resources affected:** Increased costs to regenerate lodgepole in frost pockets. Longer rotation periods will reduce economic value. Slower development of late seral habitat structure will favor early successional stage wildlife species over late. **Rating: Yellow flag**.

Trend 2: Sparse pool development or other in stream structures limit aquatic organisms in Sand and Scott Creeks. **Causes:** Canyon walls along these creeks are very steep .Unstable pumice substrates are continuously sloughing off contributing large quantities of small pumice into the creeks. Few large trees and no boulders are available within the canyons to provide in stream structure. This is especially true along the Pinnacles area of Sand Creek. Stream channel scouring from infrequent weather events also limit structure. **Ecological processes:** Erosion. **Resources affected:** Limited habitat for aquatic species that will influence fisheries management. Heavy sediment loads are deposited on private ownership downstream that plug water diversion structures. **Rating: Green flag.**

Trend 3: High water quality. **Causes**: Upper reaches are protected. Data shows water quality is high in Sand and Scott Creeks. **Ecological processes:** Hydrologic function. **Resources affected:** Domestic water supply for the Park and private landowners, fisheries, recreationists. **Rating: Green flag.**

Trend Sensitivity and Risk

Tables 3-1 and 3-2 contain a brief explanation of the susceptibility, resiliency, and risk determinations for management and natural trends.

Table 3-1. Management Trend Risk Determination. Mazama Watershed. TLS. May 1996.

Trend	Susceptibility	Resiliency	Risk to Ecosystem
1	High- due to complex fuel profiles, overstocking and ladder fuels..	Low- Ponderosa pine takes centuries to grow.	High- a large percentage of the area is in this condition.
2	High- high economic value and stands are highly susceptible to stand replacement fire.	Low- takes centuries to grow large trees and associated structure.	High risk to habitat for many wildlife species and to timber production.
3	High- ponderosa is economically more valuable than other species.	Low- takes centuries to grow large ponderosa.	High risk to habitat for many wildlife species and to timber production.
4	High-old, dense lodgepole is prime mountain pine beetle habitat.	Low- no resiliency in old lodgepole: takes 80-120 years to grow large lodgepole.	High- a significant percentage of lodgepole PAG is old.
5	Moderate- fire suppression allows conifers to out compete hardwoods. Overstocking slows growth of trees.	Moderate- Medium sized conifers are available to grow into large trees. Takes +10 years to rejuvenate hardwoods.	Moderate- loss of species diversity and high quality wildlife habitat.
6	Moderate- rain events heavy enough to carry sediments are infrequent and roads near creeks are rare.	Moderate- each system is isolated. Species can not migrate and recolonize from other systems.	Moderate-it is possible, but not probably that species could be extirpated.

Trend	Susceptibility	Resiliency	Risk to Ecosystem
7	Moderate due to overstocked conditions and lack of fire to control spread.	High with stocking control or/and re-introduction of fire.	Low- spreading slowly at this time.
8	Moderate - only a portion of the watershed is affected.	Low- soils take a long time to restore themselves.	Moderate- will inhibit or decrease vegetation establishment and growth.

Table 3-2. Natural Trend Risk Determination. Mazama Watershed. TLS. May 1996.

Trend	Susceptibility	Resiliency	Risk to Ecosystem
1	Moderate- only cold air drainage basins are prone to excessive frost heaving.	Low- frost heaving conditions are likely to occur every year.	Low- lodgepole in the cold air basins will take longer to establish.
2	High- unstable substrate and steep slopes provide continuous input of sediment into Sand and Scott Creeks.	Low- no boulders and little large down wood within canyons.	Low- these systems are .ecologically very young- natural limitations.
3	Low/High- there are no pollution sources except Scott Creek Campground. High pollution potential at campground from toilets and wastewater dumps near the stream.	High- remove pollution source and quality will improve immediately.	Low/High- low everywhere except downstream from campground. High risk downstream to domestic water source.

Management Trend 1 Map- Change in Fire Regimes

Management Trend 2 Map - Overstocked Areas

Management Trend 3 Map- Ponderosa Composition Shift

Management Trend 4 Map. Overstocked Mature Lodgepole Stands

4

Chapter 4. Recommendations and Opportunities

Management Opportunities

The following management opportunities are identified for the Mazama Watershed. These opportunities tier to trend priorities identified in Chapter 3.

Response to Trends 1, 2,3 with red flag rating and Trend 7 with yellow flag rating: Develop an integrated fire/silviculture strategy for the watershed that combines prescribed fire and commercial thinning prescriptions in a manner that mimics historic stand maintenance fire effects.

Response to Trends 1,2,3 with red flag rating and Trend 7 with yellow flag rating: Commercial and precommercial thinning for approximately 12,000 acres of mixed conifer encroachment on ponderosa pine sites. Favor ponderosa pine. Thin to recommended stocking levels to reduce risk from bugs and suppression related mortality (Cochran's Curves). In stands where the overstory ponderosa pine is not too heavily infected with mistletoe, thin around the large trees for two crown widths to reduce stress. Dense manzanita brush may be a problem to overcome. Use post harvest prescribed fire to control brush and encroachment.

Response to Trend 2 with red flag rating and Trend 7 with yellow flag rating: Commercial and precommercial thin ? acres of true mixed conifer. Thin to recommended stocking levels to reduce risk from bugs and suppression related mortality (Cochran's curves). Favor a mix of species. Armillaria root disease and mistletoe control suggestions: maintain resistant species, minimize site disturbance, avoid frequent entries, implement sanitation thinning in pole and small tree stands with less that 25% of the area infected and remove infected trees, remove large stumps (to reduce innoculum) and regenerate disease tolerant species. Remove mistletoe ponderosa pine overstory trees in old shelterwoods and around plantations. Create openings and plant ponderosa pine, rust resistant sugar pine and white pine, Thin stands around existing large ponderosa pine trees to maintain them as part of the landscape in the future.

Response to Trend 4 with red flag rating: Commercial and precommercial thin ? acres of late seral lodgepole pine .Thin to reduce stocking and risk to mountain pine beetle attack, maintain larger trees as part of the overstory for a longer period of time, and to provide replacement and recruitment snags (Cochran's curves). Salvage the dead and down lodgepole pine to reduce the fire hazard.

Response to Trends 5 and 6 with yellow flag rating: Implement Riparian Reserves Strategy (Appendix E).

Response to Trends 6 and 8 with yellow flag ratings: Subsoil unnecessary roads.

Management recommendations

The following recommendations should be taken into consideration during the development and implementation of projects within the Mazama Watershed. These recommendations are based on the interpretation of this analysis and are intended to help focus management decisions on the key issues identified during the analysis process.

The Pinnacles Canyon area on Sand Creek should be protected from disturbance due to the unstable nature of the pumice deposits. No management activities should occur at the slope break or anywhere above the break that could contribute to gullying, rilling or sediment flows into the canyon.

There are several ways to minimize fragmentation effects (Wisdom, 1993). Adjust harvest practices to maintain large segments of contiguous forest patches. Manage patches to maintain composition, structure and function of habitat patches. Minimize the contrast between patches and adjacent habitat by feathering or buffering edges. Provide connectivity to adjacent patches.

Develop silvicultural prescriptions that maintain large tree decadence in stands, maintain existing large tree structure and promote the development of future large tree structure.

Research Opportunities

Conduct a feasibility study for the re-introduction of bull trout into Sand and Scott Creek. Crater Lake National Park is currently considering plans to translocate a portion of the Sun Creek Bull Trout population to the upper reaches of Sand Creek to protect the population from catastrophic events on Sun Creek (Mac Brock, U.S. Park Service pers.

com.). By creating a duplicate population of Bull Trout, a source for reestablishment of the original population would be available in case of the extinction of the original. As discussed previously the small size (approximately 160 adults) of the Sun Creek population and the high level of isolation from other populations leaves the Sun Creek Bull Trout extremely vulnerable to extinction. By creating a duplicate population the chances of preserving the genetic identity of the Sun Creek population over the long term are greatly increased. An excellent opportunity exists for a cooperative project between the Forest Service and the Park Service to create additional populations of Bull Trout in Sand and Scott Creeks.

Data gaps for the following 2 sensitive species were identified during the analysis process. More information is needed to determine the status of these species within the watershed and to make management recommendations to protect these species. Further collecting should be done to determine which caddisfly species from the genus *Farula* is present. Perennial springs in the area should be protected until more information is known about this population. The species of caddisfly (*Psychoglypha* n. sp.) and mayfly (*Caudatella* n. sp.) were found near the analysis area. Further collecting may reveal them or other rare or endemic insect species within the analysis area.

Monitoring and Evaluation Recommendations

The following recommendations are made in addition to those identified in the Forest Plan. Management direction exists for each issue, but need for change may be imminent.

Determine condition of toilets and dishwater drains at Scott Creek campground. Take corrective action as needed. Monitor water quality below the campground.

A draft conservation strategy for *Allotropa virgata* is available, but several assumptions on species distribution and abundance used to develop management recommendations are in question. Monitoring and evaluation of the conservation strategy should be completed as soon as possible to insure appropriate management activities continue.

5

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Appendix A. Personal letter from "Wally" (Orthello L. Wallis) to "Carl" (Carl Bond) dated December 12, 1949. Mr. Wallis reports that Sand Creek joins the Williamson River and that Bear Creek "...disappears in the marshes above Upper Klamath Lake." He also reports that low stream temperatures an the Crater Lake National Park boundary may limit fish distributions. Both Orthello Wallis and Carl Bond are fisheries biologists who worked in Crater Lake N.P. during the 1940s. The original letter is in the Crater Lake National Park library.

Appendix B. Notarized letter from M.M. Mosby dated May 18, 1988. The letter states that in 1909 no irrigation diversions were occurring and that "... Sand Creek entered Klamath Marsh in the NW 1/4 of section 30 and spread out into a swamp in section 29 of T 31 S, R 8 E." A copy of the letter is in US Forest Service, Klamath Basin Adjudication Office.

Forest insects and disease pests found in the Mazama Watershed include:

mountain pine beetle, western pine beetle, dwarf mistletoes, defoliating insects (tussock moths, spruce budworm), armillaria root disease, annosus root disease, Indian paint fungus and fir engraver beetles.

Armillaria (root rot) and the effects of fire (or fire exclusion):

Fire may kill rhizomorphs in soil, but effects on inoculum survival and subsequent rhizomorph activity are unknown. Under natural conditions the amount of armillaria inoculum on a site may be reduced by competition from other fungi and by fire. Armillaria contributes significantly to decomposition and mineral cycling in many forests.

Forest harvesting and other disturbances cause fluctuations in inoculum levels in natural forests. Selective logging in old-growth forests may intensify disease development by creating large stumps for the inoculum to grow in.

P.120 Partial cutting may make stands more susceptible to disease through changes in species composition. Harvest of ponderosa pine favors regeneration of true firs. Young ponderosa pine stands can be thinned if it increases vigor and the stumps are small.

Fire may directly kill inoculum of armillaria or indirectly through stress effects on fungal mycelium which lead to natural biocontrol. Heating weakens the vitality of Armillaria mycelium making it more susceptible to parasitism by Trichoderma viride and other soil fungi. Fire exclusion interacts with silvicultural practices to promote Armillaria by allowing regeneration of species more susceptible to Armillaria.

Introduction of white pine blister rust has enhanced armillaria mortality by eliminating sugar pine and western white pine regeneration and also kills big trees that contribute to inoculum build-up.

Root diseases are caused by various fungi (e.g. armillaria spp.) which spread by root contact, root-feeding beetles, rhizomorphs or spores. Mortality is usually precipitated by other agents (stress, beetles, wind).

Dwarf mistletoe is prevalent in all PAG's and is spread by short range ballistic dispersal of seeds and birds. Severly infected trees are killed. Its spread is strongly influenced by the fire regime and management practices. The mistletoe brooms carried fire into the canopies and killed mistletoe infested areas and create new seedbeds for regeneration of the ponderosa pine. In the past most fires were started by lightning in the fall - seed dispersal time for the mistletoe - smoke and heat may have reduced the spread of the disease. Fire suppression has made mistletoe more abundant and more damaging (Maffei, ...).

RECOMMENDATIONS In mistletoe-infected pine stands group selection cuts may be appropriate. In mixed conifer types unevenage management would be best used in stands where seral species can be favored over the more pest-prone true firs. Group selection cuts where pine are reestablished by planting or ponderosa seed trees are maintained seem most likely to succeed. In many mixed conifer stands,

2/29/96

Terry.

one or more dwarf mistletoes are likely to be present and boundary design and follow-up treatment of trees surrounding the cut area will be extremely important.

In mixed conifer stands where true fire are dominant, seral species do not constitute a significant portion of the stocking, and root diseases are present and widely distributed, evenage silvicultural systems are most appropriate. This is especially true if stands contain many suppressed and or injured true firs as well. (from Helen Maffei, Plant pathologist)

In order to minimize pest-caused losses strive to avoid creation of three general stand types: overstocked pine stands; multistoried stands with significant components of dwarf mistletoe hosts and mistletoe infection of that same host in the overstory; and multistoried stands with major true fir components, a history of suppression and tree wounding, and root diseases present. (Don Goheen, Plant Pathologist, USDA Forest Service).

Fragmentation

Fragmentation effects are probably more dramatic in the mixed conifer forests than in the lodgepole or ponderosa pine forest types since the latter tend to be more "open" grown and grow in small groups or patches anyway. There will be [illegible] "edge" effect depending on the harvest method - unevenage or thinning from [illegible] will crate less of an "egde" effect than will seed tree or clearcutting methods. The clearcutting in lodgepole pine and mixed conifer and ponderosa pine in the past have created lower successional stages and habitat for those species that need it. The mixed conifer forests are more shade tolerant and are at elevations that receive more moisture and therefore fragmentation would have a more dramatic effect.

[illegible]

[illegible]

[illegible] so maybe

Fragmentation [illegible]

[illegible] dramatic [illegible]

mixed conifer stands.

Fragmentation of what? Do we need large blocks of [illegible] large blocks of [illegible] and [illegible] large blocks of [illegible] successional [illegible]?

Are the [illegible] [illegible] [illegible] in the [illegible]?

In the next 20-30 yrs there will be large blocks of late successional [illegible]

if [illegible]

EXISTING CONDITION

These Late Successional Reserves are located in stands of Ponderosa Pine and associate species that include: White Fir ›dgepole pine, Sugar Pine, White Pine, Douglas fir, and Western Hemlock. Ponderosa Pine and White Fir are the minate overstory species.

The majority of these areas are multi-layered stands where Ponderosa Pine Dominates the overstory in the lower elevations and White Fir Becomes the Dominate overstory in the higher elevations with Ponderosa Pine being almost non-existent in some of the higher elevations.

This watershed is located in a transition zone where a forest dominated by Ponderosa Pine meets the Cascade Mountain Range. In this transition zone elevation and climate change significantly over a very short horizonal distance. The vegetation in this zone changes as quickly as the climate and species such as White Fir are more adapted to the increased moisture and other climatalogical changes that occur and Ponderosa Pine becomes essentially absent in some of the stands through natural proccesses.

Fire suppression activities over the past 80+ years has created an increase in tree density, produced a multi-layered canopy, and allowed the surface fuels and shrub component to increase. These changes have all contributed to the establishment of a "ladder of fuel" that allows surface fires to climb into the crowns of even the tallest trees. The ability of a surface fire to reach the tree crowns is increased in areas where ponderosa pine is present in the overstory because this species is a prolific litter producer in the form of needles and small branches. This litter becomes suspended in the crowns of the shrubs and small trees. This fine dead fuel suspended in the air provides a source of highly flammable fuel that contributes to the fires ability to climb into the tree crowns.

Fire suppression has also favored the establishment of White Fir and Lodgepole Pine in the understory where Ponderosa ıe is the dominate overstory. Fire was the phenomena that allowed ponderosa pine to dominate sites where it is the ›tential climax as well as sites where it is seral to more shade tolerant tree species. Fire suppression has vertualy eliminated this process and the ponderosa pines ability to dominate these sites.

The surface fuel loadings range from 4 tons per acre to areas where fuel loadings are approaching 30 tons per acre with the average being 6-12 tons per acre. Most of the higher surface fuel loadings are located in stands dominated by lodgepole pine trees.

There are many acres in the higher elevations where fir is the dominate species. These areas will not be a fire hazard for many decades unless a wind storm or disease outbreak creates a rapid increase in surface fuel loadings.

FIRE HISTORY

The following information was compiled from fire records on the Chemult R.D. from 1976 thru 1995. The fire occurrence rates and percent of the area burned are shown for National Forest lands only. The average fire occurrence rate for lands managed by the Chemult Ranger District are shown for comparative purposes.

FIRE OCCURRENCE RATE (F.O.R)

The fire occurrence rate is the average number of fires that occur over a specified number of acre- in a year based on the historic occurrence rate.
This allows fire frequencies from several areas to be compared.

Formula

F.O.R = {total # of fires/ (total area protected X # years of data) } X 10,000
(expressed as # of fires per 10,000 acres per year).

Average Fire Occurrence Rate and Percent of Area Burned.

	AVERAGE FIRE OCCURRENCE RATE	PERCENT AREA BURNED ANNUALLY	PERCENT AREA BURNED 1976-95.
Chemult Ranger District	.56 fires/10mac/year.	.002%	.04%
Mazama Watershed	.65 fires/10mac/year. (68 Fires)	.00115%	.023%

Annual Area Burned

During the last 20 years approximately 2.3% of the total acres within the Mazama watershed (national forest lands have been burned by wildland fires. Approximately 2.2% of this occurred ... 1988 when the prophecy fire consumed 1196 acres in one burning period. The majority of the Prophecy fire was a stand replacement event that removed all the vegetation with the exception tree boles.

Historic Annual Area Burned

Based on historic fire return intervals of 15 years in Ponderosa pine and 30 years in Ponderosa Pine and Associate Species, and 80 years in lodgepole pine, the average annual percent of the watershed burned by wildland fires prior to the active fire suppression era would have been approximately (3%) three percent.

Wildland fires during this 20 year period would have covered approximately 60% of the total acres in the watershed compared to the 2.3% that actually occurred.

HISTORIC DISTURBANCE REGIMES

Historically fire was the primary disturbance regime in this watershed. Those areas dominated by ponderosa pine burned at intervals that ranged from 5 to 15 years. These fires were typically low intensity fires that burned under the overstory trees. These fires maintained a light fuel loading, regulated the amount of regeneration, brush, and other tree species such as lodgepole pine and Fir that became established in the stands.

Fires in those areas dominated by lodgepole pine received stand replacement fires at 80 to 120 year intervals. These fires were generally related to insect and disease attacks that caused high levels of tree mortality. These dead trees would fall and become available surface fuels that produced high intensity fires. Those trees that were still alive prior to the fire were killed by the fire and became surface fuel that made the area susceptible to another fire prior to the normal 80 year interval.

Fires in those areas where lodgepole pine was in close proximity to ponderosa pine probably burned frequently enough that the lodgepole never became mature before it was killed by fires. Lodgepole is not a fire tolerant species and the litter produced by the ponderosa pine creates fire intensities that are generally lethal to young fir and lodgepole pine trees.

Most of the Winema N.F. lands currently owned and managed by the federal government were managed by the Bureau of Indian Affairs (BIA) prior to 1961. The fire records from this era can be obtained from the National Archives in Seattle Washington.

BIA records from 1915 recorded a 1040 acre fire, cause unknown, a 550 acre lightning fire and a 60 acre lightning fire in the southeast corner of the watershed. The records indicated that the fires caused very minimal timber losses due to the light fuel loadings, absence of brush and open stand structures that were common at the turn of the century in ponderosa pine stands. The value of ponderosa pine was approximately two dollars per thousand board feet and lodgepole pine was essentially worthless, therefore, it would not be reported as damaged timber. These reports refer to acres burned over (a term used to indicate the tree canopies were consumed by the fire) these 1915 fires had acres referred to as "burned over" and then indicate very little timber was damaged because burn over occurred in lodgepole pine.

These are the Fire-Return Intervals for Oregon over the past few centuries.[1]

Forest Type	Area in (1,000 ha)	Fire Cycle Years	Area Burned Per Year (1,000 ha)
Ponderosa Pine	3,142	15	209.4
Mixed Conifer	399	30	13.3
Lodgepole Pine	757	80	9.4

Fire Cycle Years = time needed to disturb an area equal in size to the study area. The study area for this research is indicated under "Area in (1000 ha)".

One Hectare (ha) is equal to approximately 2.471 acres.

Here is a Brief description of these fire cycles based on the information above.

In Oregon, a ponderosa pine forest that covers 7,572,220 acres, fires burned an average of 517,427 acres per year, and in 15 years would cover an area of 7,761,411 acres. This indicates that the ponderosa pine forests in Oregon experienced a fire an average of once every 15 years. There would be areas that burned twice and areas that did not burn at all during this 15 year period.

In Oregon, a lodgepole pine forest that covers 1,870,547 acres, fires burned an average of 23,227 acres per year, and in 80 years would cover an area of 1,858,192 acres. Lodgepole pine forest tend to be even aged over large areas. Fires that occur in young stands generally smolder in a compacted litter layer and scattered logs. Older stands (80+ years in age) are succeptable to insect and disease attacks. Large fuel loadings are created from these events and very high intensity stand replacment fires would occur.

Lotan and others have described fire in many lodgepole pine stands as an "all or nothing" proposition. That is, fires either (1) go out after a day or two or smolder in duff for extended periods or (2) develop into rapidly spreading wildfires. Smoldering fires are common in lodgepole forests because understory fuels are sparse. Furthermore, fire spread to crowns is difficult because they are elevated well above the forest floor. However, lodgepole pine stands become more flammable as they age because dead woody fuels accumulate on the forest floor. These fuels result from past

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[1] Agee James. K Fire Ecology of Pacific Northwest Forests 1993.

fires, insect and disease outbreaks (especially mountain pine beetle), and overmaturity. For example, trees killed by a high intensity fire eventually fall to the ground creating a large fuel buildup.

Mountain pine beetle outbreaks create ground fuels by killing trees and opening up stands to drying. In general, the potential for high intensity crown fires is great twice in the life of a stand.

Historic Fire Effects on Vegetation

The fire return intervals of 5-15 years in ponderosa pine maintained an open stand of large trees with very little reproduction. Grass covered a high percentage of the ground. The dominant brush species consisted of snowbrush ceanothous, manzanita, and bitterbrush. These brush species existed in small isolated patches scattered throughout the area.

The willows and aspens that are located in a few of the moist riparian areas were maintained by fire. Fires would burn the limbs of the willows and either kill or damage the aspens, this provided the disturbance that they require to be rejuvenated. After the fire they would resprout from the undamaged root collars and produce fresh new growth and establish new plants.

Historically there where other species such as White Fir and Lodgepole Pine that would regenerate under an overstory of Ponderosa Pine. The process that allowed the Ponderosa to maintain dominance was the trees ability to withstand frequent low intensity fires. Species such as White Fir and Lodgepole Pine are very succeptable to fire induced mortality mainly because of their thin bark that provides very little thermal protection thus allowing fires to kill the cambium layer of the tree. White Fir becomes much more resistant as it grows and produces thicker bark, this attribute allowed it to become established in areas where the fire return intervals were longer than the 5-15 year intervals that occurred in the drier ponderosa pine sites.

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Appendix B. Species List

MAZAMA PANHANDLE WATERSHED SPECIES LIST:
Known or Suspected

American crow	*Corvus brachyrhynchos*
American dipper	*Cinclus mexicanus*
American kestrel	*Falco sparverius*
American pipit(water)	*Anthus spinoletta*
American robin	*Turdus migratorius*
Anna's hummingbird	*Calypte anna*
Ash-throated flycatcher	*Myiarchus cinrascens*
Badger	*Taxidea taxus*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barn owl	*Tyto alba*
Barn swallow	*Hirundo rustica*
Barred owl	*Strix varia*
Beaver	*Castor canadensis*
Belted kingfisher	*Ceryle alcyon*
Big brown bat	*Eptesicus fuscus*
Black bear	*Ursus americanus*
Black rosy finch	*Leucosticte arctoa(atrata)*
Black-backed woodpecker	*Picoides arcticus*
Black-chinned hummingbird	*Archilochus alexandri*
Black-headed grosbeak	*Pheuticus melanocephalus*
Black-tailed deer	*Odocoileus hemionous*
Black-throated gray warbler	*Dendroica nigrescens*
Blue grouse	*Dendragapus obscurus*
Bobcat	*Felis rufus*
Boreal owl	*Aegolius funereus*
Broad-footed mole	*scapanus latimanus*
Brown creeper	*Certhia americana*
Brown-headed cowbird	*Molothrus ater*
Bushtit	*Psaltriparus minimus*
Bushy-tailed woodrat	*Neotoma cinerea*
California myotis	*Myotis californicus*
Calliope hummingbird	*stellule calliope*
Cascades frog	*Rana cascadae*
Cassin's finch	*Carpodacus cassinii*
Chipping sparrow	*Spizella passerina*
Clark's nutcracker	*Nucifraga columbiana*
Common garter snake	*Thamnophis sirtalis*
Common nighthawk	*Chordeiles minor*
Common poorwill	*Phalaenoptilus nuttallii*
Common raven	*Corvus corvax*
Common yellowthroat	*Geothylpis trichas*
Cooper's hawk	*Accipter cooperii*
Coyote	*Canis latrans*
Dark-eyed junco	*Junco hyemalis*
Deer mouse	*Peromyscus maniculatis*
Douglas' squirrel	*Tamiasciurus douglasii*
Downy woodpecker	*Picoides pubescens*
Dusky flycatcher	*Epidonax oberholseri*
Elk	*Cervus elaphus*

Ermine	*Mustela erminea*
European starling	*Sturnus vulgaris*
Evening grosbeak	*Coccothraustes vespertinus*
Fisher	*Martes pennanti*
Flammulated owl	*Otus flammeolus*
Fox sparrow	*Passerella iliaca*
Fringed myotis	*Myotis thysanodes*
Golden eagle	*Aquila chrysaetos*
Golden crowned kinglet	*Regulus satrapa*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Golden mantled ground squirrel	*Spermophilus lateralis*
Gopher snake	*Pituophis catenifer*
Gray jay	*Perisoreus canadensis*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Hairy woodpecker	*Picoides villosus*
Hammond's flycatcher	*Empidonax hammondii*
Heather vole	*Phenacomys intermedius*
Hermit thrush	*Catharus guttatus*
Hermit warbler	*Dendroica occidentalis*
Hoary bat	*Lasiurus cinereus*
Horned lark	*Eremophilia alpestris*
House finch	*Carpodacus mexicanus*
House mouse	*Passer domesticus*
House wren	*Troglodytes aedon*
Lapland longspur	*Calcarius lapponicus*
Lark sparrow	*Chondestes grammacus*
Lewis's woodpecker	*Melanerpes lewis*
Long-eared myotis	*Myotis evotis*
Long-eared owl	*Asio otus*
Long-legged myotis	*Myotis volans*
Long-tailed vole	*Microtis longicaudus*
Long-tailed weasel	*Mustela frenata*
Long-toed salamander	*Ambystoma macrodactylum*
MacGillivray's warbler	*Oporornis tolmiei*
Marten	*Martes americana*
Merlin	*Falco columbarius*
Mink	*Mustela vison*
Montane vole	*Microtus montanus*
Moutain bluebird	*Sialia currucoides*
Moutain chickadee	*Parus gambeli*
Mountain lion	*Felis concolor*
Moutain quail	*Oreortyx pictus*
Mourning dove	*Zenaida macroura*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethicus*
Nashville warbler	*Vermivora ruficapilla*
Northern alligator lizard	*Elgaria coerulea*
Nortern flicker	*Colaptes auratus*
Northern flying squirrel	*Glaucomys sabrinus*
Northern goshawk	*Accipiter gentilis*
Northern harrier	*Circus cyaneus*
Northern oriole	*Icterus galbula*
Northern pocket gopher	*Thomomys talpoides*

Northern pigmy-owl	*Glaucidium gnoma*
Northern saw-whet owl	*Aegolius acadicus*
Norway rat	*Rattus Norvegicus*
Olive-sided flycatcher	*Contopus borealis*
Osprey	*Pandion haliaetus*
Pacific shrew	*Sorex pacificus*
Pacific treefrog(chorus)	*Pseudacris regilla*
Pallid bat	*Antrozous pallidus*
Peregrine falcon	*Falco peregrinus*
Pika	*Ochotona princeps*
Pileated woodpecker	*Dryocopus pileatus*
Pine siskin	*Carduelis pinus*
Porcupine	*Erethizon dorsatum*
Prairie falcon	*Falco mexicanus*
Purple finch	*Carpodacus purpureus*
Purple martin	*Progne subis*
Pygmy nuthatch	*Sitta pygmaea*
Pygmy rabbit	*Sylvilagus idahoensis*
Raccoon	*Procyon lotor*
Red crossbill	*Loxia curvirostra*
Red fox	*Vulpes vulpes*
Red-breasted nuthatch	*Sitta canadensis*
Red-breasted sapsucker	*Sphyrapicus ruber*
Red-eyed vireo	*Vireo olivaceus*
Red-tailed hawk	*Bureo jamaicensis*
River otter	*Lutra canadensis*
Rock wren	*Salpinctes obsoletus*
Rough-legged hawk	*Butreo lagopus*
Rubber Boa	*Charina bottae*
Ruby-crowned kinglet	*Regulus calendula*
Ruffed grouse	*Bonasa umbellus*
Rufous hummingbird	*Selasphorus rufus*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Sharp-shinned hawk	*Accipiter striatus*
Shrew mole	*Neurotrichus gibbsii*
Silver-haired bat	*Lasionycteris noctivagans*
Snowshoe hare	*Lepus americanus*
Solitary vireo	*Vireo solitarius*
Song sparrow	*Melospiza melodia*
Spotted frog	*Rana pretiosa*
Spotted owl(northern)	*Strix occidentalis*
Stellar's jay	*Cyanocitta stelleri*
Swainson's hawk	*Buteo swainsoli*
Swainson's thrush	*Catharus ustulatus*
Tailed frog	*Ascaphus truei*
Three-toed woodpecker(northern)	*Picoides Tridactylus*
Townsend's chipmunk	*Tamias townsendii*
Towsend's warbler	*Dendroica townsendi*
Tree swallow	*Tachycineta bicolor*
Trowbridge's shrew	*Sorex Trobridgii*
Turkey vulture	*Cathartes aura*
Vagrant shrew	*Sorex vagranx*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*

Warbling vireo	*Vireo gilvus*
Water shrew	*Sorex palustris*
Western flycatcher(Pacific-slope)	*Empidonax difficilis*
Western gray squirrel	*Sciurus griseus*
Western jumping mouse	*Zapus princeps*
Western kingbird	*Tyrannus verticallis*
Western pocket gopher	*Thomomys mazama*
Western red-backed vole	*Clethrionomys californicus*
Western spotted skunk	*Spilogale gracilis*
Western tanager	*Piranga ludoviciana*
Western terrestrial garter snake	*Thamnophis elegans*
Western toad	*Contopus sordidulus*
White-breasted nuthatch	*Sitta carolinensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-headed woodpecker	*Picoides albolarvatus*
White-throated swift	*Aeronautes saxatalis*
White-winged crossbill	*Loxia leucoptera*
Williamson's sapsucker	*Sphyrapicus Thyroideus*
Willow flycatcher	*Empidonax traillii*
Wilson's phalarope	*Phalaropus tricolor*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wolverine	*Gulo gulo*
Yellow warbler	*Dendroica petechia*
Yellow-bellied marmot	*Marmota flaviventris*
Yellow-breasted chat	*Icteria virens*
Yellow-pine chipmunk	*Tamias amoenus*
Yellow-rumped warbler	*Dendroica coronata*
Yuma myotis	*Myotis yumanensis*

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Appendix C. Habitat Types for each Species

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Table 2

Wildlife Species by Plant Association Group
Known or Suspected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
American crow					X	X	X	X	X	X	
American dipper										X	X
American kestrel		X			X	X	X	X	X	X	X
American pipit (Water)		X								X	
American robin		X	X	X		X	X	X	X	X	X
Anna's hummingbird			X	X		X	X			X	X
Ash-throated flycatcher					X						
Badger	X	X	X	X	X	X	X	X	X	X	X
Bald eagle					X	X	X	X	X	X	X
Bank swallow										X	X
Barn owl					X	X	X			X	X
Barn swallow										X	X
Barred owl							X			X	X
Beaver										X	X
Belted kingfisher										X	X
Big brown bat			X	X	X	X	X	X	X	X	X
Black bear			X	X	X	X	X	X	X	X	X
Black rosy finch		X									X
Black-backed woodpecker			X	X		X	X	X	X		X
Black-chinned hummingbird						X	X			X	X
Black-headed grosbeak			X	X	X	X	X	X	X	X	X
Black-tailed deer											
Black-throated gray warbler						X	X			X	X
Blue grouse			X	X	X	X	X	X	X		X
Bobcat		X	X	X	X	X	X	X	X	X	X
Boreal owl								X	X		X
Broad-footed mole	X	X	X	X	X	X	X	X	X		
Brown creeper					X	X	X			X	
Brown-headed cowbird					X	X	X			X	
Bushtit					X					X	
Bushy-tailed woodrat	X	X	X	X	X	X	X	X	X	X	X
California myotis			X	X	X	X	X	X	X	X	X
Calliope hummingbird		X			X	X	X	X	X		X
Cascades frog		X								X	X
Cassin's finch		X	X	X	X	X	X	X	X	X	

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Wildlife Species by Plant Association Group
Known or Suspected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
Chipping sparrow					X	X	X	X	X	X	X
Clark's nutcracker			X	X		X	X	X	X	X	X
Common garter snake		X								X	X
Common nighthawk	X		X	X	X	X	X	X	X	X	X
Common poorwill						X	X				X
Common raven	X	X	X	X	X	X	X	X	X	X	X
										X	
Common yellowthroat	X										
Cooper's hawk			X	X	X	X	X	X	X	X	X
Coyote		X	X	X	X	X	X	X	X	X	
Dark-eyed junco			X	X	X	X	X	X	X	X	X
Deer mouse	X	X	X	X	X	X	X	X	X		X
Douglas' squirrel			X	X	X	X	X	X	X		
Downy woodpecker		X								X	X
Dusky flycatcher					X	X				X	
Elk	X		X	X	X	X	X	X	X	X	
Ermine		X	X	X		X	X	X	X	X	X
European starling										X	X
Evening grosbeak			X	X	X	X	X	X	X	X	
Fisher			X	X		X	X	X	X	X	
Flammulated owl					X	X	X				X
Fox sparrow		X									
Fringed myotis											
Golden eagle		X			X	X	X				X
Golden-crowned kinglet			X	X	X	X	X	X	X		X
Golden-crowned sparrow			X		X	X					
Golden-mantled ground squirrel		X	X	X	X	X	X	X	X	X	X
Gopher snake	X										
Gray jay			X	X		X	X	X	X		
Great gray owl			X	X							X
Great horned owl			X	X	X	X	X	X	X	X	
Hairy woodpecker			X	X	X	X	X	X	X		X
Hammond's flycatcher			X	X	X	X	X	X	X		

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C.

Wildlife Species by Plant Association Group
Known or Suspected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
Heather vole		X								X	
Hermit thrush			X		X	X	X				
Hermit warbler			X	X		X	X	X	X		
Hoary bat			X	X	X	X	X	X	X	X	X
Horned lark	X	X									
House finch					X	X	X			X	
House mouse	X									X	
House sparrow										X	X
House wren					X	X	X			X	X
Lapland longspur			X	X				X	X		
Lark sparrow	X										
Lewis' woodpecker					X	X	X				X
Little brown myotis			X	X	X	X	X	X	X	X	X
Long-eared myotis			X	X	X	X	X	X	X		X
Long-eared owl		X	X	X		X	X	X	X		X
Long-legged myotis			X	X	X	X	X	X	X	X	X
Long-tailed vole	X	X			X	X	X	X		X	X
Long-tailed weasel	X	X	X	X	X	X	X	X	X	X	X
Long-toed salamander					X	X	X	X		X	X
MacGillivray's warbler		X								X	X
Marten			X	X		X	X	X	X	X	X
Merlin		X	X	X	X	X	X	X	X	X	X
Mink		X								X	
Montane vole	X	X								X	
Mountain bluebird		X			X	X	X	X		X	X
Mountain chickadee			X	X	X	X	X	X	X		X
Mountain lion					X	X	X	X		X	X
Mountain quail					X					X	
Mourning dove					X					X	X
Mule deer			X	X	X	X	X	X	X	X	
Nashville warbler		X				X	X				X
Northern alligator lizard					X	X	X	X		X	X
Northern flicker					X					X	X
Northern flying squirrel					X						X
Northern goshawk			X	X	X	X	X	X	X	X	X
Northern harrier	X	X								X	
Northern oriole										X	X

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Wildlife Species by Plant Association Group
Known or Suspected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
Northern pocket gopher	X	X	X	X	X	X	X	X	X	X	
Northern pygmy-owl					X	X	X			X	X
Northern saw-whet owl			X	X	X	X	X	X	X	X	X
Northwestern salamander		X	X	X	X	X	X	X	X	X	X
Norway rat											X
Olive-sided flycather			X	X	X	X	X	X	X	X	X
Osprey			X	X	X					X	X
Pacific treefrog (Chorus)		X	X	X	X	X	X	X	X	X	
* → Peregrine falcon		X	X	X	X	X	X	X	X	X	X
Pika		X								X	X
Pileated woodpecker					X	X	X				X
Pine siskin		X	X	X	X	X	X	X	X	X	
Porcupine		X	X	X	X	X	X	X	X	X	X
Prairie falcon		X								X	X
Purple finch			X	X	X	X	X			X	
Purple martin	X				X					X	X
* → Pygmy nuthatch					X	X					X
Raccoon										X	X
Racer	X										
Red crossbill			X	X	X	X	X	X	X		
Red fox	X	X	X	X	X	X	X	X	X	X	X
Red-breasted nuthatch			X	X		X	X	X	X		X
Red-breasted sapsucker					X	X	X			X	X
Red-eyed vireo										X	X
Red-tailed hawk					X	X	X	X	X	X	X
River otter		X								X	X
Rock wren	X	X			X	X	X			X	X
Rough-legged hawk			X	X	X	X	X	X	X	X	
Rubber boa	X										
Ruby-crowned kinglet			X	X	X	X	X	X	X		X
Ruffed grouse			X	X	X	X	X			X	X
Rufous hummingbird		X	X	X		X	X	X	X	X	X
Rufous-sided towhee						X	X				X
Sharp-shinned hawk			X	X	X	X	X	X	X	X	X
Shrew-mole					X		X				X
Silver-haired bat					X	X	X				X

* ← Pallid bat

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Wildlife Spec Plant Association Group
Known o. ected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
Snowshoe hare			X	X		X	X	X	X	X	X
Solitary vireo			X	X	X	X	X	X	X	X	X
Song sparrow						X	X			X	
Spotted frog					X	X	X			X	X
Spotted owl (Northern)						X	X				
Steller's jay		X			X	X	X	X	X	X	
Swainson's hawk		X			X	X	X	X	X	X	
Swainson's thrush						X	X			X	
Tailed frog		X					X	X		X	
Three-toed woodpecker (Northern)			X	X		X	X	X	X		X
Townsend's big-eared bat	X				X						X
Townsend's chipmunk					X		X	X		X	X
Townsend's warbler			X	X	X	X	X	X	X		
Tree swallow					X	X	X			X	X
Trowbridge's shrew	X				X	X	X				X
Turkey vulture	X		X	X	X	X	X	X	X	X	X
Vagrant shrew	X										X
Varied thrush				X		X	X	X	X		
Vaux's swift						X	X			X	
Warbling vireo										X	X
Water shrew		X								X	
Western flycatcher (Pacific-slope)						X	X	X			
Western gray squirrel					X	X	X				X
Western jumping mouse	X	X	X	X	X	X	X	X	X	X	X
Western pocket gopher	X	X	X	X				X	X		
Western red-backed vole		X	X	X		X	X	X	X	X	
Western spotted skunk					X	X	X				
Western tanager			X	X	X	X	X	X	X		X
Western terrestrial garter snake	X										
Western toad	X	X	X	X	X	X	X	X	X	X	X
Western wood-pewee			X	X	X	X	X	X	X		
White-breasted nuthatch					X	X	X				X
White-crowned sparrow		X	X	X	X			X	X	X	X
White-headed woodpecker					X	X	X				X
White-throated swift					X					X	X
White-winged crossbill			X	X		X	X	X	X		
Williamson's sapsucker					X	X	X	X	X		X
Willow flycatcher			X	X		X	X	X	X	X	
Wilson's phalarope	X									X	
Wilson's warbler							X	X		X	X
Winter wren			X	X	X	X	X	X	X	X	

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Wildlife Species by Plant Association Group
Known or Suspected Species

Species	Meadows	Subalpine /Alpine Habitats	Lodgepole Pine Dry	Lodgepole Pine Wet	Ponderosa Pine	Mixed Conifer Dry	Mixed Conifer Wet	Mountain Hemlock	Mountain Hemlock Lodgepole	Aquatic/ Riparian Habitats	Special Habitats
Wolverine			X	X	X	X	X	X	X	X	X
Yellow warbler										X	X
Yellow-bellied marmot	X									X	X
Yellow-breasted chat										X	
Yellow-pine chipmunk		X	X	X	X	X	X	X	X	X	X
Yellow-rumped warbler			X	X	X	X	X	X	X	X	X
Yuma myotis		X								X	X

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Appendix D. Species List by Habitat Type

Table 3

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D- 1

Lodgepole Pine Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
American robin	TUMI	1	1	1	1
Anna's hummingbird	CAAN	1			
Badger	TATA	3	3	3	3
Big brown bat	EPFU			3	3
Black bear	URAM	2	2	2	2
Black-backed woodpecker	PIAR		1	1	1
Black-headed grosbeak	PHME	3	3	3	3
Blue grouse	DEOB	3	3	3	3
Bobcat	FERU	2	2	2	2
Broad-footed mole	SCLA	1	1	1	1
Bushy-tailed woodrat	NECI	1	1	1	1
California myotis	MYOCA	3		3	3
Cassin's finch	CACAS	3	1	1	1
Clark's nutcracker	NUCO		3	3	3
Common raven	CORCO	1			1
Cooper's hawk	ACCCO	4	1	1	3
Coyote	CANLA	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1
Deer mouse	PEMA	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1
Elk	CEEL	4	4	4	4
Ermine	MUER	1	1	1	1
Evening grosbeak	COVE	3	3	1	1
Fisher	MAPE			3	3
Golden-crowned kinglet	RESA	3	1	1	1
Golden-crowned sparrow	ZOAT			3	
Golden-mantled ground squirrel	SPLA	4	4	4	4
Gray jay	PECA	1	1	1	1
Great gray owl	STRNE			1	
Great horned owl	BUVI	3	3	3	3
Hairy woodpecker	PIVI		1	1	1
Hammond's flycatcher	EMHA			1	1
Hermit thrush	CAGU	3	1	1	1
Hermit warbler	DEOC	3	3	3	3
Hoary bat	LACI	1	1	1	1
Lapland longspur	CALLA	3	3	3	3
Little brown myotis	MYLU	3		3	3
Long-eared myotis	MYEV	3		3	3
Long-eared owl	ASOT	3	1	1	1
Long-legged myotis	MYVO	3		3	3
Long-tailed weasel	MUFR	2	2	2	2

Lodgepole Pine Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Marten	MAAM	3	3	3	3
Merlin	FACO	3	3	1	1
Mountain chickadee	PARGA	3	1	1	1
Mule deer	OOHE	1	1	1	1
Northern goshawk	ACGE	4	4	1	1
Northern pocket gopher	THTA	1	1	1	1
Northern saw-whet owl	AEAC		3	3	3
Northwestern salamander	AMGR	3	3	3	3
Olive-sided flycather	COBO	3	3	3	3
Osprey	PAHA			1	1
Pacific treefrog (Chorus)	PSRE	4	4	4	4
Peregrine falcon	FAPE	3	3	3	3
Pine siskin	CARPI	1	1	1	1
Porcupine	ERDO	4		4	4
Purple finch	CARPU	3	3	3	3
Red crossbill	LOXCU		3	1	1
Red fox	VUVU	1	1	1	1
Red-breasted nuthatch	SICAN		1	1	1
Ruby-crowned kinglet	RECA	3	3	1	1
Ruffed grouse	BOUM	3	3	3	3
Rufous hummingbird	SELRU	1	1	1	1
Sharp-shinned hawk	ACST	1	1	1	1
Snowshoe hare	LEAM	2	2	2	2
Solitary vireo	VISO	2	2	2	2
Three-toed woodpecker (Northern)	PITR		1	1	1
Townsend's warbler	DETO			3	3
Turkey vulture	CATAU	3	3	3	3
Western jumping mouse	ZAPR	1	1	1	1
Western pocket gopher	THMA	1	1	1	1
Western red-backed vole	CLCA	1	1	1	1
Western tanager	PILU	3	1	1	1
Western toad	BUBO	3	3		
Western wood-pewee	COSO		1	1	1
White-crowned sparrow	ZOLE	3	3	3	3
White-winged crossbill	LOLE		3	1	1
Willow flycatcher	EMTR	3	3	3	3
Winter wren	TRTR	3	1	1	1
Wolverine	GUGU	3	3	3	3
Yellow-pine chipmunk	TAAM	1	1	1	1
Yellow-rumped warbler	DENCO	3	1	1	1

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Table 4

D-3

Lodgepole Pine Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
American robin	TUMI	1	1	1	1
Anna's hummingbird	CAAN	1			
Badger	TATA	3	3	3	3
Big brown bat	EPFU	3		3	3
Black bear	URAM	2	2	2	2
Black-backed woodpecker	PIAR		1	1	1
Black-headed grosbeak	PHME	3	3	3	3
Blue grouse	DEOB	3	3	3	3
Bobcat	FERU	2	2	2	2
Broad-footed mole	SCLA	1	1	1	1
Bushy-tailed woodrat	NECI	1	1	1	1
California myotis	MYOCA	3		3	3
Cassin's finch	CACAS	3	1	1	1
Clark's nutcracker	NUCO		3	3	3
Common raven	CORCO	1		1	1
Cooper's hawk	ACCCO	4	1	1	3
Coyote	CANLA	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1
Deer mouse	PEMA	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1
Elk	CEEL	4	4	4	4
Ermine	MUER	1	1	1	1
Evening grosbeak	COVE	3	3	1	1
Fisher	MAPE			3	3
Golden-crowned kinglet	RESA	3	1	1	1
Golden-mantled ground squirrel	SPLA	4	4	4	4
Gray jay	PECA	1	1	1	1
Great gray owl	STRNE			1	
Great horned owl	BUVI	3	3	3	3
Hairy woodpecker	PIVI		1	1	1
Hammond's flycatcher	EMHA			1	1
Hermit warbler	DEOC	3	3	3	3
Hoary bat	LACI	1	1	1	1
Lapland longspur	CALLA	3	3	3	3
Little brown myotis	MYLU	3		3	3
Long-eared myotis	MYEV	3		3	3
Long-eared owl	ASOT	3	1	1	1
Long-legged myotis	MYVO	3		3	3
Long-tailed weasel	MUFR	2	2	2	2
Marten	MAAM	3	3	3	3
Merlin	FACO	3	3	1	1

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Lodgepole Pine Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Mountain chickadee	PARGA	3	1	1	1
Mule deer	ODHE	1	1	1	1
Northern goshawk	ACGE	4	4	1	1
Northern pocket gopher	THTA	1	1	1	1
Northern saw-whet owl	AEAC		3	3	3
Olive-sided flycather	COBO	3	3	3	3
Osprey	PAHA			1	1
Pacific treefrog (Chorus)	PSRE	4	4	4	4
Peregrine falcon	FAPE	3	3	3	3
Pine siskin	CARPI	1	1	1	1
Porcupine	ERDO	4		4	4
Purple finch	CARPU	3	3	3	3
Red crossbill	LOXCU		3	1	1
Red fox	VUVU	1	1	1	1
Red-breasted nuthatch	SICAN		1	1	1
Ruby-crowned kinglet	RECA	3	3	1	1
Ruffed grouse	BOUM	3	3	3	3
Rufous hummingbird	SELRU	1	1	1	1
Sharp-shinned hawk	ACST	1	1	1	1
Snowshoe hare	LEAM	2	2	2	2
Solitary vireo	VISO	2	2	2	2
Three-toed woodpecker (Northern)	PITR		1	1	1
Townsend's warbler	DETO		3	3	3
Turkey vulture	CATAU	3	3	3	3
Varied thrush	IXNA	1	1	1	1
Western jumping mouse	ZAPR	1	1	1	1
Western pocket gopher	THMA	1	1	1	1
Western red-backed vole	CLCA	1	1	1	1
Western tanager	PILU	3	1	1	1
Western toad	BUBO	3	3		
Western wood-pewee	COSO		1	1	1
White-crowned sparrow	ZOLE	3	3	3	3
White-winged crossbill	LOLE		3	1	1
Willow flycatcher	EMTR	3	3	3	3
Winter wren	TRTR	3	1	1	1
Wolverine	GUGU	3	3	3	3
Yellow-pine chipmunk	TAAM	1	1	1	1
Yellow-rumped warbler	DENCO	3	1	1	1

Table 5

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D-5

Ponderosa Pine
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
American crow	COBR	4	4	4	4
American kestrel	FASP	3	1	1	1
American robin	TUMI	1	1	1	1
Ash-throated flycatcher	MYICI	3		1	1
Badger	TATA	1	1	1	1
Bald eagle	HALE	3		1	1
Barn owl	TYAL	3		1	1
Big brown bat	EPFU	3		1	1
Black bear	URAM	1	1	1	1
Black-headed grosbeak	PHME	3	3	1	1
Blue grouse	DEOB	1	1	1	1
Bobcat	FERU	2	2	2	2
Brewer's blackbird	EUCY	2	2	2	2
Broad-footed mole	SCLA	1	1	1	1
Brown creeper	CEAM		3	1	1
Brown-headed cowbird	MOAT	2	2	2	2
Bushtit	PSMI	3	3	3	3
Bushy-tailed woodrat	NECI	1	1	1	1
California myotis	MYOCA	3		1	1
Calliope hummingbird	STCAL	3	3		
Cassin's finch	CACAS	3	1	1	1
Chipping sparrow	SPPAS	1	1	1	1
Common nighthawk	CHMI	1	3	1	1
Common raven	CORCO	1			1
Cooper's hawk	ACCCO	4	1	1	3
Coyote	CANLA	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1
Deer mouse	PEMA	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1
Dusky flycatcher	EMOB	3	3	3	3
Elk	CEEL	1	1	1	1
Evening grosbeak	COVE	3	3	1	1
Flammulated owl	OTFL	3	1	1	1
Golden eagle	AQCH	3		1	1
Golden-crowned kinglet	RESA	3	3	3	3
Golden-crowned sparrow	ZOAT	3	3	3	3
Golden-mantled ground squirrel	SPLA	1	1	1	1
Gopher snake	PICA	1	1	1	1
Great horned owl	BUVI	1	1	1	1
Hairy woodpecker	PIVI		1	1	1
Hammond's flycatcher	EMHA			1	1

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By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Hermit thrush	CAGU	3	3	3	3
Hoary bat	LACI	1	1	1	1
House finch	CARME	3	3	3	3
House wren	TRAE	3	1	1	1
Lewis' woodpecker	MELE	3	1	1	1
Little brown myotis	MYLU	3		3	3
Long-eared myotis	MYEV	3		1	1
Long-legged myotis	MYVO	3		1	1
Long-tailed vole	MILO	2	2	2	2
Long-tailed weasel	MUFR	2	2	2	2
Long-toed salamander	AMMA	3	3	3	3
Merlin	FACO	3	3	3	3
Mountain bluebird	SICU	3	1	1	1
Mountain chickadee	PARGA	3	1	1	1
Mountain lion	FECO	1	1	1	1
Mountain quail	ORPI	1	1		
Mourning dove	ZEMA	1	1	1	1
Mule deer	ODHE	1	1	1	1
Northern alligator lizard	ELCO	1	1	1	1
Northern flicker	COAU	3	1	1	1
Northern flying squirrel	GLSA		1		
Northern goshawk	ACGE	4	4	1	1
Northern pocket gopher	THTA	1	1	1	1
Northern pygmy-owl	GLGN		1	1	1
Northern saw-whet owl	AEAC		3	1	1
Olive-sided flycather	COBO	1	1	1	1
Osprey	PAHA			1	1
Pacific treefrog (Chorus)	PSRE	4	4	4	4
Peregrine falcon	FAPE	3	3	3	3
Pileated woodpecker	DRPI			3	3
Pine siskin	CARPI	1	1	1	1
Porcupine	ERDO	1		1	1
Prairie falcon	FAME	4			
Purple finch	CARPU	1	1	1	1
Purple martin	PRSU	3	1	1	1
Pygmy nuthatch	SIPY			1	1
Red crossbill	LOXCU		3	1	1
Red fox	VUVU	1	1	1	1
Red-breasted sapsucker	SPRU		1	1	1
Red-tailed hawk	BUJA	3	3	1	1
Rock wren	SAOB	1			
Rough-legged hawk	BULA	3	3	3	3

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By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Rubber boa	CHBO	1	3	1	1
Ruby-crowned kinglet	RECA	3	3	3	3
Ruffed grouse	BOUM	1	1	3	3
Sandhill crane	GRCA		1	1	1
Sharp-shinned hawk	ACST	1	1	1	1
Shrew-mole	NEGI	1	1	1	1
Silver-haired bat	LANO			1	1
Solitary vireo	VISO	3	3	3	3
Spotted frog	RAPR	4	4		
Steller's jay	CYST	1	1	1	1
Swainson's hawk	BUSW	3	3	3	3
Townsend's big-eared bat	PLTO	1	3	3	3
Townsend's chipmunk	TATO	1	1	1	1
Townsend's warbler	DETO		3	3	3
Tree swallow	TABI	3	1	1	1
Trowbridge's shrew	SOTR	1	1		
Turkey vulture	CATAU	1	3	3	1
Western gray squirrel	SCIGR	3	1	1	1
Western jumping mouse	ZAPR	1	1	1	1
Western spotted skunk	SPGR	1	1		
Western tanager	PILU	3	1	1	1
Western toad	BUBO	3	3		
Western wood-pewee	COSO		1	1	1
White-breasted nuthatch	SICAR			1	1
White-crowned sparrow	ZOLE	3	3	3	3
White-headed woodpecker	PIAL			1	1
White-throated swift	AESA	3			
Williamson's sapsucker	SPHTH			1	1
Winter wren	TRTR		1	1	1
Wolverine	GUGU	3	3	3	3
Yellow-pine chipmunk	TAAM	1	1	1	1
Yellow-rumped warbler	DENCO	4	4	4	4

Table 6

Mixed Conifer Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
American crow	COBR	3	2	2	2
American kestrel	FASP	3	1	1	1
American robin	TUMI	1	1	1	1
Anna's hummingbird	CAAN	1			
Badger	TATA	1	1	1	1
Bald eagle	HALE	3		1	1
Barn owl	TYAL	3		1	1
Big brown bat	EPFU	3		1	1
Black bear	URAM	1	1	1	1
Black-backed woodpecker	PIAR		2	2	2
Black-chinned hummingbird	ARAL	2	2	2	2
Black-headed grosbeak	PHME	3	3	1	1
Black-throated gray warbler	DENI	1	1	1	1
Blue grouse	DEOB	1	1	1	1
Bobcat	FERU	1	1	1	1
Brewer's blackbird	EUCY	2	2	2	2
Broad-footed mole	SCLA	1	1	1	1
Brown creeper	CEAM		3	1	1
Brown-headed cowbird	MOAT	2	2	2	2
Bushy-tailed woodrat	NECI	1	1	1	1
California myotis	MYOCA	3		1	1
Calliope hummingbird	STCAL	1	1		
Cassin's finch	CACAS	3	1	1	1
Chipping sparrow	SPPAS	1	1	1	1
Clark's nutcracker	NUCO		3	3	3
Common poorwill	PHNU			1	1
Common raven	CORCO	1			1
Cooper's hawk	ACCCO	4	1	1	3
Coyote	CANLA	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1
Deer mouse	PEMA	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1
Dusky flycatcher	EMOB	1	1	1	1
Elk	CEEL	1	1	1	1
Ermine	MUER	1	1	1	1
Evening grosbeak	COVE	3	3	1	1
Fisher	MAPE			1	1
Flammulated owl	OTFL	3	1	1	1
Golden eagle	AQCH	3		1	1
Golden-crowned kinglet	RESA	3	1	1	1
Golden-crowned sparrow	ZCAT	3	3	3	3

Mixed Conifer Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Golden-mantled ground squirrel	SPLA	1	1	1	1
Gray jay	PECA	1	1	1	1
Great gray owl	STRNE		3		
Great horned owl	BUVI	1	1	1	1
Hairy woodpecker	PIVI		1	1	1
Hammond's flycatcher	EMHA			1	1
Hermit thrush	CAGU	3	1	1	1
Hermit warbler	DEOC	1	1	1	1
Hoary bat	LACI	1	1	1	1
House finch	CARME	4	4	4	4
House wren	TRAE	3	1	1	1
Lewis' woodpecker	MELE	3	1	1	1
Little brown myotis	MYLU	3		1	1
Long-eared myotis	MYEV	3		1	1
Long-eared owl	ASOT	3	1	1	1
Long-legged myotis	MYVO	3		1	1
Long-tailed vole	MILO	2	2	2	2
Long-tailed weasel	MUFR	2	2	2	2
Long-toed salamander	AMMA	3	3	3	3
Marten	MAAM	3	3	1	1
Merlin	FACO	3	3	3	3
Mountain bluebird	SICU	3		1	1
Mountain chickadee	PARGA	3	1	1	1
Mountain lion	FECO	1	1	1	1
Mule deer	OOHE	1	1	1	1
Nashville warbler	VERU	1	3	3	3
Northern alligator lizard	ELCO	1	1	1	1
Northern goshawk	ACGE	4	4	1	1
Northern pocket gopher	THTA	1	1	1	1
Northern pygmy-owl	GLGN	3	1	1	1
Northern saw-whet owl	AEAC		3	1	1
Northwestern salamander	AMGR	3	3	3	3
Olive-sided flycather	COBO	1	1	1	1
Pacific treefrog (Chorus)	PSRE	3	3	3	3
Peregrine falcon	FAPE	3	3	3	3
Pileated woodpecker	DRPI			1	1
Pine siskin	CARPI	1	1	1	1
Porcupine	ERDO	1		1	1
Purple finch	CARPU	1	1	1	1
Pygmy nuthatch	SIPY			1	1
Red crossbill	LOXCU		3	1	1
Red fox	VUVU	1	1	1	1
Red-breasted nuthatch	SICAN		1	1	1

Mixed Conifer Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Red-breasted sapsucker	SPRU		1	1	1
Red-tailed hawk	BUJA	3	3	1	1
Rock wren	SAOB	1			
Rough-legged hawk	BULA	3	3	3	3
Rubber boa	CHBO	1	3	1	1
Ruby-crowned kinglet	RECA	3	3	1	1
Ruffed grouse	BOUM	1	1	3	3
Rufous hummingbird	SELRU	1	1	1	1
Rufous-sided towhee	PIER	1	1	1	1
Sharp-shinned hawk	ACST	1	1	1	1
Silver-haired bat	LANO			1	1
Snowshoe hare	LEAM	1	1	1	1
Solitary vireo	VISO	1	1	1	1
Song sparrow	MELME	1	1	1	1
Spotted frog	RAPR	4	4		
Spotted owl (Northern)	STOC				1
Steller's jay	CYST	1	1	1	1
Swainson's hawk	BUSW	3	3	3	3
Swainson's thrush	CAUS	1	1	1	1
Three-toed woodpecker (Northern)	PITR		1	1	1
Townsend's warbler	DETO		3	1	1
Tree swallow	TABI	3	1	1	1
Trowbridge's shrew	SOTR	1	1		
Turkey vulture	CATAU	3	3	3	3
Varied thrush	IXNA	1	1	1	1
Vaux's swift	CHVA			1	1
Western flycatcher (Pacific-slope)	EMOI		1	1	1
Western gray squirrel	SCIGR	3	1	1	1
Western jumping mouse	ZAPR	1	1	1	1
Western red-backed vole	CLCA	1	1	1	1
Western spotted skunk	SPGR	1	1		
Western tanager	PILU	3	1	1	1
Western toad	BUBO	3	3		
Western wood-pewee	COSO		1	1	1
White-breasted nuthatch	SICAR			1	1
White-headed woodpecker	PIAL			1	1
White-winged crossbill	LOLE		3	1	1
Williamson's sapsucker	SPHTH			1	1
Willow flycatcher	EMTR	3	3	3	3
Winter wren	TRTR	3	1	1	1
Wolverine	GUGU	3	3	3	3
Yellow-breasted chat	ICVI	3	3	3	3

Mixed Conifer Dry
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Yellow-pine chipmunk	TAAM	1	1	1	1
Yellow-rumped warbler	DENCO	3	1	1	1

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Table 7

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Mixed Conifer Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
American crow	COBR	3	2	2	2
American kestrel	FASP	3	1	1	1
American robin	TUMI	1	1	1	1
Anna's hummingbird	CAAN	1			
Badger	TATA	1	1	1	1
Bald eagle	HALE	3		1	1
Barn owl	TYAL	3		1	1
Barred owl	STVA			1	1
Big brown bat	EPFU	3		1	1
Black bear	URAM	1	1	1	1
Black-backed woodpecker	PIAR		2	2	2
Black-chinned hummingbird	ARAL	2	3	3	3
Black-headed grosbeak	PHME	3	3	1	1
Black-throated gray warbler	DENI	1	1	1	1
Blue grouse	DEOB	1	1	1	1
Bobcat	FERU	1	1	1	1
Broad-footed mole	SCLA	1	1	1	1
Brown creeper	CEAM	3	1	1	1
Brown-headed cowbird	MOAT	2	2	2	2
Bushy-tailed woodrat	NECI	1	1	1	1
California myotis	MYOCA	3		1	1
Calliope hummingbird	STCAL	1	1		
Cassin's finch	CACAS	3	1	1	1
Chipping sparrow	SPPAS	1	1	1	1
Clark's nutcracker	NUCO		3	3	3
Common poorwill	PHNU			1	1
Common raven	CORCO	1			1
Cooper's hawk	ACCCO	4	1	1	3
Coyote	CANLA	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1
Deer mouse	PEMA	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1
Elk	CEEL	1	1	1	1
Ermine	MUER	1	1	1	1
Evening grosbeak	COVE	3	3	1	1
Fisher	MAPE			1	1
Flammulated owl	OTFL	3	1	1	1
Golden eagle	AQCH	3		1	1
Golden-crowned kinglet	RESA	3	1	1	1
Golden-crowned sparrow	ZOAT	3	3	3	3

Mixed Conifer Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat.
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Golden-mantled ground squirrel	SPLA	1	1	1	1
Gray jay	PECA	1	1	1	1
Great gray owl	STRNE		3		
Great horned owl	BUVI	1	1	1	1
Hairy woodpecker	PIVI		1	1	1
Hammond's flycatcher	EMHA			1	1
Hermit thrush	CAGU	3	1	1	1
Hermit warbler	DEOC	1	1	1	1
Hoary bat	LACI	1	1	1	1
House finch	CARME	4	4	4	4
House wren	TRAE	3	1	1	1
Lewis' woodpecker	MELE	3	1	1	1
Little brown myotis	MYLU	3		1	1
Long-eared myotis	MYEV	3		1	1
Long-eared owl	ASOT	3	1	1	1
Long-legged myotis	MYVO	3		1	1
Long-tailed vole	MILO	2	2	2	2
Long-tailed weasel	MUFR	2	2	2	2
Long-toed salamander	AMMA	3	3	3	3
Marten	MAAM	3	3	1	1
Merlin	FACO	3	3	3	3
Mountain bluebird	SICU	3	1	1	1
Mountain chickadee	PARGA	3	1	1	1
Mountain lion	FECO	1	1	1	1
Mule deer	ODHE	1	1	1	1
Nashville warbler	VERU	1	3	3	3
Northern alligator lizard	ELCO	1	1	1	1
Northern goshawk	ACGE	4	4	1	1
Northern pocket gopher	THTA	1	1	1	1
Northern pygmy-owl	GLGN	3	1	1	1
Northern saw-whet owl	AEAC		3	1	[illegible]
Northwestern salamander	AMGR	3	3	3	3
Olive-sided flycather	COBO	1	1	1	1
Pacific treefrog (Chorus)	PSRE	3	3	3	3
Peregrine falcon	FAPE	3	3	3	3
Pileated woodpecker	DRPI			1	1
Pine siskin	CARPI	1	1	1	1
Porcupine	ERDO	1		1	1
Purple finch	CARPU	1	1	1	1
Red crossbill	LOXCU		3	1	1
Red fox	VUVU	1	1	1	1
Red-breasted nuthatch	SICAN		1	1	1
Red-breasted sapsucker	SPRU		1	1	1

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Mixed Conifer Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Red-tailed hawk	BUJA	3	3	1	1
Rock wren	SAOB	1			
Rough-legged hawk	BULA	3	3	3	3
Rubber boa	CHBO	1	3	1	1
Ruby-crowned kinglet	RECA	3	3	1	1
Ruffed grouse	BOUM	1	1	3	3
Rufous hummingbird	SELRU	1	1	1	1
Rufous-sided towhee	PIER	1	1	1	1
Sharp-shinned hawk	ACST	1	1	1	1
Shrew-mole	NEGI	1	1	1	1
Silver-haired bat	LANO			1	1
Snowshoe hare	LEAM	1	1	1	1
Solitary vireo	VISO	1	1	1	1
Song sparrow	MELME	1	1	1	1
Spotted frog	RAPR	4	4		
Spotted owl (Northern)	STOC				1
Steller's jay	CYST	1	1	1	1
Swainson's hawk	BUSW	3	3	3	3
Swainson's thrush	CAUS	1	1	1	1
Three-toed woodpecker (Northern)	PITR		1	1	1
Townsend's chipmunk	TATO	1	1	1	1
Townsend's warbler	DETO		3	1	1
Tree swallow	TABI	3	1	1	1
Trowbridge's shrew	SOTR	1	1		
Turkey vulture	CATAU	3	3	3	3
Varied thrush	IXNA	1	1	1	1
Vaux's swift	CHVA			1	1
Western flycatcher (Pacific-slope)	EMDI		1	1	1
Western gray squirrel	SCIGR	3	1	1	1
Western jumping mouse	ZAPR	1	1	1	1
Western red-backed vole	CLCA	1	1	1	1
Western spotted skunk	SPGR	1	1		
Western tanager	PILU	3	1	1	1
Western toad	BUBO	3	3		
Western wood-pewee	COSO		1	1	1
White-breasted nuthatch	SICAR			1	1
White-headed woodpecker	PIAL			1	1
White-winged crossbill	LOLE		3	1	1
Williamson's sapsucker	SPHTH			1	1
Willow flycatcher	EMTR	3	3	3	3
Wilson's warbler	WIPU	2	2	2	2
Winter wren	TRTR	3	1	1	1

Mixed Conifer Wet
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old
Wolverine	GUGU	3	3	3	3
Yellow-breasted chat	ICVI	3	3	3	3
Yellow-pine chipmunk	TAAM	1	1	1	1
Yellow-rumped warbler	DENCO	3	1	1	1

Table 8

Mountain Hemlock/White Pine
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old	MH_WP
American crow	COBR	3	2	2	2	
American kestrel	FASP	4	2	2	2	3
American robin	TUMI	1	1	1	1	1
Badger	TATA	1	1	1	1	1
Bald eagle	HALE	3		3	3	
Big brown bat	EPFU	3		3	3	3
Black bear	URAM	1	1	1	1	3
Black-backed woodpecker	PIAR		1	1	1	1
Black-headed grosbeak	PHME	3	3	1	1	1
Blue grouse	DEOB	3	3	3	3	3
Bobcat	FERU	2	2	2	2	2
Boreal owl	AEFU			1	1	
Broad-footed mole	SCLA	1	1	1		1
Bushy-tailed woodrat	NECI	1	1	1	1	1
Calliope hummingbird	STCAL	1	1			1
Cassin's finch	CACAS	3	1	1	1	1
Chipping sparrow	SPPAS	1	1	1	1	1
Clark's nutcracker	NUCO	3	3	1	1	1
Common raven	CORCO	1			1	
Cooper's hawk	ACCCO	4	1	1	3	1
Coyote	CANLA	1	1	1	1	1
Dark-eyed junco	JUHY	1	1	1	1	1
Deer mouse	PEMA	1	1	1	1	1
Douglas' squirrel	TADO	1	1	1	1	1
Elk	CCEL	3	3	3	3	3
Ermine	MUER	1	1	1	1	1
Evening grosbeak	COVE	3	3	1	1	1
Ferruginous hawk	BURE	4	4	4	4	4
Fisher	MAPE			1	1	1
Golden-crowned kinglet	RESA	3	1	1	1	3
Golden-mantled ground squirrel	SPLA	1	1	1	1	1
Gray jay	PECA	1	1	1	1	1
Great horned owl	BUVI	3	3	3	3	3
Hairy woodpecker	PIVI		1	1	1	1
Hammond's flycatcher	EMHA			1	1	1
Hermit warbler	DEOC	1	1	1	1	
Hoary bat	LACI	1	1	1	1	1
Lapland longspur	CALLA					3
Little brown myotis	MYLU	3		1	1	3
Long-eared myotis	MYEV	3		3	3	3
Long-eared owl	ASOT	3	1	1	1	1
Long-legged myotis	MYVO	3		1	1	3
Long-tailed vole	MILO	2	2	2	2	1

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Mountain Hemlock/White Pine
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old	MH_WP
Long-tailed weasel	MUFR	2	2	2	2	2
Long-toed salamandér	AMMA	4	4	4	4	4
Marten	MAAM	3	3	1	1	1
Merlin	FACO	3	3	1	1	3
Mountain bluebird	SICU	4	2	2	2	2
Mountain chickadee	PARGA	3	1	1	1	1
Mountain lion	FECO	1	1	1	1	
Mule deer	ODHE	3	3	3	3	3
Northern alligator lizard	ELCO	1	1	1	1	
Northern goshawk	ACGE	4	4	1	1	1
Northern pocket gopher	THTA	1	1	1	1	1
Northern saw-whet owl	AEAC		3	1	1	1
Three-toed woodpecker (Northern)	PITR		1	1	1	
Olive-sided flycather	COBO	1	1	1	1	1
Western flycatcher (Pacific-slope)	EMDI		1	1	1	
Pacific treefrog (Chorus)	PSRE	3	3	3	3	
Peregrine falcon	FAPE	3	3	3	3	3
Pine siskin	CARPI	1	1	1	1	1
Porcupine	ERDO	4		4	4	4
Red crossbill	LOXCU		3	1	1	
Red fox	VUVU	1	1	1	1	1
Red-breasted nuthatch	SICAN		1	1	1	1
Red-tailed hawk	BUJA	3	3	3	3	3
Rubber boa	CHBO	3	3	3	3	
Ruby-crowned kinglet	RECA	3	3	1	1	3
Rufous hummingbird	SELRU	1	1	1	1	1
Sandhill crane	GRCA		1	1	1	
Sharp-shinned hawk	ACST	1	1	1	1	1
Snowshoe hare	LEAM	1	1	1	1	1
Solitary vireo	VISO	4	4	4	4	
Steller's jay	CYST	1	1	1	1	1
Swainson's hawk	BUSW	3	3	3	3	3
Townsend's chipmunk	TATO	1	1	1	1	
Townsend's warbler	DETO		3	1	1	1
Turkey vulture	CATAU	3	3	3	3	3
Varied thrush	IXNA	1	1	1	1	1
Western jumping mouse	ZAPR	1	1	1	1	1
Western pocket gopher	THMA	1	1	1	1	1
Western red-backed vole	CLCA	1	1	1	1	1
Western tanager	PILU	3	1	1	1	2
Western toad	BUBO	3	3			
Western wood-pewee	COSO		1	1	1	1
White-crowned sparrow	ZOLE	1	1	1	1	1

Mountain Hemlock/White Pine
By Structural Stage

1 & 2 Breeding/Foraging/Resting Habitat
3 & 4 Foraging/Resting Habitat

Species	Species_code	Early	Mid	Late	Old	MH_WP
White-winged crossbill	LOLE		3	1	1	1
Williamson's sapsucker	SPHTH			1	1	1
Willow flycatcher	EMTR	3	3	3	3	3
Wilson's warbler	WIPU	2	2	2	2	
Winter wren	TRTR	3	1	1	1	
Wolverine	GUGU	1	1	1	1	1
Yellow-pine chipmunk	TAAM	1	1	1	1	1
Yellow-rumped warbler	DENCO	3	1	1	1	2

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Appendix E. Riparian Reserve Strategy

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Aquatic Ecosystems: Mazama Panhandle Watershed Analysis

Overview

The aquatic ecosystems of the Mazama Panhandle analysis area are mainly small to medium sized perennial streams (Sand Creek, Scott Creek, Bear Creek, Lost Creek, Pothole Creek, Cavern Creek and Wheeler Creek) which generally flow from west to east. A small number of unnamed intermittent streams feed into the perennial systems in the upper reaches of Sand Creek and it's tributaries Wheeler and Cavern Creek as well as the upper reaches of Scott Creek. The streams in the system (with the exception of Sand Creek) tend to have simple drainage patterns with few or no tributaries and relatively small watershed areas. Other aquatic habitats such as wet lands, lakes and ponds are rare or nonexistent in the analysis area.

The stream channels were heavily impacted by pyroclastic flows from the eruption of Mt. Mazama approximately 7,000 years ago (Frank and Harris, 1969). The geology of the area is characterized by thick pumice deposits from the eruption overlaying older dense lava and areas of glacial till. The upper pumice layers allow high infiltration rates. The underlying lava tends to be much less permeable to water and creates areas of perched water below elevations of 6500 feet (Frank and Harris 1969). These perched water tables create the numerous springs which feed the creeks in the analysis area. Because of the highly permeable nature of the upper pumice layer intermittent streams are relatively rare in the area (15.21 miles of intermittent channel and 68.63 miles of perennial (Winema N.F. GIS data)). The pumice is highly erosive (most of it floats) and the streams transport large volumes of sand to gravel sized materials, even at low flows (Dambacher et al., 1993). The gradient of the streams decrease as they flow from west to east resulting in the deposition of sand and gravel sized materials in the flatter eastern portion of the analysis area (Frank and Harris, 1969). The streams are spring fed and the water is soft with little mineral content and low concentrations of nutrients (USGS unpublished data). Major modifications, often with deleterious effects, of aquatic systems have been caused by road building, logging, water diversion and stocking of non-native fish.

Current Condition of Aquatic Habitats in The Analysis Area

While the upper portions of the watershed are managed by the U.S. Park Service and are in natural or near natural condition these areas are high in the water sheds and represent the smaller segments **(better wording?)**of the stream systems. Of the 83.84 miles of perennial and intermittent stream in the analysis area 48.77 miles (58%) are on lands managed by the U.S. Forest Service (USFS GIS data). Over one half of the stream millage (the lower half of the watershed containing the larger stream segments making the percentage of the available aquatic habitats impacted much greater than one half **(better wording)?**) is heavily impacted by roading and logging. Extensive logging and associated roading has occurred on USFS lands. **(% of land scape harvested?)**

Stream surveys to assess aquatic habitat condition and function were conducted by USFS personnel on Sand Creek in 1992 and Scott Creek in 1995 and 1991. Surveys were limited to lands administered by the USFS. In 1989 similar surveys were conducted in Crater Lake National Park by US Park Service personnel on Scott Creek, Sand Creek and Bear Creek **(get stuff on Bear)**.

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During the 1991 and 1995 USFS stream survey on Scott Creek stumps of varying age were found on the banks of the creek and throughout the riparian zone. The 1995 survey counted all large wood in the stream (large wood was considered to be >12 inches in diameter and > 25 feet long) **(double check these numbers)**. Average values for each stream reach ranged from 19.3 to 40 pieces of large wood/mile. Large woody material is important to the structure and function of stream systems **(citation)**, especially the creation of pools, stabilization of banks, creation of cover for fish and regulation of sediment transport **(citation)**. The values encountered range from very low to moderate for forested streams such as Scott Creek**(citation)**. Past logging in and near the stream may be responsible for the low amounts of wood present in the stream. Also large flood events in the early 1960s may have flushed some wood from the system **(check and cite)** Although scattered large trees remain from these older stands and will provide some coarse woody material to the stream in the future stands along the stream tend to be dominated by earlier seral stages. During the survey the inner (within 20 feet of the stream) and outer (between 20 and 100 feet from the stream) riparian zones were classified by dominant seral stage based on percent cover. On Scott Creek the inner riparian zone tended to be dominated by the grass/forb stage with areas of shrub/sapling and lesser amounts of small tree near the Crater Lake boundary. The outer riparian zone was almost entirely dominated by the small tree seral class. The suppression of fire in the area may have allowed the canopy to become less open and the number of young trees in the stand to increase. This could result in a higher percentage of cover by the younger seral classes and a resultant bias in the data towards the younger seral classes. Scattered large and mature trees were observed along most of the stream. The trees probably represent remnant trees left behind during high-grade logging operations. The larger trees in the stands tended to be White Fir at lower elevations and Red Fir and Mountain Hemlock at higher elevations while the stumps tended to be Ponderosa Pine supporting the high-grade logging theory. Woody material needs should be sufficient in the stands along the streams are protected from further logging.

The number of pools per mile is a good measure of stream health and fish habitat quality. Moore and Gregory (1989) report that 75% of Bull Trout life history associated with pool habitats. Pools per mile were recorded during the Scott Creek stream survey. Values ranged from 4.7 / mile (extremely poor) to 50.7 / mile (marginal habitat quality). Due to the unique geologic history of the analysis area much of the area is pumice and other small sized, highly erosive volcanic materials. Few large boulders of resistant rock are available in the system to create pools. This leaves the stream dependent on large woody material for the creation of pools. The number of pools per mile is correlated with the number of pieces of large wood per mile (correlation coefficient = 0.75). In areas with little wood few pools were observed. The lack of boulders and the limited amount of large wood is further exacerbated by the high amount of sand and gravel sized material being eroded in the upper watershed and transported through the system. A naturally high sediment loading was probably present due to the young age of the stream and the inputs from the eruption of Mt. Mazma. During the stream survey dominant and subdominant stream bed substrates were estimated. Gravel was the dominant substrate in all but one reach surveyed with sand dominating in one low gradient reach. Gravel and sand were subdominant in all but two high gradient reaches with some cobble present in the other two. The geology of the area placed the stream at risk for low pool numbers. Human impacts including: sediment from logging and roading, removal of wood inputs from logging and other hydrologic modifications may have added to a naturally low number of pools.

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The 1992 survey of Sand Creek revealed a pattern similar to the one found in Scott Creek. Which is not surprising considering the similarities in geology of the two areas. However Sand Creek and it's tributary Wheeler creek have cut deep canyons into deep pumice which had filled a pre Mt. Mazama eruption glacial canyon **(citation)**. These steep walled canyons in the Pinnacles area lack vegetation and provide large inputs of small pumice material to the stream. Stream survey records show much larger amounts of wood than Scott Creek (5.2, 222.3 and 623.9 pieces / mile for the three reaches surveyed). No explanation is available for the low number (5.2 / mile) in the first reach. Pools per mile ranged from 4.5 to 9.6. These numbers are extremely low especially considering the amount of large wood present. The width to depth ratio, considered a good measure of proper hydrologic function **(check this statement)** was measured ranging from 6.4 to 7.34 considered well within the range of a healthy stream channel. The substrate of the channel was dominated by sand with some limited amounts of gravel sized pumice which the survey crew noted floated when disturbed. The highly unstable nature of the deep pumice probably is the cause of the extreme dearth of pools in the surveyed reaches. Dambacher et al. (1993) conducted a similar survey on Sand Creek in 1989 on Park Service lands. They reported gravel sized substrate in lower reaches and gravel in higher reaches. This indicates that large inputs of sand are occurring in the canyon section at and below the Forest Service / Park Service boundary. The Sand Creek watershed, especially the Pinnacles Canyon area, should be protected from disturbance due to the unstable nature of the pumice deposits. **(talk to Lorena about this creek!)**

Little information is available about the other streams in the analysis area. The tributaries of Sand Creek, Wheeler Creek and Cavern Creek as well as the nearby Lost Creek are in relatively undisturbed areas of Crater Lake National Park and are probably at natural or near natural condition.

Fisheries

Fisheries surveys were conducted in Sand Creek by USFS personnel in 1992 and by the Klamath Tribe in 1990. Both surveys detected Brown Trout and Brook Trout. Fisheries surveys were conducted in Scott Creek by USFS personnel in 1995 and 1991 and by the Klamath Tribe in 1990. All three surveys detected Brown and Brook Trout. Brown Trout were only found in the lower reaches of both creeks near the eastern boundary of Winema N.F. lands. Stream surveys conducted by Crater Lake National Park personal in 1989 found Brook Trout in all reaches of Lost Creek and Sand Creek as well as the lower reaches of Wheeler Creek and Cavern Creek. The Brook Trout population in Lost Creek was composed of numerous, small, stunted individuals. Crater Lake National Park personal surveyed Bear Creek upstream from the park boundary in 1989. Brook trout were present in high densities for 0.4 kilometers starting one kilometer upstream from the park boundary. The upper limit to Brook Trout distribution was caused by a human made dam.

Rainbow trout were introduced into Scott Creek in 1971 and Sand Creek in 1955. Rainbow trout likely have gone extinct in these systems as four surveys have failed to detect them. Brown trout were introduced into Scott Creek in 1925. The date of Brown trout introduction in Sand Creek is unknown but Wallis (1948) reports finding one Brown trout in

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Sand Creek in Crater Lake N.P. in 1947. Brook trout were introduced into Scott Creek in 1965, 1968 and 1971 and into Sand Creek from 1937 to 1940 on Park Service lands and between 1940 and 1969. These stocking records were summarized from Oregon Department of Fish and Wildlife and U.S. National Park Service records by Thomas and Ford (1993).

Bull Trout

Declines and population extinctions of Bull Trout (*Salvelinus confluentus*) have promoted a widespread concern for the persistence of this species (Rieman and McIntyre, 1993). A petition submitted to the U.S. Fish and Wildlife Service by a coalition of environmental groups in 1992 requested an emergency listing in Montana, Idaho, Washington, Nevada and Oregon. A second petition filed by the American Fisheries Society asks for a status review for the purpose of listing Bull Trout in the Upper Klamath River basin in Oregon (including the Mazama Panhandle watershed analysis area). Currently the U.S. Fish and Wildlife Service has concluded that listing the Bull Trout under the Endangered Species Act is "warranted but precluded". **(Ask Darryl about correct wording and citation)** Bull Trout are considered a species of special concern by state agencies **(Oregon?)** and the American Fisheries Society and as indicator species **(? sensitive sp.)** by the U.S. Forest Service. Currently the U.S. Forest Service and the Bureau of Land Management are following the guidelines of the Inland Native Fish Strategy **(include in citations)** to protect remaining populations of Bull Trout and other native fish until a long term management plan (Columbia Basin EIS) is completed.

Thomas and Ford (1993) found no records of fish in the analysis area prior to the introduction of exotic fish. Because no systematic inventories or surveys were conducted in the analysis area prior to fish introductions any discussion of pre-stocking condition must be considered conjectural. Some evidence exists which indicates that native species of fish may have been present in the analysis area prior to fish introductions. Charles Phillips (Wenatchee N.F.) reported speaking with a long time Chiloquin resident who reported catching Bull Trout in Sun Creek, Scott Creek, Sand Creek as well as other locations. Sun Creek which is just outside the analysis area has an extant population of Bull trout partially substantiating this record. The flows in Sand Creek are approximately twice those of Sun Creek. Water temperature and other habitat variables in Sand Creek measured in the U.S.F.S. stream survey (1992) appear suitable for Bull Trout. While no conclusive data has been discovered regarding the status of Bull Trout, a potential exists that Bull Trout may have inhabited the streams of the analysis area. Other native fish may have been present I n these streams but cold water temperatures (40 to 44 degrees reported at the Crater Lake N.P. boundary by Carl Bond in an unpublished letter to O. Wallis 1949 see appendix **??**) may have precluded use of these habitats by most species.

Currently none of the streams in the analysis area have surface connections to the Klamath Marsh or the Williamson River. Pothole Creek and Bear Creek become subsurface flows in the pumice soils west of Highway 97. Sand Creek and Scott Creek are diverted into the Sand Creek Canal west of Highway 97 and used for irrigation West and North of Klamath Marsh. For Bull Trout to have been present in the analysis area in the recent past a surface connection must have existed at some time since the streams were scoured by pyroclastic flows from the eruption of Mt. Mazama (approximately 7000 years ago). A notarized letter written by M.M. Mosby dated 18 May 1988 (see appendix **??**) states that Sand Creek had a surface connection to Klamath Marsh near the Williamson River in 1909. The letter states that while searching for lost horses with his father in 1909 Mr. Mosby observed that "...Sand Creek entered Klamath Marsh in the NW 1/4 of section 30 and spread out into a swamp in section 29 of T31S; R8E." The elevation in the NW 1/4 of section 30 is approximately 4530 feet. Assuming that this elevation represents the historical elevation of Klamath Marsh Scott Creek would have likely had surface connection to the marsh at least seasonally. An unpublished letter written by Carl Bond (U.S. Park Service **(confirm this with Steve M.)**) to O. Wallis dated December 12, 1949 (appendix **??**) further confirms the connection stating that Sand Creek joins the Williamson River outside the park [Crater Lake National Park]. Mr. Bond also states that "Bear Creek on the east disappears into the marshes above Upper Klamath Lake." If Bear Creek had a connection to Klamath Marsh then it is likely that all streams in the analysis area may have connected to the Williamson River system. Mr. Mosby also states in his letter that no diversions for irrigation were occurring in Sand Creek at that time. Klamath Basin Adjudication (USFS) records indicate the construction of diversions and associated canals on Sand Creek were built in 1919 and 1920. It is likely that diversions from Scott Creek also occurred at this time. The combination of draining Klamath Marsh by lowering the Kirk Dike **(citation)** and diverting water from the streams for agriculture has severed any connection between area streams and the Williamson system which may have existed.

The Oregon Natural Heritage Program records report Bull Trout in the Wood River and Klamath Lake. Cope (year) reported Bull Trout in the Williamson River **(get citation from Brad)**. If streams in the analysis area had at least occasional connectivity to the Williamson River / Klamath Marsh system these populations of Bull Trout could have colonized these systems and migratory individuals which reared in the Williamson River or Klamath Lake could have used these creeks for breeding. Rainbow Trout and other native fishes capable of living in cold water systems may have also colonized the Sand and Scott Creek systems.

The lowering of Klamath Marsh and the construction of Sand Creek canal eliminated any connection that might have existed between the Williamson River, Klamath Marsh and the streams of the analysis area. The severing of this connection would have caused the extinction of any migrant fish populations which used these creeks as spawning areas. The removal of the connection would have isolated any resident populations removing any opportunity for genetic interchange or recolonization after local extinctions.

(Rewrite this section!!! Use the Lande paper!!!)

Many authors (**$$$$**) have discussed the increased chance of population extinction when populations are reduced in size and / or isolated. Small populations may suffer serious genetic problems due to small population size including inbreeding depression and random genetic drift. Small populations are often able to survive long periods because of occasional input of genetic material by strays moving in from other populations. By isolating small populations from other populations the potential for serious genetic problems increases greatly. Furthermore small populations are subject to extinction from demographic (e.g.: reproductive failure due to Brook trout hybridization) and environmental disasters (e.g..: floods; droughts). Connectivity to other populations allows for recolonization following local extinctions. By severing the connection to the Williamson River / Klamath Marsh system and isolating the hypothesized fish populations in

Sand and Scott Creeks these populations would have been subject to deleterious genetic effects from small population size as well as vulnerability to local extinction because of demographic or environmental effects. The combination of these effects along with human modification of stream habitats (discussed later) could have easily extirpated native fish populations. Because these streams are now disconnected from potential sources of colonists the only fish present in the systems are exotic species which have been planted.

Introduced Brook Trout are present throughout the Sand Creek, Scott Creek and portions of the Bear Creek systems. Reiman and McIntyre (1993) report that hybridization with Brook Trout is apparently a problem for isolated, remnant populations of Bull Trout. Leary et al. (1983) documented extensive hybridization in conjunction with displacement of Bull Trout by Brook Trout. Brook Trout are believed to have restricted the distribution of Bull Trout in Sun Creek, adjacent to the analysis area, and efforts have been made to remove Brook Trout from U.S. Park Service lands for the protection of the Bull Trout population (Morris and Buktenica, 1992). Introduced Brown Trout, Rainbow Trout and Brook Trout (all stocked in the analysis area) have been associated with the decline of Bull Trout populations (Rieman and McIntyre, 1993), possibly through interspecific competition (**citation**).The Brook Trout are more tolerant of habitat modification (especially increases in water temperature) than the Bull Trout (**citation**). Habitat modification may be necessary to allow Brook Trout to extirpate Bull Trout (**citation**). The introduction of Brook Trout, Brown Trout and Rainbow Trout may have been the fatal blow to Bull Trout populations already struggling due to isolation, small population size and habitat modification.

Crater Lake National Park is currently considering plans to translocate a portion of the Sun Creek Bull Trout population to the upper reaches of Sand Creek to protect the population from catastrophic events on Sun Creek (Mac Brock, U.S. Park Service pers. com.). By creating a duplicate population of Bull Trout, a source for reestablishment of the original population would be available in case of the extinction of the original. As discussed previously the small size (approximately 160 adults) of the Sun Creek population and the high level of isolation from other populations leaves the Sun Creek Bull Trout extremely vulnerable to extinction. By creating a duplicate population the chances of preserving the genetic identity of the Sun Creek population over the long term are greatly increased. An excellent opportunity exists for a cooperative project between the Forest Service and the Park Service to create additional populations of Bull Trout in Sand and Scott Creeks.

Roads

Although exact mileages are currently unavailable **(needs to be checked with road folks)** the portion of the analysis area which is managed by the USFS is heavily roaded. The soil compaction caused by the roads reduces the permeability of the road surface and increases surface run-off which is concentrated in road side ditches and delivered to streams via culverts. Cross slope roads also intercept water moving down the slope and transfer it to the ditch and culvert systems. The roads act as intermittent channels (which are rare in the area) and deliver water more rapidly than the natural pattern of infiltration and underground movement to perennial channels via springs. The effect of the roads increases the level of peak flows but shortens their duration (L. Corzatt USFS pers. com.). The overland flow associated with roads also increases transport of sediment to the perennial creeks. These two effects of the high road densities may destabilize channel morphology and reduce the number of pools in the creeks with serious detrimental effects on aquatic organisms. Do to the scarcity of natural intermittent channels in the area, the effect of increasing the number and extent of intermittent channels (roads) by many fold may have caused major changes in the hydrologic functioning of the system (L. Corzatt USFS pers. com.).

Building roads on the unstable pumice soils may result in slope failures or debris torrents which have serious detrimental effects on aquatic systems. For example, A poorly designed culvert on the road 2308 crossing over Bear Creek had trapped a large sediment wedge above the road. In the fall of 1995 a heavy rain created high flows which washed out the road crossing and washed the sediment wedge (along with a large volume of road fill) down stream. **Where did the sediment go? What are the downstream effects? Is the blow out still contributing sediment? Are any downstream roads in danger of failing? Where did the sediment come from? Prophecy Fire? Other human caused? Are there other similar areas in the analysis area? Plans for fixing the problem? I need to get this info from Lorena.**

Recreational Impacts on Aquatic Ecosystems

Scott Creek campground is located on Scott Creek near the eastern boundary of the Winema N.F. Two out houses are located very near the creek within the flood plain and a dish water dump, several picnic tables and several fire rings are located in the riparian zone. The north bank of the creek has little vegetation (except for large trees) apparently due to foot traffic along the bank. The impact of campground users appears to be limited to the immediate area of the campground with the possible exception of down stream water quality impacts resulting from the out houses and dish water dump. Many dispersed camping areas (all associated with hunting due to the presence of "meat poles") were found along Scott Creek during the 1995 stream survey. Most appear to have been out of use for several years. Roads leading to most of the camps have been closed. Impacts from these camps probably range from minimal to zero. Other recreational impacts in the analysis area are unknown but most likely minor.

Amphibians

Declines and population extinctions have been documented for the Cascade Frog (*Rana cascade*) by several authors **(Blaustien, Lassen Park guys, see Stebbins book)** and is currently a sensitive species by the U.S. Forest Service and is classified as C2 by the U.S. Fish and Wildlife Service**(Oregon status? check the others)**. The Cascade Frog is endemic to the Pacific Northwest. It is found in higher elevations in the Olympic Mountains, the Washington and Oregon Cascades, the Mt. Lassen area and the Trinity Mountains of Northern California. **The Lassen guys** found **xxx** frogs in their survey of **xxx** historical sites in Lassen National Park. The populations in the Sky Lakes Wilderness immediately south of Crater Lake National Park may represent the southeast extent of the species current range. These populations are small compared to other locations in the Cascades and Olympic Mountains (R. Nauman USFS unpublished data). The range of the species may be limited by dry conditions to the south, east and west of the Sky Lakes / Crater Lake N.P. area. These small populations at or near the edge of the range of this species may be vulnerable to extinction. Cascade frogs were found on Scott

Creek near the Crater Lake boundary during the USFS survey of Scott Creek (1995). Oregon Natural Heritage Program records indicate that Cascade Frogs have also been found in the Vidae Falls area of Crater Lake N.P.. Cascade Frogs use ponds, lakes and still water sections of streams for breeding. They may also use ephemeral wetlands with long enough hydro periods for breeding. These habitats are extremely rare in the analysis area most likely due to the highly permeable nature of the pumice soils found in the area. All still water sites in the analysis area should be protected to insure the continuing viability of this species in the area.

Other amphibians which may be found in the analysis area include Pacific Tree Frogs (*Hyla regilla*), Western Toads (*Bufo boreas*) and Long-toed Salamanders (*Ambystoma macrodactylum*). **(should I add anything here? maybe toad declines?)**

Invertebrates

Surveys for aquatic macroinverebrates have been conducted by Wisseman (1991, 1992) on Lost Creek and Sand Creek in Crater Lake N.P. and Scott Creek and Sand Creek on the Chemult Ranger District, Winema National Forest. Overall densities for invertebrates were low to moderate. Molluscs were absent and crustaceans were represented only by ostrocods. The species richness of Scott Creek was much greater than Sand Creek and Scott Creek had double the standing crop of insects that Sand had. The densities of insects in both Scott and Sand was extremely low (Sand; 696.8 and Scott; 1307.6 insects / m^2) compared to other midsized, forested, montane streams in the Pacific Northwest which typically have 5000 to 10,000 insects / m^2.

Wisseman's (1991, 1992) conclusions regarding the limited insect fauna agree with the analysis of stream survey data presented earlier in this document. He states that in lower reaches of Sand Creek, "...unstable pumice gravels and substrates limit community development." Furthermore in both Scott and Sand Creek lack of retention structures such as large wood and debris jams, along with a lack of macro habitat complexity (mostly continuous run / riffle with few pools) and the fact that the streams are probably subject to scour during high water events all serve to limit insect productivity and diversity. The amounts of wood measured by the stream surveys were much greater on Sand than on Scott and unstable substrates / high sediment transport were much higher on Sand than Scott suggests that Wisseman's (1991) finding double the density of insects on Scott compared to Sun are caused by substrates and high sediment loads in the creeks but not by the lack of wood. **(does this last sentence make sense?)** Wisseman (1992) found areas of higher insect productivity and diversity in the upper reaches of Sun Creek with rubble / boulder substrate further supporting the idea that unstable substrates limit insect productivity.

Most of the insect taxa found by Wisseman (1991, 1992) are commonly occurring and broadly distributed taxa with winged adults which have fair to excellent dispersal capability. This is a logical pattern considering the short time (approximately 7,000 years) since the eruption of Mt. Mazma which would certainly have eliminated any insects present in the creek at that time. Although the post eruption period has been relatively short for the recolonization of the streams, several taxa of interest were discovered by Wisseman (1991, 1992). The federally listed category 2 caddisfly *Apatania tavala* was discovered in Lost and Sand Creeks between 4400 and 6200 feet elevation. An unknown species of caddisfly from the genus *Farula* was

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collected n the spring head segment of Lost Creek. Only ten species of this genus are known, all from Western North America. Most species are found in cold, isolated spring habitats at mid to high elevations in the Sierra Nevada and Cascades. Some of the species are endemic to one or several springs in a limited geographic area. Because adults are need for species identification (only larvae were collected) further collecting is required to determine the species present. Perennial springs in the area should be protected until more information is known about this population.

Two other species of interest were collected in streams near the analysis area. A undescribed species of caddisfly (*Psychoglypha* n. sp.) was collected at 5600 feet elevation in a small first order channel which is a tributary to Annie Creek. An undescribed mayfly (*Caudatella* n. sp.) was collected above 6000 feet elevation on Sun Creek. Although neither species was found in the analysis area further collecting may reveal them or other rare or endemic insect species within the analysis area.

Water Quality

The streams of the analysis area derive most of their flow from spring flows with additional flow from snow melt in the spring. Summer rain storms are rare in the area but occasional heavy summer rains may deliver large volumes of sediment to the streams **(cite Bear Creek Blow out/ rain storm)**. Frank and Harris (1969) estimated that seepage from Crater Lake provided no more than 10% of the water in the watersheds surrounding the Lake. Most springs are cold with soft water of low mineral content (Frank and Harris, 1969) but some seeps on Sand Creek have high iron content (Wisseman, 1992). Nutrients tend to be low in the streams. Total organic nitrogen for Sand Creek near the eastern USFS boundary was measured at 0.05 mg/liter and 0.03 mg/liter for Scott Creek near the eastern USFS boundry. Phosphorus was measured at 0.04 mg/liter on Sand Creek and 0.02 mg/liter on Scott Creek at the same locations (unpublished USGS data), reflecting the low productivity of these streams. **(put these numbers in context).** Wisseman (1991, 1992) reported that the insect taxa collected in the analysis area were indicative of good to excellent water quality. USFS personnel collected temperature data on Scott Creek in 1995 and Sand Creek in 1993 with automated data collectors. The maximum summer temperature recorded on Scott Creek was 10 degrees Celsius. The maximum temperature on Sun Creek was higher (16 degrees celcius) but almost all days did not peak above 13 degrees celcius. Overall water quality is good in the two streams which have been monitored. It is likely that other streams in the area have similar water qualities. **(add something about domestic and down stream uses)**

Flow data include in an appendix?

Sand 2.3 miles below San Creek Canal (Cfs)

11/17/92	4.6
3/30/93	0.2
5/12/93	11
7/13/93	1.7
9/21/93	9.4
7/28/92	5.2

Scott 0.3 miles above Sand Creek Canal

11/17/92	0.42
3/30/93	1.9
5/11/93	7.6
7/13/93	11
9/21/93	4.2
7/28/92	0.16

Discharge on Sand 1.1 miles down stream from park boundary in Cfs
24.3 (15 Oct 1967); 29.2 (25 June 1968); 19.0 (11 Sept 1968)
Discharge on Scott 4.5 miles down stream from park at road 2992 in Cfs
2.75 Cfs (09 Sept 1968)

The U.S. Park Service diverts water on Sand Creek at three points **(Percent of flows; diversion volume?)** and diverts water from Bear Creek to serve a ranger cabin **(percent of flow)** (Terry Simpson USFS pers. com.).

Facts to add some where?

Grazing in the analysis area has been limited and probably has not had a major impact on aquatic habitats except in the lower reaches crossing private lands (Phillips pers. com.).

Glacial deposits on Upper Sand Creek
Lost Creek campground is supplied from Lost Creek Spring (1968)
Cascade Spring (source of Bear Creek) from Base of Bouldery Moraine resting on dense lava. Small seasonal effects relatively uniform flow about 1.18 Cfs

Several habitat conditions have been determined to be good indicators of Bull Trout habitat quality. Moore and Gregory (1989) stated that Bull Trout need channel stability, substrate composition, cover, temp and migratory corridors.

Geothermal exploration

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Literature Cited

Add others!!!!!!

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Mazama Panhandle Watershed:
Human-Use Background

HUMAN USES

1. Characterization. What are the major human uses, including tribal uses and treaty rights? Where do they generally occur in the watershed?

The Mazama Panhandle watershed extends from the eastern crest of Crater Lake and down into the southwestern portion of the Chemult Ranger District. The watershed is characterized by its thick deposits of pumice and ash, particularly along the eastern slopes, as a result of the Mount Mazama eruption (present-day, Crater Lake) approximately 7,000 years ago. Paleoenvironmental studies have shown, however, that there were minimal effects on plants, animals, and people from the eruption. Although the pumice landscape supports a variety of vegetation and wildlife -- the climate, altitude and soil conditions of Crater Lake and its immediate vicinity was responsible for the limited supply of edible foods and other biota causing this area to be a suboptimal habitat for aboriginal hunters and gatherers.

The western portion (Cascade Range) of the Klamath territory, prior to the Treaty of 1864, was well-forested; the eastern area mostly a semi-desert. With the exception of several fertile areas along permanent water sources (such as the Klamath marsh, Agency/Klamath lakes, Williamson/Sprague rivers), most of the ethnographic Klamath territory was not desirable for habitation. Thus, the Klamath Indians used the lakes, rivers, and marsh environment for their subsistence rather than the forest-clad mountains, which they firmly believed, "invite only the solitary seeker after power (Spier 1930)."

Although the watershed was claimed as part of the Klamath territory, ethnographic studies have shown that the Indians rarely visited this area because it was believed to be a place of great supernatural powers and was thus considered a very dangerous place --- best to be avoided. In the "old days" only a "very strong man" would dare approach this area (Davis 1964). While the Klamath Indians may have feared Crater Lake, they did visit the area on certain occasions, particularly for power, strength, and luck (Barrett 1910).

According to ethnographic data, the Klamath and the people of the Rogue River drainage were not at all friendly and this was another reason for not venturing beyond the crest of the range. On occasion, however, the Klamath's hunted in this region but only in large parties. Although somewhat contradictory, they also gathered berries in the area west and northwest of Crater Lake.

If we divide the Mazama Panhandle watershed vertically into thirds, from left to right (or west to east), the watershed lies within Crater Lake National Park and the Chemult District of the Winema National Forest with the easternmost third portion located within the former Klamath Indian Reservation. The Klamath Reservation was formed during the signing of the Treaty of 1864, and passed into private and public ownership with the Klamath Termination Act of 1954. The reservation lands and transferred lands from neigboring forests were brought together to form the Winema National Forest in 1961.

Non-Indian use in the watershed area began in the 1850s, when a group of gold mining prospectors from the Jacksonville area of southern Oregon (near Medford) ventured into the Crater Lake vicinity. When the prospectors discovered there was no gold, they left. However, hearing about the wondrous "blue lake," other prospectors trickled into the area.

It was not until the 1880's when the Crater Lake area amassed increasing public interest. William G. Steel, known as the "Father of Crater Lake," began a 17 year campaign to preserve Crater Lake as a national scenic wonder. Steel, an outdoor enthusiast, founded the Oregon Alpine Club in 1887, and a much more exclusive group called the "Mazamas", to support the preservation of Crater Lake as a National Park. The Mazamas and a number of Klamath Indians gathered for a meeting at the Lake in 1896 and succeeded in convincing Congress to preserve the Lake. These efforts also initiated scientific studies of the Lake and the establishment of Crater Lake as a National Park in 1902 (Williams and Mark 1995).

Another prominent figure in the establishment of the park was Judge John B. Waldo of the Willamette Valley. Waldo was also an outdoor enthusiast, who spent many summers camping and hiking in the Cascades. He proposed a forest reserve along the crest of the Oregon Cascade range, 12 miles on either side of the divide to be managed by a joint state and federal commission. By 1893, the Lake had received partial protection when it became the Cascade Range Forest Reserve (Williams and Mark 1995). However, there was great opposition by sheep owners, who felt that a reserve would eliminate sheep grazing from alpine meadows. In 1897, the Secretary of Interior shut off grazing in all forest reserves which angered sheep owners - this measure resulted in sheep grazing studies. The first study was completed by Frederick Coville (USDA Botanist) in 1898. Coville concluded that sheep grazing was a danger to the forest only if it was unregulated. Livestock grazing was then regulated, and livestock allotments were assigned through grazing permits. A sheep allotment was assigned, in the area of the watershed, in the early 1900's. The Bear Creek Sheep and Goat Allotment was under the administration of the Klamath District of the Rogue River National Forest. In 1961, with the formation of the Winema National Forest, the permit was transferred.

Because of the remoteness of this region, industrial-scale timber extraction did not begin until 1909 when Southern Pacific railroad constructed its line to connect Klamath Falls, Oregon, to Weed, California. By 1911, the railroad ended its line at the town of Kirk which became a center for railroad logging activities. According to Tonsfeldt (1995), the lands reserved by Klamath Treaty of 1864 included "some of the best ponderosa pine forest in the United States" (p. 33). Under the treaty law prior to 1910, timber from the reservation was generally not sold to lumber manufacturers so as to prevent exploitation of Indian resources. Only timber damaged by fire or dead from other causes were allowed to be sold (Kinney 1950). Selling timber from industrial scale logging on reservation lands was not made legal until Congress passed the Indian Omnibus Act in 1910 (Tonsfeldt 1995). The first significantly large timber sales that occured within the watershed are the Middle Mt. Scott and North Mt. Scott/Bear Creek sales.

The Algoma lumber company of Klamath County purchased timber within what is referred to as the "Middle Mt. Scott Sale" in 1917. The Algoma lumber company logged apprroximately 316,879,370 board feet of timber between 1918-1930 in this sale. Initially, the lumber company used various equipment (including a donkey engine, a slide, an Ohio crane, a McGiffert, and one tractor of four sets of horse-drawn high wheels) and struggled to cut 200,000 feet/day. Shortly thereafter, they discovered the effectiveness of high-wheel logging which increased timber production of up to 300,000 feet/day. This logging method required less personnel as well. Currently 87% of the grades in the Middle Mt. Scott area have been converted into roads (Tonsfeldt 1995).

In 1914, the Pelican Bay Lumber Company of Klamath Falls negotiated with Crater National Forest to purchase timber north of the Middle Mt. Scott Sale. This sale, the North Mt. Scott/Bear Creek Sale complex (officially known as, the November 4, 1914 sale) yielded nearly 600 million board feet of timber and is reportedly the most extensive on the Winema National Forest (Tonsfeldt 1995). To reach the timber, 17 miles of rail access from Kirk needed to be constructed. Though the National Forest declined to help with the costs, the company persuaded the Indian Service to sell a unit of Klamath Reservation timber (Tonsfeldt 1995). In 1924, there were three sales near Bear Creek: the Crater National Forest Sale, the Klamath Reservation sale, and a unit of private timber in sections 31, 32, 33, T. 28S.,R. 7E and sections 4, 5, 6, T. 29S.,R. 7E.

Specifically, the North Mt. Scott tract is within the watershed and the former Klamath Indian Reservation. This unit was harvested from 1917-1927 and produced 138,876,580 board feet of timber. Logging involved both wheels and skidder methods. Though the North Mt. Scott sale has a number of complex features, Tonsfeldt (1995) believes the system does not exhibit geographical coherence and thus does not have adequate integrity. Conversely, the southernmost portion of the Bear Creek tract which is also within the watershed (from Lookout Butte to Bear Creek), is an important historic site and is considered eligible to the National Register of Historic Places.

By far, the most observable changes to the landscape are related to early railroad logging activities. Branch and spur lines followed drainages into the hills. A number of camps were constructed in remote areas, on-site and preferably near water sources, for example, for the loggers and their families, industrial and construction sites for railroad related maintenance.

As the timber industry boomed, so did the realization that timber was an economically valuable resource. This realization thus led to development of organized fire protection plans. Fire lookouts were sporadically built beginning in the 1920s but the Civilian Conservation Corps (CCC) constructed a network of lookouts and guard stations throughout the Pacific Northwest during the 1930s. These structures were established predominantly in remote areas, depending upon the local topography (for views) and adjacency to water(for personal use). Communication via telephone lines linked the lookouts to guard stations and railroads.

There is a remnant of a steel tower lookout on Boundary Butte that was constructed during the 1930s. Although we lack the precise measurement of this tower, it may have ranged in height from 35 to 175 feet, with a superstructure roughly seven by seven feet. The superstructure would have housed a firefinder and telephone (Kresek 1985). A cabin was usually associated with the lookout which measured 12 by 16 feet and served as the residence of the watchman (Rose 1988). Other buildings associated with lookouts were outhouses, sheds, and sometimes root cellars for cold storage.

2. Identify Issues and Key Questions.

The southern-most portion of the Bear Creek tract of the North Mt. Scott/Bear Creek Sale is part of an important historic site that is considered eligible to the National Register of Historic Places.

3. Describe Current Conditions.

Current human uses center around hunting, dispersed recreation, mushroom harvesting and wood cutting.

Klamath Tribes retain treaty rights to hunt and gather on former reservation lands.

4. Describe Reference Conditions.

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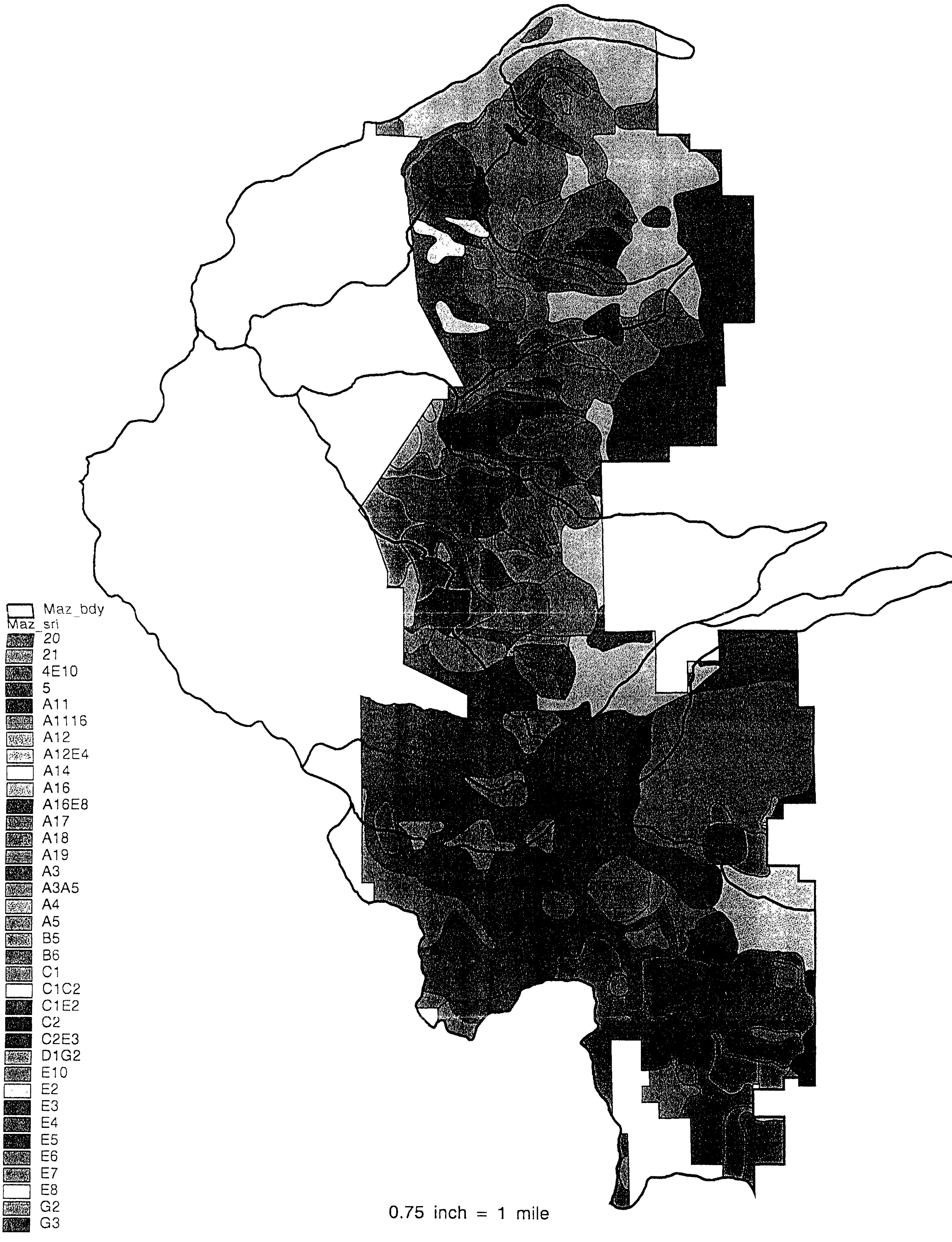
Soils within Mazama Watershed



Suitable Spotted Owl Habitat
within the Mazama Watershed