SNOW LAKES

WATERSHED ASSESSMENT

October 2005

Deschutes National Forest
Bend/Fort Rock Ranger District

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WATERSHED ASSESSMENT

This document provides updates to the following watershed assessments:

· Cascade Lakes Watershed Analysis (June 1995)

· Browns/Wickiup Watershed Analysis (December 1997)

October 2005

Deschutes National Forest
Bend/Fort Rock Ranger District

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Table of Contents

Chapter I
Introduction

Why Was this Watershed Assessment Update Done?

Watershed assessments are intended to develop a scientifically based understanding of the interaction of process and landscape patterns within the watershed to serve as a guide for the type and priority of future restoration and management activities. It also is to be used as a tool for subsequent management decisions that rely upon a greater understanding of existing and continuing conditions which may or may not be the result of human interaction with the ecosystem. This planning document will be used to determine strategies for sustaining the assessment area for the future. NEPA review or regulatory prescriptions are not required..

The Snow Lakes Watershed Assessment is an update of two earlier watershed analysis's: Cascade Lakes Watershed Analysis (WA) completed in 1995; and Browns/Wickiup WA completed in 1997. The Federal Guide for Watershed Analysis (Guide) states: "Federal Agencies will conduct multiple analysis iterations of watersheds as new information becomes available or as ecological conditions, management needs, or social issues change." The need for an update may be triggered by major changes in watershed condition or if existing analysis do not adequately support informed decision making for particular projects or issues. As analysis updates are conducted, new information is to be added to existing analyses.

The Guide outlines a six-step process for conducting a watershed analysis. The six steps in the process are listed below. In this report the six steps are separated into different chapters. Chapters begin with a short introduction explaining the purpose of each step in the process.

Six step process identified in the Federal Guide for WA

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

This document is intended to update changes in conditions within the analyzed watersheds that have occurred since the completion of the previous analysis. It **is not** intended to replace those earlier documents and those earlier documents should continue to be reviewed for planning purposes.

Characterization of the watershed

The purpose of step 1 is to identify the dominant physical, biological and human processes or features of the watershed (in this case, the assessment area) that affect ecosystem functions or conditions. When characterizing the assessment area, the team identified the most important land allocations, plan objectives, and regulatory constraints that influence resource management in the area. The watershed context is used to identify the primary ecosystem elements needing more detailed analysis in subsequent steps.

The Assessment Area
The Snow Lakes Watershed Assessment Area is located west and southwest of Bend and extends from the South Sister to the north to Davis Lake to the south (Figure 1). It is traversed by Highway 46 (Century Drive or the Cascade Lakes National Scenic Byway) which provides easy access to alpine and montane environments and is a gateway to diverse summer and winter recreation opportunities.

The assessment area covers roughly 222,100 acres and includes the entire Crane Prairie 5th field watershed to the north along with a portion of the Wickiup 5th field watershed to the south (Figure 2). There are twelve subwatersheds within the assessment area: Soda Creek, Quinn Creek, Elk Lake, Lava Lakes, Cultus River, Crane Prairie, Cultus Creek, Deer Creek, and Charlton Creek in the Cascade Lakes watershed, and Browns Creek, Davis Creek, and Wickiup in the Middle Deschutes watershed (Figure 2).

Distinguishing Watershed Features

Geology
The geology for the assessment area is less than 300.000 years old with most less than 200,000 years. The Mountain. Bachelor chain is 20,000 years old with Mountain. Bachelor being the youngest peak. The area has seen extensive volcanic activity including the eruption of Mountain. Mazama 7,600 years ago which deposited approximately one to over two feet of ash over the entire assessment area. Eruptions have occurred consistently every 500 to 1000 years within the Cascade Range.

The assessment area has seen periods of glacier activity including the Little Ice Ace (1700's and 1800's) which formed high glacial moraines including one on Mountain. Bachelor. The high lakes were formed when the glaciers retreated. Glaciated lakes such as Cultus are very clear. Springs feed many of the lakes within the watershed and also contribute to the flow of the Deschutes River. In the crest zone and in southern portion of the assessment area, many streams are intermittent due to porous soil creating underground streamflows.

Critical Headwaters Area
The assessment area is a critical headwaters area of the Deschutes Province. A great deal of ground water flows eastward and is expressed as springs which are a vital source of water throughout the Deschutes River Basin. Rainfall and snow melt combine to provide a range of 25 to 125 inches of annual precipitation.

The high permeability and porosity of this volcanic region allows precipitation to readily infiltrate the surface and percolate downward to replenish a large ground-water flow system. This is a critical recharge area which provides an important part of the surface and ground water which people from Bend to Madras depend upon. Far more water from precipitation enters the ground than is carried by surface flow/runoff. The surface water exits the watersheds via the Deschutes River below Wickiup Reservoir. Most streams are spring-fed with cold groundwater naturally high in concentrations of phosphorus. Unless regulated by a dam, these streams maintain a remarkably even flow throughout the year.

Figure 1 Locater Map - Snow Lakes Watershed Assessment Area.

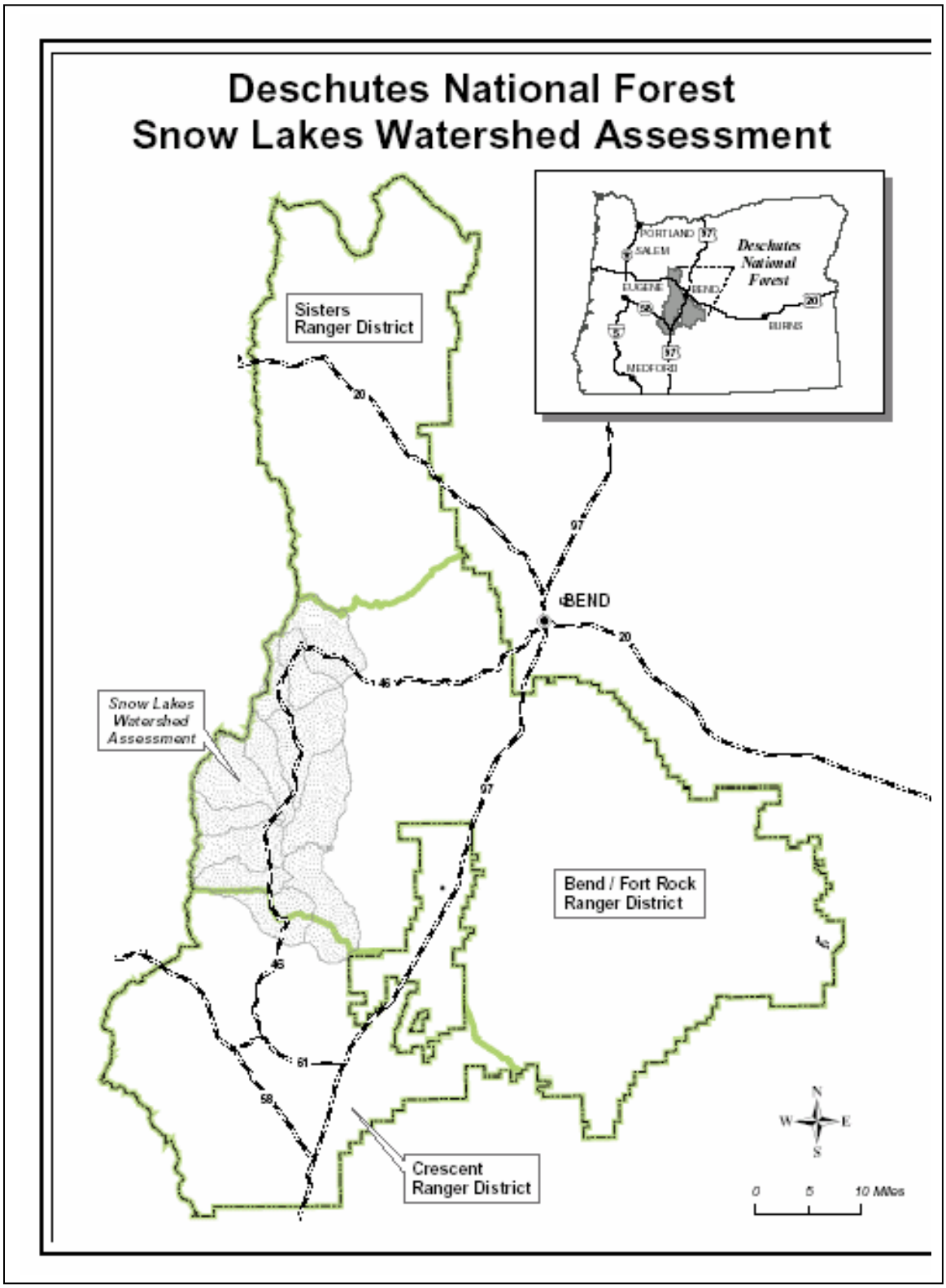
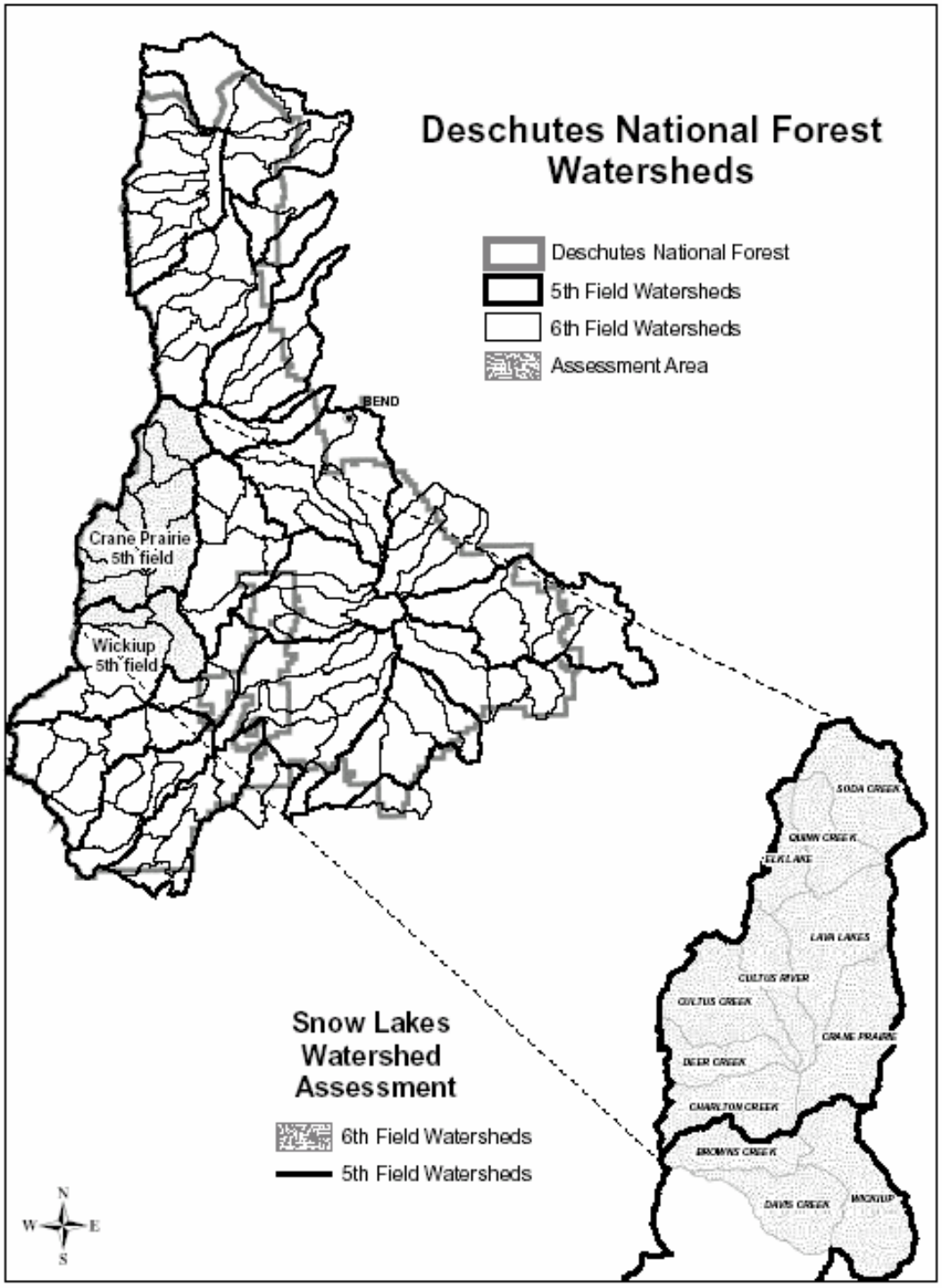


Figure 2 5th and 6th Field Watersheds, Snow Lakes Watershed Assessment Area.



Key Watersheds
The Northwest Forest Plan (NWFP) identified the Cultus subwatershed as a Tier 2 Key Watershed for its importance of high water quality. Since the NWFP was completed, federal watershed delineation standards have resulted in some changes in the watershed boundary although it encompasses the same water features. The name was also changed to Cultus Creek.

Recreation
The area receives heavy recreation use in both winter and summer. There are resorts at Elk Lake, Cultus Lake, Lava Lake, South Twin Lake and Crane Prairie Reservoir (Figure 3). There are horse camps at Quinn Meadow and Cultus Corral. There are also more than a dozen developed campgrounds as well as undeveloped areas known as "dispersed recreation' areas. Many lakes and streams are used for recreational fishing and various other activities. Hiking and camping are popular in the Three Sisters Wilderness as well as anywhere close to riparian areas and water. Biking and sightseeing are especially popular on Highway 46, the Cascade Lakes National Scenic Byway.

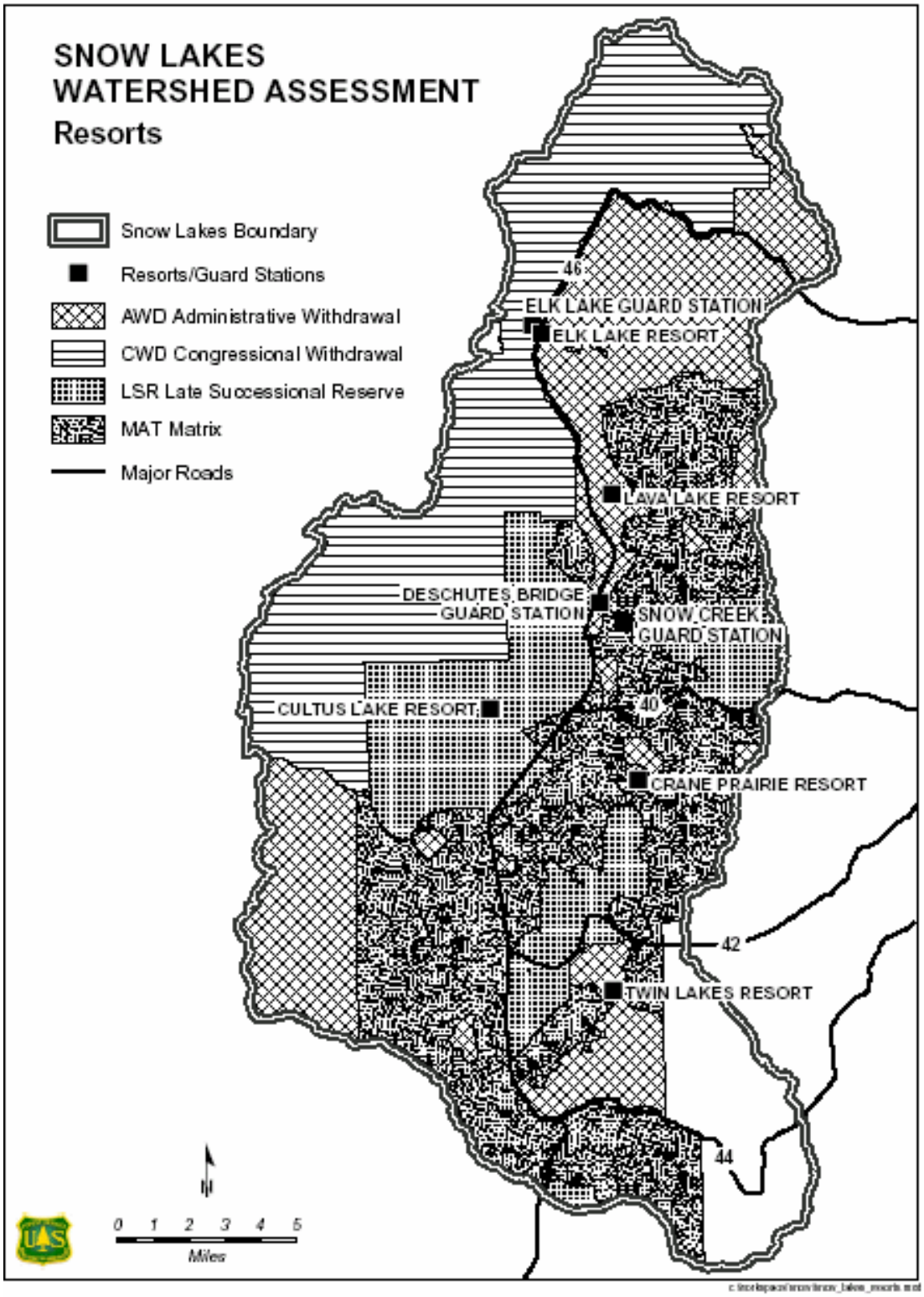
Vegetation
The vegetation in the area is comprised primarily of lodgepole pine, ponderosa pine, and mixed conifer forest communities. At higher elevations, colder forest types dominated by mountain hemlock plant associations provide striking contrast to the more common warmer and drier forest types associated with the pines and mixed conifers. Remnants of late-successional forest are present within the assessment area but their numbers and distribution have been compromised by mountain pine beetle epidemics and harvest fragmentation. Wildfire, insects, and pathogens have all shaped the historic and current conditions of these plant communities.

Fish and Wildlife
Fish and Wildlife
Fish stocking initiated over 90 years ago has increased the diversity and distribution of fish populations above that of historic conditions, but has also depressed populations of native fish. The native bull trout has been eliminated from the watershed (ODFW, 1996) and the genetic status of native redband trout populations has been altered by hybridization with hatchery rainbow trout (Phelps, 1996). Redband populations and habitat are distributed throughout much of the watershed. The creation of Crane Prairie and Wickiup Reservoirs largely transformed historically fluvial redband populations to adfluvial. Recent illegal introductions of several species of warmwater fish species has adversely affected native salmonids and other socially-desired non-native salmonids through increased predation and competition for food and cover.

A variety of wildlife utilizes the habitats available in the assessment area. Species include deer, elk, black bear, wolverine, coyote, marten, fisher, bald eagle, osprey, goshawk, black-backed woodpeckers, other avian species, small mammals and amphibians. Historically, several species of wildlife inhabiting the area (beaver, wolverine, marten, coyote, and deer) were hunted and trapped extensively.

Fire/Fuels
Fire has been a major disturbance element in the assessment area. Large, high intensity fires occurred in the lodgepole and mountain hemlock plant associations within the area as well as surrounding areas. The combination of weather, beetle-killed trees, and high recreation use contribute to the areas inherent fire-susceptibility. The magnitude of disturbance has changed significantly in some plant communities due in part to the suppression of fire since the turn of the century (Bork, 1984). Where fire was once frequent and light in the ponderosa dry plant association groups (PAGs), the effects were relatively negligible except in understory vegetation and fuels. Contemporary fires are not as expansive due to fire suppression but the intensity and

Figure 3 Resort Locations, Snow Lakes Watershed Assessment Area.



potency of fires has increased notably. While several fire starts occur annually within the area, only a very small percentage build into large scale high intensity fires.

Heritage Resources

The prehistory and history of the Snow Lake Watershed Assessment Area was described in the Cascade Lakes and Browns/ Wickiup Watershed Analyses. Few, if any, recent discoveries have changed the state of knowledge of heritage resources within the assessment area. However, forthe purpose of general contextual orientation, a brief summary of prehistory and history are included here.

The assessment area is transitional in terms of the scope of prehistoric occupation and use. At the time of contact with Euro-American culture, the assessment area is thought primarily to have been used seasonally by the Northern Paiute and also by the Tenino, reaching southward from the Columbia River; by the Molala, who crossed over the Cascades to gather seasonal foods on the eastern slope; and the Klamath. There are no archeological or ethnographic data which suggest permanent villages within the assessment area by any Native American population. Seasonal use extended from late spring to early fall and was focused on resources near wet and dry forest openings and near watercourses and lakes.

The pattern of seasonal use by prehistoric, migratory populations was persistent; archeological evidence supports the essential continuity of this use from the Mazama event onward. Models of change in the nature of seasonal use have been advanced, primarily in connection with the onset of warmer and dryer climate which stressed human populations who relied on the lakes and wetlands further east but also in connection with changes in the floral associations within and near the assessment area. Other change is expected from the role of uplands as a refugium for native populations displaced by advancing Euro-American groups.

Most prehistoric sites within the assessment area postdate the Mt. Mazama eruption. However, earlier sites have been documented within or near the area, notably at Wickiup Reservoir and Odell Lake where artifacts similar to those from the Klamath Basin have been found in paleosols below the ash fall stratum. In 2005, a pre-Mazama occupation site was discovered at the Fall River headwaters. Such pre-Mazama sites are unlikely to occur as surface expression on modern land surfaces but are expected to be encountered as subsurface expressions or exposed in erosional features.

Euro-Americans pushed into the area in the early 19th century, exploring for routes over the Cascades and for such economic uses as trapping. Settlement came considerably later, with lowland areas beginning to infill during the mid to late19th century. The uplands characteristic of the area were sparsely settled and most of the land remained in the public domain until incorporated into the Cascade Range Forest Reserve and the other permutations of public ownership leading to the modern National Forest boundary.

Early transportation routes followed stream bottoms rather than the more difficult upland areas. An early wagon road became the Sparks Lake Road in the 1920's and ultimately became the Cascade Lakes Highway.

Economic uses of the area included cattle and sheep range, timber harvest, and trapping. Historic sites that reflect these uses as well as other forest management activities are found within and adjacent to the assessment area.

Late Successional Reserve

Most of the analysis area lies within the range of the northern spotted owl. The assessment area includes all or portions of three designated late successional reserves (LSRs): Brown's Mountain, Sheridan, and Cultus; totaling approximately 32,754 acres.

Land Allocations

The management of the assessment area is directed by the *Deschutes Land and Resource Management Plan* (1990) (LRMP) as amended by the *Standards and Guidelines for the Management of Habitat for Late Successional and Old-Growth Related Species within the Range of the Northern Spotted Owl* (1994) (NWFP). Table 1 displays the LRMP allocations; Figure 3 the spatial arrangement of those allocations within the assessment area. Table 2 displays the allocations delineated by the NWFP; Figure 4 the spatial arrangement of those allocations within the assessment area.

Table 1 LRMP Land Allocations, Snow Lakes Watershed Assessment Area.

MANAGEMENT ALLOCATION	ACRES	PERCENT OF WATERSHED
General Forest	50550	23
Old Growth	3921	2
Eagle	12244	6
Osprey	8029	4
Intensive Recreation	32603	15
Dispersed Recreation	17768	8
Winter Recreation	7200	3
Wilderness	54200	24
Experimental Forest	387	<1
Special Interest Area – Davis Lake	1	<1
Special Interest Area – Hosmer Lake	72	<1
Special Interest Area – Wire Meadow	47	<1
Research Natural Area – Torrey Charlton	660	<1
Research Natural Area – Many Lakes	843	<1
Research Natural Area – Katsuk Butte	883	<1
Research Natural Area – Cultus River	315	<1
Scenic Views – Retention Foreground	751	<1
Scenic Views – Retention Middleground	91	<1
Scenic Views – Partial Retention Foreground	13162	6
Scenic Views – Partial Retention Middleground	16975	8
Bend Municipal Watershed	30	<1
Other Ownership	1295	1
Total	222027	100

Table 2 NWFP Land Allocations, Snow Lakes Watershed Assessment Area.

MANAGEMENT ALLOCATION	ACRES	PERCENT OF NWFP ACRES	PERCENT OF ASSESSMENT AREA
Congressionally Withdrawn	54200	26	24
Administratively Withdrawn	49758	24	22
Late-successional Reserves	32754	16	15
Matrix	70632	34	32
Other Ownership	1	<1	<1
TOTAL	207345	100	93

Figure 4 LRMP Land Allocations, Snow Lakes Watershed Assessment Area.

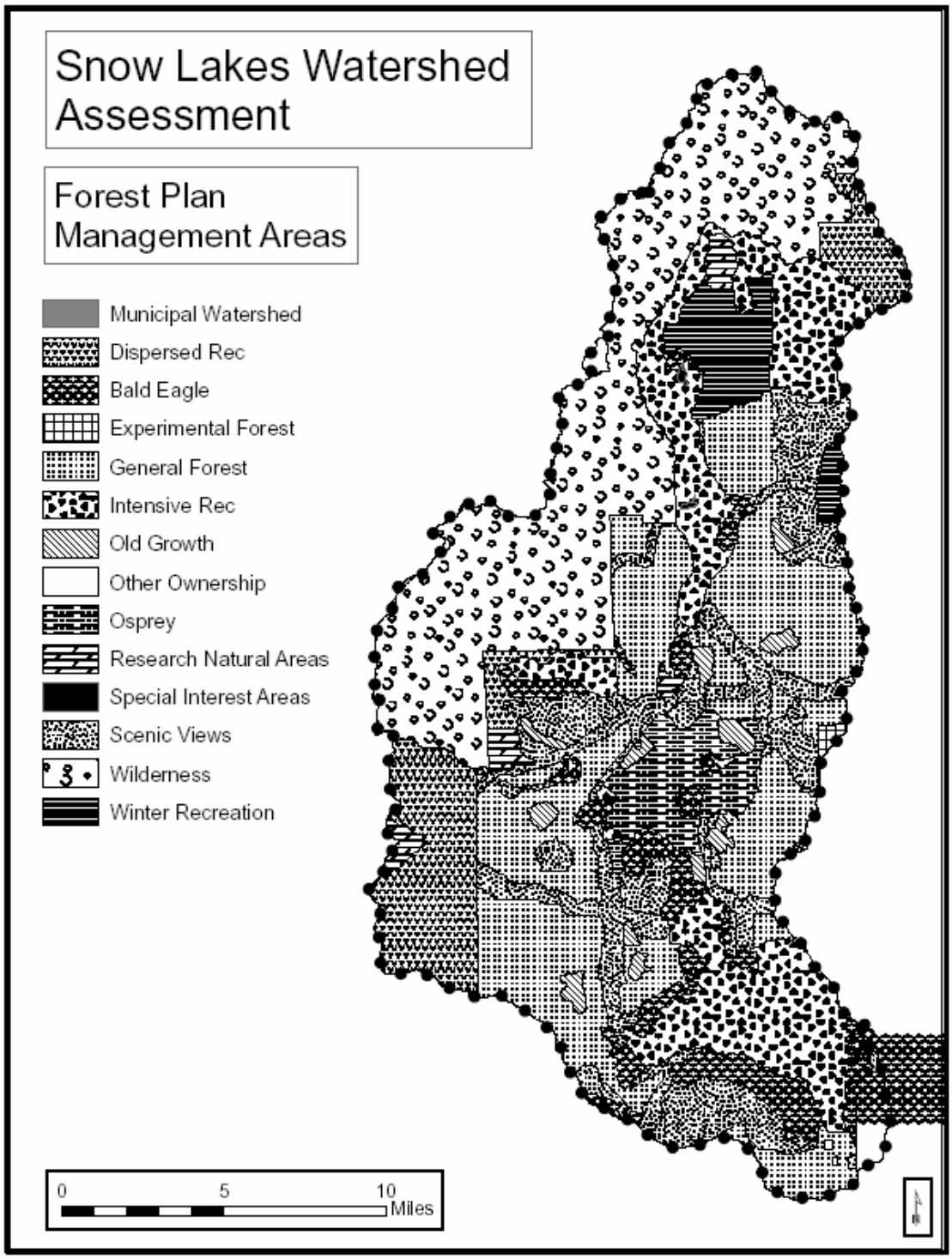
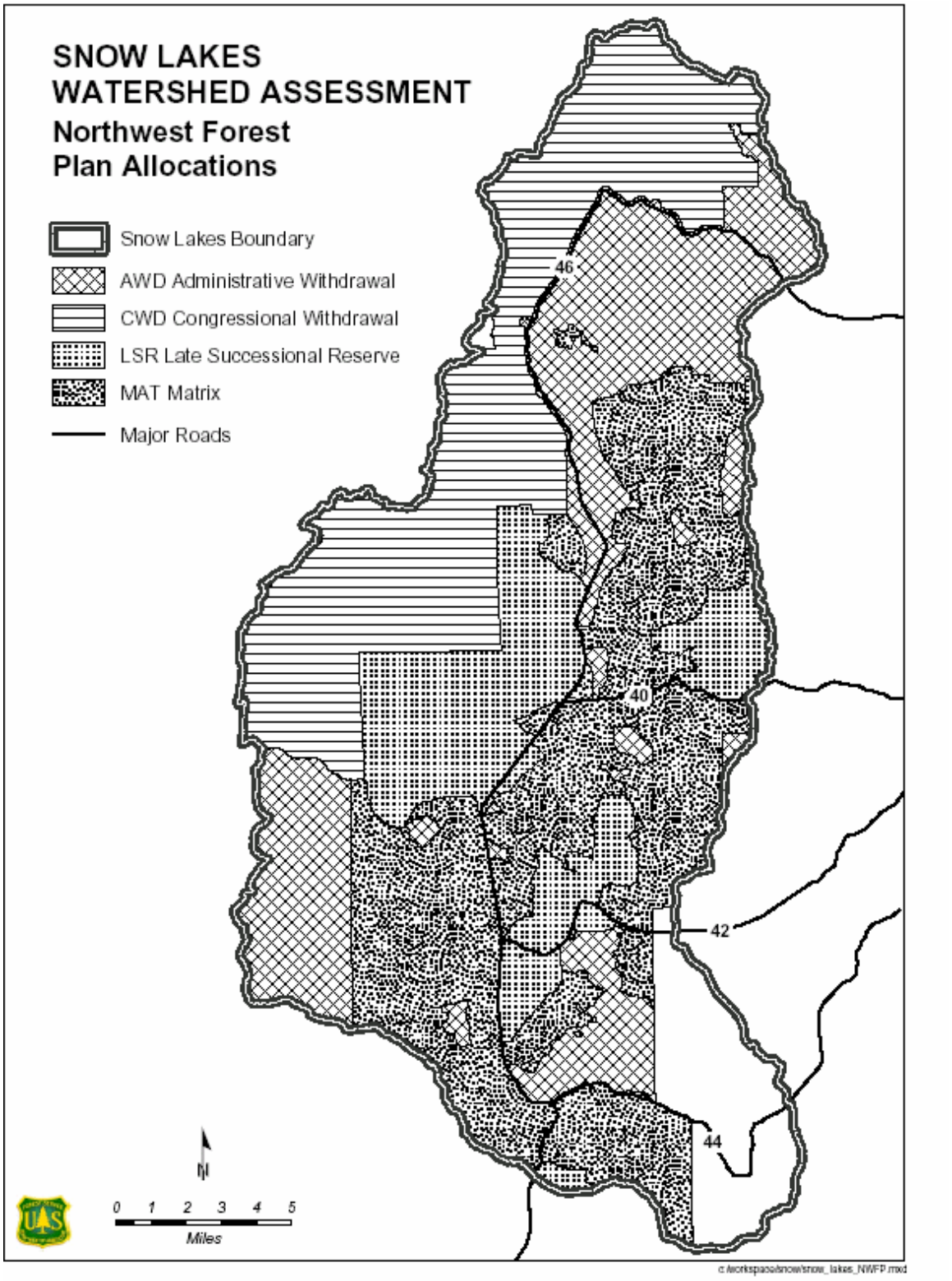


Figure 5 NWFP Land Allocations, Snow Lakes Watershed Assessment Area.



The southwest corner of the assessment area, primarily to the north, east and southeast of Wickiup Reservoir, is located outside of the NWFP boundaries, hence the almost 15,000 acre difference between the LRMP and NWFP acres.

Table 3 displays the chronology of events that have occurred within the assessment area or have affected the assessment area since the Record of Decision for the Northwest Forest Plan (NWFP) was signed in 1994 through the completion of this assessment document..

Table 3 Chronology of Events Affecting the Snow Lakes Watershed Assessment Area Since the ROD for the Northwest Forest Plan.

DATE	CHRONOLOGY
1994	The Record of Decision for the Northwest Forest Plan amended local Forest Plans and required Watershed Analysis be completed in Key Watersheds before management actions take place. A total of seven Key Watersheds are designated on the Deschutes National Forest.
1995	The original Cascade Lakes Watershed Analysis completed.
1996	Landing and Red Plague EA signed
1997	The original Browns Wickiup Watershed Analysis completed
1997	Cascade Lakes Restoration EA signed
1997	Soda Creek Restoration EA signed
2000	Trail Reconstruction EA signed
2001	Charley Brown EA signed
2003	Potentially toxic blue-green algae blooms discovered in some lakes
2004	Todd Lake Devils Triangle EA signed
2001-2005	Progressive mortality in lodgepole pine results in major changes in resource condition.
September 2005	Snow Lakes Watershed Assessment Update completed..

Chapter II
Issues and Core/Key Questions

Step number two of the six step process involves identifying issues and key questions for the watersheds. The purpose of this step is to focus the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values, or resource conditions within the assessment area. Most issues identified in both the 1995 Cascade Lakes and the 1997 Browns Wickiup analysis' were considered to still be relevant and were incorporated into this update. Where conditions within the assessment area had changed since the initial analysis and were either not addressed or only partially addressed by the previous issues, the original issue(s) were modified or new ones identified. In addition, the goals identified in the FY 06 Strategic Guidance for the Crooked River National Grassland, Ochoco and Deschutes National Forest were also considered during the development of issues.

Issues

Physical Domain

Soil Quality

- Soil impacts in the form of compaction and erosion in heavily used recreation areas has resulted in a decrease in the soils ability to function in a desirable manner.
- The cumulative soil impacts from multiple vegetation management activities in the same area may result in detrimental soil conditions which exceed the Regional Soil Quality Standards.
- Extensive areas of sensitive soil types within the watershed increase the vulnerability of those soils to negative impacts.

Water Quality

- Increased recreational use and facilities within the watershed may impact water quality.
- Lava Lake is included on the Oregon Department of Environmental Quality 303(d) list of water quality impaired waterbodies, for the parameter of low summer dissolved oxygen. The Deschutes River below Crane Prairie Dam has been on the 303(d) list in the past (2000) for high summer water temperatures, but was excluded from the most recent list (2002) under the clause of data collection occurred in a drought year.
- High concentrations of potentially toxic blue-green algae (cyanobacteria) was discovered at three waterbodies within the assessment area during 2003-2004, impacting water quality.
- Increased risk of large, stand-replacing wildfires could impact water quality and stream channel morphology.

Biological Domain

Vegetation

- Increases in extensive areas of lodgepole pine mortality caused by mountain pine beetle epidemics resulting in increased fire risk, loss of late and old growth structure, and impacts to scenic quality and recreation.

- Increases in shade tolerant species in mixed conifer forest types.

Fuels

- Fire exclusion and natural succession have changed the historical fire regime and reduced the ability to suppress wildfire.
- Forest resilience to fire, insects and disease, as a result of fire exclusion, has diminished as stand densities increase and shade tolerant species populate warm and dry sites.

Botany

- Increasing foot traffic in riparian areas is degrading potential habitat for sensitive plant species.
- Increasing disturbance and the continued introduction of seed sources have caused populations of noxious weeds to increase.

Wildlife

- Risk of loss of currently functioning wildlife habitat to fire.
- Wildlife habitat fragmentation.

Fish

- Legally introduced salmonids have resulted in adverse effects on native species (redband trout and bull trout) through competition for food and cover, or through hybridization.
- Illegally introduced fish species have resulted in adverse effects on native and legally introduced game species through predation and competition for food and cover.
- Illegally and legally introduced fish species may be influencing the trophic status, water quality, and blue-green algae blooms in some lakes and reservoirs.
- Increased risk of large, stand replacing wildfires could impact fish populations and habitat.

Social Domain

Recreation

- Adverse impacts to shorelines, stream sides and riparian vegetation due to heavy recreation use.
- Effects of blue-green algae on recreation use and economics of resorts and campgrounds.
- Impacts to vegetation and scenic integrity due to increases in Off Road Vehicle (OHV) use, especially on buttes, stream sides and near recreation areas.
- Ability to maintain sites and programs due to budget cuts, including information/education programs and interface with/for the public.
- Effects of increased use on carrying capacity of Wilderness and recreation sites and settings.

Scenic Quality

- Impacts on scenic views from the Cascade Lakes National Scenic Byway and other scenic travel corridors.
- Impacts on scenic views to landmarks, lakes, rivers, buttes and mountains from new development and other activities or events (such as power line and cell tower construction, logging, road and building construction, wildfire, insect and disease).
- Expectation of the public for scenic quality in wilderness, roadless, and undeveloped areas.

Heritage Resources

- Fire exclusion has changed the historical fire regime and has increased the risk to historic structures and both historic and prehistoric sites.
- Increasing foot traffic at archeological sites near riparian areas and some recreational developments has contributed to a loss of site integrity and an increased risk of antiquities theft and vandalism.
- Increasing OHV use may be contributing to a loss of prehistoric site integrity and an increased risk of antiquities theft and vandalism through increased, unmanaged access to historic sites and structures.
- High amounts of ground-covering duff restricts the accuracy of archeological inventory and requires multiple re-entries for long term projects.

Core/Key Questions

Physical Domain

Soil Quality

- What is the inherent soil quality within the watersheds?
- Where are the sensitive and resilient soils located in the watersheds?
- How has the dynamic soil quality been affected by forest management activities?
- Has there been a change in the inherent and or the dynamic soil qualities since the previous WA's were completed?

Erosional Processes

- What are the historical erosion processes within the watershed (e.g., surface erosion processes, mass wasting)?
- What erosion processes are dominant within the watershed (e.g., surface erosion processes, mass wasting)?
- Where are the dominant erosion processes likely to occur?
- Where have the dominant erosion processes occurred in the watersheds?
- Are there signs of accelerated erosion in the watersheds?
- Has there been a change in accelerated erosion in the watershed since the previous analysis' were completed?

Hydrology

- What are the historical hydrologic characteristics (e.g., total discharge, peak flows, minimum flows) and features (e.g., cold water seeps, ground-water recharge areas)?
- What are the dominant hydrologic characteristics (e.g., total discharge, peak flows, minimum flows) and other notable hydrologic features and processes in the watersheds (e.g., cold water seeps, ground-water recharge areas)?
- What are the current conditions and trends of the dominant hydrologic characteristics and features in the watersheds?

Stream Channels

- What were the historic morphological characteristics of stream valleys and general sediment transport and deposition processes in the watersheds?
- What are the potential water quality, riparian condition, and stream channel morphology impacts if a large high intensity fire occurs?

- What are the current conditions and trends of stream channel types and sediment transport and deposition processes prevalent in the watershed?

Water Quality

- What are the beneficial uses dependent on aquatic resources in the watersheds?
- What are the natural and human causes of change between historical and current water quality conditions?
- What are the effects of recreation and facilities on water quality?
- Where are the current Oregon Department of Environmental Quality (DEQ) 303(d) listed impaired water bodies, as required by the Clean Water Act and the associated cause(s)?
- What are the effects of blue green algae on water quality?
- What are the potential water quality, riparian condition, and stream channel morphology impacts if a large high intensity fire occurs?

Biological Domain

Vegetation

- What is the historic array and landscape pattern of plant communities and seral stages in the watershed?
- What processes caused these patterns (i.e. fire, wind, mass wasting, insects/disease)?
- What effect or effects is the change in stand conditions resulting from the dying of lodgepole pine having on late and old growth structure?
- What is the increased risk in stands of ponderosa pine and other early serial tree species due to increases in shade tolerant species? How much effect will the increase in shade tolerant species have on the growth of intermediate tree sizes?

Fuels

- Where and when is it appropriate to re-introduce fire as a tool?
- How do we restore resiliency to these fire regimes to minimize the risk and/or impacts of uncharacteristic disturbance events (i.e. fire, insects, and disease)?
- How do we create and maintain conditions that are conductive to important resource values including, but not limited to, wildlife habitat, scenic views, recreational opportunities and wilderness values?
- What are the local communities of interest?
- How do we establish and maintain safe access for the public and firefighters?
- How do we protect resources that we consider important, while maintaining resiliency from disturbance events?

Wildlife

No new core/key questions were identified relative to wildlife.

Fish

- What is the relative abundance and distribution of redband trout and bull trout within the watershed?
- What are the current habitat conditions and trends for the redband trout and bull trout?
- What was the historical relative abundance and distribution of redband trout and bull trout and the condition and distribution of habitat within the watershed?
- What are the natural and human causes of change between historical and current species distribution and habitat quality for redband trout and bull trout?

- What are the influences and relationships of species and their habitats with other ecosystem processes in the watershed?

Botany

- What is the relative abundance and distribution of plant species of concern that are important in the watershed (threatened or endangered species and special status species)?
- What are the threats to sensitive plant habitat quality in the watersheds?
- Where are the populations of noxious weeds in the watershed?
- What is the potential for noxious weeds populations to increase?
- What can be done to limit or reduce populations of noxious weeds?

Social Domain

Recreation

- What will the public tolerance level be of Wildland Urban Interface (WUI) treatments verses non-WUI treatments?
- What will be the acceptance by the public of vegetation treatments to reduce the effects of mountain pine beetle or to reduce fuel loadings be within and outside of recreation sites?
- What level of risk will the public accept for the potential of large wildfires to occur?
- How will the Bend-Fort Rock Ranger District react to further budget cuts in the recreation program area?
- How will the public react to increased fees or further privatization of recreation maintenance and operations?
- How is the increased use and lack of budget affecting the recreation experience?
- Is the District meeting all applicable standards and guidelines including but not limited to ROS, Forest Plan, W&SR. and NWFP (ACS setbacks, etc.).
- What effects do road closures have on recreation management (both opportunities and constraints)?

Scenic Quality

- What effect(s) is the change in stand conditions resulting from the dying of lodgepole pine having on scenic quality?

Heritage Resources

- What is the condition of prehistoric heritage resources and what are the trends?
- Where are the concentrations of potentially significant heritage resources?
- How has recreational use affected the integrity of heritage resources?
- How best to phase and ensure accuracy of archaeological inventory for large scale fuels and timber management projects?
- What were the prehistoric land uses in the area and how did those uses change over time in response to changing environmental and other conditions?
- Where are the concentrations of, and best habitats for, plants used in traditional practice by Native Americans?

Chapter III AND IV

Description of Current and Reference Conditions

Steps three and four of the six step processes involve describing the current and reference conditions for the assessment area. The purpose of step three is to develop information relevant to the issues and key questions identified in step two. The purpose of step four is to explain how ecological conditions have changed over time as a result of human influence and natural disturbances. A reference condition is developed to be used to make comparison with current conditions and thereby assist in developing key management plan objectives.

Physical Domain

As noted previously, the assessment area encompasses approximately 222,100 acres of National Forest system lands. It includes two 5th field watersheds; the Cascade Lakes and the northern part of the Middle Deschutes. There are 12 6th field watersheds; nine that make up the Cascade Lakes 5th field watershed and three that are part of the Middle Deschutes 5th field watershed. Only the Cultus Creek 6th field watershed in the Cascade Lakes Watershed was identified under the NWFP as a key watershed. It is a Tier 2 watershed and is a an important source of high quality water.

Climate and Weather

The climate within the assessment area can be characterized by a precipitation gradient from west to east. At the crest of the Cascades annual precipitation ranges from approximately 75 inches in the southern part of the assessment area to greater than 125 inches near South Sister. At the eastern edge of the watersheds annual precipitation drops to approximately 25 inches. These differences are due to rain shadow effects (west to east) and elevational differences (north to south) associated with the movement of moist marine air masses flowing eastward from the Pacific Ocean across Oregon.

Approximately two-thirds of the annual precipitation falls between October and March. Winter storms result in heavy snowfalls and large snowpack accumulations. In May and June, a second peak of precipitation typically occurs that is associated with thunderstorms and upper level low pressure systems. Winter low temperatures are typically in the teens and low twenties while summer high temperatures rise into the eighties and nineties. Daytime humidity is generally low in the summer and fall.

The Cascade Lakes Watershed has recently emerged from the Little Ice Age, a climate somewhat cooler and wetter than today. Between 1600 A.D. and 1900 A.D., glaciers extended down the slopes of mountain peaks considerable farther in the central Oregon Cascades. Between 1920 and 1980, all glaciers retreated greatly. Whether or not this retreat will continue is unknown. The climate-driven ecologic zones in the Cascades have likely all moved upslope somewhat since about 1920 to accommodate a warmer and drier climate.

Air Quality

Air quality in the watersheds is excellent. This is due to the relatively low human population base and the fact that there are no major sources of air pollution. Lichen species which occur in the assessment area are considered to be sensitive air quality receptors. Surveys and population monitoring in the area have shown a diverse lichen population exist within the area.

The primary threats to air quality within the assessment area are from smoke (primarily from wood heat at summer homes and lodges) and vehicle emissions (primarily from vehicles on the Hwy 46 – the Cascade Lakes Highway). There is also the risk of smoke resulting from uncharacteristic wildfire.

Geology

The assessment area is part of the volcanic Cascade Range of Oregon. It has endured eight Ice Ages during the past 800,000 years. Virtually all landforms, rocks, and soil within the assessment area are the product of volcanism and glaciation.

Most of the assessment area is probably less than 200,000 years old. It consists of many overlapping shield volcanoes such as Charlton Butte and Sheridan Mountain. Hundreds of these basaltic shield volcanoes have constructed the present Cascade Crest and slopes. The center of each is usually a cinder cone with slopes of lava flows. Sheets of cindery ash cover downwind slopes and lands beyond. Glacially eroded remnants of large basaltic cones (Broken Top, Sixbit Point, Elk Mountain, Irish Mountain, etc.) that once looked similar to Mount Bachelor are located near the Cascade Crest. The South Sister has been a major volcanic center for about 150,000 years. It has erupted a wide range of rocks including lavas, domes, and ash of basaltic to rhyolitic composition.

Although the Cascades have endured eight Ice Ages over the last 800,000 years, in Central Oregon there is direct evidence for only three (450,000 years, 150,000 years, and 25,000 years ago) and only evidence for the most recent, 25,000 years ago, within the assessment area. Each glaciation produced a major, continuous ice sheet in the Cascades from Mountain. Jefferson to south of Carter Lake. The ice caps greatly eroded the upper elevations of the Cascades and left ground moraines. By far, the greatest erosion has been done by glaciers on volcanic peaks and in the valleys below the ice cap. The ice was over 1000 feet thick in the Sparks Lake area and was at least 600 feet thick at Cultus Lake. Extensive ridges of moraines mark the location of the ends of glaciers during the Ice Ages. Below this elevation, lands have been buried under large fans of sand and gravel from glacial outwash.

Since the last Ice Age, volcanoes have continued to erupt on or near the Cascade crest. The eruption of the Mount Bachelor volcanic chain began about 20,000 years ago and ended approximately 10,000 years ago. Eruption of the Wuksi/Shukash volcanic field southeast of Crane Prairie probably occurred during this period. Approximately 7,600 years ago, the eruption of Mount Mazama (Crater Lake) 45 to 70 miles to the south covered the entire watershed with up to 3 feet of ash and pumice. About 2,000 years ago, the northern end of the assessment area was covered by more than a foot of pumice and ash from two subsequent eruptive events. These two eruptive episodes also formed a group of 100 foot thick lava flows and domes on the south flank of the South Sister.

The generally porous and permeable volcanic and glacial rocks strongly affect how the land handles water. Large amounts of melting snow and rainfall infiltrate the ground and percolate downward to perched aquifers and to the regional aquifer. This ground water emerges from a host of springs to feed many streams and some lakes. A great deal of ground water continues to flow eastward to feed springs and to supply water for water wells in other parts of the Deschutes River Basin. The surface flow of water via the Deschutes River represents only a small portion of the precipitation that falls within the watershed.

Soil Resource

Physiographic and climatic factors influencing inherent soil quality

Dominant soil types within the assessment area are derived from airfall pumice and ash soil parent materials which resulted from the eruption of Mount Mazama. The original thickness of this airfall deposit ranged from about 20 inches (0.5 m) in the southern portion of the assessment area to around 12 inches (0.3 m) in the north. Particle sizes range from fine to medium sands. Since the eruption, Mazama ash deposits have moved considerable distances down the steeper slopes and formed thick wedges and aprons on many of the landforms. Mazama ash has been stripped from many ridges and tops of buttes by erosion. The glaciated portions of the assessment area have fine sandy loam textured soils derived from the Mazama ash materials over older compacted ground moraines. The older glacial material dominates water transport and plant growth in these areas. Soil moisture regimes are Xeric (dry) in the eastern portion of the watersheds and Ustic in the moister sections of the watershed to the west. Soil temperature regimes range from frigid to cryic depending on elevation.

Soil Quality

The Soil Science Society of America proposed the following definition of "soil quality:"

> The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. (Soil Science Society of America 1997)

While a number of other definitions of soil quality have been recently proposed by research and other groups, all have one thing in common. They all refer to the capacity or the ability of a specific type of soil to function. Thus a simplified working definition of soil quality could be stated as "the ability of an individual soil to function in a desirable manner." This is the definition that will be used in this report. Soil quality can be assessed as both an inherent quality of the soil and by changes in the dynamic quality of the soil. These two types of soil quality (described below) are evaluated by different methods and used for different purposes.

- Inherent soil quality

Examples of inherent soil quality include: soil texture, soil rock content, depth, and color. Inherent soil quality is typically not changed much by forest management activities. Inherent soil characteristics are documented in the Soil Surveys and Ecological Unit Inventories and are used to determine the suitability of a given soil for performing different soil functions. Inherent soil quality depends on the specific functions that the soil is expected to perform.

- Dynamic soil quality

Examples of dynamic soil quality include soil density, soil porosity, soil strength, and the nutrient supplying capacity of the soil. Dynamic soil quality is very susceptible to a change as a result of forest management activities. It can be improved, maintained or degraded by such activities. Different soil types have different levels of resistance and resilience to different soil disturbances. Soils that exhibit lower resistance and resilience to change resulting from forest management activities are identified as sensitive soil types.

Historic Reference Soil Conditions

Questions:

- *What is the inherent soil quality within the watersheds?*
- *Where are the sensitive and resilient soils located in the watersheds?*

The inherent soil quality in the assessment area is a result of five soil forming factors: the parent material from which the soil was formed; climate; topography; organisms (both macro and micro flora and fauna); and time. These five soil forming factors work together to produce the inherent soil characteristics found in assessment area.

Inherent soil characteristics for individual soil types are described in the Deschutes Soil Resource Inventory (SRI) (Larson 1976). Table 4 groups the various soil types found within the assessment area by their similar ability to perform different soil functions.

Table 4 Deschutes NF Soil Resource Inventory Soil Groupings.

Soil Type Code	Locations
16-22, 25, 2A, GA, GB, GC, GF, GK, HG, MC, MX	Glaciated lands
41, 43-46, 96, WE, WF, XH	Glaciated outwash plains
65, 67, 70, 73, 74, 76, 97, 98, LL, LM, MN, MP, MR, PJ, PM	Benches and lava plains
4, 5, HB, HC, HE, MG, WH	Meadows
8	Bottom lands
84, 85, HM, HN, MV	Shield volcanoes
9,81, 82, 83, XP	Cinder cones
57	Ridge tops and canyon walls
89	Fault escarpments
1, 14, HK, LC	Lavas
11, LB	Forested lavas
3, 12, 13, 1A, HD, HF	Rocky areas
7	Barron flats
2, 6, 15, 5A, 7B, 9C, 9Z, XXX	Small unique areas
W	Water

A large portion of the assessment area consists of glaciated lands in the higher elevations and either benches and lava plains or glaciated outwash plains on the lower slopes. Soil groupings found in these areas have a mantle of Mazama ash deposits which influence the inherent soil characteristics. Due to the physical properties of the Mazama ash, soil thermal properties consist of a poor ability to absorb and transmit heat. This results in low lying areas having a high frost potential and low plant regeneration success rates. There is also a lack of development in these soils due to the young nature of the pumice parent materials. Soil nutrients are concentrated in the surface 10 cm of soil with drastic reductions in nutrient content below that point.

Less extensive are soils with high water tables which result in areas of wet meadows and riparian vegetation occurring throughout the assessment area. The soil found on several of the buttes in the area differ depending on the coarseness of the soil particles, length of soil development, the climate, aspect, slope gradient, and the vegetation and soil organisms operating on the site. These slopes and the associated soils are some of the most productive areas within the assessment area.

High soil quality is defined in this assessment as the ability of the soil to support sustained, vigorous and diverse ecosystems. It is also defined as the ability of the soil to maintain its inherent hydrologic functions. These include:

- sufficient vegetative cover to inhibit surface soil erosion;

- soil organic carbon levels that have evolved over time due to natural processes; and
- soil physical properties that allow water and air movement into and through the soil profile and that facilitate desired hydrologic function and biological activity.

A map of inherent (or historic) soil quality (Figure 6) was created utilizing the plant association groupings for potential natural plant communities that were developed by the assessment team. The delineation of soil quality was based on the assumption that the most productive sites result from a variety of soil forming factors. Additionally, the quality of the soil can be expressed by the plants that have the potential to grow on a site. Table 5 displays the inherent soil quality and the associated PAG groupings.

Table 5 Inherent Soil Quality Associated with Potential Native Plant Communities using Plant Association Groups (PAGs), Snow Lake Watershed Assessment Area

Soil Quality	Potential Natural Plant Community
High	Mixed Conifer Wet
	Meadows
Moderate	Mixed Conifer Dry
	Mountain Hemlock
	Lodgepole with Mountain Hemlock
	High Elevation Lodgepole
	Lodgepole Moist/Wet
Low	Lodgepole Dry
	Ponderosa

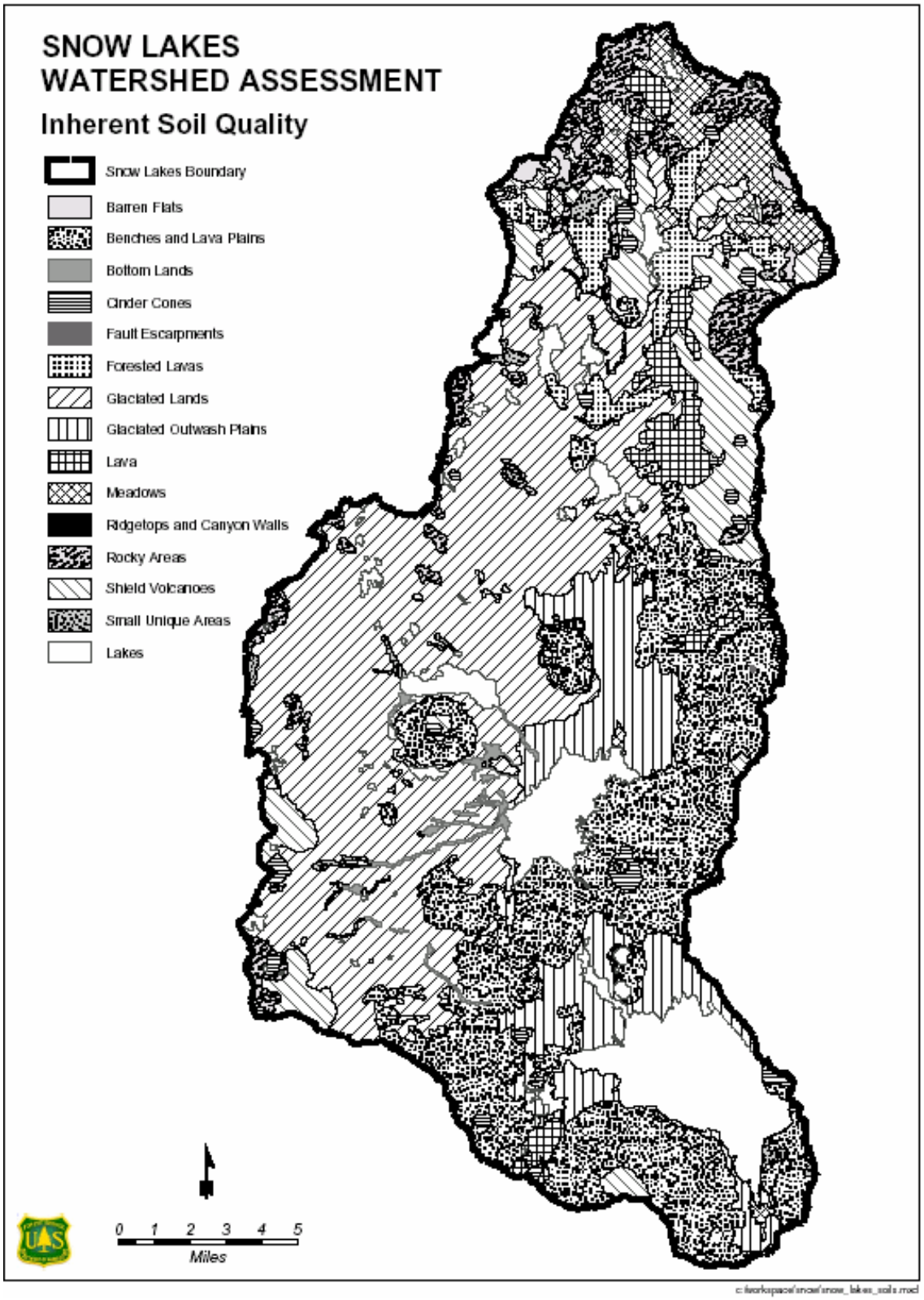
Sensitive Soil Types

Criteria for identifying soil types which are sensitive to management are listed in the Deschutes LRMP, Appendix 14, Objective 5 (page Appendix 14-2). These criteria include slopes over 30 percent, frost pockets, seasonal or year-long high water tables, extremely rocky areas, and soils that have high or extreme erosion hazard ratings. Sensitive soils within the project area include soils with seasonal high water tables, wind throw hazards, and soils on slopes greater than 30 percent. Approximately 39 percent (approximately 86,000 acres) of National Forest System land within the project area contain landtypes with localized areas of sensitive sols.

A sensitive soil rating was determined for different SRI mapping units (Larson 1976), based on a soils sensitivity to erosion, nutrient loss, and compaction. Data from the SRI was incorporated into a database to facilitate an evaluation of the susceptibility, resiliency, and overall sensitivity of each soil mapping unit delineation to the forces of erosion, nutrient loss, and compaction. Based on this analysis, soil mapping units were classified as being of low, moderate, or high sensitivity. A map of overall sensitivity of the soils in the watershed was created (Figure 6). Some mapping units are complexes of several mapping units and those sensitivities area reflected by the individual values for each separate mapping unit component i.e. low/high or low/moderate designations.

Most of the areas that are highly sensitive include places where there are harsh climatic conditions and the period of biological activity is sort. Higher sensitivity ratings also can be found in areas of the watershed where there are finer soil textures and few coarse fragments to resist the impacts. In the glaciated portion of the watershed, the depth to a restrictive layer, rock or compacted till, restricts rooting depth and results in less resilience and therefore higher sensitivity ratings.

Figure 6 Inherent Soil Quality, Snow Lakes Watershed Assessment Area.



Current Soil Conditions

Question:

- *How has the dynamic soil quality been affected by forest management activities?*

Harvest, reforestation and fuel treatment activities have been concentrated in the eastern half of the assessment area. These activities have left much of the area having compacted soils.

Soil compaction can affect the productivity of the soil in several ways. Soil compaction results in increases in the soil strength and increasing the resistance growing plant root experience. Soil strength measurements made using a recording soil penetrometer have shown increases in soil strength above that identified in soil literature as root growth limiting.

Soil compaction can also alter the soil pore size distribution resulting in a loss of the larger macro porosity. This in turn can affect both water and gas movement and storage in the soil and also influencing soil productivity.

Soil compaction can also alter the hydrologic function within a soil by reducing infiltration (water movement into the soil) and percolation (water movement through the soil) of water.

Many of the soil disturbance activities have also removed all or a portion of the nutrient and biologically rich surface soil horizons. Both soil compaction and the loss of surface soil horizons have reduced the soil quality and the ability of the soil to function in the most productive manner to enhance vegetative growth.

Recreational activities and user created roads have concentrated around water and riparian areas. As a result soil has been compacted and erosion and loss of vegetation is apparent in many of these areas.

Soil Condition Class

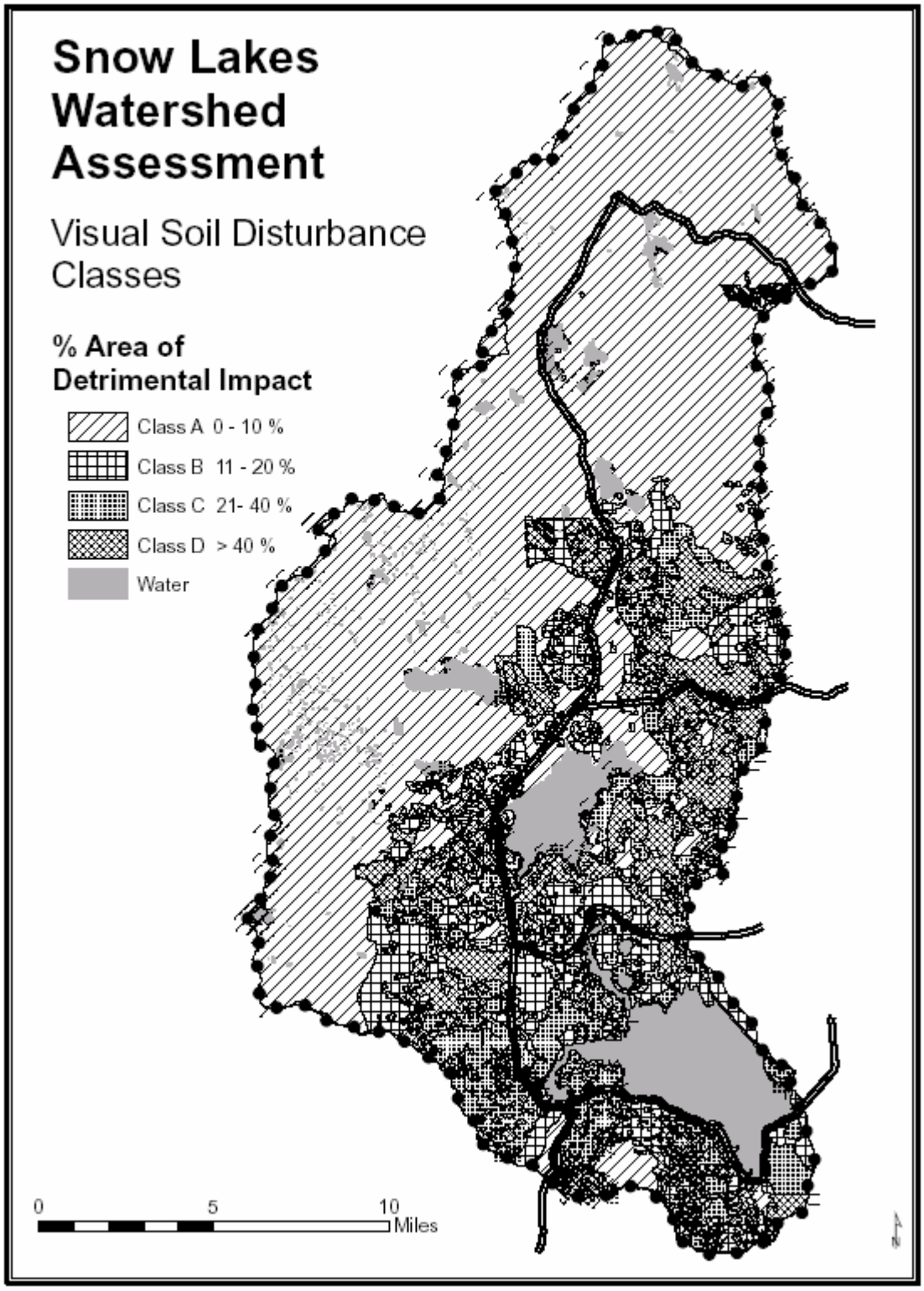
A determination of soil disturbance that has occurred due to past management activities in the watersheds was made. An aerial photo analysis was undertaken in 1994 (USDA, 1994). The analysis, including some verification of the photo interpretation, made the following determinations relative to detrimental soil impacts associated with past management practices:

- 56 percent in Soil Condition Class A = < 11 percent areal extent soil disturbance;
- 11 percent in Soil Condition Class B = 11-20 percent areal extent soil disturbance;
- 11 percent in Soil Condition Class C = 21-40 percent areal extent soil disturbance; and
- 14 percent in Soil Condition Class D = > 40 percent areal extent soil disturbance.

These figures relate only to that portion of the assessment area where the majority of the management activities have occurred.

Figure 7 displays the location and estimated current levels of detrimental soil impacts (compaction) associated with past activities. Neither the above figures nor the map reflect detrimental soil conditions associated with recreational activities or development.

Figure 7 Distribution and Estimated Levels of Detrimental Soil Impacts Associated with Past Management Activities, Snow Lakes Watershed Assessment Area.



Changes in Soil Conditions since Previous WA

Question:

- *Has there been a change in the dynamic soil qualities since the previous WA were completed?*

The primary soil disturbance that has occurred in the assessment area which could result in a reduction in soil quality or the ability of a soil to function in a desirable manner is soil compaction. In the past decade most of compacted soils that have resulted from vegetation management activities and or off road recreation activities have been treated by tilling the soil. The process is commonly referred to as subsoiling, a practice which is intended to reduce the high soil strength and restore soil macro porosity to compacted soils, thereby setting up the conditions for the soil to rehabilitate back to its non impacted condition over time.

Erosion Processes

Historic Reference Erosion Processes

Question:

- *What are the historic erosion processes within the assessment area (e.g., surface erosion processes, mass wasting)?*
- *Where have dominant erosion processes occurred in the assessment area?*

Current Erosion Processes

Questions:

- *What erosion processes are dominant within the assessment area (e.g., surface erosion processes, mass wasting)?*
- *Where are dominant erosion processes likely to occur?*
- *Are there signs of accelerated erosion in the assessment area?*

Erosional processes, both historic and current, within the assessment area are primarily surface in origin. Rain on snow events and high intensity summer thunderstorms are the primary mechanisms for sediment transport in the assessment area. They can produce sediment transport despite the rapid infiltration rates of the surface mineral soil component. Infiltration rates are offset in part by the low cohesion properties of the ash and pumice mineral soil. Soil particles are readily detached by raindrop impact and overland flow energies, especially in areas where bare mineral soil is exposed and slopes and impervious litter layers contribute to overland flow accumulations and rates. Natural erosion rates have been accelerated in the managed portion of this analysis area through such activities as road construction, timber harvesting, dispersed recreation, and off road vehicles (OHV).

Changes in Soil Conditions since Previous WA's

Question:

- *Has there been a change in accelerated erosion in the assessment area since the previous WA's were completed?*

Soil tillage (subsoiling) has been used throughout the assessment area over the past decade to rehabilitate compacted soils. This practice loosens compacted soil layers and increases water infiltration rates thus reducing the amount of water runoff resulting from soil compaction. This can in turn reduce the amount of soil erosion and sediment delivery to streams and other water bodies

Hydrology

As noted previously, the assessment area encompasses all or portions of two previously analyzed watershed analysis areas; Cascade Lakes in 1995 and Browns-Wickiup in 1997. Since those original analyses, new federal watershed delineation standards have resulted in watershed boundaries being updated with new boundary locations and watershed names. This assessment area includes 12 6th field HUCs and total approximately 222,510 acres. Nine (9) drain into Crane Prairie Reservoir and the Crane Prairie Watershed, a 5th field HUC. The other three (3) drain into Wickiup Reservoir and the Wickiup Watershed, a 5th field HUC. Both the Crane Prairie and Wickiup watersheds fall within the Upper Deschutes Subbasin, a 4th field HUC (Figure 8).

The Cultus Creek sub-watershed is identified as a Tier 2 Key Watershed in the NFWP. As such, it has the highest priority for restoration activities. However, prior to implementing management activities, the NWFP requires a watershed analysis to be completed. Special standards and guidelines that apply to this watershed are found on page c-7 of the record of Decision for the Northwest Forest Plan.

The Deschutes River, from the outlet at Wickiup Dam downstream to the urban growth boundary of Bend, is a federally listed Wild and Scenic River and State Scenic Waterway.

The assessment area include 633 lakes and ponds, two (2) reservoirs (Crane Prairie and Wickiup), 87 perennial and 135 intermittent stream miles, and 91 identified springs and seeps. These waterbodies encompass approximately 18,589 acres or 8.4 percent of the assessment area.

There is an abundance of spring complexes that form cool, clear streams. The porous soils, composed of ash and pumice overlain on glacial till, glacial outwash, and basaltic lava, absorbs and transfers precipitation subsurface (snow melt and rainwater) providing for extensive ground water exchange.

Historic Reference Hydrology

Question:

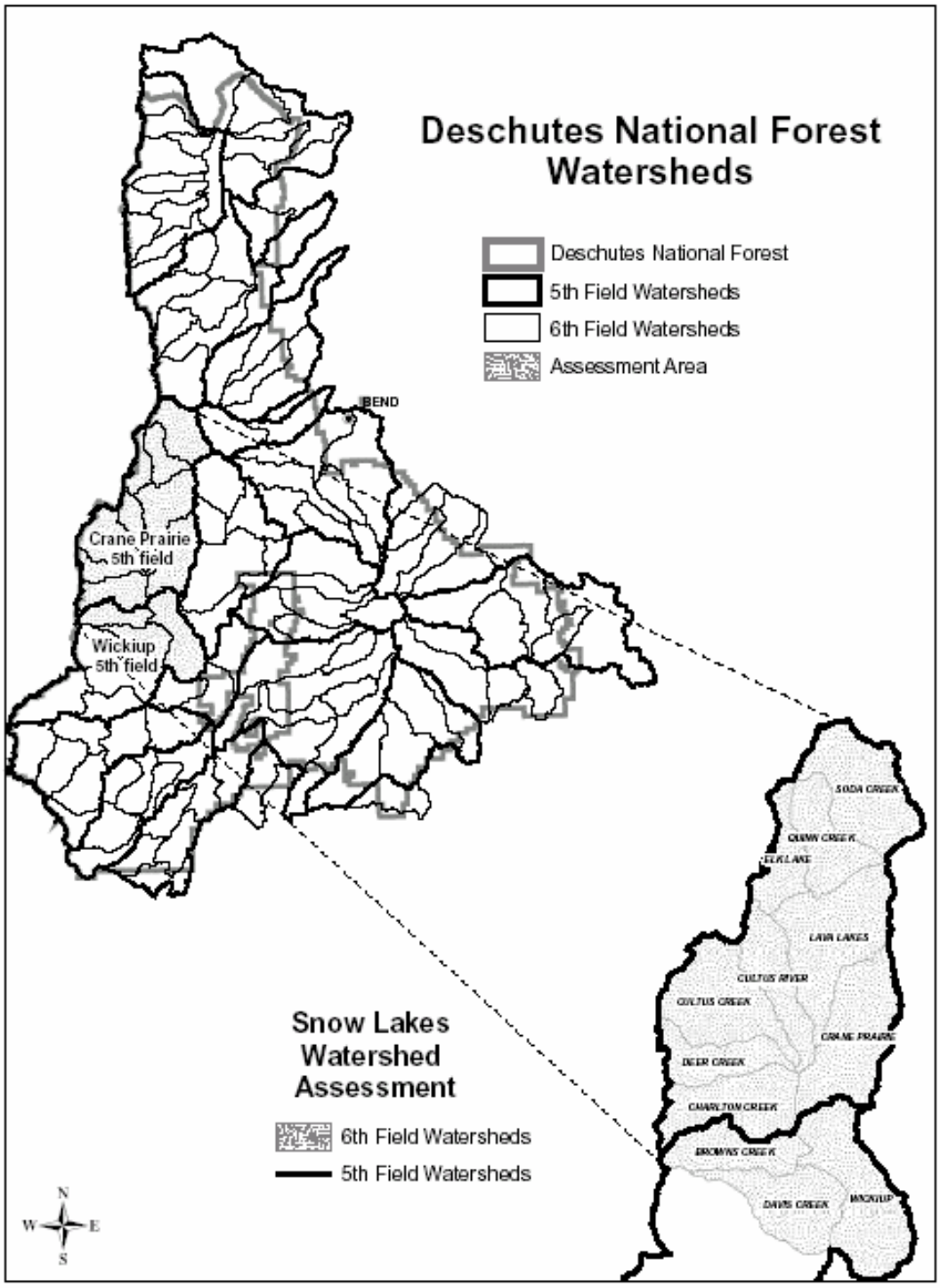
- *What are the historic hydrologic characteristics (e.g., total discharge, peak flows, minimum flows) and features (e.g., cold water seeps, ground-water recharge areas)?*

Precipitation within the assessment area varies widely, ranging from approximately 125 inches annually in the higher elevations to approximately 20 inches at the lowest elevations. Precipitation, particularly from the higher elevations, contributes to stream flow or becomes groundwater that descends south or east towards Wickiup Reservoir. Surface water exits the assessment area via the Deschutes River below Wickiup Reservoir.

Most streams are spring-fed with cold groundwater naturally high in concentrations of phosphorus. These streams maintain remarkably even flows throughout the year unless regulated by a dam.

The Deschutes River is a spring-fed system that has historically had very stable flows. As opposed to river systems that are dominated by surface runoff, a spring-fed river like the Deschutes has an incredibly stable natural hydrologic regime in which daily, monthly, and even annual fluctuations in water flows are minimal. A 1914 U.S. Reclamation Service report refers to

Figure 8 5th and 6th Field Watersheds, Snow Lakes Watershed Analysis Area.



the Deschutes River as "*one of the most uniform of all streams in the United States, not only from month to month, but also from year to year. The extreme minimum is usually in midwinter when it occasionally drops, for a few days only to (approximately) 1,100 cfs*" (USDA 1996).

The Deschutes River and its tributaries have not been greatly affected by floods throughout history. The high degree of permeability in the volcanic rock in the subbasin allows rain and melting snow to quickly sink into the ground and recharge the water table. This makes flooding less common than in other less stable and less permeable systems.

Little Lava Lake, elevation 4,739 feet, is the headwaters of the Deschutes River. The substrate varies from detritus to bedrock. Water in the lake is supplied by subsurface flows and springs on the north side of the lake. In extremely wet years, there is a surface connection between Little Lava and Lava Lake through an open channel (ODFW 1996). The source of recharge into the lake is primarily from the upslope groundwater. The groundwater originates in the snowfields of Mt. Bachelor and the Three Sisters mountains (Nielson et al. 1986).

Many lakes have formed from stream channels dammed by lava including Sparks, Elk, Lava, Little Lava, and Davis Lakes. Several, specifically Elk, Lava, and Little Lava Lakes, are fed by groundwater. Sparks and Elk Lakes have no surface outlets. Instead they discharge their water into cracks in the lava (US Forest Service WQRP, 2004).

Current Conditions

Questions:

- *What are the dominant hydrologic characteristics (e.g., total discharge, peak flows, minimum flows) and other notable hydrologic features and processes in the watersheds (e.g., cold water seeps, ground-water recharge areas)?*
- *What are the current conditions and trends of the dominant hydrologic characteristics and features in the watersheds?*

The historically stable flows of Deschutes River have been greatly altered in the past sixty years. Crane Prairie and Wickiup are two reservoirs that sit near the headwaters of the Deschutes River. Crane Prairie is located 13 river miles downstream from Little Lava Lake began regulating flows as early as 1922. Wickiup Dam, located 15 river miles below Crane Prairie, began influencing flows in 1945. Since that time, the Deschutes River has been a system modified and regulated in its water releases and flows. The river is managed year-round; water is stored in the two reservoirs during the winter in order to ensure sufficient water quantity for irrigation in the summer. As a result, the amount of surface flow and the seasonal fluctuations of flow in the Deschutes River are directly related to the water needs and demands of the irrigation season.

Crane Prairie is a 285 foot long, 36 foot high earthfill dam. The reservoir has a capacity of 55,300 acre-feet of water (BOR 2003). Three irrigation districts currently own water rights: Central Oregon, Lone Pine, and Arnold. A substantial amount of water leaks through lava at the reservoir, especially when near capacity. Dikes constructed in the 1960's on the east side of the reservoir had reduced an average seepage loss from 4,900 acre/feet to 1,700 acre/feet monthly when near capacity (McCammon, 1981 and Cascade Lakes WA, 1995)

The Wickiup Dam is a 2.5 mile long, 100 foot high earthfill dam with a rock face (BOR 2003). The reservoir is larger than the Crane Prairie Reservoir. When filling was initiated in 1942, the dam originally impounded 20,000 acre-feet of water. The capacity of the reservoir was increased until the maximum storage capacity of 200,000 acre-feet was reached in 1949. Water is stored

for irrigation purposes and water storage rights belong to the North Unit Irrigation District. The release of water is coordinated with the Oregon Water Resources Department. There is a seepage loss through the reservoir bottom, averaging 50 cfs (Brown WA, 1997)

Low flows as released from Wickiup Reservoir occur in the Upper Deschutes River during the fall, winter, and early spring in the reaches below the storage facilities. Because of these highly manipulated water releases during the summer, the Deschutes River experiences high flows as well as large fluctuating daily and monthly flows. During the November to March storage season, flows in the Deschutes River just below Wickiup Reservoir can drop to as little as 20 cfs. Conversely, during the April to October irrigation season, the river averages approximately 1,200 cfs as water is released from the reservoir (Breuner 2003). In 1996, the rising and falling ramping rates were adjusted to reduce turbidity levels in the spring and to reduce stranding of small fish and macro-invertebrates in the dewatered areas in the fall. The rates changed from 0.5 ft/day to 0.1 ft/4hrs rising and 0.2 ft/12hrs falling (USFS Wild & Scenic River, 1996).

Within the Soda Creek subwatershed, the Crater Creek canal diverts water from Crater Creek into the Tumalo Creek drainage, located outside of the assessment area boundary. The water rights in the canal, in operation since 1914, are owned by the Tumalo Irrigation District. The canal generally supplies water from July to October at a maximum flow of 20 cfs. The canal provides from 3-4,000 acre-feet of water annually (Bend WA, 1998).

Past research studies have demonstrated that harvest of watersheds can alter the quantity and timing of stream flow. However, in this assessment area, the high soil porosity and infiltration rates resulting from the volcanic soil and geologic conditions do not show signs of increases in either stream flow or surface erosion. Changes in steam flow, yield and timing associated with harvest are likely immeasurable.

Additional information regarding both the Reference and Current Hydrology Conditions can be found in the 1995 Cascade Lakes Watershed Analysis and the 1997 Browns-Wickiup Watershed Analysis.

Stream Channels

Historic Reference Condition

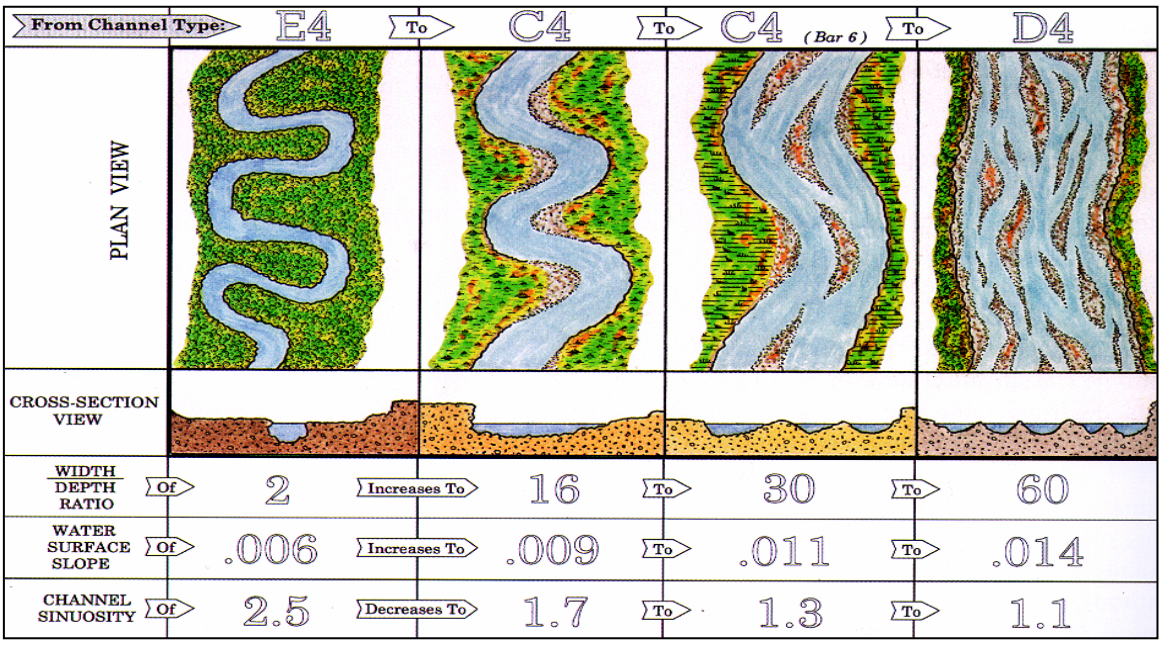
Questions:

- *What were the historic morphological characteristics of stream valleys and general sediment transport and deposition process in the assessment area?*
- *What are the potential water quality, riparian condition, and stream channel morphology impacts if a large high intensity fire occurs?*

Stream channels reflect the effects of current climate, lithology, erosional processes, stream flow regimes, and the effects of broad vegetation zones. These factors establish the basic morphology of a fluvial system because they change slowly. Management activities can alter the morphology of a system by changing the factors that form the channel such as flow conditions and erosional processes. A stream classification system has been developed to form a common language to differentiate the various types of channels occurring in nature and to better understand channel changes (Rosgen, 1996).

The Rosgen stream classification utilizes valley confinement or entrenchment, stream width to depth ratio, sinuosity, slope, and channel material to determine a stream type. These are illustrated by Figure 9.

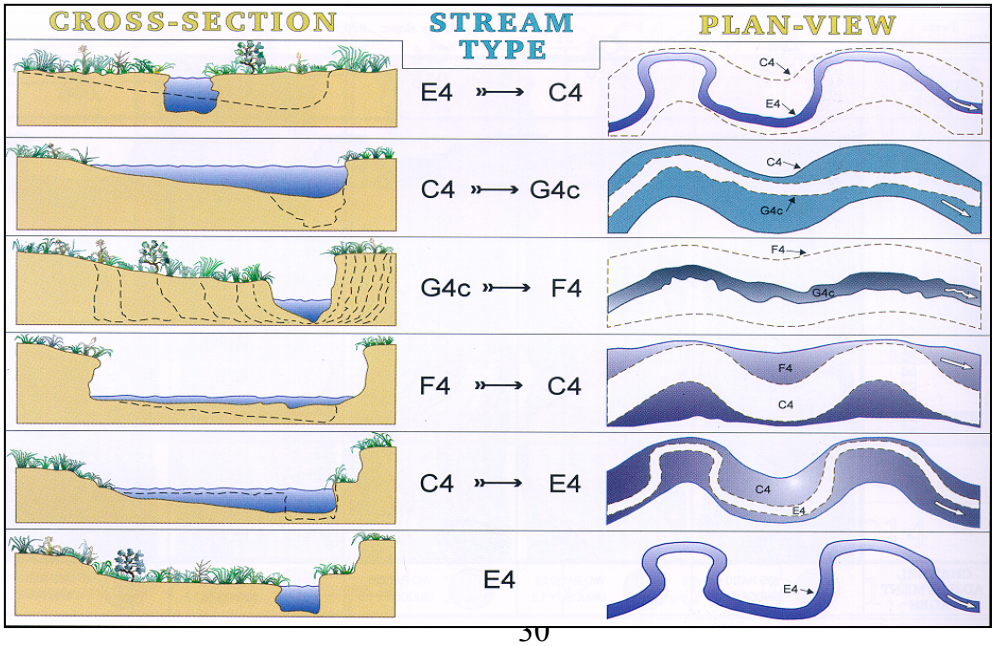
Figure 9 Evolutionary Stream Channel Changes Associated with Streambank Alternation (Rosgen 1996).



The various stream types have a varying degree of sensitivity to disturbance, recovery, sediment supply, potential stream bank erosion, vegetation controlling influence (table xx in the back of the Rosgen book). **What table?**

As channels and watershed encounter management activities the channels adjust to changes in disturbance to achieve a new equilibrium. The channels go through evolutionary processes to achieve this new equilibrium based on changes to the erosional processes, stream flow regimes, and vegetation zones depending on **Depending on What?** These changes are illustrated in Figure 10.

Figure 10 Stream Channel Changes Associated with Changes in Stream Types (Rosgen 1996).



Current Condition

Question:

- *What are the current conditions and trends of stream channel types and sediment transport and deposition processes prevalent in the assessment area?*

Changes in Conditions since Previous WA's

The hydrology in the assessment area has not measurably changed since the original analyses were completed in 1995 and 1997. In 2003 and 2004 the dam on Wickiup Reservoir was improved by incorporating safety designs to handle earth quakes. These improvements did not change the flow regulation of the dam.

There has been a large increase in beetle-killed lodgepole pine within the Riparian Reserves of Snow Creek and the Deschutes River upstream of Crane Prairie to the headwaters at Little Lava Lake. Many of these trees have fallen into the river, providing additional bank roughness and an increase in bank stability. However, due to the fuel loading associated with the deadfall, a large-scale fire of high severity could occur within these areas. This could potentially lead to adverse effects to channel stability and morphology. These include short-term and long-term increases in water temperature as shade is decreased, loss of streambank stability, loss of overhead cover from streambank vegetation, loss of long-term large woody recruitment, and chronic fine sediment input. Tumalo Creek, in an adjacent watershed, experienced an increase in instability following a 1979 wildfire which burned through the riparian area and was subsequently salvage logged.

There would be an increase in short-term large woody material recruitment as a result of a fire, but, under current conditions, instream large woody material is sufficient and is not limiting fish populations. The 1998 stream survey of the Upper Deschutes River and the 2003 Snow Creek stream survey documented approximately 180 and 194 pieces of large wood/mile, respectively. The majority of these pieces were in the small diameter category, a characteristic of the surrounding lodgepole pine forest that seldom reaches larger diameters. These numbers have likely increased in recent years following the surveys due to increased deadfall.

Table 6 displays stream attributes of selected streams and stream reaches within the assessment area. The lack of data for a particular stream or stream reach is indicated with "NA".

Table 6 Stream Attributes for Selected Streams, Snow Lakes Watershed Analysis Area.

Stream Name	Survey Date	Survey Distance (mi)	Flow Min/ Max (cfs)	Channel Gradient	% Pool Habitat	BF W/D Ratio	Total Pieces Wood/mi	Rosgen Channel Type	Entr. Ratio	Bank Stability	Wolman D50 (mm)
Cultus Cr (Reach 1)	5/97	1.9	0/336	1.3	25	12.2	223	B3	3.8	97.3	25.4
Cultus Cr (Reach 2)	5/97	0.9		2.7	21	16.9	320	B4	1.9	100	29.2
Cultus River	6/97	1.6	26/177	0.5	26	69.1	402	C4	>4*	100	11.5
Deer Cr (Reach 1)	6/89	1.7	0/200	1	31	11.6	NA	C4/5	NA	>95%*	NA
Deer Cr (Reach 2)	6/89	1.0		3.8	20	10.2	536	B3	NA	>95*	NA
Deschutes above CP (Reach 1)	6/98	4.2	40/480	0.5	14.2	23.2	160	C4	6.6	98.3	32.5
Deschutes above CP (Reach 2)	6/98	2.8		1.0	1	32.5	160	C3/4	2.1	99.7	44.1
Deschutes aboveCP (Reach 3)	6/98	1.5#		1.6	5.5	57.6	216	C3	1.3	99.7	95.1
Deschutes below CP (Reach 1)	10/ 2003	0.9	0/1170	0.4	2.2	37.7	102	C4	4.6	95.1	19.1
Deschutes below CP (Reach 2)	10/ 2003	0.7		2.4	12.7	45.9	240	B2/3	1.4	100	291.8
Snow Cr (Reach 1)	7/2003	4.2	21/44[1]	0.5	30	17.8	167	C4/5	12.2	99.8	4.2
Snow Cr (Reach 2)	7/2003	1.4		1.1	30	24	221	B4	1.7	99.7	37.6
Quinn Cr (Reach 1)	5/92	0.5	35[1]	1	6.5	14[2]	181	C4/5	NA	>95*	NA
Quinn Cr (Reach 2)	5/92	0.6		2	1.4	15[2]	274	B4/5	NA	>95*	NA
Quinn Cr (Reach 3)	5/92	0.3		<1	0	16[2]	564	C5	NA	>95*	NA

[1] **Limited Data**
[2] **Estimated Value**

Water Quality and Quantity

Historic Reference Water Quality

Question:

- *What were the historical water quality characteristics of the assessment area?*

The previous watershed analyses recommended several projects to restore or protect riparian areas impacted by recreational use. Water quality would be improved by reducing sedimentation, nutrient inputs, and increase shade. Several projects were approved under the 1997 Cascade Lakes Restoration EA and the 2002 Charlie Brown EA. Projects completed to date include replacement of many pit or vault toilets with new vaulted toilets, closing of overnight use along most of the Upper Deschutes River, closure of several dispersed sites around Wickiup and Crane Prairie Reservoirs, Cultus Lake, and Hosmer Lake, relocation of developed campsites near water, control of parking at several boat ramps, designation of dispersed campsites at several lakes, closure of user-created trails, and closure of system and user-created roads within Riparian Reserves.

Most lakes in the assessment area have a low buffering capacity to acid deposition, the potential source being acid rain. The Deschutes National Forest is tracking water quality, in part to track changes that may be attributable to acid deposition and chemical and biological changes in response to potential cultural eutrophication.

The natural lakes were formed predominantly by glacial scouring or lava flows blocking streams. The trophic statuses of the lakes range from eutrophic/mesotrophic Lava Lake to ultra-oligotrophic lakes such as Cultus Lake. However, lakes within the watershed are predominantly oligotrophic lakes, being low in nutrients, ionic concentrations, and high in transparency, and are susceptible to changes in water chemistry and biological productivity from recreational pressures.

The Cascades Lakes WA recommended monitoring of water quality of several lakes, specifically Elk, Cultus, Todd, Charlton, Irish, Taylor and Green Lakes, at regular interval, 3-5 years. Since the that analysis was completed, water chemistry and plankton sampling monitoring has occurred on Elk Lake in 1997-98, and Cultus Lake in 1997 and 2002. Funding for lake monitoring has declined since the analysis was completed and is presently non-existent. Additional monitoring within the watershed occurred at Crane Prairie Reservoir in 2002, North Twin in 1999, and Hosmer Lake in 1996 and 2003. Lava Lake was monitored in 2004 by ODEQ and Max Depth Aquatics related to a Total Daily Maximum Load assessment for nutrients. In addition, several wilderness lakes within the watershed were monitored. Baseline conditions for chemical and biological conditions were established for many of these lakes.

Water quality monitoring on lakes within the watershed has occurred infrequently in the past, therefore data is incomplete. No conclusive evidence could be drawn that water quality in the surveyed lakes had changed since prior monitoring was completed. Compounding the assessment of trends in water quality is the annual and seasonal changes in lake conditions. See Tables xx in Appendix xx for lake water quality data.

Since completion of the Browns/Wickiup WA in 1997, off-highway vehicle (OHV) use has increased significantly below the high water line in the southeastern portion of Wickiup Reservoir. Mud-bogging is the most disruptive OHV activity. Resources adversely affected include wetlands, riparian vegetation, soils, wildlife (including birds, mammals, and amphibians), and pre-historic sites. Activities may be spreading noxious weeds and creating suitable weed conditions through soil disturbance. Water seepage loss through the reservoir bottom may be

increasing because of perturbation to the natural substrate sealant. Measurable changes in turbidity are not expected because of the settling effect of suspended sediments within reservoir. Toxins such as oil and gas are likely being introduced but concentrations may be undetectable because of dilution within the 200,000 acre-foot reservoir.

Current Water Quality

Questions:

- *What are the beneficial uses dependent on aquatic resources in the assessment area?*
- *What are the natural and human causes of change between historical and current water quality conditions?*
- *What are the effects of recreation and facilities on water quality?*
- *Where are the current Oregon Department of Environmental Quality (DEQ) 303(d) listed impaired water bodies, as required by the Environmental Policy Act (EPA) and the Clean Water Act, and the associated cause?*
- *What are the effects of Blue/Green algae on water quality?*
- *What are the potential water quality, riparian condition, and stream channel morphology impacts if a large high intensity fire occurs?*

The 1972 Federal Water Pollution Control Act, or Clean Water Act, aims to restore and preserve the chemical, physical, and biological integrity of the nation's waters. Oregon has integrated the goals of the federal Clean Water Act into state Water Quality Standards. Implementation and enforcement of the Clean Water Act now rests with the U.S. Environmental Protection Agency (EPA).

The Clean Water Act directs the states to adopt and review water quality criteria as necessary to protect beneficial uses of waters of the state. Each state is then supposed to evaluate water bodies in the state and compile a list of all of the water bodies that do not meet the state's water quality standards. These standards are described using both numeric criteria and narrative statements. The water bodies that do not meet the standards are considered to be *water quality limited* and are placed on the state's 303(d) list (called the 303(d) list from Section 303(d) of the Clean Water Act).

The Oregon Department of Environmental Quality (ODEQ) has defined certain water quality standards which include the beneficial uses for streams, the criteria needed to protect beneficial uses, and the methods and policies that should be used to implement the standards. The following list identifies the specific uses for which water is to be protected in the Deschutes River Basin. Aquatic life, particularly salmonid spawning and rearing, is considered one of the most sensitive beneficial uses in the subbasin.

- ✓ Public and Private Domestic Water Supply (With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards);
- ✓ Industrial Water Supply;
- ✓ Irrigation;
- ✓ Livestock Watering;
- ✓ Anadromous Fish Passage;
- ✓ Salmonid Fish Rearing;
- ✓ Salmonid Fish Spawning;
- ✓ Resident Fish & Aquatic Life;
- ✓ Wildlife and Hunting;
- ✓ Fishing;

- ✓ Boating;
- ✓ Water Contact Recreation; and
- ✓ Aesthetic Quality

Table 7 lists the relevant 303(d) measurement standard and the beneficial uses of surface waters in the Deschutes basin that are impacted.

Table 7 Water Quality Measures and Impacted Beneficial Uses, Deschutes River Basin.

303(d)Measure	Impacted Beneficial Use
chlorophyll *a*	Public/Domestic/ private/ industrial water supply; Livestock Watering; Fishing; Water Contact Recreation; Aesthetic Quality
Turbidity/ Sedimentation	Public/Domestic/ private/industrial water supply; Resident Fish and Aquatic Life; Aesthetic Quality
D.O.	Resident Fish and Aquatic Life
Temperature	Resident Fish and Aquatic Life
pH	Resident Fish and Aquatic Life; Fishing; Water Contact Recreation; Aesthetic Quality

The 2002 list of impaired water bodies and associated parameters that fall within or near the Snow Lakes WA are Lava Lake listed for dissolved oxygen from June 1 to September 30 and below Wickiup Reservoir the Deschutes River is listed for sediment dissolved oxygen and turbidity. The 2004 list is in draft and expected to be out spring 2006.

The Deschutes River between Wickiup and Crane Prairie was listed as impaired for temperatures exceeding state standards in 2000; however, since the data was collected during drought years this section of stream was removed in the 2002 listing.

Recreation usages around waterbodies, whether it be dispersed or developed, are potential sources of nutrient and sediment input. Campsites and trails next to streams and reservoirs lead to accelerated surface erosion and have the potential to decrease bank stability. Failing pit or vault toilets in developed campgrounds or septic systems at resorts are also potential sources of nutrients.

Large volumes of fine sediment from post-fire episodic events would not likely occur due to generally gentle slopes and porous soils on the landscape. A large scale fire could increase nitrogen and phosphorus inputs to Lava Lake, Crane Prairie Reservoir, and subsequently Wickiup Reservoir, which could lead to increased blue-green algae blooms.

Additional information regarding Reference and Current Water Quality Conditions can be found in the initial watershed analyses; Cascade Lakes (1995) and Browns-Wickiup (1997).

Changes in Water Quality since Previous WA's

Increased recreational usage! (Refer recreation number increase).

Dispersed campsite improvements? Access roads obliterated? (see Browns WA page chap 3&4-13.

Increased OHV use below maxium storage capacity during summer draw down is drawing concern.

Blue-Green Algae Blooms

Significant numbers of potentially toxic cyanobacteria (blue-green algae) were discovered in Lava Lake and Crane Prairie Reservoir during the summer of 2003. These lakes were first sampled in response to recent blue-green algae blooms occurring on Diamond Lake located on the Umpqua National Forest to the south of the assessment area (Eilers, 2003, personal communication). The blooms at Lava Lake and Crane Prairie Reservoir included populations of *Anabaena flos-aquae,* which can produce anatoxin-a, a neurotoxin attacking the nervous system, and also microsystin, a hepatotoxin attacking the liver. This resulted in an intensive monitoring program on several lakes within the assessment area during the summer of 2004.

Table 8 summarizes the results of monitoring conducted in these lakes during 2004 and 2005.

Table 8 Monitoring Results of Selected Lakes for Cyanobacteria in Selected Lakes, Snow Lakes Watershed Analysis Area, 2004-2005.

Lake Name	Native Fish Species Present	Legally Introduced Fish Species	Illegally Introduced Fish Species	Year	Maximum BGA Cell Densities (cells/mL)	Maximum Microsystin Concentration (ug/L)
Crane Prairie Reservoir	RDB, WF	KS, RB, BKT	SB, TC, BC, BG, LB	2004 2005	670, 863 170, 478	7.42
Lava Lake	WF	BKT, RB	TC	2004 2005	70,893	0.68
Little Lava Lake	WF, RDB	BKT, RB	TC	2004	4233	NT
Todd Lake	NA	BKT	NA	2004	1650	NT
Wickiup Reservoir	RDB, WF	BKT, RB, BT, KS, CS	SB, TC, BC, BG, LB, BB	2004 2005	50,358	2.92

Monitoring revealed that several lakes within the assessment area, specifically Lava Lake, and both Crane Prairie and Wickiup Reservoirs, experienced algae blooms significant enough to warrant the posting of public health advisories. Monitoring also included Hosmer, Little Lava, South Twin, and Todd Lakes which all contained *Anabaena flos-aquae* at some time during the summer, but at densities below triggering posting of a health advisory. Elk Lake was also tested once but no blue-green algae species were identified.

Toxins produced by blue-green algae are referred to as cyanotoxins. Cyanotoxins most likely to be found from Central Oregon lakes are microsystin and anatoxin - a (W. Carmichael, personal communication 2004). Analysis on several samples collected from Deschutes National Forest lakes in 2004 revealed the presence of microsystin in Lava Lake and both Wickiup and Crane Prairie Reservoirs. It was present in very low concentrations (<1 ug/L) in three samples tested at Lava Lake; ranged from <1 ug/L to 7.42 ug/L at Crane Prairie Reservoir; and was not detected in two samples and at 2.92 ug/L in a third sample from Wickiup Reservoir. The Oregon Department of Human Services has included a threshold of <8 ug/L of microsystin concentration for guidance in lifting of public health advisories. Anatoxin-a was not detected in any sample from any of the tested lakes.

Recent blue-green algae blooms at Diamond Lake (Umpqua National Forest) and Odell Lake (located on the Deschutes National Forest to the south of the assessment area), are both linked to

changes in fisheries populations (Eilers, et al, 2003, 2005a). The blooms at Diamond Lake were likely the result of optimal climatic conditions in conjunction with trophic changes stemming from large populations of non-native tui chub. The chubs are thought to enhance the blooms in two possible ways: (1) by reducing the number of larger sized zooplankton that reduce algal cells through grazing, and (2) by increasing the nutrient concentration through excretion of nitrogen and phosphorus in forms available for algal growth (Eilers, et al, 2003). At Odell Lake, the non-native planktivorous kokanee salmon population is abundant and appears to have altered the trophic status of the lake in mechanisms similar to tui chub at Diamond Lake, favoring conditions for blue-green algae blooms (Eilers, 2005a). Effects to the trophic status appear to be related more to increases in nutrient concentrations than reducing the zooplankton population.

Tui chub have inhabited Lava Lake since some time prior to 1940 (Newcombe, 1941) and have long been an impediment to the trout sport fishery; however, their presence is not the dominant mechanism driving blue-green algae blooms (Eilers, et al 2005b). Nearly all the inputs of phosphorus and nitrogen are derived from precipitation and lake-bottom springs and only a small percentage by fish (Eilers, et al 2005b). Data from lake-bottom sediment core samples revealed far greater *Anabaena* densities in the past than in recent times. Reliable dating of the core sample was not attainable before about 1825, but at that time *Anabaena* was relatively abundant in the sediments and at some time prior had been much more abundant. *Anabaena* remained relatively stable for nearly 100 years after the peak near 1825 before undergoing fluctuations in abundance to the present time (Eilers, et al 2005b). Periodic fluctuations in groundwater spring discharge, which can change with tectonic activity in the fractured basalts and andesites that make up the terrain surrounding the lake, likely accounts for fluctuations in phosphorus input and *Anabaena* densities (Eilers, et al 2005b). The lake became more biologically productive in the 20th century which may be attributable to increased groundwater discharge (Eilers, et al 2005b).

Lava Lake has been treated with rotenone several times with rotenone in the past in an attempt to eliminate the tui chub population. Presently, an annual netting operation is performed by the resort owners (ODFW, 1996). This annual netting program may be having some beneficial effects to limiting blue-green algal blooms by reducing predation on phytoplankton-grazing zooplankton (J.Eilers, personal communication, 2006).

Crane Prairie Reservoir contains a diverse array of warmwater and coldwater fisheries dominated by a very abundant population of the non-native planktivorous three-spined stickleback, a moderate population of introduced kokanee salmon, and populations of other native and non-native salmonids and non-native centrarchids. Wickiup Reservoir also is inhabited by numerous native and non-native warmwater and coldwater populations. Contained within is an abundant population of introduced kokanee salmon, other native and non-native salmonids, non-native tui chub, centrarchids, and brown bullhead. The fish populations are likely influencing the nutrient cycling and trophic status of these lakes (J.Eilers, personal communication 2006), and possibly enhancing blue-green algae blooms. These interrelationships have not been researched to date.

Although toxic algae blooms can be associated with significant fish kills, none were observed at any of the lakes within the assessment area in 2004-2005. Fish kills are difficult to ascribe directly to the presence of cyanotoxins (WHO, 1999). Cyanotoxins appear to be more hazardous to terrestrial mammals than to aquatic biota (WHO, 1999). Fish kills may be the result of depleted dissolved oxygen concentrations when algae cells decompose (WHO, 1999).

Microsystins bioaccumulate in common aquatic vertebrates and invertebrates, including fish (WHO, 1999). Health risks to humans consuming fish with microsystin accumulation is not well understood, but common advice given by public health authorities is viscera not to be consumed

and caution taken for consumption of fish from waterbodies experiencing major blue-green algae blooms (WHO, 1999).

Biological Domain

Vegetation

Current and Historic Conditions

Introduction

Vegetative composition is an important feature in understanding and evaluating the physical, biological, social, and economic processes occurring in the assessment area. Interactions among processes of climate, geomorphology, succession and disturbance events yield changes in vegetative composition including structure, species, and density. Disturbance events include insect attacks, disease infestations, wind storms, fire, and management activities of humans. Succession and disturbance continually work in concert to change the landscape condition, both in terms of distribution and structure, as well as processes and ecological function.

The following summary from the Browns/Wickiup analysis (Chapters 3 and 4, page 16, 1997) provides an accurate assessment of current conditions compared to historic conditions within the Snow Watershed Assessment area:

> *Over the last several decades there has been a pronounced shift in forest structure, density, and species composition for a large proportion of the watershed analysis area…. This is particularly true within the dry forest plant association groups (dry mixed conifer and ponderosa pine…), where frequent, low-intensity fire played an active role in shaping species and structural composition. Within the last century, these once relatively stable and fire resistant forest communities have been replaced by dense, multi-storied stands of fire susceptible species…. Landscapes once dominated by open stands of large trees have been replaced by crowded stands of all sizes.*
>
> *Additionally, species composition of these forest types has shifted from the fire resistant species such as ponderosa pine, to the more ephemeral lodgepole pine and true firs.... To aggravate the shift from shade intolerant species (e.g., ponderosa pine) to shade tolerant species (e.g. white fir), selective harvest typically removed the intolerant species, allowing the more tolerant species to flourish. Shifts in composition, for both structure and density, as well as in species, has largely been the result of an active fire exclusion program, in addition to the selective harvesting pattern spanning over the last 80 years.*

Plant Association Groups

The distribution of plant association groups (PAGs) and non-forest groups within the assessment area are displayed in Table 6 and Figure 9. Plant association groups combine plant associations (Volland, 1995) by their climax species, site potential, and temperature and moisture similarities. A listing of how plant associations are grouped into PAGs can be found in Appendix C of the Deschutes National Forest Watershed Evaluation and Analysis for Viable Ecosystems (USDA Forest Service, 1994). The dominant PAGs within the assessment area include mountain hemlock (29 percent), mixed conifer, dry and wet (27 percent), and lodgepole pine, dry and wet (24 percent). Ponderosa pine, wet and dry, makes up a relatively small proportion of the assessment area (6 percent). Approximately 12 percent of the assessment area is classified as non-vegetated.

Lodgepole pine (*Pinus contorta*) is found throughout the assessment area and can be found in varying amounts within all the dominant PAGs. *(Note: Exhibit 17 of Cascade Lakes Watershed*

Analysis portrays the extensive nature of lodgepole pine within the assessment area.). Other conifer species commonly found include mountain hemlock (*Tsuga mertensiana*), subalpine fir (*Abies lasiocarpa*), ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), and Douglas Fir (*Pseudotsuga menziesii*). Western white pine (*Pinus monticola*), whitebark pine (*Pinus albicaulis*), and Engelmann spruce (*Picea engelmannii*) are found less commonly within the assessment area. Shade tolerance and relative fire resistance of these species are summarized in Tables 7 and 8, respectively.

Insects and Disease Agents

The following summary from the Browns/Wickiup analysis (Chapters 3 and 4, page 21, 1997) accurately summarizes insect and disease conditions in the Snow Watershed Assessment area:

> *Insects have the potential to cause substantial vegetative changes, causing landscape patches and patterns to emerge. Currently, mixed conifer stands are imminently susceptible to defoliator insect attacks, as well as to those by bark beetles. Although there is no certainty of these events occurring, there is a greater predisposition for outbreaks to occur, relative to other forest vegetative composition, structure, and density. If an outbreak of defoliator or bark beetle species occurs at an epidemic level, then large patches may be created across the landscape...*
>
> *Root pathogens, in addition to insects, have also contributed to landscape patterns and patches. As a root center expands, trees on the edges of openings become susceptible to infection and ultimate mortality. Over time, these openings become susceptible to infection and ultimate mortality. Over time, these openings are colonized by species more resistant to root disease, thus regenerating a new stand of different composition. Lodgepole pine and western white pine are shade intolerant species typically more resistant to root pathogens than the shade tolerant firs, thus allowing a mechanism that promotes species diversity over successional advance. Root disease pockets are easily observed in aerial photography within the mountain hemlock zone (Note: The Cascade Lakes Watershed Analysis (1995, Chapter II, Exhibit 23) includes a copy of an aerial photo depicting root disease pockets caused by laminated root rot).*

Table 9. Plant Association Groups, Snow Watershed Assessment Area.

Plant Association Group (PAG)	PAG	Acres	Percent of Assessment Area	Percent of Vegetated Area
Alpine Meadow	AMDW	2,602	1.2 percent	1.3 percent
Alpine Dry	ALPD	93	<0.1 percent	<0.1 percent
Meadow	MDW	1,615	0.7 percent	0.8 percent
Riparian	RIP	323	0.2 percent	0.2 percent
Alpine Shrub	ALSH	126	0.1 percent	0.1 percent
Mesic Shrubland	MSHB	954	0.4 percent	0.5 percent
Lodgepole pine Dry	LPD	33,367	15.0 percent	17.0 percent
Lodgepole pine Wet	LPW	20,612	9.3 percent	10.5 percent
Mixed conifer Dry	MCD	55,336	24.9 percent	28.2 percent
Mixed conifer Wet	MCW	4,439	2.0 percent	2.3 percent
Mountain Hemlock Dry	MHD	64,472	29.0 percent	32.8 percent
Ponderosa pine Dry	PPD	8,128	3.7 percent	4.1 percent
Ponderosa pine Wet	PPW	4,364	2.0 percent	2.2 percent
Whitebark pine Dry	WBPD	142	0.1 percent	0.1 percent
Vegetated Area Subtotal		196,573	88.5 percent	100.1 percent
Cinder	Cinder	1,277	0.6 percent	---
Lava	Lava	2,904	1.3 percent	---
Rock	Rock	2,266	1.0 percent	---
Water	Water	18,903	8.5 percent	---
Glacier	Glacier	228	0.1 percent	---
Non-vegetated Area Subtotal		25,578	11.5 percent	---
Assessment Area Total		222,151	100 percent	---

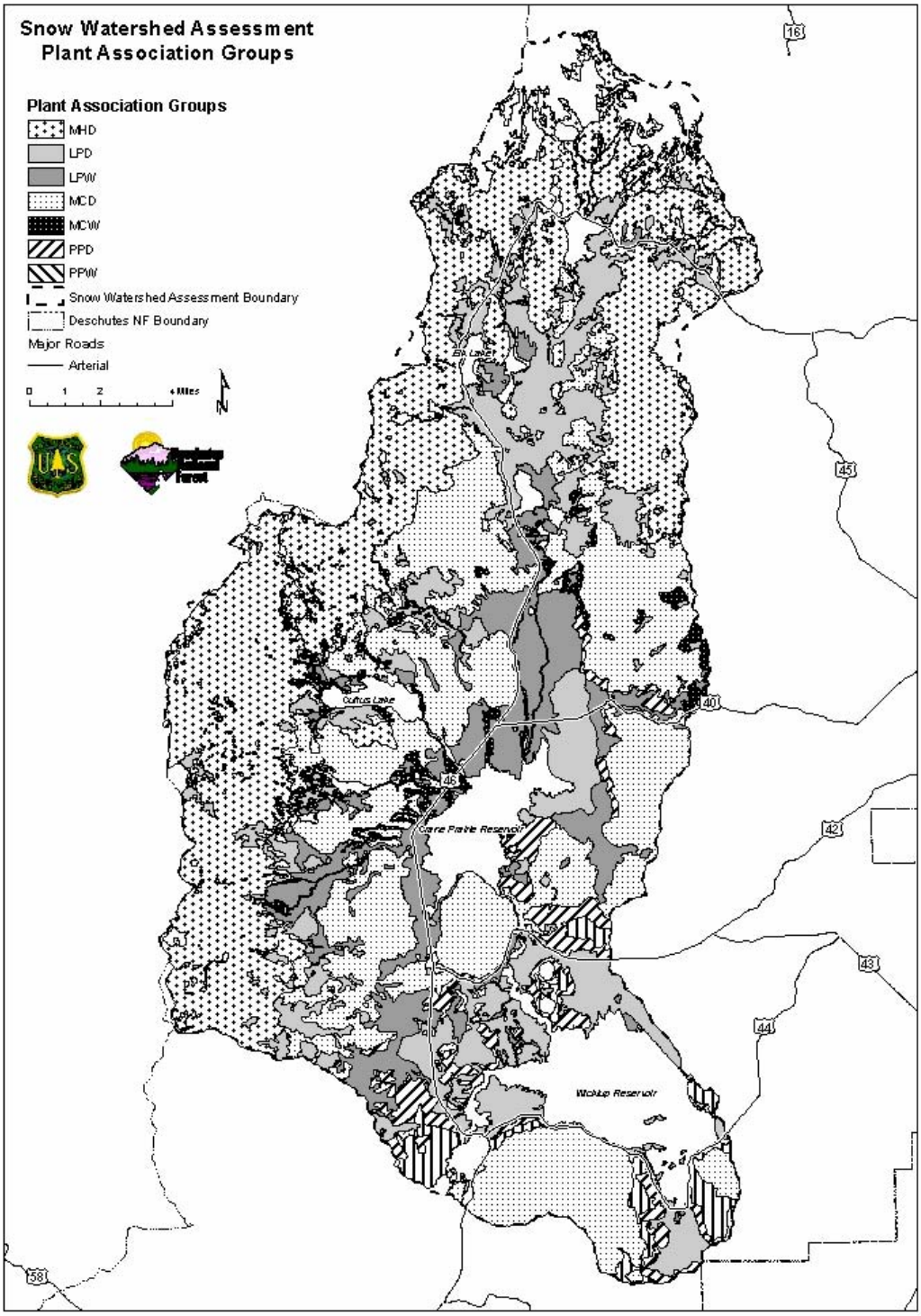
Table 10. Common Shade-Tolerant/Intolerant Tree Species, Snow Lakes Watershed Assessment Area (from Browns/Wickiup WA, Chapters 3 & 4, page).

Shade-tolerant Tree Species	Shade-intolerant Tree Species
White fir (WF)	Interior ponderosa pine (PP)
Douglas-fir (sometimes) (DF)	Douglas-fir (sometimes) (DF)
Mountain hemlock (MH)	Lodgepole pine (LP)
Engelmann spruce (ES)	

Table 11. Relative Fire Resistance of Tree Species at Maturity. Species Listed in Decreasing Order of Resistance (Agee 1993).

Tree Species	Most common way of killing
Douglas-fir (Most resistant)	Crown fires
Ponderosa pine	Crown fires
White / grand fir	Root char, crown fire
Mountain hemlock	Root char, crown fire
White pine	Scorching cambium or crowning
Lodgepole pine	Scorching cambium or crowning
Engelmann spruce (Least resistant)	Root char, scorching cambium, crowning

Figure 11 Plant Association Groups, Snow Lakes Watershed Analysis Area.



Mountain pine beetles have been the most significant agent of mortality in recent years (Eglitis, 1996). Large expanses of lodgepole pine stands have succumbed to these insect attacks, from the 1980's to the present, with shifting "hot spots" occurring each year. Lodgepole pine dry and wet PAGs have been hardest hit, and interspersed mortality has shown up in the ponderosa pine dry, mixed conifer dry, and some high-density mountain hemlock PAGs as well.

The Cascade Lakes Watershed Assessment (1995) stated that mountain pine beetle attack of the lodgepole pine forests as well as the lodgepole pine component of the mixed conifer forests had intensified during the preceding 5 years (page 32). The assessment also noted that beetles had been attacking lodgepole pine in PAGs other mixed conifer dry (page 42). The assessment stated that mortality was high along scenic corridors and around developed recreation areas such as Cultus Lake and the Cascade Lakes Scenic Byway (page 32). Increasing attacks around Lava Lake, Elk Lake and Hosmer Lake had also been reported several years preceding the assessment (page 42). Mountain pine beetle activity was estimated as occurring on approximately 40 percent of the lodgepole pine dry acres (page 49) and 60 percent of the lodgepole pine wet acres (page 52). The assessment stated that stands at risk or under attack would be dramatically altered over the following decade. The assessment projected that a majority of the lodgepole pine stands would revert to an early seral condition, considering that mountain pine beetle attacks in lodgepole pine commonly result in 80 percent or more mortality.

For this assessment, Region 6 Aerial Survey data was analyzed to spatially assess the relative levels of mortality caused by any insect or disease agents. Survey data was grouped into the following time periods:

- **1990 – 1995:** time period Cascade Lakes Watershed Assessment identified bark beetles were causing mortality (Figure 2),
- **1996 – 2004:** time period since the Cascade Lakes Watershed Assessment (Figure 3), and
- **1990 – 2004**: past and present watershed assessment periods combined (Figure 4).

Estimates of mortality for each year within each time period were added together to give a cumulative estimate of the mortality for that time period. These estimates were then grouped into 3 severity classes:

- low (less than 6 dead trees per acre);
- moderate (6 to 20 dead trees per acre); and
- high (greater than 20 dead trees per acre).

The results of this analysis are displayed for each of the three groups displayed above in Figures 10-12.

This information should be used with the following caveats:

1. The accuracy of survey data (including polygon placement and mortality estimates) can be limited by several factors including: surveyor experience, weather, time of day, time of year, and visibility (USFS 2005).
2. Damage severity classes are intended to show what areas potentially have had higher levels of mortality relative to other areas in the assessment area.
3. Survey estimates of tree mortality are for grouping purposes only and should not be considered to accurately estimate actual mortality levels. Aerial surveys generally underestimate the actual number of trees that have died (Eglitis)**.**

Figure 12 RelativeTree Mortality Levels All Causes, 1990-1995, Snow Lakes Watershed Assessment Area.

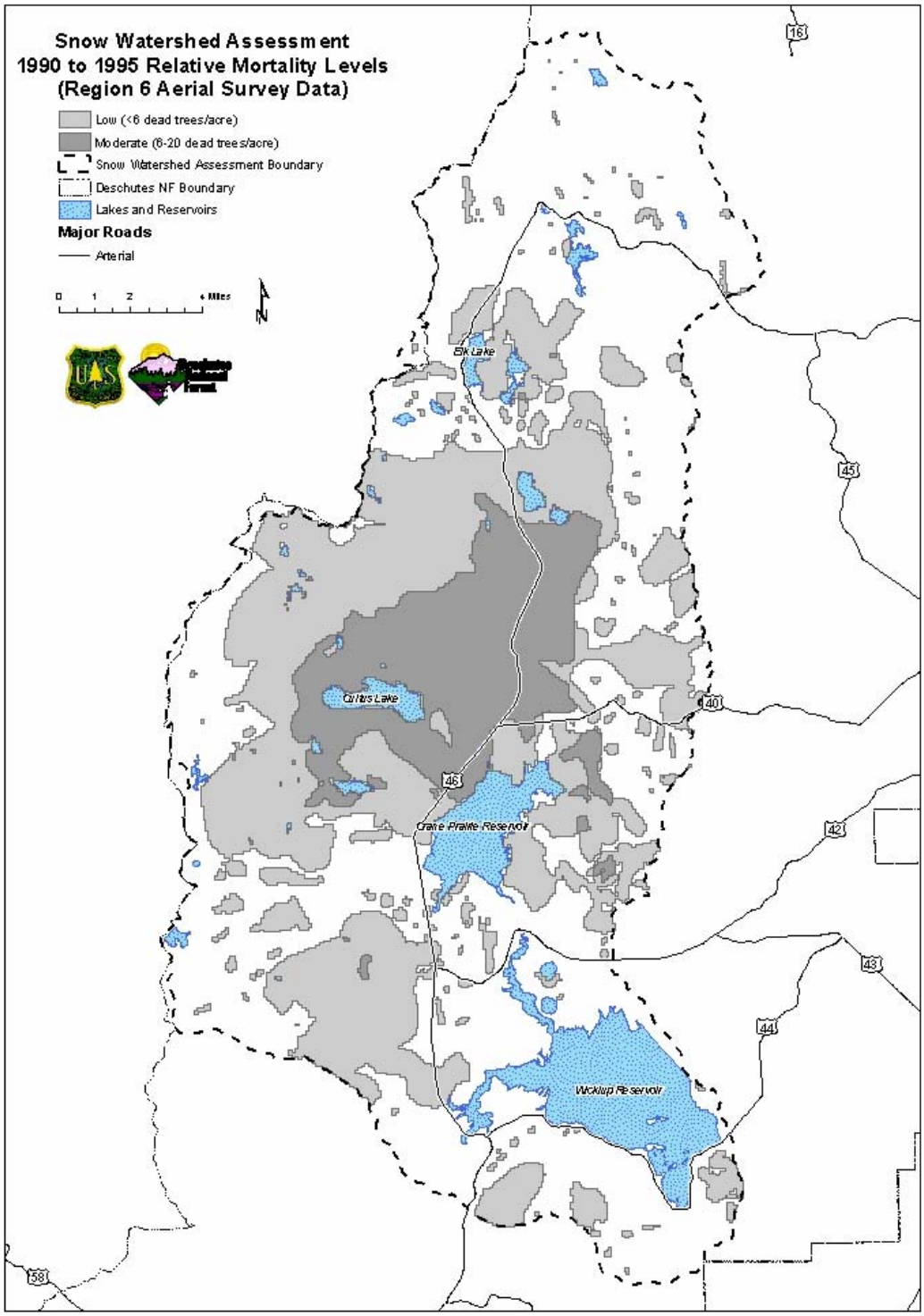


Figure 13 Relative ree Mortality Levels, All Causes, 1996-2004, Snow Lakes Watershed Assessment Area.

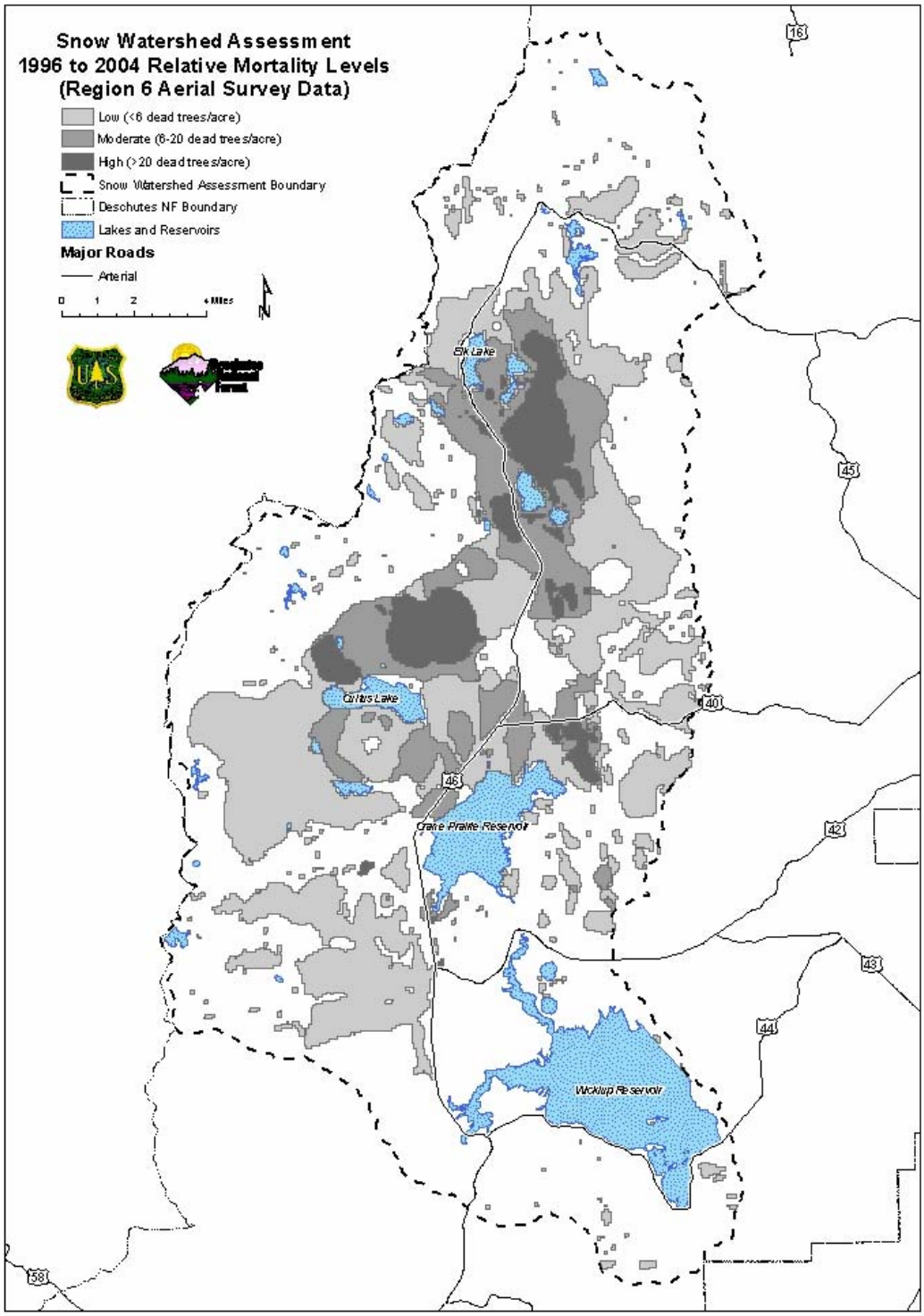
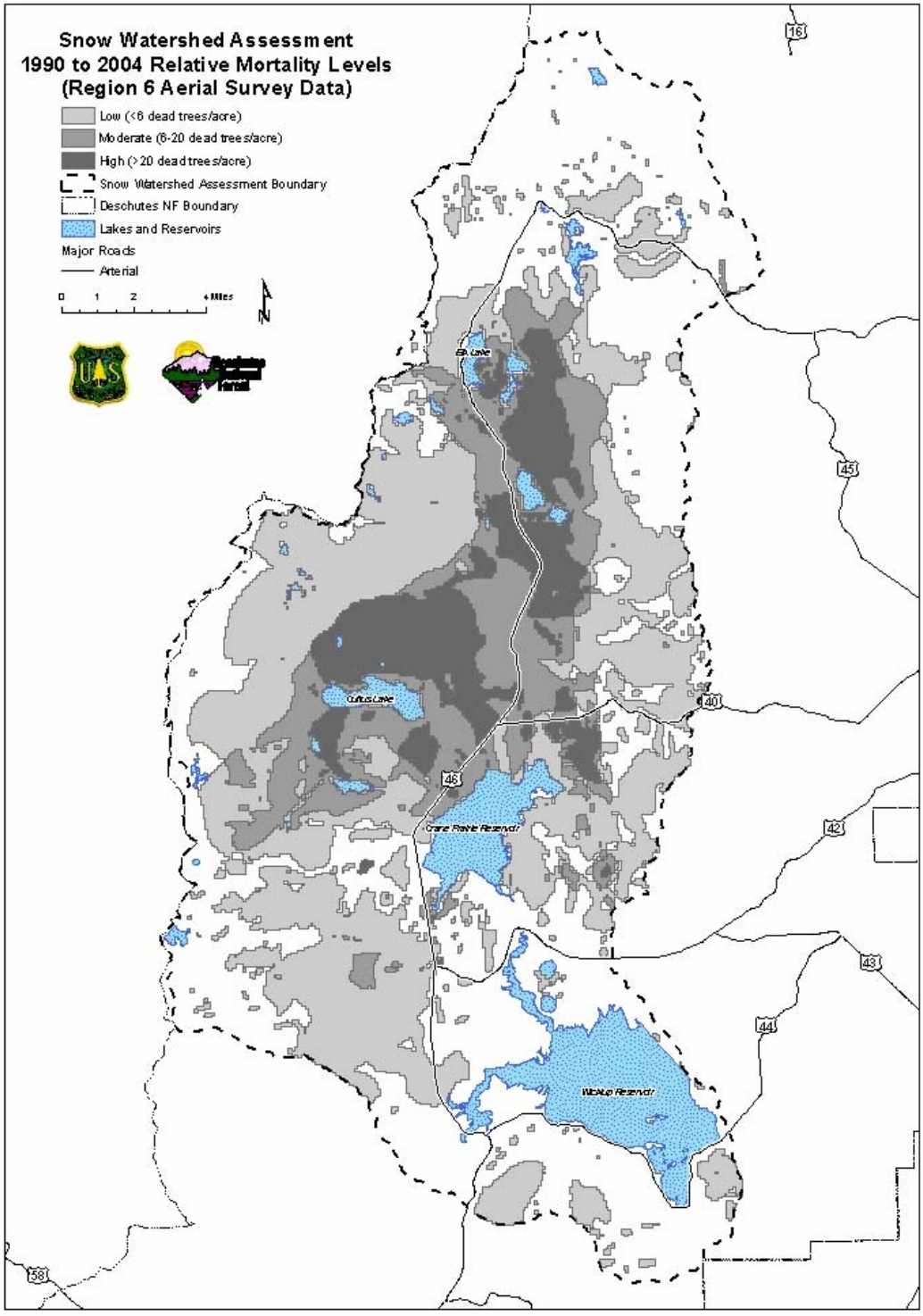


Figure 14 Relative Tree Mortality Levels, All Causes, 1990-2004, Snow Lakes Watershed Assessment Area.



For the past 15 years, including as recently as 2004, the primary mortality agent in assessment area has been the mountain pine beetle attacking lodgepole pine. During the beetle activity period of 1990-1995, relative levels of mortality were low to moderate (Figure 2). During the period from 1996-2004 (Figure 3) beetle activity has spread northward and has intensified. Relative levels of mortality range from low to high. Combined mortality estimates for the entire 1990-2004 period (Figure 4), indicate highest levels of mortality are centered along the Cascade Lakes Highway from Crane Prairie Reservoir north to Devils Lake. Plant association groups with highest levels of mortality include lodgepole pine (wet and dry) and mixed conifer (wet and dry).

Snag Longevity

Bull (1983) found that in newly created lodgepole and ponderosa pine snags, 30 to 60 percent of lodgepole pine and 30 to 70 percent of ponderosa pine remained standing after eight (8) years in lodgepole pine and ponderosa pine habitats. The estimate for lodgepole pine corresponds to information presented by Russel Mitchell (1993) in a memo to Andy Eglitis. The larger the diameter, the longer it tends to stand. The Wildlife and Tree and Log Implementation assumes lodgepole pine snags remain 6-8 years after death and ponderosa pine snags remain 6-12 years.

Historic Range of Variability: The Standard Reference Point

Questions:

- *What is the historic array and landscape pattern of plant communities and seral stages in the assessment area?*
- *What processes caused these patterns (i.e. fire, wind, mass wasting, insects/disease)?*

The Browns/Wickiup Watershed Analysis (Chapters 3 and 4, Page 25; Chapter 5 page 31) describes the use of historic range of variability (HRV):

> *One standard reference point for understanding how landscape vegetation patterns developed is with the concept of "historic range of variability"... With HRV, estimates of past landscape conditions and processes are made by looking at the probable landscape composition that existed prior to local settlement conditions (roughly 1850 to 1910) as a reference point. ... While the HRV is typically not a management goal, it provides a template for understanding the processes that have shaped the forested landscape, namely forest succession and disturbance regime.*

The Cascade Lakes Watershed Analysis (1995) used the same time (1850-1910) period to assess the historic range of variability. The two analyses, however, used different methods for determining the historic range of variability. Additionally, they used different structural stages to describe historic conditions.

Cascade Lakes Watershed HRV Analysis (pages 34 - 37)

This analysis utilized the Ochoco National Forest Viable Ecosystem Management Guide (1994) as a model to classify all existing plant communities that occur within a plant association group based on size/structure and species composition. Five size/structure stages were used:

1) grass/forb/shrub;
2) seedling/sapling;
3) pole;
4) small trees; and
5) medium/large trees.

The analysis further subdivided PAG vegetation into three seral stages: pioneer, mixed, and climax. In the pioneer stage, shade intolerant species dominate. Mixed seral stages are dominated by mid-tolerant trees or by mixtures of shade tolerant and shade intolerant tree species. Climax seral stages are dominated by shade tolerant tree species. For purpose of the analysis, mixed and climax seral stages were combined because there was insufficient data to distinguish between them.

The historic vegetative condition was based on:
- 1903 Cascade Forest Reserve Surveys,
- 1901- 1910 mapping and historical atlas information, and
- 1882 – 1884 cadastral maps and notes.

Browns/Wickiup Watershed HRV Analysis (Vegetation Appendix pages 16 - 20)

The Browns/Wickiup Watershed Analysis used the Vegetation Dynamics Development Tool to generate a picture of most likely HRV conditions. Plant association groups found within the watershed were paired to similar Potential Vegetation Types (PVTs) model files. The model was run for each PVT file, under the "historic" scenario file. Reports were run for 10, 50 and 100 year projections, and variations within simulations were noted. Seven structural stages were used:

1) stand initiation;
2) stem exclusion, open canopy;
3) stem exclusion, closed canopy;
4) understory re-initiation;
5) young, multi-story;
6) late, multi-story; and
7) late, single story.

Historic Disturbance Regimes

Historic patch sizes are based on historic disturbance processes, including fire, insect and disease agents. Table 9 combines the historic disturbance regimes described in the Cascade Lakes (Chapter II, page 38) and the Browns/Wickiup Watershed Analyses(Chapter 3 and 4, page 20).

Table 12. Historic Disturbance Regimes within Dominant Plant Association Groups (PAGs), Snow Lakes Watershed Assessment Area.

Plant Association Group (PAG)	Disturbance Factor	Disturbance Regime[1] (Intensity)	Patch Size (acres)	Landform or Geomorphic Sub-Area[2]	Elevation (range in ft)	Aspect
Lodgepole pine Dry	Fire	High	50 -1000	• Morainal • Outwash	4,400 – 6,000	All
	Insects and Disease	Moderate	10 - 1000			
Lodgepole pine Wet	Fire	Moderate	50 - 500	• Morainal • Outwash	4,500 – 5,200	All
	Insects and Disease	Moderate	10 - 1000			
Mountain hemlock	Fire	High	50 - 150	• Tephra • Crest • Bachelor Butte • Sheridan Mtn	4,800 – 7,000	All
	Insects and Disease	Moderate	50 - 200			

Plant Association Group (PAG)	Disturbance Factor	Disturbance Regime[1] (Intensity)	Patch Size (acres)	Landform or Geomorphic Sub-Area[2]	Elevation (range in ft)	Aspect
Mixed Conifer Dry	Fire	Moderate	20 - 300	• Morainal • Bachelor Butte • Browns Mtn • Davis Mtn • Ketchketch Butte • Lookout Mtn • Sheridan Mtn • Wuksi Butte	4,400 – 6,600	All
	Insects and Disease	Low	<5			
Mixed Conifer Wet	Fire	High	100 - 500	• Morainal • Crest	>5,000	All
	Insects and Disease	Moderate	100 - 500			
Mixed Conifer Wet (Englemann Spruce)	Fire	High	100 - 500	• Spruce Bottomlands	<4,400	All
	Insects and Disease	Moderate	100 - 500			
Ponderosa pine (Dry and wet)	Fire	Low	<5	• Upland • Tephra	4,200 – 4,600	All
	Insects and Disease	Low	<5			
Water	Floods	Low	<100	All except Bachelor Butte & Sheridan Mtn	>4,500	All
Meadows	Fire	Low	<50	All except Bachelor Butte & Sheridan Mtn	>5,200	All
Sparsely Vegetated [3]	Fire	Low	<50	• Tephra • Crest • Bachelor Butte • Sheridan Mtn	>6,000	All

[1] **Disturbance Regime: Low severity: 1- 25 year return interval, 0 – 20 percent tree mortality. Moderate severity: 26 – 100 year return interval, 26 - 70 percent tree mortality. High severity: >100 year return interval, >70 percent tree mortality.**

[2] **Landform or Geomorphic Sub-Area: refer to Geology, Climate and/or Soil sections of prior assessments.**

[3] **Identified within the Cascade Lakes Watershed Assessment. Occurs primarily at high elevations within the Three Sisters Wilderness and on the top o f Mount. Bachelor. PAG includes areas of rock and areas with a minor shrub or tree component.**

Comparison of Current Conditions to Historic Range of Variability

Questions:

- *What affect is the change in stand conditions resulting from the dying of lodgepole pine having on late and old growth structure?*
- *What is the increased risk in stands of ponderosa pine and other early serial tree species due to increases in shade tolerant species?*
- *How much affect will the increase in shade tolerant species have on the growth of intermediate tree sizes?*

Both earlier analyses, Cascade Lakes and Browns/Wickiup, compare current and historic vegetation conditions. In the intervening years, the most extensive change to vegetation has been associated with the ongoing mortality from mountain pine beetle activity. Additional vegetation changes are associated with wildfires and timber harvest. For the purposes of this assessment, no changes have been made to the historic conditions discussed in the two prior analyses. This assessment summarizes the historic conditions described in the original analyses. Current structural conditions have been updated to incorporate mortality associated with beetle activity, mortality associated with wildfires, and changes in structural conditions resulting from timber harvest. This assessment summarizes and updates, as needed, the comparison between current and historic conditions described in the original analyses for the following dominant plant association groups: mixed conifer, ponderosa pine, lodgepole pine, and mountain hemlock.

Mixed Conifer Dry PAG

Tree species composition within this PAG includes ponderosa pine, white fir, lodgepole pine, and Douglas-fir. Vegetation patterns are significantly outside the historic range of variation in terms of structural stage, species composition, canopy closure, and patch size and distribution. Departures from HRV are probably the most dramatic of any of the PAGs.

The relatively open, large tree structure that historically dominated this PAG has been replaced by dense, multi-storied forest structures dominated by smaller diameter trees. Species composition has shifted from being dominated by fire climax species of ponderosa pine to one predominantly dominated by shade tolerant true fir species. This shift has caused an increase in overall canopy cover above that which occurred historically. The shift in structure, density, and species composition has led to an overall increase in susceptibility to insect and disease agents. Existing multi-story stand structures, in combination with increasing levels of dead, down woody material (associated with beetle activity), are conducive to wildfires burning more intensely than they would have historically.

In addition to dramatic shifts in structure, density, and species composition, there has been a dramatic departure from historic conditions in terms of stand size and openings. What was described by the Cascade Forest Survey as fairly contiguous stands of fire climax pine dotted with ½ to 20 acre openings is now a highly fragmented landscape with regularly spaced openings generally ranging from 20 to 40 acres in size (Cascade Lakes Analysis, 1995).
Table 11 displays the HRV and current conditions for this PAG group.

Table 13. Mixed Conifer Dry PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment Area.

Cascade Lakes Watershed Analysis			Browns/Wickiup Watershed Analysis		Current Conditions
Size/Structure/Class	HRV - Pioneer	HRV - Climax	Structural Stage	HRV	
Grass/Forb/Shrub	1 – 7 percent	---	Stand Initiation	0 – 5 percent	
Seed/Sapling (0-4.9”dbh)	2 - 15 percent	1 – 10 percent			
Pole (5-8.9”dbh)	5 - 21 percent	2 – 15 percent	Stem Exclusion (Open and Closed)	0 – 5 percent	
Small (9-20.9”dbh)	12 - 40 percent	6 – 30 percent	Understory Reinitiation	0 – 5 percent	
			Young, Multi-story	0 – 2 percent	
Medium/Large (21+” dbh)	15 - 42 percent	5 – 28 percent	Late, Multi-story	5 – 15 percent	
			Late, Single-story	60 – 90 percent	

Mixed Conifer Wet PAG

Species composition is highly diverse, including ponderosa pine, white fir, lodgepole pine, Douglas-fir, western white pine, Engelmann spruce, and occasionally mountain hemlock.

This PAG makes up a relatively small percentage of the assessment area (approximately two (2) percent). Patches of this PAG are relatively small and are generally in close proximity to the mixed conifer dry PAG or the lodgepole pine PAGs.

The Cascade Lakes analysis (Chapter 2 page 46) identified that the current forest species composition and size/structure is much the same as the mixed conifer dry PAG. According to the analysis, site productivity is a little better within this PAG and allows both for higher densities and a greater proportion of fir species to be present and supported. At the time of the original

analysis, there appeared to be no large scale or epidemic insect and disease problems associated with this PAG. However, the potential for future problems was identified.

The Browns/Wickiup analysis (Chapter 5, page 32) noted that the late/multi-layer structural stage, historically prominent on the landscape (10-30 percent of acres), was still found at a rather high frequency (currently at 24 percent) throughout the that assessment area. These multi-layered stands were not considered to be quite as susceptible to insect and pathogen activities as the dry forest types, although drought conditions often negate these distinctions.

Region 6 aerial survey data is not sufficiently accurate to determine if in the intervening years beetle activity has increased within this PAG. For the purposes of this assessment, it is assumed that bark beetle populations have grown large enough and conditions have been dry enough to negate any benefits trees may have derived from being in moister soil conditions. It is assumed beetles have attacked lodgepole pine at levels similar to those for the mixed conifer dry PAG.

Table 12 displays the HRV and current conditions for this PAG.

Table 14. Mixed Conifer Wet PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment.

Cascade Lakes Watershed Analysis			Browns/Wickiup Watershed Analysis		Current Conditions
Size/Structure/ Class	HRV - Pioneer	HRV - Climax	Structural Stage	HRV	
Grass/Forb/Shrub	--- percent	---	Stand Initiation	5 – 10 percent	
Seed/Sapling (0-4.9"dbh)	0 - 20 percent	0 - 25 percent			
Pole (5-8.9"dbh)	3 - 20 percent	5 - 30 percent	Stem Exclusion (Open and Closed)	15 - 20 percent	
Small (9-20.9"dbh)	0 - 11 percent	10 - 32 percent	Understory Reinitiation	10 – 15 percent	
			Young, Multi-story	10 - 15 percent	
Medium/Large (21+" dbh)	0 - 11 percent	8 - 28 percent	Late, Multi-story	25 - 30 percent	
			Late, Single-story	5 - 10 percent	

Ponderosa Pine Dry/Wet PAG

The ponderosa pine dry and wet PAGs, make up a relatively small proportion (approximately six (6) percent) of the assessment area. These PAGs are found predominantly in the southeastern portion of the area in the vicinity of Wickiup and Crane Prairie Reservoirs. The historic and current condition of this PAG was addressed in the Browns/Wickiup Analysis (1997).

Within the ponderosa pine dry PAG, ponderosa pine dominates, with lodgepole pine present primarily as a result of fire exclusion. Within the ponderosa pine wet, ponderosa pine dominates and white fir and lodgepole pine can occasionally be present.

According to the Browns/Wickiup Analysis (Chapter 5, page 31), the late-single structural stage that historically dominated the landscape at 30-60 percent of acres is now virtually absent from the landscape. These were the open, park-like pine stands that once extended across the western states. In their place are multi-layered stands of white fir, ponderosa pine, and lodgepole pine, with the increased stand densities and the many health and vigor susceptibilities that these conditions bring. In the intervening years, there has been little change to the conditions described in the original analysis.

Table 13 displays the HRV and current conditions for this PAG.

Table 15. Ponderosa Pine Wet and Dry PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment Area.

Browns/Wickiup Watershed Analysis		Current Conditions
Structural Stage	HRV	
Stand Initiation	0 – 5 percent	
Stem Exclusion (Open and Closed)	0 – 5 percent	
Understory Reinitiation	0 – 5 percent	
Young, Multi-story	0 – 2 percent	
Late, Multi-story	5 – 15 percent	
Late, Single-story	60 – 90 percent	

Dry Lodgepole Pine PAG

Lodgepole pine is the dominant species within this plant association group.

The Cascade Lakes analysis (Chapter II, page 48), described the historic vegetation patterns and disturbance processes for this PAG as follows:

> *Historically, the lodgepole pine areas were a mix of open land recently disturbed by fire, areas of regenerating lodgepole, areas of pole sized trees, of mature trees, as well as areas of susceptible stands undergoing mountain pine beetle attack. Very few lodgepole pine would have achieved large size diameters, the exception being those trees growing on better sites. Within these constraints there was a great range of possible seral condition distribution, depending on beetle activity and fire.*

The analysis noted that present vegetation patterns are likely within the historic range of variability. The analysis also projected that while ongoing beetle activity would cause a significant shift in seral distribution from mature trees to small trees, resulting distribution of stand structures would remain within the historic range of variability.

The Brown/Wickiup analysis (Chap 5, page 31), described the current condition of this PAG as follows:

> *…the mid-structural stages are found in greater abundance across the landscape than expected under HRV. Under HRV, a large percentage of the stands were in a stand replacement stage due to a natural fire regime. Present mid-structural stage conditions can be related to the linkage of several connected actions: fire exclusion and increased stand densities which allows ideal conditions for pine beetle activity, resulting in salvage or firewood harvests following the beetles. In combination, these events have resulted in a shift towards the mid-structural stages, especially where fire exclusion activities have been most effective.*

Within the past 15 years, areas with relatively high beetle activity have been associated with this plant association group. Beetle activity has resulted in the mortality of larger diameter lodgepole pine. Trees killed during the initial years of the outbreak have begun to fall to the ground, increasing the amount of down woody material. Tree mortality has reduced the canopy cover, creating conditions favorable for the release of existing small understory trees or for the establishment of new seedlings or saplings.

Table 14 displays HRV and current conditions for this PAG.

Table 16. Lodgepole Pine Dry PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment Area.

Cascade Lakes Watershed Analysis		Browns/Wickiup Watershed Analysis		Current Conditions
Size/Structure/Class	HRV – Pioneer/Climax	Structural Stage	HRV	
Grass/Forb/Shrub	0 - 60 percent	Stand Initiation	27 - 45 percent	
Seed/Sapling (0-4.9"dbh)	0 - 50 percent			
Pole (5-8.9"dbh)	10 - 80 percent	Stem Exclusion (Open and Closed)	13 - 20 percent	
Small (9-20.9"dbh)	10 -60 percent	Understory Reinitiation	10 – 15 percent	
		Young, Multi-story	16 - 24 percent	
Medium/Large (21+" dbh)	0+ percent	Late, Multi-story	5 - 7 percent	
		Late, Single-story	NA	

Wet Lodgepole Pine PAG

Species composition is typically dominated by lodgepole pine, but has a diversity of species, including ponderosa pine, white fir, subalpine fir, and Engelmann spruce.

Historic and current conditions are similar to those described for the lodgepole pine dry PAG.

Table 15 displays the HRV and current conditions for this PAG.

Table 17. Lodgepole Pine Wet PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment Area.

Cascade Lakes Watershed Analysis		Browns/Wickiup Watershed Analysis		Current Conditions
Size/Structure/Class	HRV – Pioneer/Climax	Structural Stage	HRV	
Grass/Forb/Shrub	0 - 60 percent	Stand Initiation	10 - 20 percent	
Seed/Sapling (0-4.9"dbh)	0 - 60 percent			
Pole (5-8.9"dbh)	10 - 80 percent	Stem Exclusion (Open and Closed)	20 - 30 percent	
Small (9-20.9"dbh)	10 -60 percent	Understory Reinitiation	5 - 15 percent	
		Young, Multi-story	0 - 5 percent	
Medium/Large (21+" dbh)	0+ percent	Late, Multi-story	30 - 40 percent	
		Late, Single-story	5 - 10	

Mountain Hemlock PAG

Species composition is highly diverse. Stands are dominated by lodgepole pine and mountain hemlock, with minor amounts of white fir, western white pine.

The Cascade Lakes analysis (Chapter II, page 54) described the current condition within this PAG as follows:

> *Vegetation patterns within this PAG fall within HRV. At present, the mountain hemlock plant association groups within the watershed are shifting towards a more "climax" mountain hemlock forest type and an associated increase in the abundance and sizes of laminated root disease mortality centers. This shift is thought to be part of historic processes and has not*

been influenced to any significant degree by human intervention...Very little management has occurred in this PAG because it falls into Congressionally Withdrawn (wilderness) and Administratively Withdrawn (dispersed recreation) land use allocations.

The Browns/Wickiup analysis (Chapter 5, page 32) described the current condition as follows:

...the general landscape has not departed greatly from HRV conditions, with the exception of a delay in some fire activity. Although specific locations may show a departure from what would be expected under historic landscapes, the departure from HRV is not as great as that seen in dry forest communities.

...the multi-layer structural stage, which historically was dominant on the landscape (20-40 percent of acres) is found at a higher frequency within the watersheds (about 60 percent of hemlock acres are now in the late-old stage). These multi-layered stands are not quite as susceptible to insect and pathogen activities as the dry or moist forest types, and have become more dominant on the landscape simply by fire exclusion activities and resulting succession al advancement that comes in the absence of disturbance.

Table 16 displays the HRV and current conditions for this PAG.

Table 18. Mountain Hemlock Dry PAG, Historic and Current Structure Conditions, Snow Lakes Watershed Assessment Area.

Cascade Lakes Watershed Analysis			Browns/Wickiup Watershed Analysis		Current Conditions
Size/Structure/ Class	HRV - Pioneer	HRV - Climax	Structural Stage	HRV	
Grass/Forb/Shrub	0 - 5 percent	---	Stand Initiation	10 – 20 percent	
Seed/Sapling (0-4.9"dbh)	0 - 5 percent	0 – 3 percent			
Pole (5-8.9"dbh)	0 - 5 percent	0 – 40 percent	Stem Exclusion (Open and Closed)	30 - 40 percent	
Small (9-20.9"dbh)	0 - 3 percent	5 - 50 percent	Understory Reinitiation	10 - 20 percent	
			Young, Multi-story	0 - 10 percent	
Medium/Large (21+" dbh)	0 - 1 percent	5 - 20 percent	Late, Multi-story	20 - 30 percent	
			Late, Single-story	0 - 10 percent	

Fuels

Introduction

Fire Occurrences

Historically, lightning was the major ignition source of large fires within assessment area. Native Americans also initiated some fires to maintain habitat for game animals and cultural plants. Weather patterns in July and August brought thunder storms to the Deschutes Basin with a relatively high frequency. Provincially, the assessment area is in a high lightning frequency zone. Table II-4 in the Cascade Lakes Watershed Assessment (Chap II page 38) describes the sizes of historic disturbances associated with natural fire ignition and is further discussed on page 48 of the same chapter. Today, the majority of fire occurrence in the assessment area is a result of lightning or recreational use and is usually suppressed at less than a one-quarter of an acre in size. Successful suppression activities have resulted in significant increases in fuel concentrations thereby increasing the risk of uncharacteristic wildfire events that exceed historic levels.

Recreational use has increased since 1995 and is expected to continue due to more people recreating on the forest.

During the 10 year period between 1995 and 2004, 365 lightning and human caused fires occurred within the assessment area, averaging 36-37 fires per year. The Cascade Lakes Assessment (1995) estimated between 20 to 57 fires a year could be expected to occur within the assessment area boundaries (Chapter II, page 71). The Browns-Wickiup Assessment estimated an average of 8-9 fires per year..

Historic Conditions

Questions:

- *Where is it appropriate to re-introduce fire as a tool?* ***What was the historic role of fire within the assessment area?***
- *How do we restore resiliency to these fire regimes to minimize the risk and/or impacts of uncharacteristic disturbance events (i.e. fire, insects, and disease)?* ***What role has fire suppression played in the creation of the current landscape condition?***
- *How do we create and maintain conditions that are conductive to important resource values including, but not limited to, wildlife habitat, scenic views, recreational opportunities and wilderness values?* ***How have changing forest conditions affected fuel loadings, public and firefighter safety, and other resource values?***

The 1995 Cascade Lakes Watershed Analysis identified the following fire and fuel issues:

- **Public safety and resource protection were diminished.**
- **Reduced resiliency to forest disturbance events.**

The 1997 Browns/Wickiup Watershed Analysis identified the following key issues:

- **Fire exclusion and natural succession have changed the historical fire regime and reduced the ability to suppress wildfire.**
- **Forest resilience to fire, insect and disease, as a result of fire exclusion, has diminished as stand densities increase and shade tolerant species populate warm and dry sites.**

These issues continue to be relevant for this analysis.

Fire has historically been a major disturbance element across these landscapes (Agee, 1993). The magnitude of fire disturbance has changed significantly in some plant communities due to fire exclusion during the last 100 years. Active fire suppression in the assessment area began between 1900 and1930. As noted previously, this has resulted in a decrease in the size of fire events which in turn has affected the shaping of the existing vegetation mosaic within the assessment area.

Historically, large, high intensity fires occurred in the lodgepole and mountain hemlock PAGs and adjacent areas. These occurred because of the long fire return intervals (60-80 years or longer) and of relatively low intensity due to low fuel loadings. Stand replacement fires occurred where fuel loadings were higher or more continuous.

In the ponderosa pine and mixed conifer PAGs, fire return intervals were much shorter, fire intensities much lower due to significantly lower fuel loadings, and high intensity, stand replacement fires infrequent or limited to sites where higher fuel loadings and/or understory stand development were present.

Because of fire exclusion, unstable conditions have been created in many of the ponderosa pine and dry mixed conifer stands and resulting in an increasing the potential for more frequent and larger scale disturbances. Since the initial assessments, the increase in bark beetle activities in lodgepole pine stands and both the ponderosa pine and mixed conifer PAGS, has resulted in additional increases in fuel loadings and significantly higher risks of uncharacteristic wildfire events in these stand types.

Current Conditions

Questions:

- *What are the local communities of interest?*
- *How do we establish and maintain safe access for the public and firefighters?*
- *How do we protect resources that we consider important, while maintaining resiliency from disturbance events?*

Since 1995, two large fires, totaling approximately 1,260 acres, have occurred in the Cascade Lakes portion of the assessment area.. The 1996 Charlton Fire burned 4,343 acres, including approximately 1,009 acres within the Cascade Lakes portion of this assessment area. The 1998 Elk Lake Fire burned 251 acres, all within the Cascade Lakes area, all outside the wilderness. Both fires were lightning caused and ignited in mixed conifer stands. The Charlton Fire burned primarily in the Three Sisters Wilderness Area. The Elk Lake Fire was located entirely outside the wilderness. It threatened recreational developments, burned three recreation residences, and forced the closure of portions of the Cascade Lakes highway.

Since 1997, two large fires, totaling approximately 6,461 acres, have burned in the Browns/Wickiup portion of the assessment area.. The 2001 Crane Complex burned 713 acres and was ignited by lightning in a mature stand of dead and down lodgepole. The 2003 Davis Fire burned approximately 21,112 acres, including approximately 5,748 acres locatedin the Browns Wickiup portion of the assessment area. This human caused fire started in the East Davis Camp Ground on the Crescent Ranger District.

The assessment if bisected by the Cascade Lakes Highway which traverses much of the existing ponderosa pine, mixed conifer, and lodgepole pine PAGs. Additionally, a number resorts such as Cultus Lake, Elk Lake, Lava Lake, Twin Lakes, Crane Prairie, dispersed and developed recreation sites, and Forest Service facilities, including historic sites, such as Elk Lake, Deschutes Bridge, and Snow Creek Guard Stations, are also located within or adjacent to these PAGs. The Elk Lake Resort was identified as a community at risk in the Federal Register under the National Fire Plan. The other sites, not specifically identified in the Federal Register are identified as local communities of interest by the Forest fire and fuels organization. Access to most of the resort sites is by two lane, paved road; access to most other sites is most commonly single lane, dirt road with turnouts. In both instances, roadside vegetation is dense with high levels of ground fuels. This vegetation commonly is immediately adjacent to the road with little or no open space between the travel surface and the vegetation.

Table 17 identifies the communities listed in the Federal Register (communities at risk) and local communities of interest located within the boundaries of the assessment area.

Table 19 Communities at Risk and Local Communities of Interest, Snow Lakes Watershed Assessment Area.

Name of Area	Type of Community	Federal Register/Local Interest
Lava Lake Resort	Recreational	Local Interest
Cultus Lake Resort	Recreational	Local Interest
Twin Lakes Resort	Recreational	Local Interest

Name of Area	Type of Community	Federal Register/Local Interest
Crane Prairie Resort	Recreational	Local Interest
Elk Lake Resort	Community	Federal Register
Elk Lake Guard Station	Historical Site	Local Interest
Deschutes Bridge Guard Station	Historical Site	Local Interest
Snow Creek Guard Station	Dwelling for Firefighters	Local Interest

Additionally, developed campgrounds and dispersed recreation sites along the Deschutes River, Cultus Lake, and both reservoirs are also local communities of interest and/or concern. With increasing recreational use, comes increasing risks of human caused fires. This in turn increases the risk of such fires impacting water quality, wildlife habitat, and other resources. The increasing recreational use within or adjacent to areas of high fuel loadings and/or high or extreme fire behavior potential also adversely impacts both public and firefighter safety.

Forest Road 46 (Cascade Lakes Highway) is the major, and only, north-south highway traversing the entire length of the assessment area. As such, it provides much of the public access to resorts, campgrounds, and other public and private developments in the assessment area. , including those listed above. In the middle third of the area, Forest Road 4270 provides the major access along the east side of Crane Prairie Reservoir between Forest Road 42 and the junction with the Cascade Lakes Highway. Forest Roads 40, 42, and 46 provide the primary east-west access to the recreational areas located near both reservoirs and both Cultus and Little Cultus Lakes. Increased tree mortality associated primarily with bark beetle activity since 1990, is located primarily along both sides of Road 46 and north of Road 42. Such activity, and the resultant mortality, has been increasing in the northern portion of the area (above Lava and Hosmer Lakes and reaching across Road 46 into the Three Sisters Wilderness.

Fire Behavior Potential by Fuel Model

Table 17 describes the current conditions associated with fire behavior potential within the assessment area. The extreme/high acreage is primarily associated with the lodgepole pine PAGs where significant bark beetle activity has been occurring over the past decade. The moderate acres are generally associated with the ponderosa pine and mixed conifer PAGs where bark beetle activity has also been increasing but at lower rates due to low densities of lodgepole pine. These acres, historically characterized by low intensity, relatively frequent fires, are also experiencing increasing fuel loadings resulting from stand development and succession. The low rated acres are predominately associated with the higher elevation mountain hemlock and associated PAGs where fire suppression activities have been less frequent (long fire return interval)..

Table 20 Current Acreage by Fire Behavior Potential, Snow Lakes Watershed Assessment Area.

Fire Behavior Potential	Acres
Extreme/High	103877
Moderate	19722
Low	77854

Acreage calculated in GIS using landsat data and plant associations. Fire behavior potential based on surface fire potential flame length, rate of spread and fire line intensity using the BEHAVE fire spread model (Andrews 1986).

Fuel Loadings
A rapid accumulation of fuels continues to occur due to insect and disease infestations, increasing stand densities, fire exclusion, and recent drought conditions. These issues were identified in the original assessments and continue to be relevant today. Increases in stand densities have led to intensification of competition for site resources potentially affecting plant vigor and the ability of vegetation to withstand the effects of disturbance (resiliency). The resulting increase in mortality significantly contributes to fuel loads. These heavy fuel loads reduce the ability of firefighters to control a fire and limit suppression capabilities.

The landscape which was once dominated by early seral tree species that were resilient to historic levels of disturbance (i.e.; fire, insect and disease) is now dominated by late seral, shade tolerant tree species with the associated high fuel accumulations. The increase in stand densities associated with the increase in the number and distribution of late seral, shade tolerant trees across the landscape has resulted in large increases in bark beetle activity, the incidence and spread of disease populations, fuel accumulations and resulting in reduced resiliency to disturbance and the associated increased risk of high intensity, uncharacteristic wildfire.

Wildlife

Introduction

Past habitat condition assessments (11 total) have been completed within the assessment area that provide information on reference and current conditions. These efforts include the following:

- the Browns/Wickiup Watershed Analysis;
- the Browns/Round Mountain Late Successional Reserve (LSR) Assessment;
- Cultus Mountain. LSR Assessment;
- Sheridan Mountain. LSR Assessment;
- the Cascades Lakes Watershed Analysis;
- the Red Plague Timber Sale Environmental Assessment (EA);
- the Charlie Brown EA; and
- Bald Eagle Management Area (BEMA) plans for the Crane Prairie and Wickiup Reservoirs areas.

The watershed has a rich array of habitats that are important to many species including those listed by the Endangered Species Act. Following is a brief accounting of selected habitat types and special management designations important to wildlife.

Northern spotted owl:

Critical habitat = 15,086 acres (7 percent)
Nesting/roosting/foraging habitat = 20,966 ac. (9 percent)
Historic nest sites = 5 (Cultus Mountain., Applejack, Benchmark, Deer Lake, and Lucky Lake)

Spotted owl pairs have not been monitored for years and their current locations (or those of other pairs) are unknown. There are no spotted owls in that portion of the assessment area located within the boundaries of the Crescent Ranger District.

Northern bald eagle:

Bald eagle management area (BEMAs) = 12,243 ac.(6 percent) in 21 sites (includes partials) on Bend-Ft. Rock Ranger District (RD) plus 2-3 sites on Crescent RD.
Historically active nests in BEMAs (Bend-Ft. Rock RD) = 18; Crescent RD = 1-2

Active nests in 2005 (Bend-Fort Rock RD) = 13 active, 2 unknown, 3 inactive. Crescent RD nests – unknown.\0

It should be noted that not all active eagle nests are within BEMAs.

Osprey Management Area:
Total acreage = 8,100 ac. (100 percent associated with Crane Prairie reservoir)
Active nests unknown

Key Elk Areas:
Crane Prairie KE
Clover Meadow KE
Total acreage = 12,170 ac. (5 percent)

Old Growth Management Areas:
Total acreage = 3,921 ac. (2 percent) in 12 sites

Late Successional Reserves (LSR):
Cultus Mountain. (19,527 ac.)
Sheridan Mountain. (partial, 5,200 ac.)
Browns Mountain. (7,322 ac.)
Round Mountain. (partial, 77 ac.)
Davis (partial, 627 ac., significantly fire damaged in 2003)
Total = 32,753 ac. (15 percent)

All of the LSRs have approved management plans.

Late and Old Structure Forests (LOS):
Density 1 = 64,728 ac.
Density 2 = 6,417 ac.
Total = 71,145 ac. (32 percent)

Riparian/Aquatic Habitats:
Total Acreage = unknown
Prominent sites include: Wickiup and Crane Reservoirs, Hosmer Lake, Lava Lakes, Elk Lake, Charlton Lake, Cultus Lake, Little Cultus Lake, Deer Lake, Johnny Lake, North and South Twin Lakes, Lemish Lake, Doris Lake, Blow Lake, Browns Creek, Charlton Creek, Cultus River, Cultus Creek, Moore Creek, and Deschutes River..
There are also a number of valuable wet meadows and springs in the assessment area.
Approximately 60 percent of the wildlife species in the watershed utilize riparian/aquatic habitats.

Special/Unique Habitats:
Caves
Aspen
Forested lavas
Dry and wet meadows
Cliffs/talus
Snags/logs

Species of special status or concern include (partial listing):

Northern spotted owl (ESA threatened)
Northern bald eagle (ESA threatened)
Oregon spotted frog (ESA candidate)
Pacific fisher
Wolverine
American marten
Great gray owl
Osprey
Northern goshawk
American peregrine falcon
Greater sandhill crane
White-headed woodpecker
Black-backed woodpecker
Northern three-toed woodpecker
Pileated woodpecker
Pygmy nuthatch
Flammulated owl
Northern pygmy owl
Neotropical migrant birds (87 spp. excluding waterfowl and shore birds)
Bats (5 species)
Crater lake tightcoil snail

Reference/Current Conditions

Introduction

Generally, accurate population data on the vast majority of wildlife species is non-existent due to the time and expense involved. However, information from Breeding Bird Surveys, big game harvest statistics, research data sets, local surveys, etc. are often available and may be extrapolated to draw conclusions for individual species or groups of species. Reference or historic data is particularly lacking for most species, so past population levels are best inferred from what is known about past habitat conditions. The following discussion is organized to address individual species that are of concern, e.g. proposed, endangered, threatened, sensitive (PETS). In addition, other selected species will be addressed individually that are Species of Concern (SOC), economically important or ecological significant. In order to reduce the complexity of addressing all of the 262 species potentially within the analysis area, most have been grouped into habitat guilds. Guilds are assemblages of similar species into communities with common biological needs. Reference the Appendix for the details on guilds.

PETS Species

Northern Spotted Owl:

Reference Conditions -

- Higher population level than the present is probable, but numbers unknown.
- Less habitat fragmentation due to having no timber management units, roads, facilities, etc.
- Owls likely occupied sustainable climatic climax forest including mixed conifer dry (MCD) on north aspects and mixed conifer wet (MCW) types.
- Dispersal of young and other movements were less restricted.
- Prey base populations were likely higher due to the greater availability of coarse woody materials (CWM).
- Predation was likely lower due to larger more contiguous stands.

- Genetic diversity was greater with a larger number of owls and less isolation.

Current Conditions -
- Federal listing - Threatened.
- Population - five pairs of owls have been documented in the past on Bend-Ft. Rock (BFR) Ranger District portion of the watershed. Included are: pair # 1001 (Cultus Mt.), #1002 (Applejack), #1003 (Benchmark), and # 1006 (Lucky Lake). The Crescent Ranger District has no pairs in their portion of the assessment area. Only project specific surveys have been done since 1995 on the BFR
- Fragmentation is moderate to high, primarily due to timber harvest units and roads
- Residual potential habitat types remain but are isolated in relatively small areas of the watershed.
- Dispersal and movement of owls is potentially limited due to past timber harvest units, roads, wildfires etc.
- Prey base populations are likely lower due to removals of CWM by management activities and wildfires over significant acreage in the watershed.
- Predation is potentially significant due to a large amount of high contrast edge and small forest interior habitats.
- Genetic diversity is potentially constrained due to habitat fragmentation and constrained movements.
- Owls are present in the Cultus Mountain and Sheridan LSRs. Cultus LSR - five historic pairs present. Sheridan LSR has high potential for owl occupancy (note: one historic pair, #1005, outside watershed boundary).
- No owl pairs are present in the Round Mountain or Browns Mountain. LSRs. Browns LSR - enough suitable habitat is present to potentially support one pair of owls; however, it is isolated due the effects described above. Some fragmentation has occurred and nest trees may be limiting. Round Mountain. LSR - there is an inadequate amount of suitable habitat present to support a pair of owls (59 acres); however, it is/would support dispersing owls. Isolation is likely a problem for dispersal from other areas.
- Davis LSR portion within the assessment area has essentially been destroyed by the fire.
- Designated (ESA) Critical Habitat Unit (#CHU OR-6) including the entire CHU in the vicinity of Cultus Mountain, which contains approximately 2.982 acres of classified nesting-roosting-foraging (nrf) habitat. Nearly 100 percentage of the CHU is also designated late successional reserve.
- There is an estimated 24,791 acres of nrf habitat on the BFR Ranger District with the majority (85 percent)within the Snow assessment area.

Northern Bald Eagle:
Reference Conditions -
- Historic population level unknown.
- Nesting and roosting habitats likely more plentiful and of higher quality, i.e. large ponderosa pine and Douglas-fir trees.
- Foraging habitat dominated by rivers with some natural lakes with native trout the primary forage.
- No contamination of egg shells by pesticides.

Current Conditions -
- Federal listing - Threatened.

- Population - Present population (summer breeding) averages 21 pairs (~41 percentage of the Forest's population). A large influx of eagles occurs at Wickiup reservoir as the water level is drawn down in late summer and early fall, exposing bullhead catfish to predation. The winter population is unknown and variable depending upon forage availability. Likely a higher level than historically due to the construction of large reservoirs in the area that have good fish populations, critical to successful reproduction.
- Nesting and roosting habitats are presently adequate but their long-term sustainability is uncertain due to risks to insect, disease, wildfire and human disturbance. The 2003 Davis fire eliminated a large amount of potential bald eagle nesting/roosting habitat south of Wickiup reservoir.
- Foraging habitat is excellent but species have shifted from native trout to introduced species (e.g. kokanee, brook trout, brown trout, bass, etc.). Bull trout have been extirpated from the watershed. Disturbance from heavy recreational activities may be adversely affecting the foraging of eagles.
- Egg shell contamination from pesticides has occurred but presently does not appear to be a significant problem affecting reproductive success of eagles.
- Browns Mountain. LSR - presently supports 3-4 known active pairs. Potential exists for additional nesting habitat; however, the forage base in nearby reservoirs and rivers may be limiting. Solitude is poor adjacent to Crane Prairie Reservoir but good in the remainder of the LSR due to road closures. Round Mountain. LSR - no current nesting eagles; however, a sub-adult was observed on Round Mountain in June 1997. Potential nesting habitat presently exists but the area is about three (3) miles from the nearest foraging area. Solitude is only fair due to open roads and an active lookout on the mountain. Davis LSR - majority of habitat destroyed by the 2003 Davis fire but some residual remains. Sheridan LSR - relative low potential for eagle use due to distance from water bodies. Cultus LSR -2-3 historic pairs.

Oregon Spotted Frog:

Reference Conditions -

- Historic population unknown but likely higher due to better quality riparian habitats and fewer predators.
- Riparian habitats were more plentiful prior to the inundation of the Deschutes and Cultus rivers by Crane Prairie and Wickiup reservoirs.
- Predators were limited to native trout and shorebirds common to riverine systems, i.e. natural Deschutes river corridor, or small natural lakes.

Current Conditions -

- Federal status - Candidate species.
- Population - Current populations are low and isolated. However, not all areas have been surveyed. Documented populations in Davis Lake, Deschutes River, Dilman meadow ponds, and Crane Prairie Reservoir.
- There is less high quality riparian habitat today. The fluctuating reservoir level reduces the amount and quality of non-woody aquatic vegetation along shorelines which is important to this species (Leonard et al. 1993). The eggs of frogs may also be left on dry ground. Warm water temperatures that have been associated with shallow reservoirs are also a potential problem.
- Introductions of non-native fishes (e.g. bass) and the increases in predatory birds (e.g. sea gulls, cormorants, osprey, etc.) in the area have occurred since the reservoirs where constructed which are likely negative impacts on spotted frogs.
- Browns Mountain. LSR - Browns Creek is potential, high quality habitat for spotted frogs but has not been surveyed. Adjacent areas of Crane Prairie Reservoir and the Deschutes River

between Wickiup and Crane Prairie Reservoirs are also potential habitat. Round Mountain, Davis and Sheridan LSRs - no habitat. Cultus LSR - potential populations in marsh above Little Cultus Lake and in the Cultus River.

American Peregrine Falcon:
Reference Conditions -
- Population level unknown.
- Breeding habitat not present. Foraging habitat potential, particularly along the Deschutes River.

Current Conditions -
- Federal status - delisted.
- Population - None known but some movement through the area, e.g. Crane Prairie reservoir area in 1993.
- Foraging habitat potential has declined due to a reduction in riverine riparian habitats.
- Egg shell thinning contributed to population declines but should now be controlled.
- Browns Mountain. LSR -no potential nesting habitat. Browns Creek and Crane Prairie Reservoir could provide good foraging. Round Mountain, Davis, Sheridan and Cultus LSRs - no potential nesting habitat. Limited foraging habitat.

Pacific Fisher
Reference Conditions -
- Population level unknown
- Extensive upper elevation old-growth forests were likely present and supported fishers.

Current Conditions -
- Federal status - Candidate
- Population - None known but likely a few present.
- The Cultus and Sheridan LSRs - likely have the highest potential for fisher occupancy. Browns Mountain. LSR - moderate potential for use. Round and Davis LSRs - low probability.

Habitat Guilds

All data was derived from the Deschutes National Forest (DNF) wildlife habitat relationships data base. Individual species may be listed in multiple guilds and also may be repeated in the declining population category. All potential habitat users are included, which may include those who are rare or on the edge of their range. Importance of use is not discussed in this narrative. Reference the Analysis Files for the summary data tables on plant association groups (PAGs) species lists, riparian species, home range size, use codes, abundance, etc.

Riparian/Aquatic Guild
Reference Conditions -
- Representative species assigned - 9. MIS designated - 3. Approximately 78 total species (spp) on DNF.
- Historic population levels unknown
- Riverine aquatic habitat was the dominant type historically in the watershed.
- High lakes, including Johnny and Found, were in pristine condition and were important for breeding for some species, e.g. Barrow's goldeneye, bufflehead, etc.

Current Conditions -

- Representatives include bald eagle (federal Threatened) and spotted frog (federal Candidate). At least 11 species have declining population trends.
- Reservoir construction significantly altered the riverine riparian habitats (i.e. flowing water) to reservoir aquatic riparian habitats.
- Wickiup Reservoir ranks poor to fair for riparian habitat due to fluctuating water levels, which limits the establishment of stable aquatic vegetation. However, it does provide extensive shallow water and shoreline habitats for waterfowl and some shorebirds. Crane Prairie Reservoir is more stable and has well established aquatic plant communities. It also provides extensive areas of flooded lodgepole pine forest snags, which are valuable for perching birds. Some areas have good willow communities. There is less open shoreline than at Wickiup.
- Overall, waterfowl, shore birds, bald eagles and osprey have benefited from improved foraging conditions in the reservoirs. Riverine aquatic species (e.g. harlequin duck, dipper) have been negatively impacted by the reservoirs.
- High elevation lakes in the watershed are in good condition but now have human recreation related disturbance and potential water quality impacts. Introductions of non-native fish species to these systems have likely negatively impacted both native fish species and amphibians.
- Browns Mountain. LSR - Browns Creek provides nearly pristine aquatic habitat. The Deschutes River also has very good habitat but its flows are regulated by Crane Prairie dam. There are approximately 18 acres of water within the LSR; however, there are over 1 ½ miles of Crane Prairie Reservoir adjacent to the LSR boundary. Cultus LSR - significant riparian/aquatic habitats including both lakes and streams. Round Mt., Davis and Sheridan LSRs – no riparian/aquatic habitats present.

Riparian/Terrestrial Guild

Reference Conditions -

- Representative species assigned -19. MIS designated - 3. Approximately 206 spp on DNF.
- Historic population levels unknown.
- Riverine riparian zones was the dominate type historically in the watershed.
- Lake and spring riparian zones were limited.

Current Conditions -

- Representatives include greater sandhill crane (TES, species of concern, Oregon listed), Preble's shrew (TES, species of concern), and Cascades frog (species of concern, Oregon listed). At least 20 species have declining population trends.
- Reservoir construction significantly changed high quality riverine riparian zones along the Deschutes River to fluctuating zones along the reservoir shorelines.
- Willows are presently the dominate reservoir shoreline riparian species because they are capable of surviving seasonal water inundation.
- The natural lakes and springs in the area continue to provide high quality riparian zones.
- Browns Mountain. LSR - Browns Creek (3 miles of length) and the Deschutes River (1 ½ miles in length) provide a narrow but high quality riparian zone. Large springs within the Browns Creek Riparian Reserve are providing high quality wildlife habitat and unique plant communities. Cultus LSR - significant riparian/terrestrial habitats. Round Mountain, Davis and Sheridan LSRs - no significant water bodies within the area of the watershed.

Marsh/Wet Meadow Guild

Reference Conditions -

- Representative species assigned -14. MIS designated -3. Approximately 176 total spp on DNF.
- Historic population levels unknown.
- Wet meadows were associated with the Deschutes river flood plain.
- Wet meadows likely burned during periods of drought in the past.

Current Conditions -
- Representatives include long-billed curlew (TES), Preble's shrew (species of concern) and spotted frog (federal Candidate). At least 28 species have declining population trends.
- Reservoir construction inundated large wet meadows.
- Wet meadows in the area of upper Browns Creek have declined in quality due to invasion of coniferous trees. Fire suppression in the area has likely contributed to conifer establishment.
- Browns Mountain. LSR - contains about 71 acres of wet meadows in the southern portion along upper Browns Creek. Cultus LSR - marsh habitat at the inlet to Little Cultus Lake. Round Mountain, Davis and Sheridan have LSRs - none present.

Dry Meadow Guild
Reference Conditions -
- Representative species assigned - 6. MIS designated - 2. Approximately 178 total spp on DNF.
- Historic population levels unknown.
- Meadows in the area of Johnny Lake (Round Meadow and Long Meadow) are likely dry or only seasonally wet.

Current Conditions -
- Representatives include the great gray owl (species of concern, Oregon listed). At least 14 species have declining populations.
- Limited habitat type (25 acres) within the watershed that is found primarily in the high elevation areas.
- Meadow conditions were not evaluated but most are within a roadless area and are therefore, likely in good condition with the potential of some impacts from recreationists. There is also the potential for coniferous tree invasion of dry meadows where fire has been excluded for extended periods of time.
- All LSRs - none present.

Shrub Guild
Reference Conditions -
- Representative species assigned - 24. MIS designated - 3. Total spp on DNF undetermined.
- Historic population levels unknown.

Current Conditions -
- Representatives include the northern sagebrush lizard (species of concern). Number of declining species populations undetermined.
- Shrub communities are predominantly in the understories of coniferous forest stands. Only a few are relatively pure shrub fields, which are confined to dry south slopes on buttes and rock, cinder and lava areas.
- Fire suppression has likely allowed shrub communities to become older and taller. However, shading by tree canopy may reduce shrub density where timber harvest has not occurred for many years. Lack of fire has allowed shade tolerant trees such as white fir to become more

densely established. Firs have fuller crowns which affect shrubs more significantly then pines. Fire sensitive shrubs including sagebrush and bitterbrush have likely increased on suitable sites. In some stands prescribed burning in association with timber harvest has greatly increased the density of fire adapted shrubs such as ***Ceanothus*** spp.

- Browns Mountain. LSR - extensive shrub communities in the xeric plant associations with most on the south and west slopes of Browns Mountain. Nearly pure Ceanothus stands in old harvest units are present in the northern portion of the LSR near Wuksi and Shukash Buttes. Round Mountain. LSR - well established understories of shrubs are present on all but the northern aspect of Round Mountain. Ceanothus stands are very dense in some older harvest units on the west aspect with ponderosa pine overstory. Davis LSR - shrubs presently limited due to the recent wildfire. Sheridan and Cultus LSRs - primarily in understories of coniferous forest stands.

Alpine/Subalpine Guild

Reference Conditions -

- Representative species assigned - 10. MIS designated - 2. Total spp on DNF undermined.
- Historic population levels unknown.
- Very limited habitat type in the watershed.

Current Conditions -

- Representatives include the wolverine (TES, species of concern). Declining species are undetermined.
- Habitat is limited to the extreme upper elevations near The Twins.
- Conditions were not evaluated; however they are likely good since the area is roadless. Fire frequency in the high elevation areas is low; however, its exclusion by management has likely allowed trees to increase in density and distribution in these areas (Landscape Area 1A).
- All Mountain.LSRs -none present.

Coniferous Forest—Early Seral Guild

Reference Conditions -

- Representative species assigned - 14. MIS designated - 3. Approximately 34-84 total spp on DNF depending upon PAG (lodgepole low, mixed conifer high).
- Historic population levels unknown.
- Early seral conditions were produced by stochastic natural disturbances including wind, fire and insect/disease events. Patch sizes were variable and location was affected by a multitude of variables including large scale climatic conditions, e.g. drought.
- The extent of early seral conditions could be predicted through an intensive analysis of wildfire events. However, this was not done and presents many complications that could reduce accuracy. Other factors such as windthrow can not be reconstructed.

Current Conditions -

- Representatives include several neotropical migrant birds, e.g. western bluebird, Calliope hummingbird, etc. At least 10 spp. in mixed conifer have declining populations.
- Presently there are an unknown number of acres of early seral forest in the assessment area.
- Past timber harvest activities have created most of the present early seral stands. Within the more intensely managed zones the early seral stage amounts are unknown. Lodgepole pine PAGs have the highest proportion of early seral stage Natural meadows and edges with the meadows and lakes meet some of the needs of this group. Additionally, areas within extensive lava, which have fewer trees, may provide early seral conditions.

- Browns Mountain. LSR - 14 percent is in early seral. Round Mountain. LSR – four (4) percent is in early seral. Davis LSR - unknown, Sheridan LSR –unknown, Cultus LSR - unknown.

Coniferous Forest—Mid Seral Guild

Reference Conditions -

- Representative species assigned - 11. MIS designated - 2. Approximately 41-82 total spp on DNF depending upon the PAG (lodgepole low, mixed conifer high).
- Historic population levels unknown.
- The amount and distribution of mid-seral forest stages are unknown. The climatic conditions, fire frequency and intensity, and other stochastic natural events were the controlling agents historically. Many stands likely attained the more simple structure of middle aged stands where distinct stories and the establishment of shade tolerant species were just beginning.

Current Conditions -

- Representatives include a variety of the more common forest dwelling species such as blue and ruffed grouse, red-breasted nuthatch, porcupine and mule deer. At least 12 species in mixed conifer have declining populations.
- Presently there is an unknown acreage of mid-seral forest in the assessment area.
- The mid-seral stage is the most dominant forest habitat within the watershed. In the heavier managed areas, the acreage is unknown on the more significant PAG acreages. Lodgepole pine PAGs have the largest proportion in the mid-seral stage.
- Browns Mountain.LSR - 28 percent is in mid-seral. Round Mountain LSR - 25 percent is in mid-seral. Davis - unknown. Sheridan LSR - unknown. Cultus LSR – unknown.

Coniferous Forest—Late Seral Old-Growth (LSOG) Guild

***Sub-Guild*: LSOG/Ponderosa Pine Dry/Wet Plant Association Groups (PAG)**

Reference Conditions -

- Representative species assigned - 17. MIS designated - 3. Approximately 85 total spp on DNF.
- Historic population levels unknown.
- Past wild fires likely created a mosaic of late seral structural conditions. Stands on mesic north aspects and along riparian areas probably had multiple stories with relatively high canopy coverage. More xeric stands were likely dominated by very large yellow bark pine with open understories with patchy regeneration. Patch sizes probably ranged in size. Canopy gaps were created by windthrow and pathogens like root rots. Mistletoe infections likely caused localized crown fires even with low intensity stand ground fires due to the brooming effect on branches and the build up of fuels in these sites.
- Species that are dependent upon large trees, snags and relatively open understories for foraging were probably plentiful.

Current Conditions -

- Representatives include bald eagle (TES), flammulated owl (species of concern, Oregon listed), Williamson's sapsucker (Oregon listed), pygmy nuthatch (Oregon listed), and silver-haired bat (survey & manage). At least 13 species have declining populations.
- Past timber harvest has removed or altered many late seral ponderosa pine stands in the assessment area. No existing late seral stands were observed that have not had at least single tree selection harvest within them. Nearly all are affected by fragmentation of the landscape by units which have increased edge contrast and its associated effects on micro-site conditions within the adjacent stands.

- Fire exclusion has had a significant affect on the remaining late seral ponderosa pine stands. The understory tree component has greatly increased in density, and shade tolerant species such as white fir have increased. Existing overstory ponderosa pine appears to be declining in vigor and becoming susceptible to pathogens such as western pine beetle due to the increased stress from competition for the available resources of water and nutrients.
- Currently there is approximately 71,145 acres of late seral forest in the assessment area.
- Ponderosa pine PAGs comprise an unknown acreage of the total late seral acreage.
- Average patch size of late seral ponderosa pine is unknown.
- Browns Mountain. LSR - 14 percent of total area is in late seral ponderosa pine (1,375 ac. all stages). Fragmentation is moderate to heavy in this type. Round Mountain. LSR - none present. Davis LSR - unknown. Sheridan LSR - unknown. Cultus LSR - unknown.

<u>Sub-Guild</u>: LSOG/Mixed Conifer Dry/Wet PAGs

Reference Conditions -

- Representative species assigned -16. MIS designated - 3. Approximately 99 total spp on DNF.
- Historic population levels unknown.
- The mixed conifer dry PAG likely had fairly frequent fire intervals depending upon slope, aspect, topographic position, etc. Consequently, ponderosa pine and Douglas-fir were dominant overstory trees and thin barked firs were reduced by ground fires. The wet PAG had longer fire intervals and was able to more fully develop multiple canopy layers; however, this PAG is very limited within the assessment area. Patch sizes were likely variable with larger patches in the more mesic sites such as north slopes or where fire frequency was short and kept fuel loadings low. Firs have a higher mortality rate, which would have contributed to within stand canopy gaps.
- Due to the greater plant species diversity and more complex structure in these PAGs, wildlife use would have been expected to be greater than in the more simple associations, particularly for those species that require large trees, snags and semi-open understories.

Current Conditions -

- Representatives include northern spotted owl (TES), northern goshawk (Oregon listed), and hoary bat (survey & manage). At least 17 species have declining populations.
- Past timber harvest has removed or altered many late seral mixed conifer stands in the assessment area. No existing late seral stands were observed that have not had at least single tree selection harvest within them. Nearly all are affected by fragmentation of the landscape by units which have increased edge contrast and its associated effects on micro-site conditions within the adjacent stands.
- Fire exclusion has had a significant affect on the remaining late seral mixed conifer stands. The understory tree component has greatly increased in density, and shade tolerant species such as white fir have increased. Existing overstory ponderosa pine appears to be declining in vigor and becoming susceptible to pathogens such as western pine beetle due to the increased stress from competition for the available resources of water and nutrients. Other species (white fir, lodgepole pine, Douglas-fir) have also shown increased mortality from insect and disease agents, e.g. root rots, mountain pine beetle, mistletoe, spruce budworm, etc.
- Mixed conifer PAGs currently comprise unknown acreage of the total late seral acreage.
- Average patch size of late seral mixed conifer is unknown.
- Browns Mountain. LSR -36 percent of the total area is in late seral mixed conifer (3,925 ac. all stages).). Fragmentation is low to moderate in this type. Round Mountain LSR -71 percent of the total area is in late seral mixed conifer (223 ac. all stages). Within the Round

Mountain.LSR, fragmentation is low, however due to its small size there are low to moderate impacts from adjacent harvest units because of edge effects on interior forest conditions. Davis LSR - unknown. Sheridan LSR - unknown. Cultus LSR - unknown.

Sub-Guild*: *LSOG/Lodgepole Pine Dry/Wet PAGs

Reference Conditions -

- Representative species assigned -11. MIS designated - 2. Approximately 44 total spp on DNF.
- Historic population levels unknown.
- The lodgepole pine PAGs are generally even aged due to historic stand replacement fires. Patch sizes were variable depending upon climatic conditions, fuel continuity, topographic position, etc.
- The wet PAG has significantly better site productivity and produces larger trees with a greater biological age.
- Mountain pine beetle and other pathogens are normal control agents in lodgepole and contribute to fuel loadings and subsequent fires. Species such as black-backed woodpecker and American marten have adapted to the cycles of lodgepole that provide large amounts of snags and coarse woody debris. However, due to the relatively simple stand structure, lower plant diversity and the lower site productivity that is common to lodgepole sites, the associated wildlife community is also lower in diversity and abundance.

Current Conditions -

- Representatives include black-backed woodpecker (Oregon listed), great gray owl (survey & manage, Oregon listed), and American marten (Oregon listed). At least seven (7) species have declining populations.
- Past timber harvest and salvage have significantly affected the age class proportions of lodgepole pine forest in the assessment area. Epidemic bark beetle populations have occurred in many stands. Fire exclusion has altered the natural rotation of age classes and patch sizes/shapes. Late seral lodgepole stands are limited and primarily located within the roadless area or narrow riparian zones.
- Lodgepole pine PAGs currently comprise an unknown acreage of the total late seral forest acreage.
- Average patch size for late seral lodgepole pine is unknown.
- Browns Mountain. LSR – six (6) percent of the total area is in late seral lodgepole pine (1,761 ac. all stages). Fragmentation is moderate to high in this type. Round Mountain LSR - none present. Davis LSR - unknown. Sheridan LSR - unknown. Cultus LSR – unknown..

Sub-Guild*: *LSOG/Mountain. Hemlock PAG

Reference Conditions -

- Representative species assigned -14. MIS designated -2. Approximately 64 total spp on DNF.
- Historic population levels unknown.
- The Mountain Hemlock PAG has a relatively long fire frequency. Fires were most likely stand replacement events after periods of drought. Fuel loadings and dense understories would develop between fire events. Snow loading, windthrow and insect/disease pathogens were also common stand disturbance agents. Patch sizes were likely very large with small canopy gaps due to the agents described. White pine blister rust is a mortality agent that is more prevalent in this PAG than the others.
- Wildlife communities in these PAGs are less rich than those in mixed conifer stands due to the higher elevations and lower site productivity. However, there are several unique species

(e.g. wolverine, Clark's nutcracker) that use these habitat types. Some areas provide high value elk habitat because of the solitude, more abundant water, and unevenaged structure of the stands.

Current Conditions -

- Representatives include northern spotted owl (TES), northern three-toed woodpecker (species of concern, Oregon listed), northern goshawk (Oregon listed), and fisher (species of concern, Oregon listed). At least 11 species have declining populations.
- Past timber harvest has had minimal impact on these PAGs. Some road construction has occurred which has contributed to fragmentation. Recreation impacts have occurred as related to trail construction and use and dispersed camping. Present levels of insect/disease pathogens appear endemic and within the normal expected range of variability.
- Mountain. Hemlock PAGs currently comprise an unknown acreage of the total late seral forest acreage.
- Average patch size for late seral Mountain hemlock is unknown.
- Browns Mountain LSR - none present. Round Mountain LSR - none present. Davis LSR - none present. Sheridan LSR - unknown. Cultus LSR – unknown.

Unique-Special Habitats Guild

Sub-Guild: Edge (Ecotones)

Reference Conditions -

- Representative species assigned -15. MIS designated -3. Approximately 38 total spp on the DNF (partial list - limited to obligate/dependents).
- Historic population levels unknown.
- Natural (inherent) edges were created by wildfire, windthrow, insect/disease, etc. in the past. The ecotones associated with the contrast between different vegetative communities or different seral stages are important to many wildlife species. Resources for different life functions may be attainable within a relatively small area in ecotones as compared to forest interior habitats. The degree of edge contrast is also an important influence. For example, a recent wildlife could create a very open patch adjacent to late seral forest for a high contrast edge. A low contrast edge could be between a mature stand and old-growth forest.

Current Conditions -

- Representatives include great gray owl (survey & manage), pygmy owl (Oregon listed), hoary bat (survey & manage), and fringed myotis (survey & manage, Oregon listed). At least three (3) of the obligate/dependent species have declining populations.
- Timber harvest, road construction, reservoir construction and other activities have greatly increased the amount of edge in the watershed. As an example, the patch sizes of vegetation in a managed landscape are generally much smaller than historic natural patches. Small patches have a much larger edge to interior ratio. The type of edge has also been significantly altered. Management created or induced edges generally have a much higher contrast than inherent edges. High contrast edges have a greater degree of influence on the adjacent later seral patch. Research has shown micro site influences from 400-600 feet on average. These subtle changes may influence vegetation, temperatures, snow loading, etc. that in turn affect wildlife species in either positive or negative ways..
- The amount and types of edges have not been quantified for this analysis or for the LSRs. Refer to the previous discussions for the LSOG sub-guilds on fragmentation, which is a good indicator of the amount of edge.

Sub-Guild: Snags/Logs

Note: Many of the species in this sub-guild are members of other guilds. However, the majority are totally or significantly dependent upon snags/logs for a critical part of their life cycle. Snags and logs have an important role in ecosystem function, therefore it was determined that a evaluation of this group of species was essential.

Reference Conditions -

- Representative species assigned -13 snags, 5 logs. MIS designated - 4 snags, 3 logs. Approximately 57 total spp use snags and 26 total spp use logs on the DNF.
- Historic population levels unknown.
- Snags and logs were provided by natural tree mortality (old age), windthrow, wildfire, insect/disease vectors, ice storms, etc. Other than crown wildfires and epidemic insect infestations, most tree mortality occurred as individuals or in small patches. Windthrow rarely occurs in this area in large patches.
- Snags provide a variety of functions to the ecosystem. They have a role in lightning fires which are critical to natural processes. Hundreds of individual organisms have been documented to live in or upon standing snags. They all have a role in the functioning system. Wildlife species, as an example, use them for nesting, foraging and perching. Woodpeckers (primary excavators) excavate nest and roost holes in them, which are very important to a number of other species (secondary nesters). Populations of woodpeckers provide an invaluable benefit to the forest by controlling the numbers of many destructive forest insect pests.
- Fallen trees/snags would remain on the site unless moved by water courses or by gravity down slope. They would undergo a natural process of deterioration which is critical to many invertebrates, fungal species and other organisms. They have a significant role in soil structure and chemistry, which affects all the living components of the system. Logs provide benefits to wildlife in numerous ways including: protective cover, travel ways, foraging sites, and nesting/reproduction sites.

Current Conditions -

- Representative include great gray owl (survey & manage), pileated woodpecker (Oregon listed), western bluebird (Oregon listed), silver-haired bat (survey & manage), and American marten (Oregon listed). At least 15 of the snag dependent species populations are declining and at least one (1) of the log dependent species populations is declining.
- Timber harvest/salvage activities have had significant negative impacts upon snag/log densities and distribution. Fuelwood cutting, hazard tree removals, road construction, prescribed burning, brush piling and burning, and other activities have also reduced snags and logs. Fire suppression has eliminated the recruitment of snags/logs in several ways. Direct and indirect mortality of trees as related to fire has been greatly reduced. Trees killed by fire are now quickly salvaged whereas they remained on site historically. Species such as the black-backed woodpecker are dependent upon fire killed trees. Trees that were injured (stressed) by fire often died later after attacks by insects/disease agents.

***Sub-Guild*: Talus/Rock/Lava Flows**

Reference Conditions -

- Representative species assigned -12. MIS designated -3. Total species on the DNF undetermined.
- Historic populations unknown.
- Very stable habitat types that developed via geomorphic processes. Vegetation influences within or adjacent to these areas have been more transient but may significantly influence the value of these areas for wildlife species.

- Talus and rock are minor habitat components in the watershed. Lava flows, including cinder areas, are more prevalent. These areas provide a unique diversity within the forested ecosystem. Some plants are specialized for these environments. Precipitation is often funneled off rocks, which may improve site conditions for more water dependent plants, e.g. quaking aspen. Seasonal ponds may form adjacent to large lava flows and provide valuable aquatic/riparian habitats for a variety of species.

Current Conditions -
- Representatives include long-eared myotis (species of concern, survey & manage) and pika (special interest). At least one (1) species population is declining.
- Direct affects by management activities have included road construction and rock quarries. Indirect affects have been primarily due to timber harvest within (e.g. forested lavas) or adjacent to these features.

Note: the other sub-guilds in this category were not assessed due to their lack of presence or very minor representation in the assessment area/LSRs.

Generalist Guild

Reference Conditions -
- Representative species assigned -23. MIS designated - none. Total species on the DNF undetermined.
- Historic populations unknown.
- This species group utilizes a wider range of habitat types and conditions than the previous guilds. The composite reference conditions of the other guilds describe the wide breadth of habitats of this guild.

Current Conditions -
- Representatives do not include any notable species as far as status with the exception of the golden eagle which has special protective legislation. Declining populations undetermined.
- Both natural and human induced vegetative changes that increase habitat diversity will benefit most generalist species. Permanent losses of habitat from road and facility construction, as an example, are obviously damaging even to generalists. Nearly all generalists have a specific life cycle requirement that must be met. The large number of species in this category and the individual biological traits of each present a complexity that is outside the scope of this scale of assessment.
- Browns Mountain. LSR - habitats are diverse. Round Mountain. LSR - small area, low diversity. Davis LSR - dominated by post fire habitat few remaining green trees. However, species utilizing extensive open area post-fire and areas with high snag densities include western and mountain bluebird, northern three-toed woodpecker, black-backed woodpecker and Lewis' woodpecker. Sheridan LSR – unknown. Cultus LSR - unknown.

Evaluation of Trends and Ecological Function

Introduction

The following narrative presents the most significant elements relating to present trends and ecological functions in the watershed and Late Successional Reserves (LSRs) as related to wildlife species and their habitats. The term "sensitive" includes all, as applicable, threatened, endangered, sensitive, survey and manage, and State listed species as previously described in this analysis. Effects of human and natural changes in the environment as related to wildlife are composite professional opinions from having utilized all the available information as appropriate to a large scale analysis. Special land management area designations from the Northwest Forest

Plan (NWFP) and the Deschutes National Forest (DNF) Land and Resource Management Plan (LRMP) are noted if of significance to the wildlife resource. Maps of the described Sub-Landscapes are available in the Browns-Wickiup Watershed Analysis document.

Browns-Wickiup Landscape Areas

Sub-Landscape High Elevation Unroaded

- Direct impacts from humans are very low. Approximately 0 percent of this sub-area is in the early stage and 33 percent in the mid seral stage. There are no roads but constructed trails exist. Trend is stable and at capacity for wildlife. Risk to catastrophic fire is likely higher due to past fire suppression efforts, however high elevation mountain hemlock forests have a relative long fire interval.
- Late seral forest comprises about 59 percentage of the sub-area.
- Ecological function is very good. This sub-area provides an important potential refuge for species that are sensitive to human disturbance that require large, unfragmented home ranges, e.g. fisher, wolverine, spotted owl, northern goshawk. It is also an important area for elk.
- There are no LSR (NWFP) lands within this sub-area; however, it is designated as Matrix (NWFP) and provides important habitat and connectivity between LSRs for northern spotted owl and other species. This function remains intact and stable.
- Effects to sensitive species in this zone are very low.

Sub-Landscape Roaded

- Direct impacts from past logging activities and roading are moderate to high. Approximately 16 percentage of the sub-area is in the early stage and 50 percent in the mid seral stage. Road density is unknown. Trend is likely stable but capacity to support some species has been lowered. Large clearcuts have broken up fuel continuity but the area is likely at risk where lodgepole pine occurs in continuous blocks.
- Late seral forest comprises about 31 percent of the sub-area.
- Ecological function is impaired but not significantly. Late seral habitats should be maintained on at least 15 percent of this landscape unit (NWFP 1990).
- There are no LSR lands within this sub-area; however, it is designated Matrix.
- Effects to sensitive species are likely low-moderate overall. Wolverine may be precluded from using the area due to human access. This sub-area provides forage for elk in clearcuts near the edges but, interiors of the larger units probably have low use. Road closures in the area appear to be effective. Snags and CWD levels are below the minimums needed in harvest units but acceptable elsewhere.

Sub-Landscape Johnny & Found Lakes

- Direct impacts from humans are low. Trend is stable but below capacity due to effects of non-native fish introductions on amphibians and other life forms in the food chain. Disturbance by recreationists will likely increase and adversely affect a few of the more sensitive species.
- Late seral forest comprises 80 percent (41 ac.) of this small sub-area.
- Ecological function is impaired for aquatic species but good for terrestrial riparian species.
- There are no LSR lands associated with these lakes; however, the lands adjacent to the lakes are designated as Riparian Reserve (NWFP).
- Sensitive species that have likely been negatively affected include: northern spotted owl (low impact), spotted frog (moderate-high), bufflehead (low), Barrow's goldeneye (low), wolverine (moderate), fisher (low), and marten (low). Various warblers (e.g. yellow warbler) and other species that utilize riparian vegetation are potentially affected by human use near water, however it is unknown if there are conflicts in this sub-area.

Sub-Landscape Highway 46 Corridor

- Direct impacts from humans are moderate to high. Approximately 12 percent of this sub-area is in the early stage and 52 percent in the mid seral stage. Road density is unknown. Trend is slowly improving as the former harvest units grow replacement trees; however, there has likely been soil compaction in the units.
- Late seral forest comprises about 34 percent of the sub-area. A large (456 ac.) old-growth area (Management Area 15, LRMP) is within it.
- Ecological function is acceptable overall; however, the edge effects of harvest units has likely decreased the amount of suitable core areas within the remaining late seral stands. Fire exclusion has resulted in the increase of stem density in the understories of many stands, e.g. mixed conifer dry PAG. Function may be at risk to future catastrophic wildfires
- There are no LSR lands within this sub-area; however, it is designated Matrix. This sub-area is important for habitat connectivity between LSRs.
- Effects to sensitive species are moderate to high due to fragmentation, roading and the reduction of late seral forest. Elk and deer are likely more vulnerable to hunters because of the road densities and the open harvest units. Snags and CWD levels are variable and appear to be below the minimum amounts needed in past harvest units. . There are three designated BEMAs and portions of two others within it. Road closures to protect the nesting areas have been ineffective in several locations. Often eagles establish their nests in trees adjacent to existing roads within the closure areas. When illegal entry is made later in the year by fishermen, campers, etc. they drive their vehicles by the established nests. Failures are common and are likely a consequence of this disturbance.

Sub-Landscape North Wickiup

- Direct impacts from humans are moderate to high. Approximately 19 percent of this sub-area is in the early stage and 63 percent in the mid seral stage. Road density is unknown. Trend is slowly improving as the former harvest units grow replacement trees.
- Late seral forest comprises about 17 percent of the sub-area.
- Ecological function is currently acceptable; however, impacts have occurred from fragmentation and roading. Fire exclusion has caused stand understories to become more dense, increased large tree mortality and increased fuel loadings within designated Bald Eagle Management Areas (BEMA, Management Area 3, LRMP). Reservoir construction may have increased windthrow by reducing surface roughness and exposing residual stands to stronger winds, which has caused losses of large trees within BEMAs.
- There are no LSR lands within this sub-area; however, the western portion of it is designated Matrix.
- Effects to sensitive species are moderate to high due to fragmentation, roading and disturbance from recreationists who are using Wickiup Reservoir. Elk and deer are likely more vulnerable to hunters. However, some road closures in the area have mitigated these effects while others have been compromised. Snags and CWD levels appear to be below the minimum amounts needed.

Sub-Landscape Eaton Bu.

- Direct impacts from humans are low to moderate. Approximately 18 percent of this sub-area is in the early stage and 52 percent in the mid seral stage. Road density is unknown. Trend is slowly improving as the former harvest units grow replacement trees.
- Late seral forest comprises about 28 percent of the sub-area and is confined primarily to the north end within a designated BEMA.

- Ecological function is acceptable but the amount of late seral habitat is of concern. Fire exclusion has caused stem densities and tree composition to change within the BEMA.
- There are no LSR or Matrix lands within this sub-area.
- Effects to sensitive species are moderate to high due to the reduction of late seral habitat and current condition of existing late seral stands. Road impacts have been mitigated by several closures to protect nesting bald eagles and appear to be effective. Snags and CWD levels are likely acceptable in the northern portion of this sub-area but not elsewhere.

Sub-Landscape Davis Arm

- Direct impacts from past logging and roading are moderate to high. Additionally, there are both direct and indirect impacts to wildlife from recreationists using Wickiup Reservoir. Approximately 32 percent of the sub-area is in the early stage and 67 percent in the mid seral stage. Road density is unknown. Trend is presently down. Extensive harvest activities (salvage) have likely compacted soils and exacerbated recovery of habitat.
- Late seral forest comprises about 0 percentage of the sub-area.
- Ecological function is impaired due to the lack of late seral forest and impacts from dispersed recreation within riparian corridors, e.g. vegetation trampling and cutting.
- There are no LSR lands, however it is designated Matrix. These lands are not essential as movement corridors.
- Effects to sensitive species are moderate to high. The lack of large trees likely prevents potential bald eagle nesting in an area adjacent to high quality foraging habitat. The disturbance from recreationists is another potential adverse effect to eagles.

Sub-Landscape Forested Lavas

- Direct impacts from humans are moderate due to past timber harvest and roading. Approximately 33 percent of this sub-area is in the early stage and 42 percent in the mid seral stage. Road density is unknown. Trend is stable overall with some local declines in harvest units.
- Late seral forest comprises about 25 percent of the sub-area.
- Ecological function is acceptable; however, regeneration of harvested stands has been very slow.
- There are no LSR lands; however, it is designated Matrix.
- Effects to sensitive species are moderate. Snags and CWD levels are below acceptable levels.

Sub-Landscape Wickiup Bu.

- Direct impacts from humans are moderate. Approximately 12 percent of this sub-area is in the early stage and 81 percent in the mid seral stage. Road density is relatively high due to past timber harvest units and a cinder pit. Trend is slowly improving.
- Late seral forest comprises about two (2) percent of the sub-area.
- Ecological function is acceptable. However, fire exclusion is increasing the risk of wildfire in the future in some areas (e.g. upper slopes). Many of the older shrubs are becoming decadent and have numerous dead stems. Late seral structure is significantly lacking.
- There are no LSR or Matrix lands within this sub-area.
- Effects to sensitive species are moderate. This sub-area is a designated BEMA. However, it is an alternate site that has not been occupied. The principal need is to re-establish large ponderosa pines for potential nest trees. Snags and CWD levels are below the minimum amounts needed.

Sub-Landscape Davis Mt. (pre-fire)

- Direct impacts from humans are moderate. Approximately 12 percent of this sub-area is in the early stage and eight (8) percent in the mid seral stage. Road density is unknown. Trend is improving.
- Late seral habitat comprises about 79 percent of the sub-area.
- Ecological function is good. However, many stands have experienced a significant increase in understory tree density of shade tolerant species such as white fir. The increased competition is likely causing higher mortality of the overstory ponderosa pine.
- The majority of the sub-area is in Matrix. A small portion in the SW corner is in the Davis Mt. LSR. Only a small strip along the eastern edge is outside of NWFP allocations.
- Effects to sensitive species are low to moderate. Fragmentation from harvest units and roading is the principal effect as related to reduction of late seral core areas from edge effects. This sub-area is likely used by nearby northern spotted owls for foraging and dispersal. Several large BEMAs are within the sub-area adjacent to Wickiup Reservoir and a portion of another occurs near Davis Lake. Fire exclusion may cause long-term negative effects on eagles by increasing the probability of crown fires. Road closures within the BEMAs are generally effective but could use improvement. Snags and CWD levels are variable and meet the minimum requirements only in the remaining late seral patches.

Sub-Landscape Shoreline/Reservoir

- Direct impacts from humans are moderate to high. Approximately 11 percent of this sub-area (excluding reservoir surface) is in the early stage and 81 percent in the mid seral stage. Road density was not calculated due to the limited, narrow zone around the shoreline of Wickiup Reservoir. Trend is downward due to impacts from dispersed recreation uses.
- Late seral forest comprises about seven (7) percent of the sub-area.
- Ecological function is impaired. Impacts are primarily related to soil compaction, vegetation destruction and disturbance to wildlife from recreationists. Additionally, in some areas understory tree densities have increased dramatically due to fire exclusion.
- There are no LSR lands within this sub-area. Roughly half of the shoreline of Wickiup Reservoir will be designated Riparian Reserve.
- Effects to sensitive species are moderate. Bald eagles have likely been displaced from potential nesting areas along the shoreline due to human disturbance. However, they appear to be successfully nesting in areas in the adjacent uplands. Snags and CWD appear to be below the minimum amounts needed in many areas. Foraging impacts are also likely but not proven. Overall effects of the reservoirs have been positive for many species, including a diversity of migrating waterfowl and shorebirds.

Sub-Landscape N. Twin Lake

- Direct impacts from humans are moderate to high. Approximately one (1) percent of this sub-area (excluding water surface) is in the early stage and two (2) percent in the mid seral stage. About 47 percent of this small sub-area is water surface. Road density is unknown. Trend is stable.
- Late seral forest comprises about 97 percent of the sub-area.
- Ecological function is acceptable. However, the understory tree component is changing due to lack of fire. Increased competition will affect the remaining overstory trees over time. Most of the area around the lake is designated BEMA, so retention and recruitment of large diameter ponderosa pine is of concern. Habitat has been permanently removed/altered by a developed campground.
- There are no LSR lands within this sub-area; however, it is both Matrix and Riparian Reserve.

- Effects to sensitive species are moderate. The established BEMA is unoccupied. Potentially suitable nest trees are present, and the lake provides potential forage fish. Other forage areas are within reach of eagles if they were to nest in this sub-area. The effects of heavy recreational use of the lake and its small size may be the reason for birds not nesting there. Recent road closures on the south end of the lake will likely help reduce potential disturbance to wildlife. The entire west shore of the lack lacks solitude due to a developed trail there and the proximity of the area to a highway.

Sub-Landscape S. Twin Lake

- Direct effects from humans are moderate to high. Approximately 0 percent of this sub-area (excluding water surface) is in the early stage and 37 percent in the mid seral stage. Water surface accounts for about 42 percent of this small sub-area. Road density is unknown. Trend is declining.
- Late seral forest comprises about 71 percentage of the sub-area.
- Ecological function is acceptable but at risk due to fire exclusion. Stand understories are becoming more dense and insect/disease vectors are increasing their impacts. Large overstory trees will become more stressed and vulnerable to these processes. Habitat has been permanently removed/altered by a campground and a resort. Hiking and biking trails surround the lake.
- There are no LSR lands within this sub-area; however, it is both Matrix and Riparian Reserve.
- Effects to sensitive species are moderate. The principal problem is human disturbance.

Sub-Landscape Davis Lava Flow

- Direct effects from humans are low. Approximately 0 percent of this sub-area (excluding pure lava) is in the early stage and 22 percent in the mid seral stage. Lava flow surface accounts for about 79 percent of this sub-area. Road density is very low and limited to the edges of the lava flow. Trend is stable.
- Late seral forest comprises 78 percent of the vegetated sub-area and is confined to an "island" in the south-central portion of the flow. This area is a designated BEMA and has two other BEMAs adjacent to it along the shores of Davis Lake.
- Ecological function is good. Fire exclusion within the described island is the principal concern. However, it was not field evaluated. Regeneration of trees is always an issue within forested lavas, so the role of fire must be placed in this context. There are no LSR lands within this sub-area; however, it is both Matrix and Riparian Reserve.
- Effects to sensitive species are low. Bald eagles are not presently nesting in the area, but the potential is good given the proximity of high value foraging areas at Davis Lake.

Sub-Landscape Browns Mt. LSR

- Direct effects from humans are moderate to high. Approximately 14 percent of this sub-area is in the early stage and 27 percent in the mid seral stage. Road density is about 5.7 mi./sq. mi. Trend is slowly improving.
- Late seral forest comprises about 56 percent of the sub-area. There is one large BEMA and three old-growth areas within this sub-area. A portion of the LSR is also within osprey Management Area #5.
- Ecological function is variable across the LSR with the central portion around Browns Mt. being good and the other areas only marginally acceptable. Fire exclusion and past logging units are the principal causes of negative effects. Tree regeneration of units near Wuksi and Shukash Buttes has been retarded due to heavy ceanothus invasion.

- Effects to sensitive species are moderate to high. Human disturbance in the portion of the LSR adjacent to Crane Prairie Reservoir is a concern for effects on bald eagles. Past selective harvest of large ponderosa pine and Douglas-fir eliminated most of the potential nest trees for northern spotted owls. Timber harvest and roading in areas adjacent to the LSR have significantly eliminated dispersal habitat for spotted owls. Other LSOG species may be negatively affected by edge effects from fragmentation of late seral habitats throughout the LSR. Snags and CWD levels are below the minimums needed in many stands.

Sub-Landscape Round Mt. LSR

- Direct effects from humans are moderate. Approximately four (4) percent of this sub-area is in the early stage and 25 percent in the mid-seral stage. Road density is about 4.0 mi./sq. mi. Trend is stable.
- Late seral habitat comprises about 71 percent of the sub-area.
- Ecological function is acceptable. Fire exclusion is primarily an issue on the western and southern aspects where ceanothus presently dominates many stand understories. A few stands adjacent to the LSR also have this problem. Habitat has been permanently removed/altered by the lookout facility and access road on the mountain. The removal of trees to accommodate helicopters and improve visibility from the lookout are also impacts. A seasonal road closure helps in retaining some solitude in the area. Edge effects are of high concern in this LSR due to its small size.
- Effects to sensitive species are moderate. Past harvest and edge effects are the principal concerns. Sub-adult bald eagles have been observed on the mountain, and it is considered to have nesting potential. Spotted owls could potentially travel thought this sub-area, but nesting is unlikely due the limited amount of late seral forest present. Other LSOG species may be affected by edge effects around the perimeter of the LSR.

Snow Watershed Assessment Area

Quantitative data at the sub-landscape scale (i.e. "landscapes") described in the preceding section are only available for the Browns-Wickiup portion of the assessment area. The following section examines the trends and ecological conditions for wildlife for the entire assessment area.

The most significant trend affecting wildlife habitats in the assessment area is tree mortality from mountain pine beetles. The late multi-forest habitats in designated LSRs (32,461 gross acres), which are to provide habitats in the long-term for northern spotted owls and other dependent species, have approximately 8,135 acres (25 percent) with moderate or high levels of tree mortality. The Cultus LSR is particularly important to spotted owls (5 historic pairs) and has 66 percent of its acreage with moderate/high tree mortality. In comparison, the Matrix allocation area has only 15 percent of its area (gross 49,498 acres) in moderate/high tree mortality. In summary, the LSRs have an unacceptable level of tree mortality. However, roadless areas and steep terrain within the LSRs will limit management's options for future treatments.

Northern bald eagles require very large ponderosa pine or Douglas-fir trees in open forest environments. The ponderosa pine and mixed confer dry forest types are preferred. These habitats were historically naturally maintained by relatively frequent, low intensity wildfires. In the Matrix allocation, which is most commonly in the area of preferred nesting by eagles near water bodies, approximately 45 percent is classified as frequent fire habitat types. Within the mixed conifer dry type, 12 percent of it has moderate/high tree mortality. The ponderosa pine dry type has about one (1) percent in the moderate/high tree mortality level. In summary, the Matrix lands have had past and current management activities that appear to be reducing tree mortality.

Habitats associated with streams and lakes are of very high value to many wildlife species. A quantitative analysis of tree mortality in these areas was not done. However, the watershed as a whole has abundant riparian/aquatic habitats (4,319 acres of natural lakes and 87 miles of perennial streams) and many of them are within areas mapped with moderate/high tree mortality. Catastrophic wildfire in these areas would have significant long-term negative impacts on these habitat types both for terrestrial and aquatic species.

A significant portion of the watershed is in LRMP recreation allocations (dispersed, intensive, winter), which total approximately 57,571 acres or 26 percent of the gross assessment area acreage. Given that many other allocations (e.g. wilderness) also attract recreations in high numbers, the potential for human-wildlife conflicts is high. This is particularly important as related to disturbance sensitive species such as bald eagles during the nesting season. Reference the recreation section of the watershed analysis for additional discussion on recreation trends, which have increased since the last evaluation. Population increases in Bend, Sunriver, LaPine and Redmond suggest that in the long-term, the issue of disturbance of wildlife by recreationists will likely significantly expand.

In summary, the trend changes of higher tree mortality, tree density increase, and recreation increases by humans in the watershed could lead to significant negative effects on some wildlife species. Species associated with late successional forest, open single-story forest, and riparian/aquatic habitats could be impacted by insect/disease epidemics or catastrophic wildfires in the future. Human-wildlife conflicts and the loss of solitude for sensitive species will increase with changes in the local human population and visitations from non-local recreationists. Changes in recreation use types and patterns (e.g. OHVs, snowmobiling) will also exacerbate the impacts.

Fish

Historic Reference Conditions

Fish Distribution

Historically, the assessment area was inhabited with abundant populations of native redband trout (***Oncorhyncus mykiss*** gairdneri), bull trout (***Salvelinus confluentus***), mountain whitefish (***Prosopium williamsoni***), and possibly sculpin (***Cottus*** spp.).

The distribution of native redband trout, bull trout, and mountain whitefish was dependent upon connection to the Deschutes River. Lava Lake was the northern terminus of fish distribution for all three species. Lakes and streams north of Lava Lake within the watershed were fishless, as were most of the lakes now located within the Three Sisters Wilderness. Clear, cool, stable, spring-fed stream systems with abundant spawning gravels provided conditions favorable to native fish. Forest structure, density, species composition (lodgepole pine and mixed conifer), and the fire regime condition classes were within the historic range of variability, providing abundant instream large woody debris and shade to streams. There were no migrational barriers allowing fish distribution to stream headwaters.

Crane Prairie supported numerous miles of sinuous meadow stream lined with sedges and willows prior to inundation. Historic accounts recall of abundant fish populations within the Deschutes River (ODFW, 1996). Lava Lake, Little Lava Lake, Cultus Lake, Little Cultus Lake, Winopee Lake, Muskrat Lake and perhaps Snowshoe Lake supported populations of native fish. These lakes varied in trophic status from ultra-oligotrophic to mesotrophic. Lakes of higher trophic status likely corresponded to higher redband trout densities because of the enriched food sources.

Fluvial populations of bull trout accessed the numerous miles of the cool, spring-fed Deschutes River and multiple tributary streams to spawn in the fall months. Historic records note of large bull trout up to 37" length being trapped at Pringle Falls downriver of the watershed (ODFW, 1996). Mountain whitefish were likely abundant and well distributed within the accessible habitats.

Fish Habitat Conditions
Clear, cool, stable, spring-fed stream systems with abundant large woody material, shade, and gravels provided conditions favorable to the native fish species and meeting the strict environmental requirements of the bull trout. Except for Lava, Little Lava, Cultus, Little Cultus, Winopee and perhaps Snowshoe, the lakes were fishless. The aforementioned lakes, varying in trophic status from ultra-oligotrophic to mesotrophic, provided suitable habitat to native fishes.

Current Conditions

Questions:

- *What is the distribution of populations of illegal fish introductions?*
- *What effects do illegal introductions have on other fish and wildlife species?*
- *What is the potential for these populations to increase their distribution?*

Species and Distribution
The present fish distribution and species make-up is much different than reference conditions. The bull trout was extirpated from the watershed in the 1950's (ODFW, 1996), and the genetic status of redband trout within the watershed has been compromised after decades of planting with various hatchery rainbow stocks by state agencies.

On November 29, 2002, the U. S. Fish and Wildlife Service, under direction of the Endangered Species Act, published the court-ordered proposed critical habitat designation for the Klamath River and Columbia River populations of bull trout, which included many areas of the Upper Deschutes River. Within the Snow Lakes Watershed, this proposal included Lava Lake, Little Lava Lake, Crane Prairie and Wickiup Reservoirs, Browns Creek, Cultus River, Snow Creek, and the Deschutes River up to Little Lava Lake. The Final Rule for Critical Habitat was published in the Federal Register on October 6, 2004 and became effective on November 6, 2004. The Upper Deschutes River was not designated as critical bull trout habitat. However, the U.S. Fish and Wildlife Service has expressed interest in conducting a feasibility study for reintroduction of bull trout into its historic range within the watershed.

Columbia River Basin redband trout are found within the Deschutes River and all perennial tributaries up to Little Lava Lake, and all lakes and reservoirs including tributaries that have a surface water connection to the Deschutes River. Populations are dominated by adfluvial life histories because of the presence of Crane Prairie and Wickiup Reservoirs, but fluvial and resident populations also exist. The most abundant populations exist within Crane Prairie Reservoir and the Deschutes River up to Little Lava Lake, and are highly sought after by anglers. There are no redband trout populations within the watershed north of Little Lava Lake. Hybridization has occurred between the hatchery stocks and the native redband trout, diluting the genetic purity of the redband trout populations. Genetic testing on two sites within the watershed in 1996 revealed hatchery genetic contributions of 22.2% and 4% (ODFW rainbow strain 72) from Deer Creek and Winopee Creek, respectively (Phelps, et al 1996). The genetic status of redband trout within the Deschutes River and Crane Prairie Reservoir would likely closely resemble the results observed from Deer Creek (Marx, et al 1997). Genetic testing of redband

trout is planned for Crane Prairie Reservoir in 2006. ODFW currently operates its fish stocking program under a Memorandum of Understanding with the Forest Service.

The redband trout fishery within Crane Prairie Reservoir is supplemented with an annual stocking with hatchery fish, which are primarily products of an annual ODFW egg take conducted on the Deschutes River above Crane Prairie Reservoir. These fish are known as "Cranebows". The development of this hatchery brood stock is an attempt to utilize locally adapted stock to improve survival and growth to meet fishery objectives and is consistent with the Native Fish Conservation Strategy, which dictates protection and enhancement of wild stocks (Marx, personal communication 2006). Additional hatchery rainbows not of Crane Prairie Reservoir descent are also stocked (Lot 053).

Recreational fishing is a very popular activity in the watershed. An active fish stocking program initiated by Oregon state fisheries management agencies early in the 20th century, along with several illegal introductions by unknown parties, has greatly increased the distribution, species composition, and angling opportunity. Today, nearly every lake and perennial stream within the watershed is inhabited with salmonid fish (over 70 lakes within the watershed currently stocked). Native redband trout have been adversely affected by these introductions, both legal and illegal, primarily by increased competition for food and cover, hybridization, and increased predation. Increased interspecific competition may have been a contributing factor to the extirpation of the bull trout.

Under current management, the Oregon Department of Fish and Wildlife (ODFW) augments or maintains most fish populations through stocking of fingerling salmonid species, while also stocking some waterbodies with legal-sized fish for "put-and-take" fisheries. Fish species intentionally stocked by ODFW in the past, most of which are still stocked currently, include rainbow trout (*Oncorhyncus mykiss*), eastern brook trout (*Salvelinus fontinalis*), cutthroat trout (*Oncorhyncus clarki*) lake trout (*Salvelinus namaycush*), Atlantic salmon (*Salmo salar*), kokanee salmon (*Oncorhyncus nerka kennerlyi*), brown trout (*Salmo trutta*), and coho salmon (*Oncorhyncus kisutch*).

Within Crane Prairie Reservoir, illegal fish introductions have included largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), tui chub (*Gila bicolor*), and three-spined stickleback (*Gasterosteus aculeatus*). Some, if not all, of these species have moved downriver into Wickiup Reservoir. In addition, robust populations of brown bullhead (*Ictalurus nebulosus*) are found within Wickiup Reservoir and North Twin Lake. The explosion of the stickleback population and the discovery of bluegill and black crappie in Crane Prairie Reservoir occurred since completion of the 1995 Cascade Lakes WA. The brown bullhead population has increased significantly since completion of the 1997 Browns/Wickiup WA. These illegal introductions have had serious effects on native and stocked salmonid game species, as they compete for food resources and cover. Illegally introduced populations of tui chub have existed for many years at Lava and Little Lava Lake. Non-native fish are now important prey base for several wildlife species including bald eagles, osprey, cormorants, kingfishers, otters, and others.

"Cranebow " populations within Crane Prairie Reservoir have been depressed in recent years, likely due to interspecific competition with non-native species, primarily sticklebacks. In response, ODFW changed their stocking strategy in 2004 to larger individuals (6" length). This has resulted in greater survival of stocked fish to enter the sport fishery. The presence of planktivorous fish, such as chubs, sticklebacks, and kokanee salmon, may be tied to the formation of cyanobacteria (blue-green algae) blooms in the reservoirs (See Water Quality section).

Recent research has discovered the tapeworm *Schistocephalus solidus* as being prevalent in three-spined sticklebacks within Crane Prairie Reservoir (Shields, et al 2003). The life stage present in fish is the larval form, in which one or more larvae can comprise a large portion of the internal cavity and total weight of the host fish. Infested fish may exhibit impaired swimming ability, increasing susceptibility to predation by large fish such as rainbow trout, largemouth bass, and avian species, contributing to a higher incidence of the tapeworm (ODFW, 2001). Growth rates in fish foraging on tapeworm-infested sticklebacks were speculated to experience reductions in survival and growth rates, but recent research on captive largemouth bass refuted this theory (Shields, et al 2003). However, growth rates and survival in captive ducklings were reduced by a diet composed of infected sticklebacks (Shields, et al 2003). The effects on redband trout, either directly through infestation, or indirectly through effects on prey species, has yet to be determined.

Fish in Crane Prairie Reservoir have also been known for decades to contain the tapeworm *Ligula intestinalis.* The effects to the host fish are similar to *Schistocephalus solidus* (ODFW, 2001).

Habitat Conditions

The construction of Crane Prairie Reservoir in 1922 (enlarged in 1940) and Wickiup Reservoir in the 1940's altered fish habitat conditions within the watershed. The two projects inundated approximately 39 miles of reference stream channel when at full pool, and added nearly 14,500 surface acres of lake habitat. The creation of the two reservoirs increased the overall rearing habitat for redband and bull trout by greatly increasing water volume, but reduced spawning habitat through inundation. Life history characteristics were transformed from predominately fluvial to predominately adfluvial. Although bull trout are extirpated from the watershed, habitat conditions still exist for adfluvial populations because of the presence of cool, spring-fed stream systems connected to the reservoirs. During drought years, which have occurred frequently in recent years, available habitat within the two reservoirs is reduced from reservoir drawdown. There is no legal minimum pool requirement for either reservoir (ODFW, 1996). During drawdown, aquatic food production is reduced and competition with other fish species is increased (ODFW, 1996). Significant areas of Crane Prairie Reservoir may be avoided by redband trout because of summer temperature increases. Some areas distant from stream channels reach 75° F (ODFW, 1996).

The majority of redband trout spawning occurs within the Deschutes River above and below Crane Prairie Reservoirs, and in Cultus River and Snow Creek. Cool water temperatures may be limiting redband trout spawning and rearing in some spring-fed streams such as Browns Creek, Quinn River, and North Davis Creek. High summer water temperatures in the Deschutes River between Crane Prairie and Wickiup Reservoirs, typically reaching peaks of 75-80º F. (exceeding state water quality standards in some years), degrades habitat conditions for redband trout. Occasional low flows also limit redband habitat as there is no minimum flow requirement for the river below Crane Prairie Dam. Redband habitat is also adversely affected in the Deschutes River below Wickiup Dam, where surface flows exit the watershed, by low winter flows (20 cfs minimum requirement).

Summer algae blooms in Crane Prairie and Wickiup reservoirs, typically dominated by blue-green species, reduces foraging ability of redband trout by reducing visibility. Blooms also result in increases in pH (>9.0) and when blooms die –off , decreases in dissolved oxygen and increases in ammonia, factors which can cause stress or even death to fish (WHO, 1999), including redband trout. No large fish kills have been noted within the watershed despite robust blue-green algae blooms in recent years.

Crane Prairie and Wickiup Reservoir dams block downriver movement of spawning gravels within the Deschutes River. A restoration project implemented since completion of the previous watershed analyses (1998) added spawning gravels and large woody material below Crane Prairie Dam. There is no upstream fish passage at either dam, limiting fluvial and adfluvial migrational spawning runs of redband trout. The outlet at Crane Prairie Dam is screened, but fish still occasionally bypass the screens during maintenance operations. The outlet at Wickiup Dam is unscreened, resulting in significant movement of fish, including redband trout, out of the reservoir into the Deschutes River.

The previous watershed analysis that included the Crane Prairie area (1995 Cascade Lakes WA) noted an increase in beetle-killed lodgepole pine occurring since 1990. This trend has continued to the present and heavy mortality within wet lodgepole pine stands has occurred inside Riparian Reserves of Snow Creek, Cultus River, Quinn Creek, and the Deschutes River upstream to Lava Lake. In addition, high mortality has also occurred within the Riparian Reserves of Cultus Creek and Deer Creek in wet mixed conifer stands. Abundant dead trees have fallen into the stream channels, providing fish hiding cover, pool habitat, and aquatic invertebrate habitat. However, due to the fuel loading associated with the deadfall within and outside of Riparian Reserves, a large-scale fire of high severity is likely to occur, potentially leading to adverse effects to fish populations and habitat. Potential adverse effects include short-term and long-term increases in water temperature as shade is decreased, loss of channel and streambank stability, loss of overhead cover from streambank vegetation, loss of long-term large woody recruitment, and episodic and chronic fine sediment input. Fine sediment input from post-fire episodic events would be limited due to generally gentle slopes and porous soils on the landscape. A large-scale fire could increase nitrogen and phosphorus inputs to Lava Lake, Crane Prairie Reservoir, and subsequently Wickiup Reservoir, which could contribute to formation of blue-green algae blooms.

There would be an increase in short-term large woody material recruitment as a result of a fire, but under current conditions, instream woody material is sufficient and is not limiting the fish populations. Stream surveys of Quinn Creek (1992), Upper Deschutes River (1998), Cultus River (1997), Snow Creek (2003), and Cultus Creek (1997) documented 303, 180, 402,194, 274 pieces of wood/mile, respectively. Deer Creek was surveyed in 1989 and noted abundant instream wood, but wood counting protocols differed from subsequent surveys. The majority of wood pieces counted in the surveys were in the small diameter category (<12”), a tribute to the surrounding predominately lodgepole pine stands that seldom reach larger diameters. These numbers have likely increased in recent years post-stream survey due to increased deadfall.

In addition to the restoration project implemented on the Deschutes River below Wickiup Dam mentioned previously (1998), several other fish habitat restoration projects have been implemented within the watershed since completion of the two original watershed analyses. These projects have improved habitat and passage for redband trout, among other species. Additional large woody material structures were added to Wickiup Reservoir within the Deschutes River and Browns Creek channels. Large trees were also placed in the first 1.5 miles of the Deschutes River above Crane Prairie Reservoir, intended to provide cover to spawning redband trout. Fish passage, primarily intended for juvenile fish, was improved through removal of culverts and the associated roadbed at two crossings of Cultus River, and the removal of a small dam on Deer Creek. Placement of spawning gravel in the Deschutes River below Wickiup Dam is slated for October 2006 in response to gravel depletion associated with dam operations. Redband trout populations would benefit. Other channel restoration and riparian planting projects have occurred within the watershed but were not associated with redband trout habitat.

Critical elements of bull trout habitat still exist in some areas within the watershed. Stream reaches not inundated or otherwise impacted by reservoirs remain similar in condition to reference condition, although some of these areas are now experiencing heavy tree mortality as described previously. Cool, spring-fed streams have adequate temperature regimes for bull trout spawning and rearing. Large woody material is abundant in most stream reaches, but fine sediment volumes within spawning gravels may exceed the tolerable range of bull trout in many areas. Reintroduction of bull trout would face environmental and social challenges. Competition with introduced species (including those socially desirable), potential hybridization with brook trout, intensive recreational fishing pressure, and limited suitable spawning grounds are among the issues to be considered prior to reintroduction.

Botany

Cascade Lakes 5th Field Watershed

Questions:

- *What is the relative abundance and distribution of pant species of concern that are important in the watershed (threatened or endangered species and special status species)?*
- *What are the threats to sensitive plant habitat quality in the watershed?*

Introduction

Portions of this watershed have been surveyed for Threatened, Endangered, and Sensitive (TES) plants. Surveys have covered about 40 percent of the watershed. Since the original watershed analysis was completed in 1995, some species have been dropped from the Regional Forester's Sensitive Plant list (Snowline Cymopteris, Bolander's Hawkweed, and Jepson's Monkeyflower), and others have been added (Bog club-moss, Slender Sedge, Porcupine Sedge, Pale Sedge, Skin Lichen, Silverskin Lichen, Luminous Moss, Marginate Splashzone Moss, ***Ramaria amyloidea*** Moss, Rhizomnium Moss, Scheuchzeria, and Water Clubrush). In 2004, the former "Survey and Manage" list of plant species was re-evaluated. Some species were dropped altogether after discovering they were more common than previously thought; others were moved over to the Regional Forester's Sensitive Species list.

No Threatened or Endangered plant species, or their habitats, are known to occur within this watershed. There are however, Regional Forester's Sensitive plant sites within the watershed. Following is a list Sensitive species which are known to occur or that have been reported within the watershed boundary.

Shasta Arnica (*Arnica viscosa*)

A population containing several hundred plants exists on a lava flow near Moraine Lake. It is the only known population of this sensitive species, although few surveys have been conducted with the intent of locating more.

Its range extends from Central Oregon to northern California, where it is considered uncommon.

Its habitat is alpine or subalpine rocky sites, relatively steep scree and talus slopes above or at treeline, elevation 6,500 feet to 9,200 feet. The most likely habitat is to be found in the northwest corner of the project area, north of Highway 46.

Status:

This species is on the Regional Forester's Sensitive Plant List dated July 2004, the Oregon Natural Heritage Program's List 2, (taxa Threatened or Endangered or extirpated in Oregon, but more common elsewhere).

Pumice Grape-fern (*Botrychium pumicola*)
This Central Oregon endemic is known from alpine and montane habitats. It occurs in the pumice soils of lodgepole pine openings and frost pockets, and also at elevations as high as 9,100 feet. There are four known alpine sites within the watershed: one on Mount Bachelor, two sites on Broken Top, and one on Tumalo Mountain. Additional potential habitat is present in these high-elevation regions but extensive surveys have not been conducted. Within the lower-elevation, montane site type, there are likely more sites that remain to be found, although much of the potential habitat has been surveyed.

Status:
On the Regional Forester's Sensitive Species list dated July 2004; on the Oregon Natural Heritage Program's List 1 (taxa Endangered or Threatened throughout their range).

Newberry Gentian (*Gentiana newberryi*)
One sighting has been documented from within the watershed on the shore of a Cascade lake. Twelve populations have been mapped in the nearby Tumalo Creek area just outside the watershed's eastern boundary.

Potential habitat is found in moist meadows or adjacent to streams and rivers above 4,700 feet, and is most apt to occur in the northern portion of the watershed area. It is likely that more sites are present but have not yet been found, due to a paucity of surveys in the area.

Status:
On the Regional Forester's Sensitive Plant list; on the Oregon Natural Heritage Program's List 2 (taxa Threatened or Endangered or extirpated in Oregon, but more common elsewhere).

Ground Cedar (*Lycopodium complanatum*)
There are no known sites of this species within the watershed, although a similar species exists in a meadow near Highway 46. It has not been found elsewhere on the Deschutes National Forest.

Potential habitat occurs at the edges of wet meadows within coniferous forest; it has also been found on dry, forested midslopes with low canopy cover. Within the watershed, it may occur elsewhere but its narrow habitat preference may be limiting.

Status:
On the Regional Forester's Sensitive Plant list; on the Oregon Natural Heritage Program's List 2 (taxa Threatened or Endangered or extirpated in Oregon, but more common elsewhere).

Scheuchzeria *(Scheuchzeria palustris ssp. americana*)
This species is known from one site within the watershed, a bog near Little Cultus Lake, and is not known to occur elsewhere in the vicinity.

Potential habitat is open-canopied bogs, fens, and other wetlands where it is often in shallow water. It is primarily known from west of the Cascade Mountains. It is likely to occur in other sites within the watershed, especially with potential habitat in the Many Lakes area nearby.

Status:
On the Regional Forester's Sensitive Plant list; on the Oregon Natural Heritage Program's List 2 (taxa Threatened or Endangered or extirpated in Oregon, but more common elsewhere).

***Rhizomnium nudum* (Moss)**
This moss is known from two (2) locations in the watershed; one in the Devil's Lake area and the other in the Cultus Lake area.

Its habitat is coniferous forests that include silver fir, western hemlock, mountain hemlock, western red cedar, and Engelmann spruce; on the Deschutes National Forest sites (the grand sum includes the two sites previously mentioned), lodgepole pine, Engelmann spruce, mountain hemlock, and western white pine are the primary forest trees. It occurs on humus or mineral soil in seepages, vernally wet depressions or intermittently wet, low-gradient channels. Exposure varies from full sun to full shade. There are likely more sites yet to be found within the watershed.

Status:
It was placed on the Regional Forester's Sensitive Plant list in 2004; on the Oregon Natural Heritage Program's List 2 (taxa Threatened or Endangered or extirpated in Oregon, but more common elsewhere).

Potential Habitat

Potential habitat exists for the following Sensitive plant species; although to date there are no known sites for them within the watershed:

Tall Agoseris (*Agoseris elata*)
Non-forest and openings in ponderosa pine and, rarely, lodgepole pine. Dry edges of moist ecotones adjacent to moist meadows, lakes, stream courses, riverbanks. Nearest known occurrences are on the Sisters Ranger District. **Low probability.**

Estes' Artemisia (*Artemisia ludoviciana* spp. *estesii*)
At river's edge just above the zone of aquatic sedges, in association with riparian vegetation such as rushes and willows. This Central Oregon endemic is known from three locations on the Deschutes National Forest, along the Deschutes River at lower elevations. **Low probability**.

Gorman's Aster (*Aster gormannii*)
Endemic to Oregon, in non-forest and forest openings, subalpine and alpine, dry exposures, and open rocky slopes. Known from the west side and crest of the Cascade Mountains between 4,000 feet and 6,500 feet. **Low probability**.

Brewer's Reedgrass (*Calamagrostis breweri*)
Moist-dry alpine and subalpine meadows, open slopes, streambanks, and lake margins between 4,600 feet and 6,000 feet. Has not been found on the Deschutes National Forest; nearest sites are west of the Cascade Mountains. **Low probability**.

Porcupine Sedge (*Carex hystericina*)
Found in wet to moist conditions in riparian zones, and in or along ditches/canals in prairies and wetlands within true fir/Douglas-fir/ponderosa pine forests and also in juniper woodlands at elevations between 3,400 feet to 4,300 feet. Known from a site on the Ochoco National Forest, but not found to date on the Deschutes National Forest. **Moderate probability**.

Slender Sedge (*Carex lasiocarpa* var. *americana*)
Known from sites elsewhere on the Bend/Ft. Rock Ranger District, and also from Big Marsh on the Crescent Ranger District. **Moderate probability**.

Pale Sedge (*Carex livida*)
Sites with water tables above ground level for the majority of the growing season, peatlands. Known sites are between 2,000 feet and 8,000 feet. **Moderate probability**.

Green-tinged Paintbrush (*Castilleja chlorotica*)
Many sites for this Central Oregon endemic have been discovered on the Bend/Ft. Rock Ranger District, the closest being about five miles east of the watershed. Typical habitat includes open areas and forested openings in ponderosa pine, lodgepole pine, and mixed conifers, in rocky soils, often with sagebrush or bitterbrush. It has been found at elevations between 4,200 feet and 8,200 feet, although locally the majority of populations have been limited to an elevation band of 4,200 feet to 4,800 feet, in association with bitterbrush. The exceptions locally are two small sites that have been found at elevations of 5,300 and 5,900 feet. **Low probability**.

Silverskin Lichen (*Dermatocarpon luridum*)
Rocks or bedrock in streams, rivers, or seeps, usually submerged or inundated for most of the year. Associated with ***Alnus rubra***, ***Pseudotsuga menziesii***, ***Tsuga heterophylla***, ***Acer*** spp., subalpine or alpine meadow vegetation. **Low probability**.

Skin Lichen (*Leptogium cyanescens*)
On trees in humid forests; widely scattered. On mossy trees and rocks or directly on rock when near water. Considered riparian until 2002. Recently documented in upland settings on vine maple, big leaf maple, and in moss on white oak. Associated with Western Hemlock and Pacific Silver Fir Zones in mixed conifer stands, mature big leaf maple and Douglas-fir stands, maple and willow thickets. **Low probability**.

Water Lobelia (*Lobelia dortmanna*)
In shallow water, up to a depth of 2 meters, at the margins of lakes and ponds. Known mainly from low elevations, but found on the Sisters Ranger District at an elevation of 3,500 feet, which is the only known site in Oregon. **Low probability**.

Inundated Club-moss (*Lycopodiella inundata*)
Deflation areas in coastal back-dunes; montane bogs, including sphagnum bogs; less often, wet meadows. Known on Deschutes National Forest from the Crescent Ranger District. There may be habitat present at small, high-elevation lakes in the wilderness. **Moderate probability**.

Adders-tongue (*Ophioglossum pusillum*)
Moist to wet meadows among low shrubs, sedges, and grape-ferns. Found at elevations between 5 feet and 5,000 feet. This species has not been found on the Deschutes National Forest. **Low probability**.

Fungus (*Ramaria amyloidea*)
Coral-like fungus on moist humus or wood, or under duff. May favor hemlock. Fall species. Associated with ***Abies*** spp., ***Pseudotsuga menziesii*** and ***Tsuga heterophylla***. There is a known site on the Crescent Ranger District. **Moderate probability**.

Luminous Moss (*Schistostega pennata)*

On mineral soil in damp caves and crevices and on the soil-bearing root masses of fallen trees. Often near streams or other wet areas. Requires humid, heavily shaded microsites. Most commonly found within silver fir plant series but also common in western hemlock and mountain hemlock series. Also in lodgepole pine stands near water. Stands are typically late seral or old growth. Known sites on the Crescent Ranger District. **Moderate probability**.

Water Clubrush (*Scirpus subterminalis*)
Generally submerged to emergent in quiet water 2-8 decimeters deep, in peatlands, sedge fens, creeks, ditches, ponds and lakes. Known from the Crescent Ranger District in Big Marsh. **Moderate probability**.

Marginate Splashzone Moss (*Scouleria marginata*)
Often forming dark mats on exposed to shaded rocks in streams; seasonally submerged or emergent. **Moderate probability**.

Threats to Sensitive Plant Habitat Quality

The following factors have affected or may affect sensitive plant habitat quality in the watershed:

Trampling: The pumice grape-fern occurs in soils that are usually loose and free from other vegetation, making the populations vulnerable to foot traffic (human or otherwise). Three of the four known sites within the watershed occur in areas where hikers are present. Two of these sites; Mount Bachelor and Tumalo Mountain; are especially vulnerable. Annual monitoring on Mount Bachelor since 1992 shows a generally downward trend on the population on the very top, and it is likely that human visitation is playing a role in this trend. On Tumalo Mountain, where a long-sought historical population was rediscovered in 2001, signs and trail design have helped to keep hikers off this very small population. Two other populations, on Broken Top, are less vulnerable, although one lies on a slope adjacent to a hiking trail. Annual monitoring at that site since 2002 has not detected foot traffic disturbance.

One of the Newberry's Gentian sites within the watershed lies in another popular hiking locale, situated in a meadow at Todd Lake. Trails there have so far shown no deleterious impacts to this population, and recent trail definition by placing bridges over the rivulets and signage are helpful improvements to the situation. Elsewhere in the watershed, where as-yet unsurveyed habitat may exist, foot, horse, or bike traffic, or dispersed camping, could be negatively impacting habitat quality.

Invasive Plant Species Encroachment:

Questions:

- *Where are the populations of noxious weeds in the watershed?*
- *What is the potential for noxious weeds populations to increase?*
- *What can be done to limit or reduce populations of noxious weeds?*

No noxious weeds are known to be in close association with sensitive plant populations in the watershed at this time. However, noxious weeds are present in the watershed and more are found every year. This trend could eventually threaten sensitive plant habitat and sites, and especially, overall native plant species diversity.

Since 1995, the general trend has been one of more weed sites. One bright note is the eradication of one site at the Winopee Lake trailhead, containing oxeye daisy and scotch broom. Otherwise,

spotted knapweed has increased its number of sites along Highway 46 and has appeared at the Lucky Lake trailhead. Two Canada thistle sites have appeared at Sparks Lake.

Of special concern is the proliferation of spotted knapweed (***Centaurea maculosa***) within the watershed, especially along roadsides. The watershed is well removed from the private lands that are located mainly in and surrounding Bend and LaPine where spotted knapweed populations are the densest. To date, sites of these plants have been limited mostly to roadsides and pullouts, primarily along Roads 46, 40, 42, and 43. They are being treated with a combination of herbicides and hand-pulling. Biological control agents (insects that are a plant species' natural enemies) have been released on various spotted knapweed sites in Central Oregon.

Another invasive species of concern in the watershed is reed canary grass (***Phalaris arundinacea***). It has been noted along the upper Deschutes River between Little Lava Lake and Blue Lagoon, on the shore of Lava Lake, and the shorelines of Crane Prairie Reservoir. It has the strong potential to spread via the waterway to Wickiup Reservoir, if indeed it isn't already there, and other points downstream and out of the watershed. Treatment is difficult to effect on this species because of its tenacious roots and its location in or very near water.

Another invasive plant species in the watershed is Dalmation toadflax (***Linaria dalmatica***), with isolated sites primarily in high-use recreational spots. This species is also difficult to treat because it sprouts vigorously from any piece of root left remaining after hand-pulling, and the Forest Service does not have authority at the present time to use herbicides against it.

Canada thistle (***Cirsium arvense***), an invasive that often, but not always, prefers moist conditions, has been discovered in the watershed since 1995. There are sites at Red Crater Quarry, Sparks Lake, and Crane Prairie Reservoir. It spreads via seeds, and once established, especially by creeping underground stems. Thus, hand-pulling this species, unless treated when the site only has a few individuals and the soil is loose, is ineffective. Biological control agents were placed at the Sparks Lake sites in 2003 and 2004.

On Benchmark Butte, two sites of Tansy Ragwort (***Senecio jacobaea***) were discovered in old timber sale units in 1996. A re-visit to one of these sites in 2004 did not find it; the other site was not visited.

Wickiup Dam, which lies adjacent to the watershed, supports a large population of St. John's Wort (***Hypericum perforatum***), along with lesser amounts of spotted knapweed.

There are many other invasive plant species that could invade the watershed, such as diffuse knapweed (***Centaurea diffusa***) and yellow starthistle (***Centaurea solstitialis***). Increased weed infestations in the watershed can be expected with increasing recreational use, high road densities, and existing disturbed sites.

Sparks Meadow historical disturbance - This 300-acre meadow, at the northern end of Sparks Lake, has been subject to a variety of man-caused and natural disturbances. The cumulative effect has been that overall native plant diversity has been compromised. The 1995 Cascade Lakes Watershed Analysis described the type and nature of these disturbances (Appendix pgs. A-26-27).

There was a historic record of Newberry's Gentian site in the meadow (specific location not known), but surveys in 1991 and 1997 did not locate this species although suitable habitat appears to be present.

Fire Suppression - Since the era of fire suppression began, the size and number of forest openings has been reduced in the watershed. Openings create important islands for plant diversity and habitat for sensitive species as well. Encroachment of meadows by lodgepole pine is an example of this situation, whereby competition and shading from trees reduce opportunities for native and sensitive plants to flourish.

Wickiup 5th Field Watershed

Questions:

- *What is the relative abundance and distribution of pant species of concern that are important in the watershed (threatened or endangered species and special status species)?*
- *What are the threats to sensitive plant habitat quality in the watershed?*

Introduction

Portions of the Browns/Davis/Wickiup Watershed have been surveyed for TES plants. Surveys for these plants have covered about 20 percent of the watershed.

Changes to the Regional Forester's Sensitive Plant List and the Survey and Manage species were previously discussed in the previous section on the Cascade Lakes 5th Field Watershed and not further discussed here.

No Threatened or Endangered plant species, or their habitats, are known to occur within the watershed. Additionally, no sensitive plant species are known to be present within the watershed.

Potential Habitat for Sensitive Species

The following sensitive species may have potential habitat within the watershed boundary:

Tall Agoseris (*Agoseris elata*)

Nonforest and openings in ponderosa pine and, rarely, lodgepole pine. Dry edges of moist ecotones adjacent to moist meadows, lakes, stream courses, riverbanks. Nearest known occurrences are on the Sisters Ranger District. **Low probability**.

Shasta Arnica (*Arnica viscosa*)

A population containing several hundred plants exists in the watershed to the north, on a lava flow. It is the only known population of this sensitive species on the Deschutes National Forest, although few surveys have been conducted with the intent of locating more.

Its range extends from Central Oregon to northern California, where it is considered uncommon.

Its habitat is alpine or subalpine rocky sites, relatively steep scree and talus slopes above or at treeline, elevation 6,500 feet to 9,200 feet. There is a possibility habitat may be present on The Twins. **Moderate probability**.

Gorman's Aster (*Aster gormannii*)

Endemic to Oregon, in non-forest and forest openings, subalpine and alpine, dry exposures, and open rocky slopes. Known from the west side and crest of the Cascade Mountains between 4,000 feet and 6,500 feet. There may be habitat around The Twins, although to date there are no known sites on the Deschutes National Forest. **Low probability**.

Pumice Grape-fern (*Botrychium pumicola*)
This Central Oregon endemic is known from alpine and montane habitats. It occurs in the pumice soils of lodgepole pine openings and frost pockets, and also at elevations as high as 9,100 feet. There are no sites known within the watershed. There is a small possibility that habitat may be present. Additional potential habitat is present in these high-elevation regions but extensive surveys have not been conducted. **Low probability**.

Brewer's Reedgrass (*Calamagrostis breweri*)
Moist-dry alpine and subalpine meadows, open slopes, streambanks, and lake margins between 4,600 feet and 6,000 feet. Has not been found on the Deschutes National Forest; nearest sites are west of the Cascade Mountains. **Low probability**.

Porcupine Sedge (*Carex hystericina*)
Found in wet to moist conditions in riparian zones, and in or along ditches/canals in prairies and wetlands within true fir/Douglas-fir/ponderosa pine forests and also in juniper woodlands at elevations between 3,400 feet to 4,300 feet. Known from a site on the Ochoco National Forest, but not found to date on the Deschutes National Forest. **Moderate probability**.

Slender Sedge (*Carex lasiocarpa* var. *americana*)
Known from sites elsewhere on the Bend/Ft. Rock Ranger District, and also from Big Marsh on the Crescent Ranger District. **Moderate probability**.

Pale Sedge (*Carex livida*)
Sites with water tables above ground level for the majority of the growing season, peatlands. Known sites are between 2,000 feet and 8,000 feet. **Moderate probability**.

Green-tinged Paintbrush (*Castilleja chlorotica*)
Many sites for this Central Oregon endemic have been discovered on the Bend/Ft. Rock Ranger District, the closest being about seven miles northeast of the watershed. Typical habitat includes open areas and forested openings in ponderosa pine, lodgepole pine, and mixed conifers, in rocky soils, often with sagebrush or bitterbrush. It has been found at elevations between 4,200 feet and 8,200 feet, although locally the majority of populations have been limited to an elevation band of 4,200 feet to 4,800 feet, in association with bitterbrush. The exceptions locally are two small sites that have been found at elevations of 5,300 and 5,900 feet. There is a **low probability** of habitat occurring in the lower elevations of the watershed around Wickiup Reservoir.

Silverskin Lichen (*Dermatocarpon luridum*)
Rocks or bedrock in streams, rivers, or seeps, usually submerged or inundated for most of the year. Associated with ***Alnus rubra***, ***Pseudotsuga menziesii***, ***Tsuga heterophylla***, ***Acer*** spp., subalpine or alpine meadow vegetation. **Low probability**.

Newberry Gentian (*Gentiana newberryi)*
One sighting has been documented in the watershed to the north, on the shore of a Cascade lake. Additionally, twelve populations have been mapped in the Tumalo Creek area. These populations constitute many thousands of plants.

Potential habitat is found in moist meadows or adjacent to streams and rivers above 4,700 feet. There is a **low probability** of its presence in this watershed, mostly due to its not being found to date, and its distance from the local population center.

Skin Lichen (*Leptogium cyanescens*)

On trees in humid forests; widely scattered. On mossy trees and rocks or directly on rock when near water. Considered riparian through 2001. Recently documented in upland settings on vine maple, big leaf maple, and in moss on white oak. Associated with Western Hemlock and Pacific Silver Fir Zones in mixed conifer stands, mature big leaf maple and Douglas-fir stands, maple and willow thickets. **Low probability**.

Water Lobelia (*Lobelia dortmanna*)
In shallow water, up to a depth of 2 meters, at the margins of lakes and ponds. Known mainly from low elevations, but found on the Sisters Ranger District at an elevation of 3,500 feet, which is the only known site in Oregon. **Low probability**.

Inundated Club-moss (*Lycopodiella inundata*)
Deflation areas in coastal back-dunes; montane bogs, including sphagnum bogs; less often, wet meadows. Known on Deschutes National Forest south of the watershed, on the Crescent Ranger District. There may be habitat present at small, high-elevation lakes. **Moderate probability**.

Ground Cedar (*Lycopodium complanatum)*
There are no known sites of this species on the Deschutes National Forest.

Potential habitat occurs at the edges of wet meadows within coniferous forest; it has also been found on dry, forested midslopes with low canopy cover. Within the watershed, it may occur but its narrow habitat preference may be limiting. **Moderate probability**.

Adders-tongue (*Ophioglossum pusillum*)
Moist to wet meadows among low shrubs, sedges, and grape-ferns. Found at elevations between 5 feet and 5,000 feet. This species has not been found on the Deschutes National Forest. **Low probability**.

Fungus (*Ramaria amyloidea*)
Coral-like fungus on moist humus or wood, or under duff. May favor hemlock. Fall species. Associated with **Abies** spp., **Pseudotsuga menziesii** and **Tsuga heterophylla**. There is a known site south of the watershed on the Crescent Ranger District. **Moderate probability**.

***Rhizomnium nudum* (Moss)**
This moss is known from two locations in the watershed to the north, one in the Devil's Lake area, and the other in the Cultus Lake area.

Its habitat is coniferous forests that include silver fir, western hemlock, mountain hemlock, western red cedar, and Engelmann spruce; on the Deschutes National Forest sites (the grand sum includes the three sites just mentioned), lodgepole pine, Engelmann spruce, mountain hemlock, and western white pine are the primary forest trees. It occurs on humus or mineral soil in seepages, vernally wet depressions or intermittently wet, low-gradient channels. Exposure varies from full sun to full shade. There may be habitat for this species within the watershed. **Moderate probability**.

Scheuchzeria (*Scheuchzeria palustris* spp. *americana*)
This species is known from one site in the watershed to the north, near Little Cultus Lake, and is not known to occur elsewhere in the vicinity.

Potential habitat is open-canopied bogs, fens, and other wetlands where it is often in shallow water. It is primarily known from west of the Cascade Mountains. It may have habitat within the watershed. **Moderate probability**.

Luminous Moss (*Schistostega pennata)*
On mineral soil in damp caves and crevices and on the soil-bearing root masses of fallen trees. Often near streams or other wet areas. Requires humid, heavily shaded microsites. Most commonly found within silver fir plant series but also common in western hemlock and mountain hemlock series. Also in lodgepole pine stands near water. Stands are typically late seral or old growth. Known sites to the south of the watershed, on the Crescent Ranger District. **Moderate probability**.

Water Clubrush (*Scirpus subterminalis*)
Generally submerged to emergent in quiet water 2-8 decimeters deep, in peatlands, sedge fens, creeks, ditches, ponds and lakes. Known from the Crescent Ranger District in Big Marsh. **Moderate probability**.

Marginate Splashzone Moss (*Scouleria marginata*)
Often forming dark mats on exposed to shaded rocks in streams; seasonally submerged or emergent. **Moderate probability**.

Threats to Sensitive Plant Habitat Quality
The following factors have affected or may affect sensitive plant habitat quality in the watershed:

Trampling: Much of the potential habitat for sensitive species in the watershed is associated with moist areas; currently they are likely to be in good condition. However, should human visitation increase to these areas, foot trampling could become an issue for habitat quality.

Invasive Plant Species Encroachment:

Questions:

- *Where are the populations of noxious weeds in the watershed?*
- *What is the potential for noxious weeds populations to increase?*
- *What can be done to limit or reduce populations of noxious weeds?*

Of greatest concern to sensitive plant habitat quality is the invasive species issue. No noxious weeds are known to be in close association with sensitive plant habitat in the watershed at this time; however, noxious weeds are present in the watershed and more are found there every year. This trend could eventually threaten sensitive plant habitat, and especially, overall native plant species diversity.

Since 1997, there have been very few new weed sites located. The only one documented is a newcomer to the watershed, Dalmation toadflax, near the north arm of Wickiup Reservoir.

Of special concern is the proliferation of spotted knapweed (*Centaurea maculosa*) within the watershed, especially along roadsides. The Browns/Wickiup watershed is well removed from the private lands that are located mainly in and surrounding Bend and LaPine and where spotted knapweed populations are the most dense. To date, sites of these plants have been limited mostly to roadsides and pullouts, primarily along roads 46, 42, and 44. It is also present in the watershed at Wickiup Dam, both twin lakes, the south shore of Wickiup, and the north arm of Wickiup. Populations are being treated with herbicides along Highway 46 and Road 42, and are hand-

pulled elsewhere. Biological control agents (insects that are a plant species' natural enemies) have been released on various spotted knapweed sites in Central Oregon, although not in the watershed.

Another invasive species of concern in the watershed is reed canary grass (***Phalaris arundinacea***). It is currently known from South Twin Lake and the north arm of Wickiup Reservoir. It has been noted along shorelines in the watershed to the north and immediately adjacent to the watershed around Davis Lake. It has high potential to be present elsewhere on the shores and arms of Wickiup. Treatment is difficult to effect on this species because of its tenacious roots and location in or very near water.

Dalmation toadflax (***Linaria dalmatica***) is present in the watershed with one known site, near an arm of Wickiup Reservoir. It is likely elsewhere in the watershed. This species is also difficult to treat because it sprouts vigorously from any piece of root left remaining after hand-pulling. The Forest Service does not have authority at the present time to use herbicides against it.

Canada thistle (***Cirsium arvense***), an invasive that often, but not always, prefers moist conditions. It is present in numerous spots in the Browns-Wickiup watershed. It is found at both Twin Lakes, the shores and arms of Wickiup Reservoir, and just outside the watershed, on the shore of Davis Lake and on the SE arm of Crane Prairie. It spreads via seeds, and once established, especially by creeping underground stems. Thus, hand-pulling this species, unless treated when the site only has a few individuals and the soil is loose, is ineffective.

Wickiup Dam supports a large population of St. John's Wort (***Hypericum perforatum***), along with lesser amounts of spotted knapweed. St. John's Wort is also present near Wickiup along Highway 46, and on the north and west arms of Wickiup.

There are many other invasive plant species that could invade the watershed, such as diffuse knapweed (***Centaurea diffusa***) and yellow starthistle (***Centaurea solstitialis***). Increased weed infestations in the watershed can be expected with increasing recreational use, high road densities, and existing disturbed sites.

Fire Suppression: Since the era of fire suppression began, the size and number of forest openings has been reduced in the watershed. Openings create important islands for plant diversity and habitat for sensitive species as well. Encroachment of meadows by lodgepole pine is an example of this situation, whereby competition and shading from trees reduce opportunities for native and sensitive plants to flourish.

Social Domain

Introduction

The Snow Lakes Watershed Assessment Area is an area with many features that attracts ever increasing numbers of recreation visitors throughout the Pacific Northwest. Scenic alpine lakes, clear-flowing streams, rivers surrounded by snow-capped volcanic peaks, forests, and meadows all combine to provide a dramatic and appealing setting to those seeking a range of activities.

The summer and fall months are full of activities such as fishing, camping, boating, hiking, hunting, driving for pleasure as well as off-highway vehicle (OHV) riding, and sightseeing along the Cascade Lakes Scenic Byway. This road is usually clear of snow by Memorial Day weekend and closed as early as mid-November. At the north end of the assessment area, the area receives

heavy use from backcountry skiers and snowmobilers during the winter. They come for the attraction of the Mount Bachelor ski area as well as to many of the sno-parks and groomed trails for both cross-country skiing and snowmobiling activities. These facilities are just to the east of the watershed area.

With tourism ranking as the third largest industry in Oregon, Deschutes County has experienced a dramatic increase over the past two decades in its population and travel and tourism activities. This area is one of Oregon's most important recreation centers for both winter and summer seasons. The 1995 population for Deschutes County was 92,245 with projected growth to 106,671 in the year 2000. This target was surpassed by 8 percent as the population of Deschutes County in 2000 was 115,367. The 1995 population for the City of Bend was 40,000 with increases projected to 44,000 in the year 2000 and 49,500 in the year 2005. Again, these projections were off as the population in Bend in 2000 was 52,029 and with the population in 2005 at 66,357. Between 1995 and 2004, the Central Oregon population grew by an incredible 46 percent (Economic Development for Central Oregon website).

Both dispersed and developed camping, related to water bodies, are the most popular activity in the watershed. At the reservoirs (Crane Prairie and Wickiup) the majority of visitors are comprised of RV or trailer campers, with some tent use. In many cases, dispersed camping is a family tradition that originated in the 1940's or 1950's. Families and friends annually make their pilgrimage to their traditional campsite, passing the tradition on through the generations. More recently, the increase in population of central Oregon has increased recreation visits on the Deschutes National Forest. This increase in use is most keenly felt in the Three Sisters Wilderness, and at developed and at dispersed areas associated with water.
Dispersed recreation has become more of a concern to the Forest Management team, if not a priority for funding or managing on the ground. From the mid-1990s to early 2000s, "Field Rangers" and fee demo compliance personnel would frequent some dispersed areas, mostly at Cultus and Hosmer lakes and Crane Prairie and Wickiup reservoirs, on occasion to provide some Forest Service presence and basic grounds maintenance (i.e. litter patrol).

Implementation of restoration projects in dispersed sites/areas are accomplished primarily through recreation/riparian projects (Recreation/Riparian projects were developed from a Forest program that provided funding to priority projects. This program lasted only a few years until funding was reduced and the program dissolved.), YCC crews, volunteers, the Forest road crew, and partnerships with OSMB, concessionaires, and others.

In 1997, the new "old-fashioned" way to accomplish not only restoration efforts, but follow-up monitoring and visitor compliance, is the Field Ranger Program on the Bend-Ft. Rock Ranger District. This program provided the hands-on restoration work and more importantly, a Forest Service presence to provide information to the public on the reasons for the important restoration work being implemented. Without this presence, restoration efforts could easily be undone or impacted from an unaware visitor. This has occurred on several past recreation/riparian projects. Signs can provide some information to the public in regards to restoration efforts, but they are often removed and they don't provide a mechanism for public feedback to projects.

Recreation

Questions:

- What will the publics tolerance level be of Wildland Urban Interface (WUI) treatments verses non-WUI treatments?

- What will be the acceptance by the public of vegetation treatments to reduced effects of mountain pine beetle or to reduce fuel loadings be within and outside of recreation sites.
- What level of risk will the public accept for the potential of large wildfires to occur?
- How will the Bend-Fort Rock Ranger District react to further budget cuts in the recreation program area?
- How will the public react to increased fees or further privatization of recreation maintenance and operations?
- How is the increased use and lack of budget affecting the recreation experience?
- Is the District meeting ROS, Forest Plan, W&SR. NWFP and ICBEMP standards (ACS setbacks, etc.) standards?
- What effect does road closures have on recreation management (both opportunities and constraints)?

Scenic Quality

Questions:

- What affect is the change in stand conditions resulting from the dying of lodgepole pine having on scenic quality?

Heritage Resources

Questions:

- *What is the condition of prehistoric heritage resources and what are the trends?*
- *Where are the concentrations of potentially significant heritage resources?*
- *How has recreational use affected the integrity of heritage resources?*
- *How best to phase and ensure accuracy of archaeological inventory for large scale fuels and timber management projects?*
- *What were the prehistoric land uses in the area and how did those uses change over time in response to changing environmental and other conditions?*
- *Where are the concentrations of, and best habitats for, plants used in traditional practice by Native Americans?*

Condition of Heritage Resources

The Deschutes National Forest is responsible for inventorying and protecting significant sites and those for which the significance remains unknown. This is a long-standing responsibility under law and much of the Forest's activity in this regard occurs in the context of implementing NEPA for project planning. Impacts and effects from such ongoing uses as recreation and such unplanned incidents as wildfire are also included within the Forest's responsibilities under the National Historic Preservation Act--even when no NEPA decision is at hand.

Preservation and enhancement of significant historic properties is also incumbent upon the Forest. Historic buildings such as the Muskrat Lake Trappers Cabin and the Deschutes Bridge historic administrative complex continue to deteriorate. Many historic structures are gone; the historic Davis Mountain Lookout (ca. 1933) (Figure 13) was destroyed or removed long ago. A notable exception, and one which points the way for future resource management is the Elk Lake Guard Station, now stabilized and interpreted for the public.

Figure 15 Davis Mountain Lookout, 1937.

Changes in the condition of the known heritage resources within the Snow assessment area are only sporadically known since there is no systematic program of monitoring or condition assessment. It is known that standing historic structures are continuing to deteriorate absent a program of stabilization but the specific extent and nature of the deterioration at individual structures is largely unknown. Archaeological resource theft and trafficking are known to be occurring on National Forest lands and other public lands in Deschutes, Jefferson, and Crook Counties. The extent of such illegal activities within the assessment area is not known; however, the incidence of artifact theft increases during periods of economic stress. Nationwide the economic recovery is delayed and rising housing and energy costs have marginalized some sectors of the Central Oregon population.

Another significant change is a social rather than a resource issue; the Confederated Tribes of the Warm Springs Reservation and the Klamath Tribes have become more active participants in the management and protection of National Forest resources, including archeological sites, food resources, and basketry materials.

Heritage Resource Values at Risk and Trends of Concern

The primary sources of risk to heritage resources are wildfire and wildfire suppression, invasive species, recreation, artifact theft, fuels management and timber harvest programs, and ongoing, unarrested deterioration of heritage resources.

Wildfire can cause significant damage to prehistoric and historic resources. Wooden structures are consumed by fire. Rock art is damaged from heat-caused spalling or by deposition of combustion by-products onto rock art surfaces. The effects of heat penetrate into the soil column, modifying the hydration band on obsidian artifacts, a primary source of dating information, and post-fire erosion can damage archeological deposits. Wildfire suppression, especially with heavy equipment, can damage, even obliterate, surface founded cultural resources. Suppression also leads to reduction in the size and distribution of forest openings, which in turn contributes to the reduction in opportunities for native plants.

Increasing disturbance and the continued introduction of seed sources has caused populations of such invasive species as spotted knapweed, oxeye daisy, Scotch broom, and toadflax, to increase. Such increases can displace plants which have cultural importance to native populations.

Recreation use of the National Forest system lands may lead to increased risk to heritage resources when that use is concentrated on prehistoric or historic sites or where recreation use may involve, directly or indirectly, historic buildings. The effects of recreation use may be unintentional, as in the case of trampling, or they may be intentional, where vandalism and artifact theft accompany public access to heritage resources.

The extensive projects envisioned to resolve the issue of lodgepole mortality pose significant risks to heritage resources, primarily because of the difficulty of achieving an accurate inventory of those properties during environmental analysis. The large areas involved and significant duff in some cases have precluded accurate inventory within the temporal and budgetary constraints of proposed projects.

All land management agencies make choices in how their funds are spent. Typically, heritage resources are nearly invisible during the Forest Service's national strategic planning and, consequently, funding suffers at the National Forest level. The typical consequence is neglect and deterioration of heritage resources as scarce fiscal resources are directed elsewhere. However, innovative approaches and effective, local management solutions will help the Forest affirmatively redeem its responsibilities toward the protection of heritage resources within the assessment area.

Chapter V
Synthesis and Interpretation of Information

Step number five of the six step process outlines a procedure for the synthesis and interpretation of information. The purpose of step five is to compare existing and reference conditions of specific ecosystem elements and to explain significant differences, similarities, or trends and their causes.

Physical domain

- **Trend P1: Increasing awareness of soil quality issues by both the public and agencies has led to increased public involvement in soil issues and questions about the impacts to soils resulting from ground disturbing forest management activities.**
    - Cause
        - Ongoing controversy as to whether or not soil quality is being degraded during the implementation of forest management activities.
        - Lack of availability of site specific soil quality monitoring on some soil types.
    - Effect/Outcomes
        - Court challenges of forest planning projects.
        - Delays in the implementation of projects.
        - Ongoing questions as to whether or not planned mitigation measures and soil restoration methods are adequate..
    - Opportunities
        - Implementation of Forest Service draft National Soil Quality Monitoring Protocols.
        - Develop an updated Forest soil monitoring program that focuses on effectiveness soil monitoring as described in the Forest Service Manual (FSM 2520).
- **Trend P2: Increases in the awareness of water quality issues by both the public and agencies leading to increases in water quality monitoring and increases in opportunities for cost share aquatic restoration projects.**
    - Cause
        - Increase in numbers of recreating public.
        - Introduction of non native fish species.
        - Nutrient enhancement from various sources. Uncharacteristic wildfire events.
    - Effect/Outcomes
        - Riparian impacts fromm human activities and an effect on water quality.
        - Public wants streams, fish and wildlife habitat protected.
        - Increased awareness of Blue-green algae populations in central Oregon lakes which have affected recreation use at popular recreation sites.
        - 303 (d) listed streams and lakes (temperature, etc).
        - Decline in amphibians and native fish stocks.
        - Impacts to water based recreation use and opportunities.
        - Economic impacts to concessions and to near by communities.
    - Opportunities

- Continued water quality monitoring.
- Look for aquatic restoration opportunities.

Biological domain

- **Trend B1: Increases in tree mortality in lodgepole pine, ponderosa pine, mixed conifer, and mountain hemlock forest types.**
  - Cause
    - Forest succession.
      - Increasing amounts of mature stands of lodgepole pine which are susceptible to mountain pine beetle attacks.
      - Encroachment of shade tolerant species resulting in increasing stand densities.
    - Fire exclusion.
  - Effects/Outcomes
    - Increased fuel loading resulting in increased risk of wildfire in the lodgepole pine and mountain hemlock forest types and uncharacteristic wildfire in the in ponderosa pine and mixed conifer forest types. Changes in stand densities.
    - Increased risk of loss of large residual trees to insect and disease.
    - Shift in lodgepole pine stands from a late structure to and early structure at the landscape level.
    - Changed scenic quality due to large areas of dead and dying trees and conversion to other forest types.
  - Opportunities
    - Look at opportunities to thin stands and salvage dead trees.
    - Plan treatments to strategically reduce risk of wildfires (landscape treatments/ fuel break strategies).

- **Trend B2: Increasing risk of loss of vegetation diversity and the associated loss of habitat diversity due to uncharacteristic fires.**
  - Cause
    - Wildfire.
    - Increases in the amount of tree mortality in the assessment area..
    - Increased fuel loading as a result of tree mortality.
    - Missed fire cycles.
  - Effects/Outcomes
    - Effects on wildlife habitat may or may not be favored depending on the type of wildlife species affected.
    - Increased risk of wildfire causing reduced habitat diversity due to extensive areas of early seral vegetation.
  - Opportunities
    - Plan vegetation treatments to strategically reduce risk of wildfires while promoting vegetation diversity and associated habitat diversity.

- **Trend B3: Extensive areas of early seral vegetation occurring in watersheds to the north and south of the analysis area due to recent large fires.**
  - Cause

        - Large uncharacteristic fires in adjacent watersheds that occurred over a three year period prior to 2005.
    - Effects/Outcomes
        - On a landscape scale, remaining late and mid seral habitats are more concentrated and limited.
        - Increases the importance of maintaining functioning late seral habitats in assessment area.
    - Opportunities
        - Supports need to maintain and protect currently functioning late seral habitats in assessment area.

- **Trend B4: Past forest management has resulted in succession advancement from late structured stands to early structured stands.**
    - Cause
        - Past harvest activities.
        - Lack of prescribed fire.
    - Effects/Outcomes
        - Fragmentation of the forest matrix causing a decrease in amount and quality of habitat for interior dependent species and an increase in edge.
        - Decline in solitude for species which are sensitive to disturbance.
        - Loss of connective habitat between LSR's and other habitats.
    - Opportunities
        - Manage plantations to promote the growth of large trees.
        - Manage the landscape to promote a diversity of habitats.

- **Trend B5: Trend to late seral stage of meadows and riparian stream sides**
    - Cause
        - Natural succession through lack of disturbance.
        - Changing water regimes.
    - Effects/Outcome
        - Loss of riparian vegetation and associated habitat.
        - Encroachment of trees species into meadows and riparian areas.
    - Opportunities
        - Meadow and riparian area restoration opportunities.
        - Maintain and enhance these types of habitats.

Social domain

- **Trend S1: Increased risk to the public and to recreation facilities including cabins, resorts, and campgrounds from an increasing threat of wildfire.**
    - Cause
        - Increasing tree mortality and associated fuel loading in lodgepole pine, ponderosa pine, mixed conifer, and mountain hemlock forest types.
    - Effects/Outcomes
        - Increased risk of injury and mortality to the public and fire fighters during wildfire events
        - Increased risk of damage and or loss of recreation facilities such as cabins, resorts, and campgrounds in the assessment area.
        - Increased demand for protection from wildfire.
    - Opportunities

        - Opportunities to implement authorities described in the 2003 Forest Service Healthy Forest Initiative (HFI) and 2004 Healthy Forest Restoration Act (HFRA).

- **Trend S2: Human use in the watersheds continues to increase and diversify**
    - Cause
        - The numbers of recreating public continues to increase over time.
        - Recreating public is older, more highly educated and more mobile, with higher income levels, increasing urban living and increasing ethnic diversity.
    - Effects/Outcomes
        - Impacts to riparian vegetation and soils in high use areas continues to occur resulting in degraded riparian vegetation and water quality.
        - Increase in noxious weeds along major roads.
        - Increase risk of human caused wildfires.
        - Increased risk of injury and/or mortality as a result of wildfires.
        - Increased recreation demand in developed, undeveloped, and wilderness settings.
        - Public would like the Forest Service to manage for natural places, quiet, natural appearing landscapes and information and education programs.
        - Public would like the Forest Service to provide family oriented activities closer to home for more frequent visits.
        - Increased use of OHV's, mostly in the southern portion of the assessment area and especially on buttes.
        - Increasing recreation demand such as camping, fishing, and motor boating in developed and undeveloped settings.
        - Recreation users continue to access dispersed sites using an extensive network of roads.
        - Increased use of the scenic byway in the assessment area resulting in the preservation and enhancement of views having an even higher priority.
    - Opportunities
        - Continue to seek and Federal Highways Administration and Oregon Forest Highways enhancement funds and to implement scenic improvements
        - Increase interpretive signing
        - Design vegetation management activities to maintain scenic views in high use areas while reducing or minimizing the risk of wildfire
        - Design vegetation management activities to improve escape routes for potential wildfire

Chapter VI
Management Goals and Recommendations & Data Gaps and Monitoring

The final step in the six step process is to provide recommendations that meet those management goals set forth by the Deschutes NF Land Resource Management plan as amended by the Northwest Forest Plan and the Aquatic Conservation Strategy. This step brings the results of the previous steps to conclusion, focusing on management recommendations that are responsive to watershed processes and trends identified in the analysis. Data gaps and monitoring activities that are responsive to trends, issues and core/key questions are also identified in this step.

Recommendations and monitoring needs are focused on those conditions that have changed since the earlier analyses were completed. Therefore this update is not intended to be all inclusive, or to replace the earlier analyses. This analysis and discussion is expected to be integrated and used in concert with the earlier analyses to identify opportunities and projects within the assessment area.

Management Goals

Manage vegetation in the watersheds to address the recent changes in conditions.

- Manage vegetation within the assessment area to reduce large amounts of dead and dying trees.
- Manage vegetation to reduce the risk to the public and resources that may occur as a result of catastrophic wildfire.
- Promote the growth of vegetative and healthy forest conditions to meet future habitat needs and those conditions described in management plans.

Work to address issues and needs resulting from increased human use in the watersheds.

- Manage assessment area in a manner that provides recreation opportunities identified by the public such as naturally appearing landscapes, information and education programs.
- Provide for protection of watershed resources which may be degraded due to increased public use.

Process Used for Developing Recommendations

Recommendations for this update focused on the change in condition within the analysis area that has occurred since the previous analyses were completed. In particular the increase in tree mortality that has occurred since the previous analyses and the increased use of the area by recreating public.

The following outlines the process used to by the team to develop recommendations.

- Initially the following criteria were used to quantify a change in existing conditions that occurred since completion of the previous analyses:
    - Vegetation mortality;
        - Tree mortality mapping.
        - PAG/fire regime/condition class.
- Next, those values and risks that influenced recommendations were identified
    - Provide for public safety – concentrations and escape routes.

    - Protection of facilities.
        - Resorts.
        - High use recreation sites.
    - Maintain or protect important resources – lakes/ streams/ riparian areas/ watersheds
        - Protect and enhance existing critical wildlife habitat – owl (CHU).
        - Protect and enhance existing critical wildlife TSE habitat – eagle, owl, plants.
    - Protection of water quality.
    - Protection and enhancement of scenic quality.
        - Visual – scenic foregrounds.
    - Protection of Experimental Forest/ special interest areas/ roadless.
- Next, those constraints which may affect what is being recommended were identified,
    - Access constraints,
        - Land allocations/Roadless allocations,
        - Slope limitations which limit types of activities that may occur,

Limitation of the Analysis

- Tree mortality mapping is coarse in scale with relatively low accuracy,
- Tree mortality is ongoing,

Watershed Recommendations

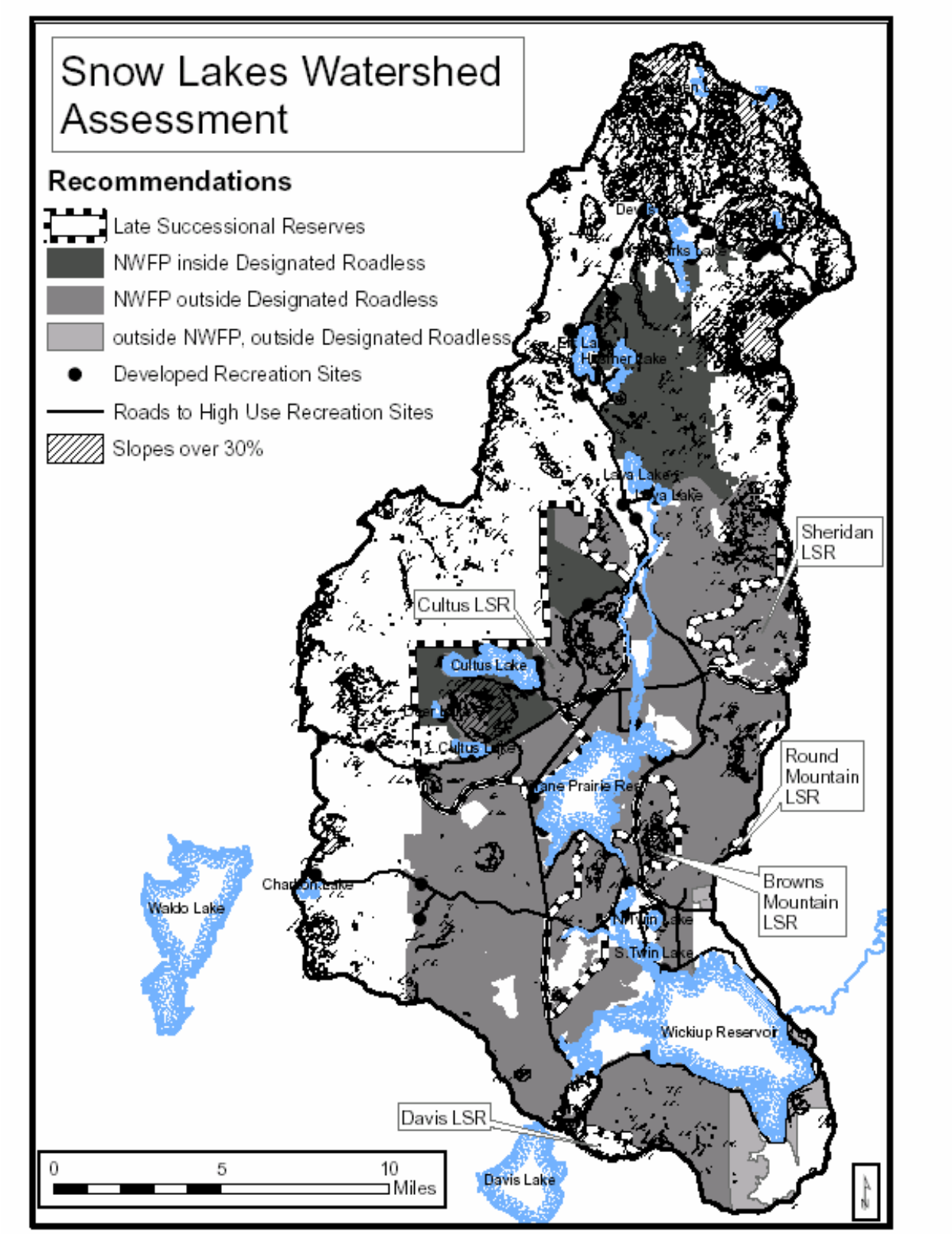
Watershed recommendations were developed based on a stratification of areas within the assessment area. Three general categories of recommendation areas were defined:

1) recommendations for NWFP land allocations outside of designated roadless areas;
2) recommendations for NWFP land allocations within designated roadless areas; and
3) recommendations in and around high use recreation areas.

Stratifying recommendation areas based on NWFP land management allocations helped to group those areas with similar management strategies and constraints. Further subdivision of these areas based on whether or not they occurred within Designated Roadless Areas also helped to group areas that have similar management strategies and constraints. Identification of an additional group of recommendations based on the location of high use recreation areas including facilities, major highways, and roads that may function as escape routes are included. This addresses the issue of increased risk to the public resulting from a change in watershed conditions.

These stratification categories are displayed in Figure 14.

Figure 16 Management Recommendation Category by NWFP Land Allocation, Inventoried Roadless Areas, and High Use Recreation Use Areas, Snow Lakes Watershed Assessment Area.



Recommendations by Northwest Forest Plan Management Allocation

NWFP Allocation Areas that are Outside of Designated Roadless

Matrix – areas outside of roadless and having moderate to high tree mortality

Areas in Matrix which have moderate to high tree mortality are recommended as priority areas for vegetation treatments to reduce the risk of uncharacteristic wildfire and provide protection to the public and watershed resource values.

Background

There are 70,349 acres of Matrix land allocation within the assessment area. Approximately 18 percent of that acreage has been determined to have moderate to high tree mortality (Table 17). The recent tree mortality has occurred predominately in the lodgepole pine plant association group (PAG). Reasons for prioritizing these areas for treatment include the moderate and high tree mortality in these areas and the fact that Matrix land allocation is the least restrictive of the NWFP land allocations within the analysis area. Treatment of these areas would also lower the wildfire risk to nearby facilities including Lava Lake Resort, Crane Prairie Resort, Deschutes Bridge Guard Station, and Snow Creek Guard Station. Vegetation treatments could include harvest, mechanical fuel treatments, prescribed fire, or a combination of these activities.

Cultus LSR

The Cultus LSR is recommended as a priority area for vegetation treatments due to the large amount of tree mortality in the LSR and the risk that this condition poses to the recreating public and resources within the watersheds.

Background

The Cultus LSR consists of 19,304 acres in the Cultus Creek and Cultus River 6th field watersheds. Cultus Creek Watershed is identified in the NWFP as a Tier II subwatershed due to its valued high water quality. Vegetation within the LSR is predominantly lodgepole pine and mixed conifer PAG,s. Approximately 73 percent of the area within the LSR has been identified as having moderate to high tree mortality (Table 17). This by far exceeds the amount of tree mortality found in any of the other NWFP land allocations within the analysis area. The Cultus LSR is also a high use recreation site. Facilities within or adjacent to the LSR include Cultus Lake Resort, boat docks, several camp grounds, trail heads, Deschutes Bridge Guard Station, and Snow Creek Guard Station.

Browns Mountain LSR and Sheridan LSR

The Browns Mountain LSR is recommended as opportunity areas for vegetation treatments to promote those management objectives described for LSR allocations.

Background

Table 21 Relative Mortality Levels, by Northwest Forest Plan Allocation, Snow Lakes Watershed Assessment Area.

Northwest Forest Plan Allocation	Allocation Acres	Mortality observed (Region 6 Aerial Survey Data 1990 to 2004)									
		None		Less than 6 tpa (1)		6 to 20 tpa (2)		More than 20 tpa (3)		Greater than 6 tpa (2 and 3 combined)	
		Acres	% of Allocation	Acres	% of Allocation	Acres	% of Allocation	Acres	% of Allocation	Acres	% of Allocation
Outside Northwest Forest Plan	**15,143**	**14,105**	**93.1 %**	**1,038**	**6.9 %**	**0**	**0.0 %**	**0**	**0.0 %**	**0**	**0.0 %**
Administratively Withdrawn (AWD)	**49,498**	**30,026**	**60.7 %**	**10,125**	**20.5 %**	**5,056**	**10.2 %**	**4,291**	**8.7 %**	**9,346**	**18.9 %**
Congressionally Withdrawn (CWD)	**54,091**	**25,070**	**46.3 %**	**21,203**	**39.2 %**	**3,601**	**6.7 %**	**4,217**	**7.8 %**	**7,817**	**14.5 %**
Late Successional Reserve (LSR)											
• **Browns Mountain**	7,288	5,371	73.7 %	1,804	24.8 %	100	1.4 %	12	0.2 %	113	1.5 %
• **Cultus**	19,304	1,538	8.0 %	3,579	18.5 %	9,209	47.7 %	4,978	25.8 %	14,187	73.5 %
• **Davis**	626	99	15.9 %	526	84.1 %	0	0.0 %	0	0.0 %	0	0.0 %
• **Round Mountain**	76	65	84.8 %	12	15.2 %	0	0.0 %	0	0.0 %	0	0.0 %
• **Sheridan**	5,167	1,650	31.9 %	3,510	67.9 %	7	0.1 %	0	0.0 %	7	0.1 %
LSR Subtotal	**32,461**	**8,723**	**26.8 %**	**9,431**	**29.1 %**	**9,316**	**28.7 %**	**4,990**	**15.4 %**	**14,307**	**44.1 %**
Matrix (MAT)	**70,349**	**30,235**	**43.0 %**	**27,437**	**39.0 %**	**8,182**	**11.6 %**	**4,495**	**6.4 %**	**12,677**	**18.0 %**
Other Ownership (OOS)	1	1	100.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %
Total	**221,542**	**108,161**	**48.8 percent**	**69,234**	**31.2 percent**	**26,155**	**11.8 percent**	**17,992**	**8.1 percent**	**44,147**	**19.9 percent**

Neither LSR currently contains any significant number of acres identified as having moderate or high tree mortality. Approximately 25 percent of the acres in the Browns Mountain and 68 percent of the acres in the Sheridan LSR have low levels of mortality (Table 17).

Matrix – areas outside of roadless and having low or no tree mortality

Areas in Matrix having low to no tree mortality are recommended as opportunity areas for vegetation treatments to both reduce the risk of uncharacteristic wildfire and promote healthy forest.

Background

Areas in Matrix that have low numbers of dead trees ponderosa pine, mixed conifer, and lodgepole pine PAG's.

NWFP Allocation Areas that are Within Designated Roadless

Matrix – areas of moderate to high tree mortality

Explore opportunities to treat roadless areas within matrix which have moderate to high tree mortality to reduce the risk of uncharacteristic wildfire and provide protection to the public and watershed resource values.

Background

Cultus LSR

Explore opportunities to treat roadless areas within the Cultus LSR which have moderate to high tree mortality to reduce the risk of uncharacteristic wildfire and provide protection to the public and watershed resource values.

Background

High Use Recreation Areas

Recommendations were next identified which focuses on High Use Recreation Areas including facilities, major highways, and roads that may function as escape routs within the watersheds.

Resorts, Campgrounds, and Administrative Sites

Vegetation conditions consisting of areas with high tree mortality in the vicinity of resorts, campgrounds, administrative sites are recommended as a priority for vegetation treatments to reduce the risk of uncharacteristic wildfire and provide protection to the public and watershed resource values.

Travel Corridors to and from High Use Recreation Areas

Provide for public and fire fighter safety by creating "defensible space" along travel corridors that access high use recreation areas.

Cascade Lakes Scenic Byway

Manage vegetation to restore views that have been lost due to ingrowth or have been degraded by dying trees.

Interpret vegetation conditions and other resources along scenic byway through interpretive signing.

Recommendations Specific to Heritage Resources – All Allocations

Develop a systematic monitoring program that targets all historic structures and rock art sites in the Snow Lakes watershed and a sample of historic and prehistoric site deposits, with priority directed toward those in proximity to recreation areas. Baseline condition information is deficient in the assessment area.

Consider heritage resources for protection by fuel reduction and fuelbreak programs.

Fuels management can help to protect cultural properties. Areas with known concentrations of prehistoric sites can be protected from wildfire by appropriate programs of fuels management, especially prescribed fire. Prescribed fire should be designed and conducted with specific consideration for traditional plant resources so as to protect existing populations and to foster the increase of concentrations of desirable plant resources. Fuelbreaks can be designed in such a way as to maximize protection of sensitive heritage resources, including standing structures.

Incorporate protection of heritage resources as a goal in suppression planning.

Pre-identification of sensitive resources and areas, cross-training of fire and heritage resource personnel, call-up and mobilization procedures for wildfires are recommended actions for balancing the requirements of fire suppression and heritage resource protection.

Design invasive species eradication projects by considering the fostering of valuable traditional native plant resources. Include active coordination with Native American traditional practitioners.

Consider expansion of onsite and offsite opportunities for sharing archeological and historical information with external customers, including through the use of electronic applications and simple on-site interpretation.

The demand for goods and services is expected to increase, including archeological and historical information. The assessment area has several appropriate opportunities for interpretation including, but not limited to, pre-Mazama use of Wickiup Reservoir, early development of recreational opportunities in the Cascade Lakes, especially Elk Lake, prehistoric use of upland resources, prehistoric utilization of toolstone at Devil's Flow, and the concerns of modern Native American populations for the health and availability of traditional resources. Recently a visitor register was placed at the Devil's Pass rock art site, another development which helps point the way for future management. This register tracks visitation, provides interpretation, and delivers a preservation message.

Expand law enforcement presence to curtail artifact theft.

Artifact theft is ongoing. It would be prescient of the Forest to anticipate the increased risk of artifact theft under such predisposing conditions.

Undertake a systematic program of evaluation of prehistoric and historic sites with a target of 30 sites evaluated before the next scheduled watershed analysis. Most of the prehistoric and historic sites within assessment area are unevaluated.

Multiple re-entries for fuels and timber management require multiple inventory and monitoring efforts so that the deficiencies of large scale surveys in heavy duff can be overcome.

Use project surveys as a component of a larger program of regional inventory in order to overcome sampling error in the current inventory of heritage resources.

Recommendations Specific to Snow EA Planning Project Area

The following are options for refining the Snow EA planning project boundary.

- Consider adjusting the current project boundary to include additional matrix allocation having moderate and high tree mortality which occurs outside of designated roadless areas.
- Consider adding additional areas of the Matrix allocation having low to no tree mortality occurring outside of designated roadless areas.
- Consider dropping the relatively minor amounts of area within designated roadless areas from this planning project.

Data Gaps and Monitoring

Physical Domain

- **Soils**
  - Need for soil disturbance monitoring surveys to increase site specific soil monitoring information which can be referenced in NEPA documents
  - Continue to develop criteria used to determine soil sensitivity, resistance and resilience to various soil disturbances
  - Continue monitoring soil restoration activities (subsoiling in particular) to determine effectiveness
  - Continue to evaluate different types of harvest and fuel treatment equipment to determine potentials for mitigating soil impacts
  - Current soil inventory is at a level 4 and is now nearly 30 years old, soil management interpretations would be improved by the updating to current soil survey information to a level 3 soil survey that meets National Cooperative Soil Survey (NCSS) standards
- **Water**
  - Continue water quality monitoring
  - Conduct surveys to identify aquatic restoration opportunities as well as opportunities for partnerships for aquatic restoration projects

Biological Domain

- **Vegetation**
- **Fuels**
  - The Healthy Forest Initiative and Healthy Forest Restoration Act include recent legislation which provides additional authorities for treating hazardous fuels within a defined urban interface. There is a need to explore options for initiating a Community Wildland Protection Plan to facilitate using these current NEPA authorities.
- **Wildlife**

- Need for surveys to update information on owl locations
- Need to do a habitat analysis that can be used as a basis for owl monitoring
- Need to do a bald eagle management plan in areas of Elk, Hosner and Cultus lakes
- Key elk areas need management plans in areas of clover meadow and crane prairie reservoir
- Need for analysis of riparian zones to identify trend shifts from beaver activity
- Need updated information of current conditions of meadow areas in regard to invading trees
- Need to map Nesting Roosting and Foraging (NRF) habitat to determine amounts, current condition, and potential for future habitat.

Social Domain

- **Recreation**
  - Need for off highway vehicle (OHV) monitoring to determine how much use there is and in what areas
  - Bring forward off highway vehicle (OHV) recommendations
    - Protect buttes from damage resulting from OHV use
    - Monitor use of buttes by OHV
- **Scenic quality**
  - Continue to monitor the types and amounts of use in the watershed by public
- **Cultural resources**

    - Conditions at specific historic structures are known only in general, specific data are absent in most cases. Need for baseline condition assessments and ongoing monitoring to determine needs for stabilization or other protection.

    - The demand for access to traditional plants by Native Americans is not known for the assessment area. Need for coordination and information gathering in order to identify areas of concern and to develop opportunities for restoration through the use of fire and other means.

    - Heritage resource inventory contains significant sampling error because it has been driven by specific projects. A comprehensive knowledge of the distribution and nature of prehistoric sites is missing.

    - Highly detailed and accurate data at prehistoric and historic sites in areas of high recreation use is missing in most instances. The absence of such data makes it difficult to determine the incidence and nature of impacts, including trampling and artifact theft.