October 2009

Whychus Watershed Analysis Update

Sisters Ranger District
Deschutes National Forest

October 2009

Table of Contents

Executive Summary

Purpose and Scope of this Document

- Updates the 1998 Sisters/Whychus Watershed Analysis
- Analyzes effects of changes in the watershed since 1998
- Identifies trends of concern
- Prioritizes areas to guide future management
- Provides recommendations
- Identifies data gaps and monitoring needs
- Provides information for cumulative effects analysis


Black Crater Fire 2006

Major changes in the Whychus Watershed since 1998 include:

- **Name Changes**- In 2006, all Squaw place names on Federal lands in the watershed were legally changed through the State and National Geographic Names Board process. This removes a term which is offensive to many Native Americans and complies with State law.
- **Collaborative Watershed Restoration has improved conditions.** Concerted efforts by many agencies, groups, and individuals have increased water flows in Whychus Creek, conserved large blocks of habitat, closed roads, and increased educational efforts. Several large restoration projects improving wetland, floodplain, and riparian habitats are in progress.
- **Anadromous fish are being restored.** Steelhead and spring chinook salmon have been reintroduced to Whychus Creek in 2007 and 2009. Fish passage at Pelton/ Round Butte dam has been constructed.
- **Mortality in High Elevation Forests.** Approximately 70,000 acres of lodgepole pine and other conifer trees have died, largely due to insects and natural cycles of disturbance.
- **Renewed concern regarding the risk of a Carver Lake moraine dam failure on South Sister causing risks to life and property in Sisters.**
- **Four large wildfires have burned into the watershed.** These include the 2002 Cache Mountain Fire, the 2006 Black Crater and Lake George fires, and the 2007 GW Fire. Approximately 12,000 acres or 7 % of the watershed has been burned since 1998.
- **Population increases in Sisters and Deschutes County.** At least 10 new subdivisions or developments have been built in Sisters since the installation of a sewer in 1998. Deschutes County continues to be one of the fastest growing areas in the State.
- **New science and data-** Many resource areas have new data, studies, and analysis approaches, including new Fire Regime science.
- **New regulatory information**- i.e. The length of Whychus Creek and Indian Ford Creek have been included on the Clean Water Act 303-D list because they do not meet water quality standards.
- **Evolving social and management issues-** These include: risks of flooding to streamside developments, increased use by off road vehicles, and trail pioneering.

OVERVIEW

What is Watershed Analysis?

"Watershed Analysis is a systematic procedure to characterize the aquatic, riparian, and terrestrial features within a watershed. Managers use information gathered during watershed analysis to refine riparian reserve boundaries, prescribe land management activities, including watershed restoration, and develop monitoring programs (NWFP, ROD, 1994, pg. 10).

This information helps guide future management and suggests future projects. It serves as a foundation for future project level analysis and decision-making. The analysis helps to ensure that activities are consistent with ecosystem management objectives as described in the *Deschutes National Forest Land and Resource Management Plan* (LRMP) as amended by the *Record of Decision for Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl*. Watershed Analysis process is based on the six step analysis process outlined in the *Federal Guide for Ecosystem Analysis at the Watershed Scale (version 2.2) and associated modules.*

This analysis is not a decision making process. Project level recommendations for federal lands must be further analyzed according to the National Environmental Policy Act (NEPA) process.

Why Was this Watershed Analysis Update Done?

The Federal 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 disturbance events, or if existing analyses 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.

This update serves to support analysis for future management and identifies recommendations for future management activities. This document provides important new information but **does not** update and rewrite all aspects of the original 1998 Sisters Whychus Watershed Analysis. Both documents are useful summaries and should be used as references.

How was this Watershed Analysis Update Prepared?

This update is based on an interdisciplinary analysis done by a team of Forest Service specialists between November 2008 and March 2009. This is a dynamic document that may be updated and modified as needed.

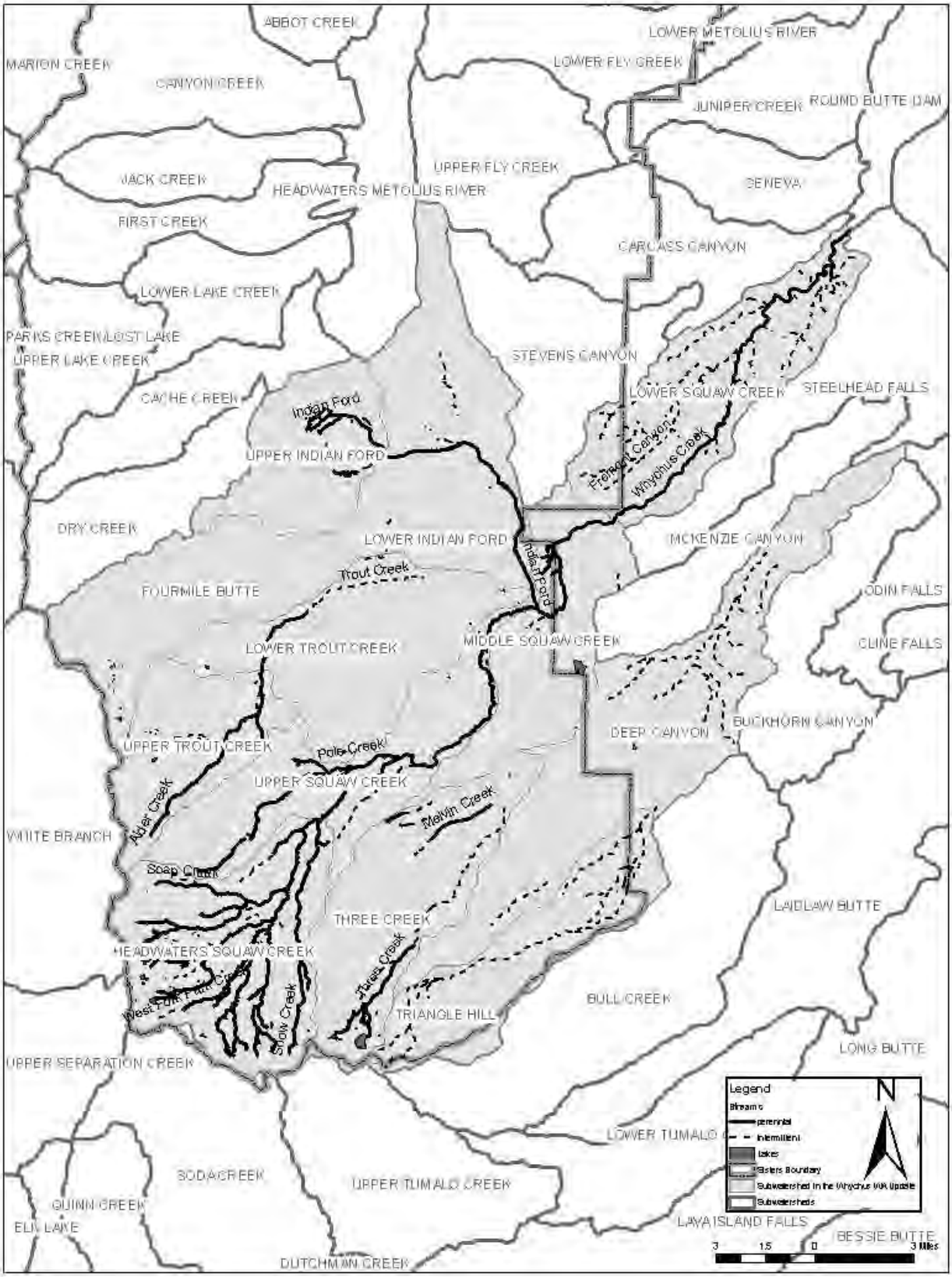
Public Involvement and Scoping

Information for this analysis is derived from the public comes from several sources including:

- Whychus Wild and Scenic River Scoping and Public Field Trips
- Glaze Forest Restoration Project Scoping and Public Field Trips
- SAFR Project Scoping and Public Field Trips
- Meeting with the City of Sisters and other local agencies to discuss watershed issues including, private land restoration and flooding risks.
- Meetings with USGS Scientists and local agencies to discuss Carver Lake and geologic hazards.
- Information provided by Agency partners.

Chronology:

1994	The Record of Decision for the Northwest Forest Plan amended local Forest Plans and requires Watershed Analysis be completed in Key Watersheds before management actions take place.
1998	The original Sisters/Whychus Watershed Analysis is completed. Whychus and Three Creeks are two of seven Key Watersheds designated on the Deschutes National Forest.
1999	The first water rights purchase for Whychus Creek is completed by Oregon Water Trust and partners returning 1.8 cubic feet/second to the creek.
2002	The 3,888 acre Cache Mountain Fire is started by lightning and burns 485 acres in the watershed area.
2006	The Black Crater Fire is started by lightning and burns 9,396 acres in the watershed area.
2006	The 5,537 acre Lake George Fire is started by lightning and burns 979 acres in the watershed area.
2007	The 7,357 acre GW Fire is started by lightning and burns 1,029 acres in the watershed area.
2008	The Glaze Forest Restoration Project Environmental Assessment is completed. It is the first commercial thinning project to proceed without an appeal on the Sisters Ranger District since 1996 (12 years). This 1,200 acre old growth restoration project was initiated by Conservation and Forest Industry partners and demonstrates innovative new thinning techniques and a collaborative approach.
2008	The City of Sisters begins a comprehensive Sisters/ Whychus Creek Restoration Management Planning to address issues surrounding urban development in the floodplain.
2009	The Sisters Area Fuels Reduction (SAFR) Project is approved without appeals from the conservation community. An appeal by Forest was dropped
2009	The Whychus Watershed Analysis Update is compiled into this document.


ABBOT CREEK
LOWER METOLIUS RIVER
MARION CREEK
LOWER FLY CREEK
CANYON CREEK
JUNIPER CREEK
ROUND BUTTE DAM
UPPER FLY CREEK
JACK CREEK
HEADWATERS METOLIUS RIVER
SENEVA
FIRST CREEK
CARCASS CANYON
LOWER LAKE CREEK
PARKS CREEK/LOST LAKE
UPPER LAKE CREEK
STEVENS CANYON
CACHE CREEK
LOWER SQUAW CREEK
STEELHEAD FALLS
Indian Ford
UPPER INDIAN FORD
Whychus Creek
DRY CREEK
LOWER INDIAN FORD
MCKENZIE CANYON
Trout Creek
FOURMILE BUTTE
MIDDLE SQUAW CREEK
CLINE FALLS
LOWER TROUT CREEK
DEEP CANYON
BUCKHORN CANYON
UPPER TROUT CREEK
Pole Creek
UPPER SQUAW CREEK
Alder Creek
Melvin Creek
WHITE BRANCH
Soap Creek
LAIDLAW BUTTE
THREE CREEK
HEADWATERS SQUAW CREEK
Three Creek
BULL CREEK
TRIANGLE HILL
LONG BUTTE
UPPER SEPARATION CREEK
LOWER TUMALO CREEK
SODA CREEK
UPPER TUMALO CREEK
QUINN CREEK
ELK LAKE
LAVA ISLAND FALLS
BESSIE BUTTE
DUTCHMAN CREEK
Legend
Streams
perennial
intermittent
Lakes
Sisters Boundary
Subwatershed in the Whychus WA Upside
Subwatersheds
N
3
1.5
0
3 Miles

WHYCHUS WATERSHED ANALYSIS AREA
DISTINGUISHING FEATURES

SETTING

- **The Whychus Watershed Analysis Area surrounds Sisters, Oregon.** It is located in the southern half of the Sisters Ranger District, Deschutes National Forest, and is within Jefferson and Deschutes Counties. It lies approximately 15 miles northwest of Bend, Oregon.

PHYSICAL

- **Key Watersheds-** Whychus Creek and Three Creeks
- **Cascade Mountain backdrop**- Three Sisters, Broken Top
- **Unique geology-** The area has become more volcanically active in the past 11 years with activity centered around South Sister**.** New monitoring has been tracking volcanic activity**.** The area with highly permeable outwash plains of sand and gravel left by glaciers.
- **Subwatersheds:** Watershed Boundaries have changed in the past 11 years. The area now covers portions of 12 subwatersheds, including: Upper Indian Ford, Lower Indian Ford, Fourmile Butte, Upper Trout Creek, Lower Trout Creek, Headwaters Whychus Creek, Upper Whychus Creek, Middle Whychus Creek, Lower Whychus Creek, Three Creek, Triangle Hill and Deep Canyon.
- **Part of Columbia River Basin-** The analysis area is within the Upper Deschutes River Basin and in a larger context the Columbia River Basin. Whychus Creek enters the Deschutes River above Pelton and Round Butte Dams, the Deschutes flows into the Columbia River, which flows into the Pacific Ocean.
- **Whychus Creek is a snow melt river system with variable flashy flows-** It is prone to seasonal flooding through rain- on snow events or rapid snow melt.
- **Precipitation:** The area is located on a steep rain gradient on the eastern slope of the Cascade Mountain range.
- **Elevations :** Range from 10,358 feet at the top of South Sister to 3200 feet near Fremont Canyon.

BIOLOGICAL

- **Important Fishery-** Whychus Creek once supported large steelhead runs**.** Reintroduction of Steelhead and Salmon is proceeding under permit requirements with the relicensing of Pelton/Round Butte Dams.
- **Trademark Ponderosa Pine Forests-** The Whychus Creek area is known for large ponderosa pine trees and scenic forest views.
- **Diversity of Fire Regimes and Vegetation-** All five Fire Regimes are present, although much of the area historically experienced frequent low intensity fire. Higher elevations and moisture gradient areas support diverse subalpine, moist, and dry mixed conifer forests.
- **Diversity of Wildlife-** Typical westside species, such as the Northern Spotted owl, survive here at the edge of their range. Supports a diversity of wildlife including pine forest species such as goshawks and white headed woodpeckers. Bald eagles have been delisted since 1998.
- **Rare endemic wildflower, Peck's penstemon –** Contains the southern extent of the global population of the endemic wildflower Peck's Penstemon. Habitats support a high diversity of wildflowers and native plants.
- **Wet meadow habitats-** The Three Creeks lake area,Trout Creek swamp, Pole Creek Swamp, Glaze Meadow and Indian Ford area all contain significant wet meadows.
- **Invasive Plants (Noxious Weeds) -** Expanding noxious weed populations are associated with

private lands, roads, urban areas, and past management.

SOCIAL

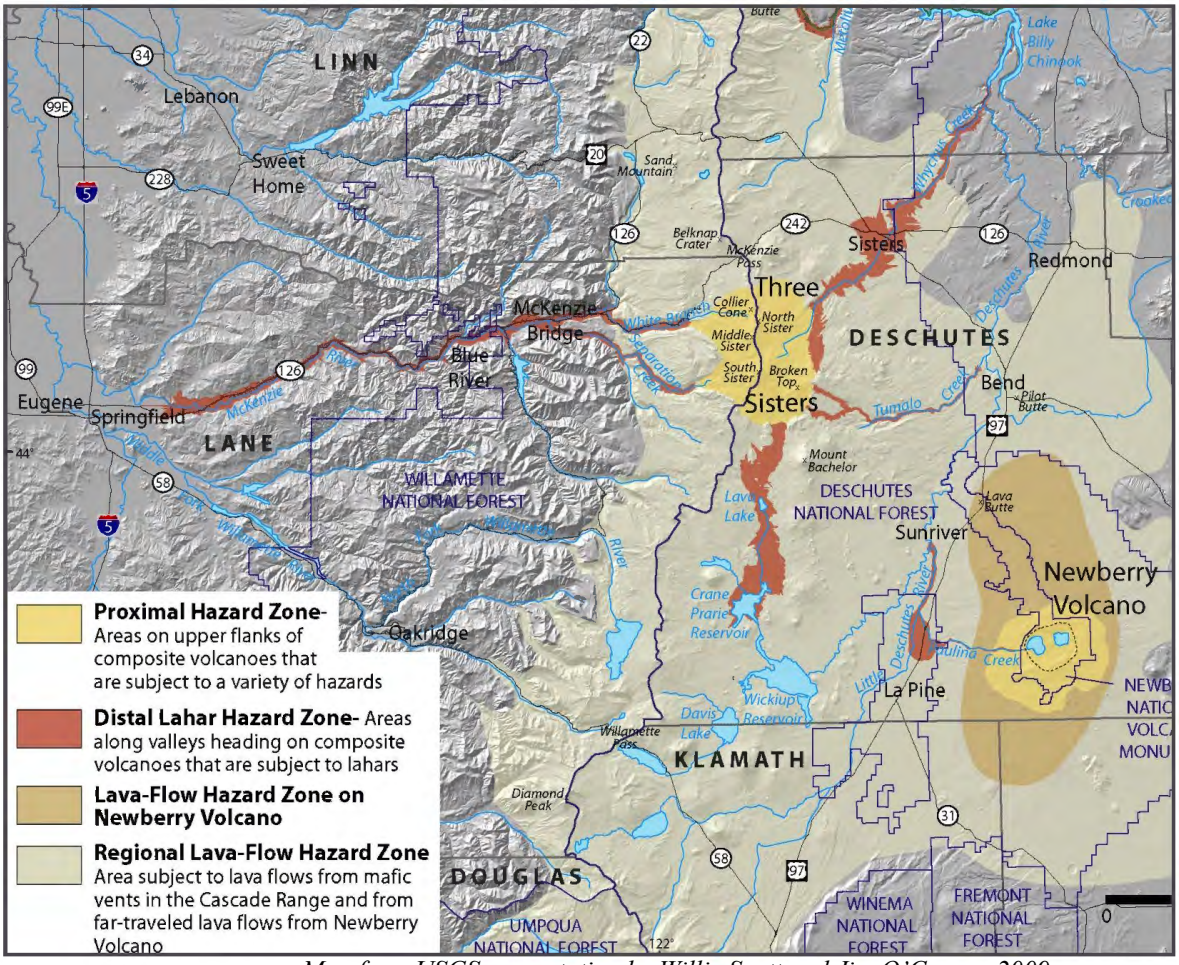
- **Long history of Native American use and early European settlement**
- **Ownership-** 75% Public lands, 25% Private lands
- **State Highway 20-** Oregon's busiest route over the Cascade Mountains
- **Important Recreation and Residential Area-** The popular tourist destination and community of Sisters is within the analysis area.
- **Growing population and new developments**
- **Large areas of forest/ urban interface**
- **Wild and Scenic-** Whychus Creek is a Wild and Scenic River. The Resource Assessment completed in 2007 rated it's geology, hydrology, fisheries, scenic resources, cultural prehistory, and traditional use as outstandingly remarkable values. The Whychus Creek Wild and Scenic River Management Plan will be finalized in 2010.
- **Valued scenic vistas-** The Three Sisters and front country are viewed from across Central Oregon.

Key Findings- By Resource Area

The following is a synopsis of resource reports and team synthesis.
For more detail, see the attached Resource Reports.

Physical Domain

Geology

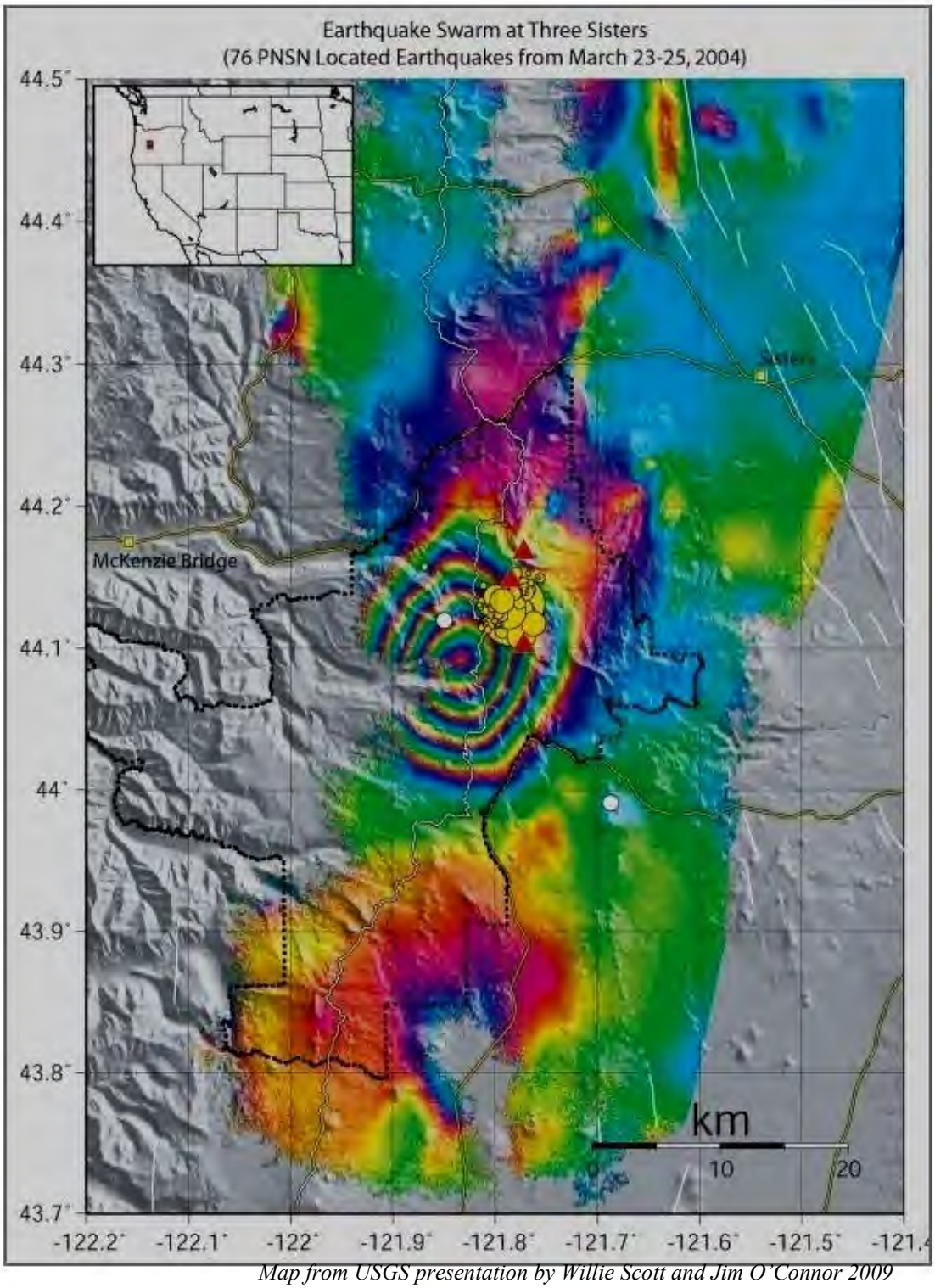


Map from USGS presentation by Willie Scott and Jim O'Connor 2009

Summary of Geology Findings

South Sister has become more volcanically active but activity has slowed since 2004.

- An uplift (bulge) was discovered in 2001 about three miles west of the volcano's summit.
- Scientists believe the uplift is caused by magma — hot molten rock and gases — pushing up from deep below the Earth's surface to a depth of about 4 miles below the surface. As the magma intrudes into the rocky crust, it pushes up the ground above it.
- Until 2004, the bulge rose an average of just over an inch a year. In 2007 it was reported the bulge had slowed to about half the previous rate and is now growing about half an inch a year. It is believed this pulse of magma intrusion has ended or slowed down.
- This volcanic activity and associated earthquakes have reawakened fears that Carver Lake on the side of South Sister could suddenly drain and cause flooding in Sisters.



Map from USGS presentation by Willie Scott and Jim O'Connor 2009

.

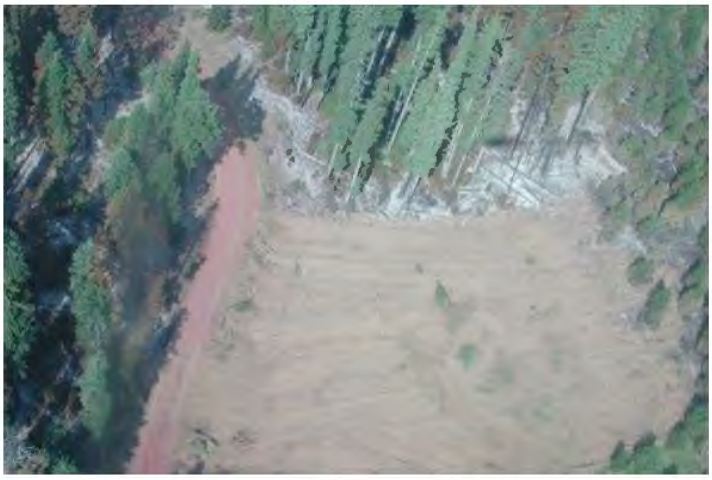
Soils

Summary of Soils Findings

- The 2006 Black Crater fire burned approximately 9,389 acres, including 4,827 acres of National Forest lands. It caused moderate soil damage on 59% of the area, low on 40% and high on 1%.
- Small portions of the GW, Cache Mountain, and Lake George fires also burned within the Whychus watershed. Most of the fire burn intensity and or burn severity for the three fires and within the Whychus watershed were mapped at a moderate to low level.

Stand replacement burn on east slope of Trout Creek

- Approximately 200 acres within the GW fire were salvaged logged in 2008. Only a portion of the salvage units are within the Whychus watershed boundary. The only salvage activities that occurred within the Cache Mountain and Lake George fires were road side removal of danger trees.
    - Post harvest soil monitoring on the Black Crater salvage determined that the soil disturbance resulting from salvage activities was within the acceptable limits defined by the FS Regional Soil Quality Standards.



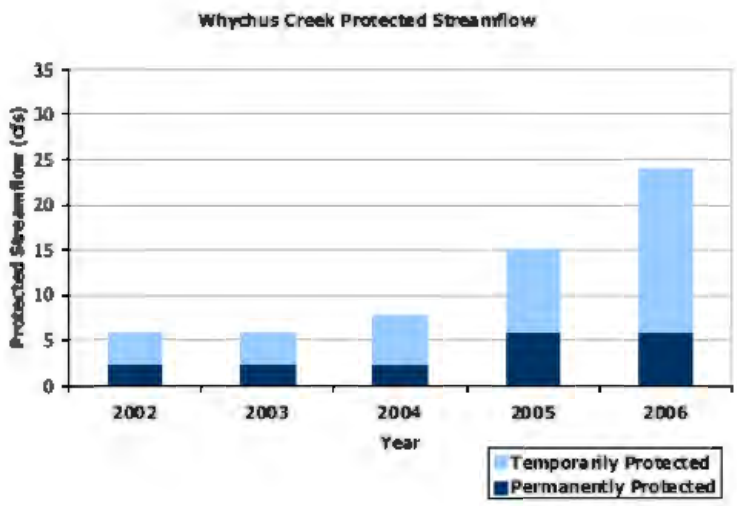
Safety Zone on Black Crater Fire

Hydrology

Summary of Hydrology Findings

Whychus Creek Flow Restoration

- Water flows on Whychus Creek have improved through conservation efforts, purchase, and leasing.
- Summer low flows on Whychus Creek have increased from 1 cubic foot per second (cfs) to 15 - 20 cfs with a goal of 20 cfs.
- Some surface water from Pole Creek is now reaching Pole Creek Swamp because the City of Sisters rarely uses their 2 cfs surface water right on Pole Creek. However, this is still very little water and flow acquisition of a portion of the other water rights may be important.



More Flood events

- **Winter Flood events, generally caused by Rain-on -Snow have increased in frequency in the past 10 years.** Six of the top eleven peak flows during the past 102 years have occurred in the last 10 years, two occurred in November of 2006 and 2007 (both approximately 1,200 cfs).

Winter flood on Trout Creek near land to be developed McKenzie Meadows -2006

More Concern about Carver Lake

***Background**: Carver Lake is located on South Sister off the Prouty Glacier at 7,800 feet in the Three Sisters Wilderness. It is the largest of the moraine dammed lakes in the Oregon Cascades Range. Lake volume is estimated to be 33,000,000 cubic feet. In 1986 USGS notified the Forest Service that it had identified Carver Lake as a major flooding threat to the City of Sisters. Discussions of risks and solutions have been going on for the past twenty years.*

Carver Lake on South Sister – USGS photo

- **FEMA Mapping change**- New FEMA mapping shows a "Carver Lake Inundation Zone" in the city of Sisters that has raised concerns with local officials. The mapping may be inaccurate in that it does not show water moving to the east in old channels, which would likely carry water.
- **Updated Information from USGS** - Forest Service and other area officials met with USGS scientists in 2008 to discuss Carver Lake risks, new information, and next steps.
    - The moraine dam could fail by a variety of mechanisms, the lake could empty entirely or stop after partial drainage, the character and magnitude of downstream events depend on rate of outflow from lake and the rate of outflow is dependent on numerous variables related to breach formation; too complicated to accurately forecast.
    - The most realistic scenario modeled in 1987 reports estimated 10,500 cfs (5 times the volume of the flood of record- 2000 cfs) at the gaging station near Peterson Ridge and 3,700 cfs in Sisters. The time estimated for the flow to arrive was 2.7 hours.
    - Areas immediately below Carver Lake, along South Fork of Whychus Creek, and along main stem of Whychus Creek to flats below 1514 Rd bridge are potentially at risk from debris flow. It is difficult to estimate the magnitude of flooding on the alluvial fan through Sisters.
    - Better flow models are now available, but breach and debris-flow behavior are still beyond rigorous modeling and subject to substantial uncertainty. New approaches for improved modeling require detailed topography of channel, flood plain, and fan.
    - Mitigation measures to reduce risk in case of dam failure (zoning, levees, warning systems) are possible. Warning systems require maintenance.
    - City Officials need to formally request USGS to proceed with costs estimates for more accurate modeling.
- It appears that normal flood events or rain on snow events have a greater probability of happening than a Carver Lake Dam breech.

Hydrological Restoration on Whychus creek and its tributaries

- **Trout Creek Swamp Restoration 2004**. Trout Creek Swamp has undergone a hydrological restoration that is complete and effective. By blocking the ditches, the water table in the swamp has risen to a higher level longer into the season surface and has restored the hydrologic function of the wetland. It is holding up well and is a good example of effective techniques *(Recommendation of 1998 WA).*

- **Camp Polk Meadow Purchase and Restoration 2009–** A significant meadow and section of Whychus Creek were purchased by the Deschutes Land Trust and the meandering stream course and wet meadow hydrology are being restored.
    - The Whychus Creek Restoration at Camp Polk Meadow Preserve began its first phase in June 2009. A 1.7 mile reach of Whychus Creek, which had been ditched, straightened, and pushed to the side of the valley prior to 1943, will be restored similar to the original meandering channel with connection to the floodplain. The Deschutes Basin Land Trust is partnering with the USFS and Upper Deschutes Watershed Council and in design and implementation of this project. *(Recommendation of 1998 WA).*

Camp Polk Restoration- a restored meandering new stream channel for Whychus Creek
Photo by Deschutes Land Trust

- **Rim Rock Ranch Restoration -** A Conservation easement on Rim Rock Ranch has also been acquired by the Deschutes Land Trust and a restoration is in progress of another stretch of creek and meadows floodplains.
    - A design for the Whychus Creek Restoration at Rimrock Ranch was completed in 2009. The project is located 9 miles downstream of the City of Sisters on private land owned by the Bakers with a conservation easement owned by the Deschutes Basin Land Trust. A 1.9 mile reach of Whychus Creek, which had been ditched, straightened, much like Camp Polk Meadows, is proposed to be restored to a meandering, meadow channel that is connected to the floodplain. The Deschutes Basin Land Trust is partnering with the USFS and Upper Deschutes Watershed Council and in design and implementation of this project. *(Recommendation of 1998 WA).*

- **Three Sisters Irrigation Dam (TSID) Project is in progress-** It should be complete by 2011. It involves 1400 feet of channel work. The project is located approximately 4 miles upstream of the City of Sisters on USFS lands with an easement owned by the Three Sisters Irrigation District. Currently the TSID dam is a fish passage barrier and does not have a fish screen. In addition, the 1700 ft reach of Whychus Creek downstream of TSID has downcut approximately 10 ft making the previous, deactivated wood dam unstable. The plan is to design an off-channel fish screen, fish passage over the dam, restore some wetlands and create a stable stream channel downstream of TSID to prevent the wood dam from failing. The USFS is partnering with the Upper Deschutes Watershed Council to design and implement this project *(Recommendation of 1998 WA).*

.

Plantings, signing, and site protections at Turtle Beach on Whychus Creek. This site was formerly a ford where vehicles drove through (and up) the creek.

- **Whychus Riparian Protection Project 2005** improved riparian conditions and reduced streambank erosion at a total of 59 sites resulting in the closure of 1.1 miles of system roads and the closure of an unknown amount of user created roads, camping access management, and adding Respect the River signage near the creek off Rd 16 and 1514. *(Recommendation of 1998 WA).*

- **Riparian plantings** has been done in many areas along Whychus Creek *(Recommendation of 1998 WA)*

- **City of Sisters Floodplain Management Plan 2009-** As part of Whychus Creek watershed-scale restoration efforts, the Upper Deschutes Watershed Council (UDWC), City of Sisters and other partners have developed a *Draft Whychus Creek Restoration and Management Plan* (WPN 2009) to restore Whychus Creek in the developed reaches that flow through and near the City. The Restoration Plan will guide the on-the-ground implementation of restoration projects over the coming years *(Recommendation of 1998 WA).*

- **Three Sisters Irrigation District Canal piping for Water Conservation** – This project has been planned approved and is in progress. A portion of the conserved water will be returned instream *(Recommendation of 1998 WA).*

- **City of Sisters conversion from septic to wastewater treatment facility**. This project was approved in 1998 and completed *(Recommendation of 1998 WA).*
- **Toilet replacement at Whispering Pine campground-** Protected water quality of Trout Creek
- **Entire length of Whychus Creek was listed under Clean Water Act**- The entire length of Whychus Creek has been listed on the Clean Water Act 303D List, rather just than segments downstream of the irrigation dam. This is not because it has increased water temperatures or water quality issues but because of listing protocol.
- **Indian Ford Creek listed under Clean Water Act 303D List** –Indian Ford Creek has low flows due to irrigation withdrawals and point source pollution from Black Butte Ranch sewage system which continues to degrade riparian and aquatic systems along the creek.
- **Trout Creek changed by Black Crater Fire and subsequent rehabilitation**- The Black Crater Fire severely burned a portion of Trout Creek riparian areas. Black Crater Burned Area Emergency Rehab (BAER) work upsized culverts downstream of the fire. Some flooding was observed in forests and town the following winter. Danger Trees were dropped in the riparian zones of Trout Creek after the fire.

  Trout Creek Burned Area Emergency Response hydrology projects:
  - Upsized the 1510-400, 1018, and 1024 road culverts.
  - Removed the 1510 and 1008 road culverts.
  - Improved drainage and fords on all road-stream crossings on USFS lands downstream of Black Crater Fire.

Many undersized culverts near Trout Creek were replaced after the Black Crater Fire

Illegal tree cutting along Whychus Creek

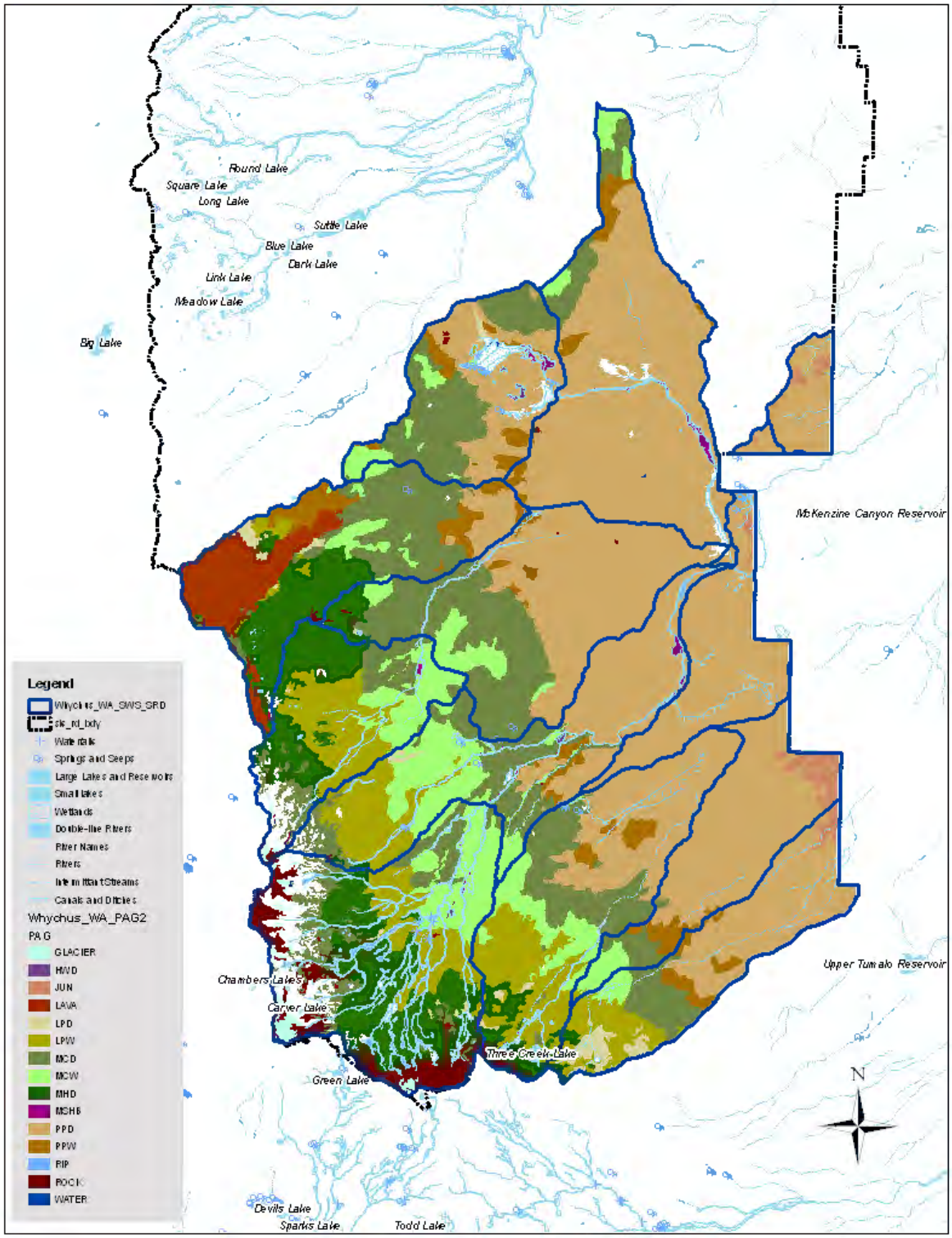
- **Illegal tree cutting-** Dispersed campers and residers (people who live in the forest) are cutting more streamside trees.
-
- **Off Road Vehicles** - Increased use of OHVs has been seen in the watershed. Some of this use affects riparian habitats.

- **Tree mortality** has increased in riparian areas in Three Creek and upper Whychus Creek drainages, including big ponderosa pine, and mistletoe trees. Some of these areas are spruce bottomlands in wet areas difficult to thin.

- **Watershed Boundaries have been changed** Watershed boundaries and names were updated multiple times after the original Whychus Watershed Analysis. Currently, some portion of the following subwatersheds are in the Whychus Watershed Analysis update area: 1) Upper Indian Ford, 2) Lower Indian Ford, 3) Fourmile Butte, 4) Upper Trout Ck, 5) Lower Trout Ck, 6) Headwaters of Whychus Ck, 7) Upper Whychus Ck, 8) Middle Whychus Ck, 9) Lower Whychus Ck, 10) Three Creek, 11) Deep Canyon, 12) Triangle Hill.

Biological Domain

Forest Vegetation

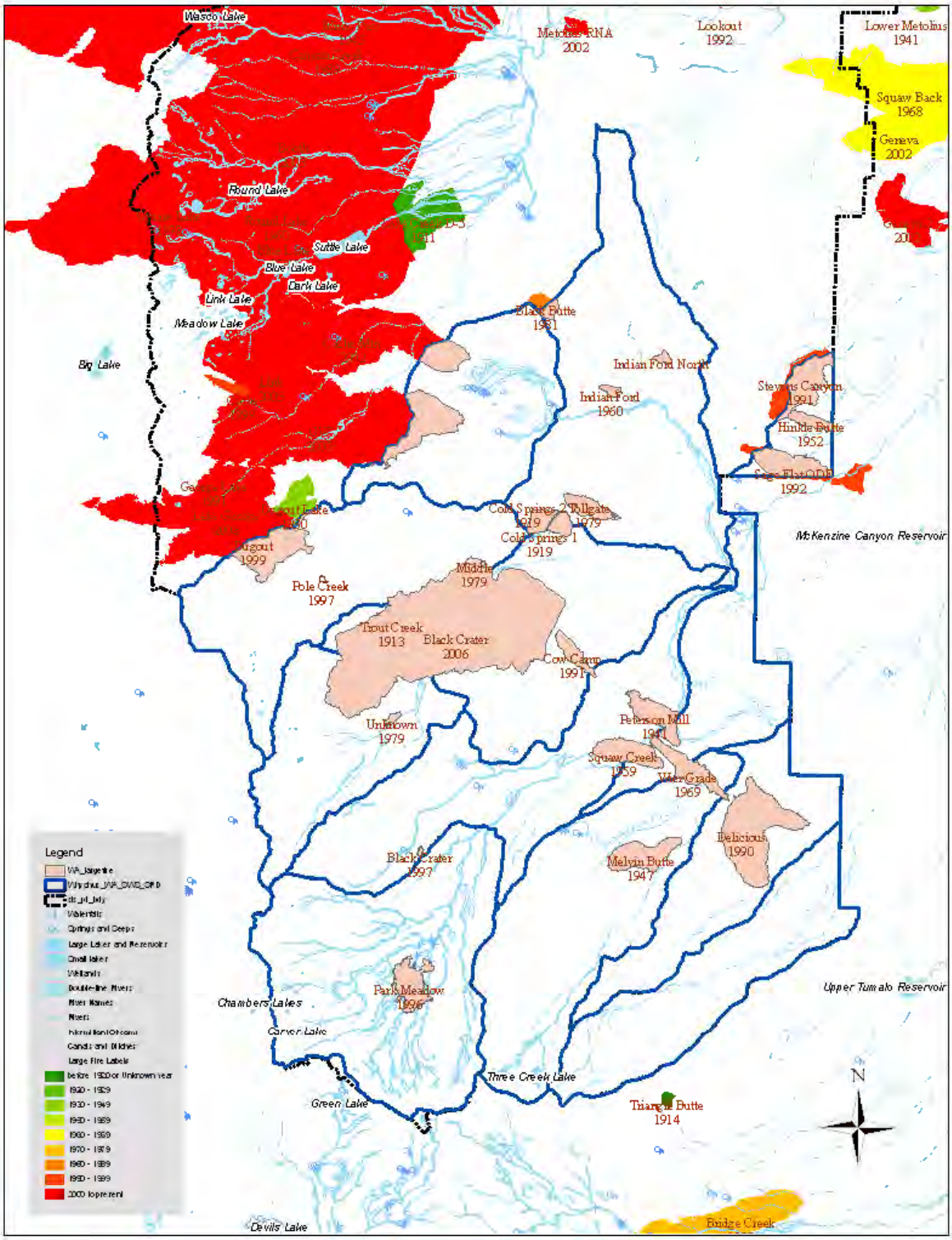


Updated Plant Association Groups (PAGs) for the Whychus Watershed

Summary of Forest Vegetation Findings

- **More dead trees**- There has been a watershed level mortality event since 1998, creating 60, 000-70,000 acres of dead trees.
    - The biggest change is in lodgepole caused by an infestation of Mountain pine beetle. However, there is more mortality in the whole watershed, including loss of big pine.
- **Continued successional changes from fire suppression-** The the trends discussed in the 1998 Watershed Analysis are still happening and are a bit farther along.
- **Wildfire has affected forests**
    - 7% (12,374 acres) of the watershed area has been involved in wildfire since 1998.
    - 1% (1,814 acres) of the watershed area has experienced stand replacement fire in which virtually all vegetation canopy was consumed/removed.
    - 1% (1,508 acres) of the watershed area has experienced mixed severity fire in which 25% to 75% of the vegetation canopy was consumed/removed.
    - As a result of the recent wildfires, there has been a shift in size structure across the landscape. The grass/forb/shrub class has increased and the pole, small and medium/large size classes have experienced a slight decrease due to fire.
    - Continued mortality can be expected in areas that experienced mixed mortality over the next 3-5 years as severely damaged trees succumb to secondary mortality agents.
- **Little Vegetation Management in this watershed since 1998**- The District vegetation management priorities were focused on the Metolius watershed to deal with: 1) Thinning in the Metolius Basin, because of public concern, 2) Fire salvage of a series of large wildfires since 2002. A small amount of thinning /harvest has occurred:
    - Broken Rim- 300-400 acres, many trees died after thinning because entry was delayed.
    - Black Crater Fire salvage- -1 unit.
    - Black Butte Ranch area- Small tree thinning.
    - SAFR Project -in progress, urban interface fuels reduction.
- **Whychus Late Successional Reserve Assessment has been completed and approved** – This document identifies priorities, strategies and triggers for vegetation management to benefit Late Successional Species in the Whychus Late Successional Reserve. It would also allow some mistletoe prevention work with small clearcuts (limit 100 acres a decade).
- **Large trees are dying**- Potential Old Growth has been reduced due to recent large wildfire and the mountain pine beetle outbreak, with the biggest effect being the large reduction in potential old growth lodgepole pine from mountain pine beetle. However large pine are also dying.
- **Continued loss of aspen**- Aspen are continuing to decline. An aspen inventory has been completed. Wood market decline is affecting ability to do vegetation management- sell wood products.
- **Collaborative Forest Restoration Project approved-** The 1,200 acre Glaze Forest Restoration Project is a partnership between a conservation group (Oregon Wild), a timber industry group (Warm Springs Biomass Project), and the Forest Service to restore the unique forests in the Glaze area and break barriers of mistrust. The partners supported the Forest Service in developing a plan of ecologically based management actions, including mosaic thinning in the Old Growth and second growth forest areas. The project was approved without appeal and is under stewardship contract to proceed under winter logging conditions.

Fire Ecology



Summary of Fire Ecology and Fuels Findings

Wildfires

- Between 1998 and 2009, four wildfires over 10 acres in size burned in the watershed.
- Approximately 4% of the watershed has burned since 1998.

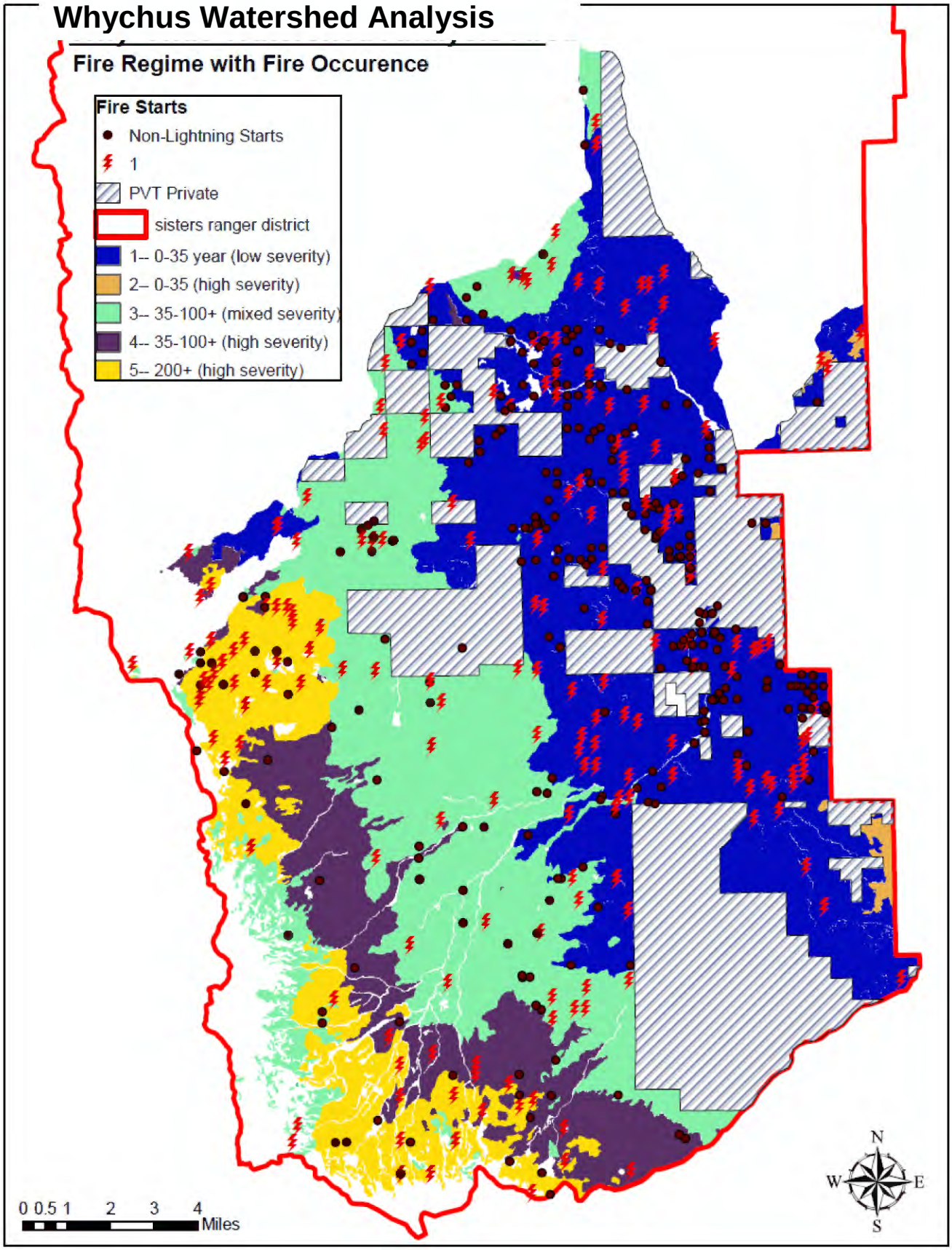
Fire Name	Year	Total Size (acres)	Watershed Project Area (acres)
Cache Mountain	2002	4,358	485
Black Crater	2006	9,396	9,396
Lake George	2006	5,550	979
GW	2007	7,357	1,029
Total		26,661	12,374

- **Cache Mountain Fire** – Started on Cache Mountain in July 2002 by lightning. The fire moved east and required evacuation of Black Butte Ranch and nearby resorts and camps. The fire entered Black Butte Ranch and burned 2 homes.
- **Black Crater Fire**- Started in July 2006 in the Three Sisters Wilderness by lightning. The fire subsequently burned to the east and outside the wilderness. It threatened the city of Sisters and caused multiple subdivision evacuations. Contained at 9,407 acres, including 5,147 acres of National Forest lands. Burned Area Emergency Rehabilitation (BAER) Treatments including trail and road drainage work and invasive plant control were completed.
- **Lake George Fire**- Started on August 7, 2006 in the Mt Washington Wilderness. The cause was believed to be lightning. The fire subsequently burned to the east and outside the wilderness. At the time of containment the fire had burned on the Deschutes National Forest and 607 acres on the Willamette National Forest.
- **GW Fire**- Started in August 2007 in the Mt Washington Wilderness by lightning. The fire subsequently burned to the east and outside the wilderness.

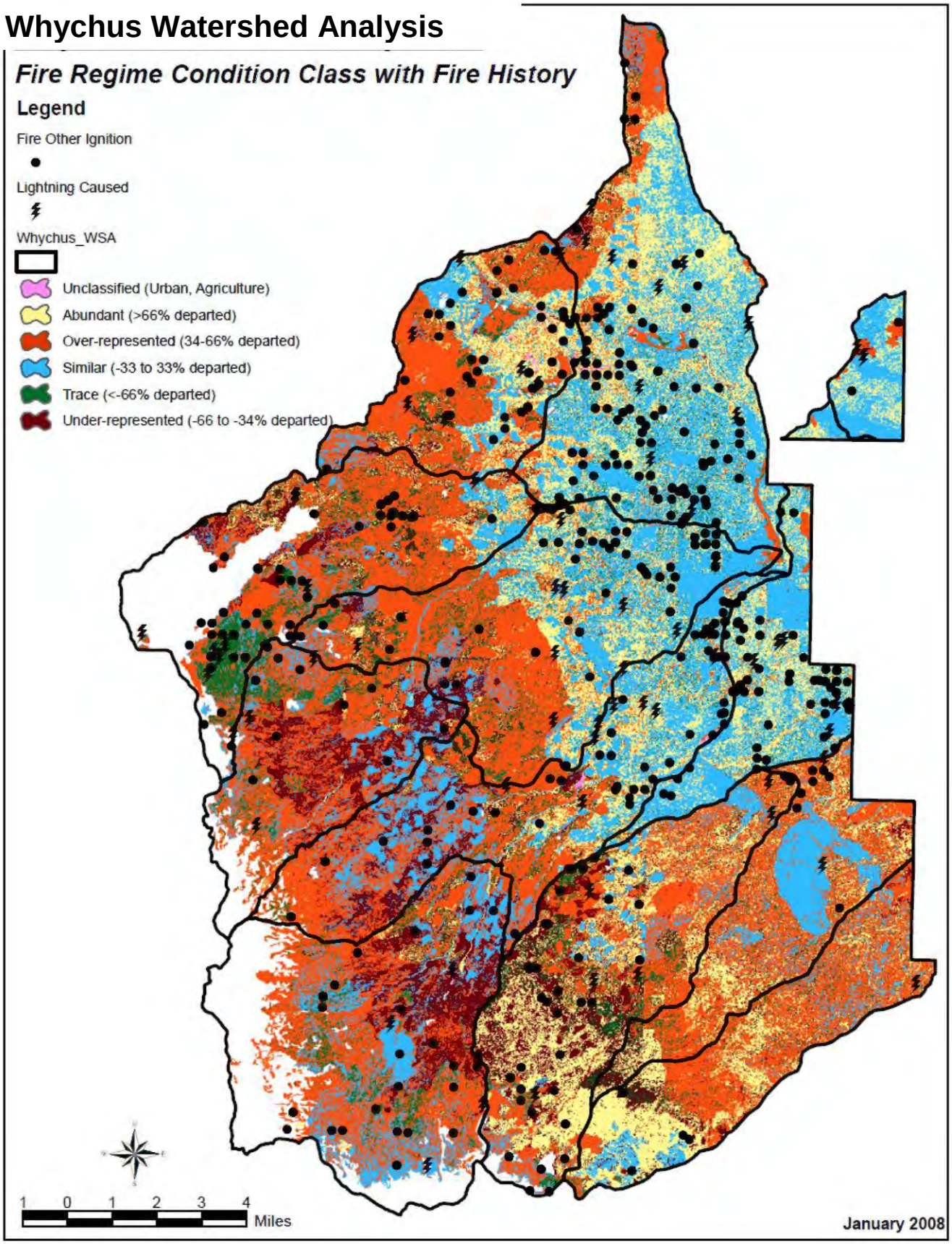
- **Prescribed Fire escape and concerns about smoke**- The escape of a prescribed fire in the Metolius basin in 1998 (Wizard Fire) caused some loss of confidence in prescribed fire and resulted in changes to required procedures. Concerns about smoke from prescribed fire continue. Both aspects may have ramifications on future prescribed fire use.

- **Fire regimes in the Whychus Watershed vary with elevation and moisture.**
  Five different Fire Regimes are present.
  - **Fire Regime *(FR)*** = A general classification of the role fire would play across a natural landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993, Brown 1995).
  - **Condition Class** (***CC***)- Is the degree of departure from the natural (historic) range of variability within a fire regime.
- **Rain Gradient**- A steep rain gradient influences Whychus Watershed vegetation and fire regimes.
  - This rain gradient creates a diversity of forest types, fire regimes, and influences fire behavior

Whychus Watershed Analysis



Whychus Watershed Analysis



- **The exclusion of fire has altered most of the mid-low elevation Whychus Watershed Forests from their historic structure, composition, and diversity.** Fire regimes in ponderosa pine and mixed conifer forests have been significantly altered from their historic fire return interval, and the risk of losing key ecosystem components is high.

    - **High elevation forests are for the most part, within their historical ranges for fire return and fire regimes.** The risk of losing key ecosystem components is low but large numbers of dead trees and the connectivity to lower elevation forests may cause high elevation fires to spread to lower elevation forests as occurred in the B&B Fire in the Metolius Basin in 2003.

    - **Ponderosa Pine Forests/ Juniper Forests -** Most fire starts are found within the ponderosa pine forests. Cheatgrass has invaded ponderosa pine and juniper forests making them vulnerable wildfires.

    - **Mixed Conifer Forests**- 37% of the acreage burned in the last 100 years was in Dry or Wet Mixed Conifer Plant Association Group (PAG).

    - **Lodgepole Pine Forests-** Are at the edge of the range of fire return interval of 100-150 years, patch sizes can be small (10-100 acres) or large scale, large beetle infestation and high mortality.

    - **New trend- High Elevation Forests-** Approximately 30% of the fires in this forest type are started by lightning, the rest are human caused.

Fish

Summary of Fisheries Findings

- **Fish reintroduction** - Steelhead trout (2007) and spring chinook (2009) have been reintroduced to Whychus Creek *(Recommendation of 1998 WA).*

Steelhead are being reintroduced into Whychus Creek

- **New consultation and analysis requirements -** The reintroduction adds new regulatory requirements including required consultation on steelhead with US Fish and Wildlife Service and the need to address essential fish habitat for chinook in Biological Evaluations.

- **New Fish Screen Plan**. A plan is being developed by the Upper Deschutes Watershed Council to prioritize and address screen installation on small diversions on Whychus Creek. Also see discussion on Three Sisters Irrigation Dam Project above. *(Recommendation of 1998 WA).*

- **Fish barriers -** The Sokol Diversion remains a fish barrier and needs to be addressed. It does not have a State permit. The Leithauser Diversion needs screens and needs to be addressed.

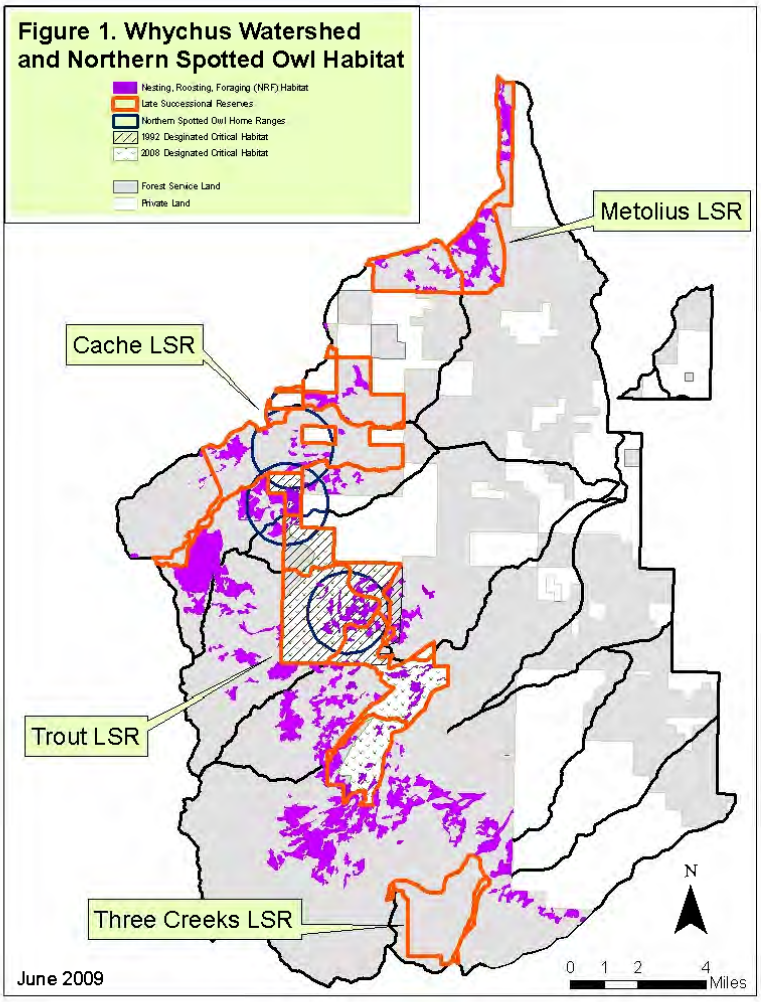
- **Non-Native fish**- Brook Trout are still entering into the Whychus system from breeding lake populations.

Wildlife

Spotted owl in Old growth Pine

Summary of Wildlife Findings

- **Loss of Spotted Owl Activity Centers on the Sisters Ranger District** - Due to wildfires and vegetation management projects, the number of activity centers across the District has been reduced from 21 in 2001 to 9 in 2009.
    - Black Crater is one of three known spotted owl activity centers in the watershed and the only potentially active owl in the watershed.
    - The other two are Bluegrass Butte to the north of Black Crater and Trout Creek to the south. The Bluegrass Butte and Trout Creek activity centers are considered potentially viable but inactive.
    - All three home ranges contain less than 40% suitable NRF habitat (1,158 acres) within 1.2 miles of the activity center, the minimum amount of habitat considered necessary to



ensure viability of a pair. However, owls on the Forest have routinely nested and reproduced in home ranges with less than 40% suitable habitat.

- **Changes to mapped Spotted Owl habitat** - Habitat mapping of Nesting, Roosting Foraging habitat (NRF) was completed in 1992, then again in 1998. In 2004 a better data set was compiled via Arc GIS and aerial photo interpretation portraying a more accurate estimate of NRF across the Forest. However prior to implementing new vegetation management projects, NRF is ground-truthed within the boundary of each new project area. Generally, during field reconnaissance, it has been determined that the GIS mapping efforts over estimated the amount of NRF that exists within these project areas. Not all NRF has been ground-truthed across the forest or district. Not all NRF has been ground -truthed in the watershed.

- **New US Fish and Wildlife Service Recovery Plan for the Spotted Owl** - Emphasizes all plant association groups and their connectivity. The plan identified threats to the owl as previous and ongoing loss of suitable habitat from harvest and catastrophic unplanned fires and competition with barred owls.
    - Nesting, Roosting Foraging habitat (NRF) habitat has been lost to the Black Crater fire and insects and disease.
    - There has been a loss of connectivity in lodgepole forests and wildfire areas.
    - Suitable spotted owl associated with mixed conifer stands in LSR will continue to be impacted by insects and disease, loss of large trees, and is at risk of large-scale loss from unplanned fires.

- **De-listings** -The Bald Eagle and Peregrine Falcon have been delisted because populations are stable.

- **Black -backed Woodpecker habitat has increased**. There is more black-backed woodpecker foraging habitat associated with high elevation dead trees.

- **Other species benefiting from dead lodgepole**-
    - American marten-Down logs provide habitat for rodent population, and provides a network of subnivean foraging habitat for American Marten.
    - Down logs adjacent to water bodies within the Three Creeks Lake Basin also provide amphibian habitat, moist cool microsites used in dispersal.

- **Cattle Allotment Closed** - The Whychus Creek Allotment (approximately 45,000 acres) has been closed. Although the allotment was last used in 1983, the remaining 26 miles of unmaintained fencing and several cattle guards present a safety hazard for mule deer and elk moving through the area. Officially closing the allotment will allow opportunities to remove these wildlife hazards and improve ungulate habitat *(Recommendation of 1998 WA).*

- **Fence at closed Glaze Cattle Allotment is being removed.** Partner groups from the Sierra Club and Black Butte Ranch have been removing broken down barbed wire fences that present a safety hazard for mule deer and elk *(Recommendation of 1998 WA).*

- **A Deer and Elk Management Plan for winter and transitional ranges** was developed in 1998 *(Recommendation of 1998 WA).*

Botany- Rare Plants and Invasive Plants

Summary of Botany Findings

Rare Plants

- **Peck's penstemon has been affected by lack of fire**- Fire exclusion and successional changes continue to threaten the plant.
    - One small population the watershed has been extirpated by successional changes.
    - Other populations have declined in size where disturbance has occurred.

- **Updated Conservation Strategy for Peck's penstemon** – The Strategy has been revised and contains new monitoring and management information.
- **Expansion of the plants range**- A new large population (9000 plants) of Peck's penstemon was found in 2007 on the southern edge of the plants range. The population is unusual in that it occurs under a dense lodgepole and spruce canopy and appears more mat-like than usual.

Invasive Plants

- **Noxious weeds are now called "invasive plants" and they are expanding, especially on private lands** – Invasive populations of knapweeds and other non-native plants are exploding in some areas near new developments and have worsened on most private parcels since 1998. Worst problem areas include:
    - The section of Whychus Creek between the irrigation dam and the city of Sisters.
    - The Sisters Airport (Private land).
    - The Reed Ranch (Private land).
    - The Sisters Industrial Park (Private land).
    - McKinney Butte Road (Private land).

Diffuse Knapweed Infestation at Sisters Airport

- **New Partnership**- A New partnership with the City of Sisters and Deschutes County has begun to raise awareness and address some invasive weed areas inside City limits.

- **Wildfire Support can bring in invasive plant seed -** Invasive plants in fire camps (at area schools and rodeo grounds), airports, and in the parking areas of private contractors continue to be an issue as they can spread seed on vehicle tires and shoe treads into wildfire areas and throughout the forest. Some work has been done by Deschutes County, the Rodeo Grounds and the Sisters Schools to improve conditions but continued work is needed.
- **Lack of policies and procedures for Invasive Plants in Deschutes County**- There is no enforcement actions procedures for infested private lands because Deschutes County has no official enforcement policies.
- **Increased Awareness of Invasive Plants**- Public interest has increased and educational events and weed pulls are more common *(Recommendation of 1998 WA).*
- **Weed Free hay is now required on public land** *(Recommendation of 1998 WA).*
- **Horse manure at Three Creeks horse camp is now** removed by High Country Disposal rather than dumped in the forest, to reduce weed spread *(Recommendation of 1998 WA).*
- **Gravel pits have been surveyed for Invasive Plants** *(Recommendation of 1998 WA).*
-

Wildflowers in Trapper meadow

Social Domain

Cultural Resources/Tribal Concerns

Summary of Findings

- **Name Changes** - Name changes were implemented in 2006 that changed all Squaw place names in the watershed to comply with State Law and remove a word considered derogatory by many Native Americans *(Recommendation of 1998 WA).*

Whychus Watershed Place Name Changes
Approved by the National Geographic Names Board in 2006

Old Name	New Name	Word Origin/Meaning	Location
1) Squaw Creek	**Whychus Creek** ***Pronounced "Why- choose"***	*Historic*- Earliest recorded name from 1855 Pacific Railroad Reports. Derived from Sahaptin language. Meaning: "The place we cross the water"	Sisters Ranger District /Crooked River National Grasslands/BLM/Private *Deschutes & Jefferson County*
2) North Fork of Squaw Creek	**North Fork of Whychus Creek**	***Historic*- see above**	**Sisters Ranger District *Deschutes County***
3 South Fork of Squaw Creek	**South Fork of Whychus Creek**	***Historic*- see above**	**Sisters Ranger District *Deschutes County***
4) Squaw Creek Rim	**Whychus Creek Rim**	***Historic*- see above**	**Private/Sisters Ranger District *Deschutes County***
5) Squaw Creek Falls	**Upper Chush Falls**	***Native American*- Sahaptin word for water**	**Sisters Ranger District *Deschutes County***

Administrative Name Changes (4 changes):

- Squaw Creek Irrigation District Dam, Canal, and Reservoir were changed to ***Three Sisters Irrigation District Dam, Three Sisters Canal, and Watson Reservoir.*** These changes were made at the request of the Irrigation District.
- Squaw Creek Trailhead *changed to* ***Chush Falls Trailhead***,

New Name (1 new name)

Chush Falls- The waterfalls commonly known as Squaw Creek Falls was actually unnamed. Because of high recreation use, safety, and administrative reasons this waterfall was given a name. Chush means "water" in the Saphaptin language. The feature named Squaw Creek Falls is located upstream and was renamed *Upper Chush Falls*.

- **Communication and information sharing between the Forest Service and the Tribes has improved in the last decade**. Continuing efforts to understand and address Tribal concerns is needed. Several projects have brought Tribal elders and resource specialists together with Forest Service specialists. Information sharing and cooperation is at unprecedented levels, but still need improvement. Information about resources of Tribal interest remains fragmentary and incidental. There are no systematic methods in place to locate, identify, and communicate to Warm Springs about such resources.
- **Cultural Resources are being damaged by unmanaged use**. Graffiti, rock climbing and associated chalk trails are affecting some sites.
- **The historic structure (shelter) at Lava Camp Lake campground** fell into disrepair and was removed.

Land Use

- **The population has increased in Sisters and Deschutes County**.
    - In 1990, 708 people lived in Sisters and in 2008 that increased to 1,910. In addition 6-10,000 people live in subdivisions near Sisters.
    - Population growth rates in Sisters have varied from a high of a 32% increase in 2003 to a 4.7% increase in 2008.
    - Deschutes County continues to grow at a faster rate than other Oregon counties, having the highest percent change from 2007-2008 of any county in Oregon; and having the third largest population change, behind only Washington and Multnomah counties. In 1990 the population was 74,958 and in 2008 it was estimated at 167,051.

- **Increased Development**- Development in town accelerated with the installation of a city sewer system. This has resulted in more Forest/Urban interface and associated issues.
    - New development or expanded subdivisions include:
        1. Coyote Springs
        2. Buck Run 2
        3. Timber Creek
        4. Industrial Park Apartments and Houses
        5. Additions to Squaw Creek Canyon Estates
        6. Aspen Lakes and golf course
        7. Village at Cold Springs
        8. New High School
        9. Pine Meadow Ranch
        10. Five Pines Campus
        11. McKenzie Meadows

- **Potential for future development has increased**- There are currently about 990 un-built platted lots in Sisters.

- **Change in ownership**– Large blocks of private timber lands have changed hands and residential development proposals have been discussed at the following parcels:
    - Skyline Forest
    - Trout Creek

- **Land Conservation**- the Deschutes Land Trust, Trust for Public Lands, Wolftree, and others have conserved several large private properties:
    - Camp Polk- significant springs and wet meadows, being restored
    - Alder Springs- Lower Whychus-With help of Trust for Public lands- now part of Crooked River Grassland/Ochoco National Forest
    - Rimrock Ranch- Conservation easement, private restoration
    - Wolftree property- restoration

- The Indian Ford Allotment Grazing Management Plan was updated in 2007*(Recommendation of 1998 WA)*. The Decision Memo authorized the continuation of the current grazing management with new mitigations for protection of aspen regeneration and Peck's penstemon.

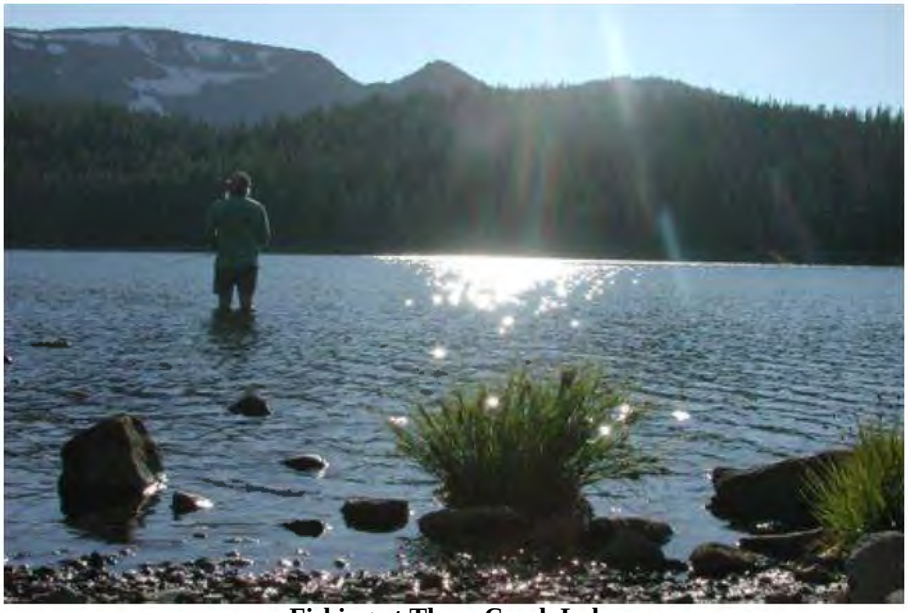
Scenery

Summary of Scenery Findings

High Mortality Lodgepole pine

- **Public attitude about vegetation management**- The public is more accepting of vegetation management, prescribed fire, and visual impacts after the 10 major wildfires on the Sisters District since 2002.
    - Smoke and blackened areas are still a concern for many.
    - Concern over the size of trees thinned continues but a few projects have gone through without appeals.
    - There has been a series of generally well accepted vegetation management projects- Highway 20, Black Butte Ranch Fuels reduction, Metolius Basin Forest Management project.
- Dead trees in the Three Creek area are affecting visual quality.

Recreation/Special Uses



Fishing at Three Creek Lake

Summary of Recreation Findings

- **Population growth has resulted in more use-** This includes: more hiking, off highway vehicles (OHV's), mountain bikes, horseback riding, birdwatching, etc.
    - Growth in the city of Sisters has increased interest in adjacent forest trails. Trail requests continue.
        - Peterson Ridge Mountain Bike Trail has expanded
        - There are more horse trails for equestrians
        - Sisters Trails Committee Trails have expanded
- **Harmful unmanaged use has increased** – This includes vandalism and misuse such as: dumping, shooting trees and wildlife, partying and leaving trash, graffiti, driving vehicles through and up the creek, and illegal road and trail building. Restoration closures have been breached and educational sign removed, defaced or destroyed.
- **Increased OHV use** – especially near subdivisions at urban interface.
- **More user conflicts-** Conflicts between user groups have increased.
- **More road and trail pioneering-** Aggressive "outlaw" road and trail pioneering is a problem.

- **Facility improvements**- Some recreational facility improvements have been completed
    - Park Meadow Trailhead was moved *(Recommendation of 1998 WA).*
    - Accessible toilets were installed at Three Creeks Lake, Three Creeks Meadow, and Whispering Pines Campgrounds
    - Pole Creek Trailhead received a new toilet and perimeter fencing that has helped to direct use patterns and reduce impacts to vegetation at this site

- **Facilities at Black Pines Springs were removed** and it was converted to a dispersed site *(Recommendation of 1998 WA).* More work remains to control OHV's and protect the springs.

- **"Creek Boating" is occurring on Whychus Creek**- This form of extreme kayaking occurs during high water flows, there are few opportunities most years and high flows and instream wood makes this a dangerous sport.

- **The Recreation Enhancement Act fee program (formerly fee demo)** is not providing relief in the way of trails maintenance as funds are have not been used to maintain trails since the early 2000's. As such, much of the trails maintenance is done with support from various volunteer groups and individuals.
- **Increased Commercial Use in the wilderness**- A High amount of commercial use is occurring in the three Sisters wilderness in summer months. Better management is needed.

- **Whychus Wild and Scenic River planning** is in final stages.

- **Increased need and demand for firewood** as energy costs have climbed.

- **Cone collection and mushrooms** have increased.

- **Wood market** is down.

Roads

Summary of Roads Findings

- **Current road densities still exceed recommended densities**.
    - Some road closures have been accomplished.
        - Approximately 11.3 miles of decommissioned or closed in then Black Crater/Trout Creek areas in 2002.
        - Whychus Riparian protection project closed 1.1 miles of system roads and the closure of an unknown amount of user created roads in the Whychus Creek area and controlled use at 59 riparian sites with boulders.
        - Black Crater Fire Area Closure Order. Closed numerous roads within Black Crater Fire perimeter. Note – this order may be rescinded when Travel Management Plan in implemented.
- Only 7-10% of roads receive any type of annual maintenance. Some localized erosion problems exist.
- Logging use on roads continues to decline. The majority of current road use is for recreation.

- There are no current traffic counts on forest roads.
- New user created roads are a problem.
    - More road pioneering in firewood cutting areas.

- **A Travel Management Plan** will be implemented in 2010 and will present big changes to allowed vehicle uses on forest.

- **OHV use is increasing**, there are more trails and damage to resources.
- **Glaze Meadow Special Closure Order** – Oct 4, 2000. This order closed the Glaze Old Growth area to vehicle use.
- **Bridge installed**- A new temporary Acrow bridge was installed over Indian Ford Creek for the Glaze Forest Restoration Project.
- **Bridge removed** -The Snowmobile Bridge over Whychus Creek deteriorated and was removed.
- **Drainage improvements**- Were accomplished with the Black Crater Fire BAER work – including installation of Bottomless Arch Culvert at Trout Creek on Road 1510400, Rock Ford Crossing of Trout Creek at 1008 Road, and Upsized CMP at Trout Creek Tributary on Rd 1018.
- **Use on Highway 20** has stabilized over the past 10 years and traffic counts are slightly down.

Utilities

Summary of Utilities Findings

- **Infrastructure improvements for the City of Sisters**-include new wells and reservoir tanks
    - The Cities water right for the Pole Creek diversion is not being used and water is currently entering the swamp.
- **Patterson Ditch Improvements**- There have water saving improvements to the Patterson Ranch water diversion off Pole Creek. The place where water is diverted was moved so that water in excess to the water right returns to Pole Creek. Previously the Diversion took the entire flow of Pole Creek. Water use is now to be regulated by season and water right. The new diversion point is west of Pole Creek Swamp and the ditch runs through 6 miles of National Forest.
- **Ditch vandalism**-There has been occasional vandalism at Pole Creek Ditch, plugging up and diverting water.
- **Increased capacity**- Central Oregon Electric lines along Road 16/Rd 4606 was upgraded to increase capacity.

WHYCHUS WATERSHED ANALYSIS UPDATE TRENDS

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Reduced stream flows during summer months **Trend 1** **UPDATE- Improved flows, however more stream flow restoration is still needed**	Dewatering through stream diversion for irrigation use	Complete dewatering of some streams during summer months Lack of connectivity to down stream flows and increased water temperatures Loss of riparian vegetation along streams due to drying out during summer months Increased bank erosion due to lack of riparian vegetation Groundwater Recharge	Fish and Wildlife habitat and populations Riparian vegetation Streambank stability Water temperatures – Match to 303(d) Treaty rights for fishing
Reduction in riparian vegetation along streams Decrease in riparian habitat effectiveness **Trend 2** **UPDATE- Improved flows have improved conditions somewhat, however more stream flow restoration is still needed**	Grazing on private and public lands Willow removal on private lands Dewatering caused by irrigation diversions Unscreened diversions Fire exclusion Loss of beaver User trails and campgrounds in riparian reserves	Increased bank erosion due to lack of riparian vegetation Reduced sediment filtration provided by riparian vegetation Reduced shading of water resulting in increased water temperatures Function of special habitats Nutrient input into streams supporting invertebrates	Fish and instream habitat Riparian species habitat/ populations Water quality Cultural plants protected by treaty rights

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Decrease in cottonwood galleries and aspen and localized increase in structure and shrubs in some riparian areas **Trend 3** **UPDATE- Same**	Channelization and drainage Loss of beaver Fire exclusion Dewatering Timber harvest	Habitat function Water storage and release Growth and recruitment of cottonwoods and other species Natural succession	Neotropical migrant bird habitats and populations Aquatic species habitat Survey and manage species (lichens, wildlife, mollusks, and bryophytes)
Hardening and channelization in lower reaches of Whychus Creek **Trend 4** **UPDATE- Floodplain restoration projects are improving conditions but more is needed.**	Flood control measures	Loss of sinuosity resulting in increased energy and increased bank erosion and down cutting of stream Channel formation	Fish and instream habitat Floodplain habitat Peck's penstemon habitat
Blocking of overflow channels in lower reaches of Whychus Creek **Trend 5** **UPDATE- Floodplain restoration projects are improving conditions but more is needed.**	Flood control measures	Concentration of high flows in main channel resulting in accelerated bank erosion Loss of energy dissipation provided by overflow channels Loss of periodic scouring of floodplains Cottonwood growth and regeneration	Fish and instream habitat Floodplain habitat Peck's penstemon habitat Cottonwood galleries
Decrease in size and quality of wetlands and wet meadows **Trend 6** **UPDATE- Meadow restorations are improving conditions but more is needed.**	Ditching Water diversion Fire exclusion	Hydrology Reproductive success Species composition	Species associated with special habitats Late summer flows Aquatic connectivity

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Removal of large wood in and adjacent to streams and wetlands **Trend 7** **UPDATE- Same, but Trend has reduced in frequency due to changed silvicultural practices in riparian reserves on public land**	Timber harvest Channel clearing to protect irrigated dams Public water supply and demand	Pool development Flooding pattern Habitat development for survey and manage species, wildlife species, and aquatic species	Fish habitats and populations Survey and manage plant and wildlife habitat and populations Riparian soils and function
Increase in detrimental soil impacts, mainly detrimental soil compaction – trend has peaked **Trend 8** **UPDATE- Same, but Trend has reduced in frequency due to changed silvicultural practices and equipment.**	Timber harvest Roading	Reduced soil productivity Reduced seedling survival Increased root disease associated with compaction Reduced water infiltration rates in compacted areas increasing run-off	Site productivity and tree growth Water quality Fish and wildlife habitat Heritage resources Scenic quality
Increased run-off due to roads Decreased road maintenance **Trend 9- Same**	Concentration of channelized water Increase in compaction on roads and landscape – changes infiltration rates Decreasing budgets and commercial activities which performed maintenance	Increased peak flows Sediment delivery Disruption of hydrologic process	Water quality Fish and wildlife habitat Riparian species habitat and populations Recreation traffic flow

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Increased fuel loadings and increased risk of high intensity fires in PP, MCW, and MCD PAGs. Shift from a complex moderate fire severity regime in all PP, MCW, and MCD PAGs. Fire sizes and intensities have been increasing in the PP and Juniper PAGs. **Trend 10** **UPDATE- Same, with increase in risk in high mortality areas in high elevation forests and lodgepole/mixed conifer**	Fire exclusion Increased population growth Denser forests Increase in cheatgrass Insects and disease	Fire behavior/intensity Natural succession Age class distribution Insect and disease susceptibility	Late successional habitat and species Bald eagle habitat Dispersal habitat Forest/urban interface homes Big game forage, esp. winter range Firefighter/public safety Urban interface areas
Increase in human started fires, especially in the PP PAG near forest urban interface **Trend 11** **UPDATE- Human caused fire starts have increased throughout the watershed**	Increased population growth and use Urban interface development Fire exclusion	Fire behavior/intensity Natural succession Age class distribution Insect and disease susceptibility	Late successional habitat and species Bald eagle habitat Dispersal habitat Big game forage, esp. winter range Forest/urban interface homes Private forest lands Firefighter/public safety Urban interface areas

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Increased management to reduce fuels (mowing, thinning, burning, etc.) to lower wildfire risks and benefit fire evolved ecosystems **Trend 12** **UPDATE-Same**	Increased risk of extreme fire behavior Forest /urban interface homes Desire to reintroduce fire	Fire behavior/intensity Natural succession Age class distribution Insect and disease susceptibility	Late successional habitat and species Dispersal habitat Big game forage, esp. winter range Firefighter/public safety Urban interface areas
Increased need for additional fire camp sites **Trend 13** **UPDATE-Same**	Wildfire risk Urban interface Safety and costs	Efficiency Less transportation time for crews and equipment Fire behavior/intensity	Firefighter/public safety Late successional habitat and species Dispersal habitat Big game forage, esp. winter range Urban interface areas
Increase in management may cause blowdown in some lodgepole stands **Trend 14** **UPDATE-Same**	Timber harvest Unit design and layout Wind	Fire behavior Natural succession Insect and disease susceptibility Natural decay and recruitment	Focal species for the lodgepole PAG Soils

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Decrease in med/large tree structure in MCW, MCD, PP, and Riparian PAGs **Trend 15 UPDATE-Loss of old growth in lodgepole and high elevation forests due to mountain pine beetle**	Timber harvest Fire exclusion Insects and disease Roads Hazard tree reduction Land ownership patterns	Natural succession Reproductive success Fire behavior Predation Gene flow Microclimate Connectivity Nutrient cycling	Eagle/osprey nest sites NRF habitat for spotted owls, late successional species Woodpecker habitat Furbearer habitat Stream shading Loss of large wood imput into streams and forests
Landscape Patterns have changed in PP, MCD, MCW, and Riparian PAGs. Fragmentation and edge have increased and patch size and connectivity have decreased. **Trend 16 UPDATE-Loss of mixed conifer District wide has reduced connectivity**	Timber Harvest Fire exclusion Roads Increased Population Growth Land Ownership Patterns Conversion of agriculture lands to developments	Natural Succession Reproductive Success Fire Behavior Predation Gene Flow Microclimate Loss of Stand Stability Age Class Distribution Competition Migration	Late successional and interior forest species and habitats Dispersal ability of late successional species (spotted owls) Neotropical migrant bird species Low mobility species Deer and elk security Visual quality
Species composition has changed in MCD and MCW from pioneer species dominated stands to climax species dominated stands to white fir dominated stands. Stand densities have increased and vertical structure is more complex in PP, MCW, MCD PAGs Juniper has increased in the PP PAG. Increase in shrub component and decrease in grass and forb component **Trend 17 UPDATE-Same**	Fire exclusion Timber Harvest Historic livestock grazing on grasses and forbs	Natural Succession Reproductive Success Fire Behavior Predation Grassland development Microclimate Loss of stand stability Age class distribution Insect and disease disturbance and susceptibility Disturbance processes	Late successional species and habitats Future nesting, roosting, and foraging habitat for spotted owls DF and PP associated species, especially woodpeckers and goshawks Forest structure Riparian reserves Juniper/grassland habitat and associated species Firefighter/public safety

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Increase in old growth in Lodgepole and High Elevation PAGs. Decreased stand age diversity. **Trend 18** **UPDATE-<u>Trend has reversed</u> due to high mortality. Now a decrease in old growth and beginning of an increase in stand age diversity.**	Fire exclusion Insect outbreak	Fire behavior Natural succession Loss of stand stability Insect and disease susceptibility Prey base cycling	Focal species for each PAG (i.e., black-backed woodpecker) Tree encroachment on high elevation meadows
Decrease in connectivity between riparian reserves and uplands **Trend 19** **UPDATE- Same**	Timber harvest Roads Irrigation diversions	Natural succession Reproductive success Fire behavior Predation Gene flow Microclimate	Spotted owl dispersal habitat Survey and manage species habitat Aquatic species habitat
Decrease in large snags and down woody material **Trend 20** **UPDATE-Same**	Timber harvest Firewood cutting Hazard tree reduction	Natural Succession Reproductive Success Fire Behavior Predation Microclimate Natural decay and recruitment Nutrient cycling	Snag and log dependent species and nesting/denning habitat for woodpeckers, marten, fisher, etc. Aquatic species habitat Stream shading Loss of large wood input to streams and forests
Decrease in Late successional species and increase in early and mid seral species **Trend 21** **UPDATE-Same**	Timber harvest Fire exclusion Urban interface	Reproductive success Predation	Proposed, endangered, threatened, sensitive, and survey and manage species

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Degradation/encroachment of meadows and special habitats **Trend 22** **UPDATE-Same**	Irrigation diversions Channelization Ditching Fire exclusion Timber harvest	Reproductive success Predation Genetic fitness Fire behavior Microclimate Stream flow Water quality	Great gray owl nest sites Townsends big eared bats – cave vandalism Aquatic species - habitat loss
Decrease or extirpation of native fish species **Trend 23** **UPDATE-Improved trend with reintroduction of anadromous fish**	Dams Irrigation Diversions Dewatering Ditching Channelization Fish stocking – genetic concerns	Gene flow Food chains Aquatic connectivity Migration	Eagle and osprey foraging Aquatic species habitats and populations – unnatural predators Biodiversity Treaty rights Fishing Water quality
Increase in exotic and non-native wildlife and fish species **Trend 24** **UPDATE-Same**	Timber harvest Fire suppression Urban interface	Reproductive success Genetic fitness Predation	Neotropical migrant bird species, spotted owl, woodpeckers, fish and aquatic species populations and interactions
Increase in non-native plants **Trend 25** **UPDATE-Trend has increased, especially on private lands**	Weed spread along roads Ground disturbance Contaminated equipment Horses/contaminated feed Lack of weed control on private lands Little enforcement outside the City of Sisters	Biodiversity Natural succession	Native plant and wildlife species and habitat

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Increased contact with Tribes **Trend 26** **UPDATE-Same**	Joint projects	Management sensitivity to Federal Trust obligations	Cultural resources Treaty rights
Increasing resident population Increased tourism **Trend 27** **UPDATE-Same**	Rapid growth in Deschutes County Central Oregon popularity Increased urban interface	Fire ignitions Fire suppression techniques Forest ecology (reduction in habitat) Compaction, Degradation	Sensitive habitats in popular destinations Urban interface areas Recreational experience Heritage resources Firefighter/public safety
Changes in land use and ownership especially the conversion of farm and forest lands into developed lands Homes being built on floodplains Shift towards light industry, tourism, and residential uses **Trend 28** **UPDATE-Same**	Increased population Agriculture Limited private lands in Sisters area available for public facilities such as school and sewer plants Limited water	Habitat connectivity Migration Flood processes/flooding homes Water quality/water distribution Fire behavior Natural succession	Experience to urban Loss of sense of place Flood damage to homes Riparian reserves Restoration options Urban interface areas Habitat quantity/quality Terrestrial wildlife and plant species and habitats Fire suppression – loss of resources
Increase in public lands due to land exchanges (1998-2009) **Trend 29** **UPDATE-Trend has changed from an increase in public lands to a decrease in public lands through exchanges**	Timber harvest Economics City growth and need for developable lands Tradeoff for other valuable parcels	Management options Habitat connectivity	Management costs Forest habitats Public use and enjoyment

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Continued proposals for land exchanges Decline in potential for future acquisition of private lands Current land ownership pattern limits development **Trend 30** **UPDATE-Same**	Developments Land ownership patterns Increasing growth	Management options Habitat connectivity	Management costs Forest habitats Peck's penstemon habitat
Decrease in grazing Lack of funding to monitor grazing **Trend 31** **UPDATE- Same**	Economics Environmental concerns Decline in large ranches Increase in small speciality operations raising exotics – llamas, etc.	Erosion Compaction Hydrologic process Habitat quality (introduction of noxious weeds Natural succession Migration (fences)	Aquatic species and habitats Special habitat and associated species Grass dependent species
Increase in man-made ponds and irrigation canals **Trend 32** **UPDATE-Trend has stabilized with ditch piping, however, more small residential ponds**	Irrigation diversions to support agriculture and ranches and also associated with housing and development Landscaping trend	Reproductive success Predation Genetic fitness Stream flows Water quality Migration Risk of stream dewatering Pond and chemical spills	Eagle and osprey foraging Aquatic species and habitats
Increased forest/urban interface Illegal dumping, OHV use, trespass **Trend 33** **UPDATE-Trend has intensified with more urban interface and more people**	Private lands surrounded by National Forest Increased population growth in Deschutes County	Fire behavior Natural succession Habitat connectivity Conflicts with traditional uses (hunting and target practice) Migration Reproductive success Predation Microclimate	Heritage resources Forest structure Interior forest species Large tree dependent species Aquatic species Big game forage and cover Quality of life Firefighter/public safety

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Continued need for forest commodities, mineral sources, and special forest products (e.g., gravel, mushrooms, firewood, geothermal energy, etc.) **Trend 34** **UPDATE- Same**	Population growth Management philosophy	Food chain Natural decay and recruitment Nutrient cycling Changing public desires and values	Proposed, endangered, threatened, and sensitive species Public demand for non-renewable resources Survey and manage species Unique habitats Loss of large wood input to streams and forests
Increase in utility easements on public lands – trend has leveled **Trend 35** **UPDATE-Same**	Population growth Urban interface – land ownership patterns Increased noxious weed spread Maintenance Technology	Erosion Fire behavior Natural succession Reproductive success Microclimate Migration	Scenic quality Wildlife/plant species and habitats Firefighter/public safety Heritage resources
Increase in road densities – trend has peaked Some unmaintained are closing themselves but need hydrological fix **Trend 36** **UPDATE-Same**	Timber harvest Recreational activity Lack of funding for road inventory	Successional patterns Reproductive success of some species Predation Microclimate Hydrologic process Sediment routing	Fish, wildlife and plant habitats Hunting success Heritage resources Recreational experience Special habitats Riparian reserves Disturbance to wildlife species from human presence

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Road use has changed from logging to recreation **Trend 37** **UPDATE-Same**	Reduced logging Increased resident and tourist population Popularity of driving for pleasure	Management options Difficult and controversial to close roads Recreational funding does not support maintenance	Wildlife, fish, and plant habitats Spread of noxious weeds Safety
Traffic volume on Highway 20 and Highway 242 has increased **Trend 38** **UPDATE-Same**	Increased resident and tourist population	Migration corridors Spread of noxious weeds	Deer Air quality Recreational experience Safety Sanitation rest stops
Increased recreation use including more people, horses, mountain bikes, OHV's, etc. Increased day use Increased dispersed use Increased facilities use More motor homes, fewer tents **Trend 39** **UPDATE- Same**	Population growth Improved access More and improved facilities/opportunities	Infiltration Erosion Compaction Noxious weed sites Vegetation growth and reproduction Riparian zone function Reproductive success	Heritage resources Facility quality Localized impacts to special habitats (Three Creeks area, subalpine areas, etc.) Disturbance to wildlife and plant species and habitats Riparian habitats Recreational experience
Increase in non-recreational forest camping/living **Trend 40** **UPDATE-Same**	Economy – lack of affordable housing Population growth Increased access Riparian habitats created by canals	Floodplain functioning Erosion Compaction Reproductive success Vegetation growth and reproduction	Riparian species and habitats Recreational experience Heritage resources Water quality Disturbance to wildilfe and plant species and habitats

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Changes in wilderness use Overnight use has declined Day use has increased **Trend 41** **UPDATE-**	Increasing resident and tourist population	Localized damage to streams and lakes	Trailheads are inadequate Sensitive alpine habitats
Increase in wilderness trespass (i.e., snowmobile use, illegal digging of alpine plants, etc.) **Trend 42** **UPDATE-**	Lack of Forest Service presence Lack of recreational funding Inadequate signing of wilderness boundary Increased public use Increased populations Changes in recreational use	Reproductive success Migration/travel routes Succession Erosion Predation Genetic fitness	Wolverine, fisher, marten, lynx and other high elevation species Sensitive alpine habitats Recreational experience
Scenery has grown in importance Changes in USFS scenery management philosophy to manage for ecological aesthetic **Trend 43** **UPDATE-Same**	Popularity of Sisters and Central Oregon Driving for pleasure People's expectations	Natural processes are not always understood or accepted by public	Management options Forest ecology
Degradation of scenic quality **Trend 44** **UPDATE-Same**	Timber harvest Fire exclusion Prescribed fire Localized high mortality areas Lack of big trees	Succession Fire behavior Biodiversity Insect and disease susceptibility Connectivity	Desired landscape character Forest ecology

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK
Loss of important heritage resource information through vandalism, removal of artifacts, development on private lands, and decomposition of wood and metal **Trend 45** **UPDATE-Same**	Increased recreational use Increase in population growth		Heritage resources Culturally sensitive plants
Recreation budgets have decreased Facilities need improvements **Trend 46** **UPDATE-Same**	General budget decline in Forest Service Increased age of facilities Increased use of facilities	Recreational experience	Localized site damage Quality of experience Safety
Increased volcanic activity on South Sister- has slowed **Trend 47- NEW**	Geological processes	Earthquakes Lake stability	Public safety Watershed resources (soil, water, habitat)
Increased number and intensity of winter floods **Trend 48- NEW**	More rain on snow events Global warming?	Streambank stability Sediment transfer Streamside housing developments	Streambank integrity Housing constructed in floodplains

Landscape Strategy Areas and Recommendations

In 1998 the Interdisciplinary Team divided the Whychus Watershed analysis area into five **Landscape Strategy Areas**. These areas were delineated after synthesis and integration of trends and assessment of ecosystem risks. Where Strategy Areas overlapped, several strategies could apply.

> **Priority** was determined by evaluating significance in terms of connectivity to other areas outside the analysis area, importance to humans and other species, legal requirements, and effects to rare or fragile components. Priorities in order of importance were Most Urgent, Urgent, High, Moderate, and Low. **Feasibility** was rated by extent of cooperation required, complexity, resource constraints, and cost. Feasibilities in order of difficulty were Most Difficult, Difficult, and Moderate.

In 2009 the Interdisciplinary Team reassessed trends and ecosystem risks and found most were similar. However, due to the loss of mixed conifer habitat District-wide from 10 project fires since 2002 and a growing area of forest mortality from insects and disease, the Cascade Forest Area moved up in priority. Good progress reduced the urgency rankings. The rankings are compared in the table below.

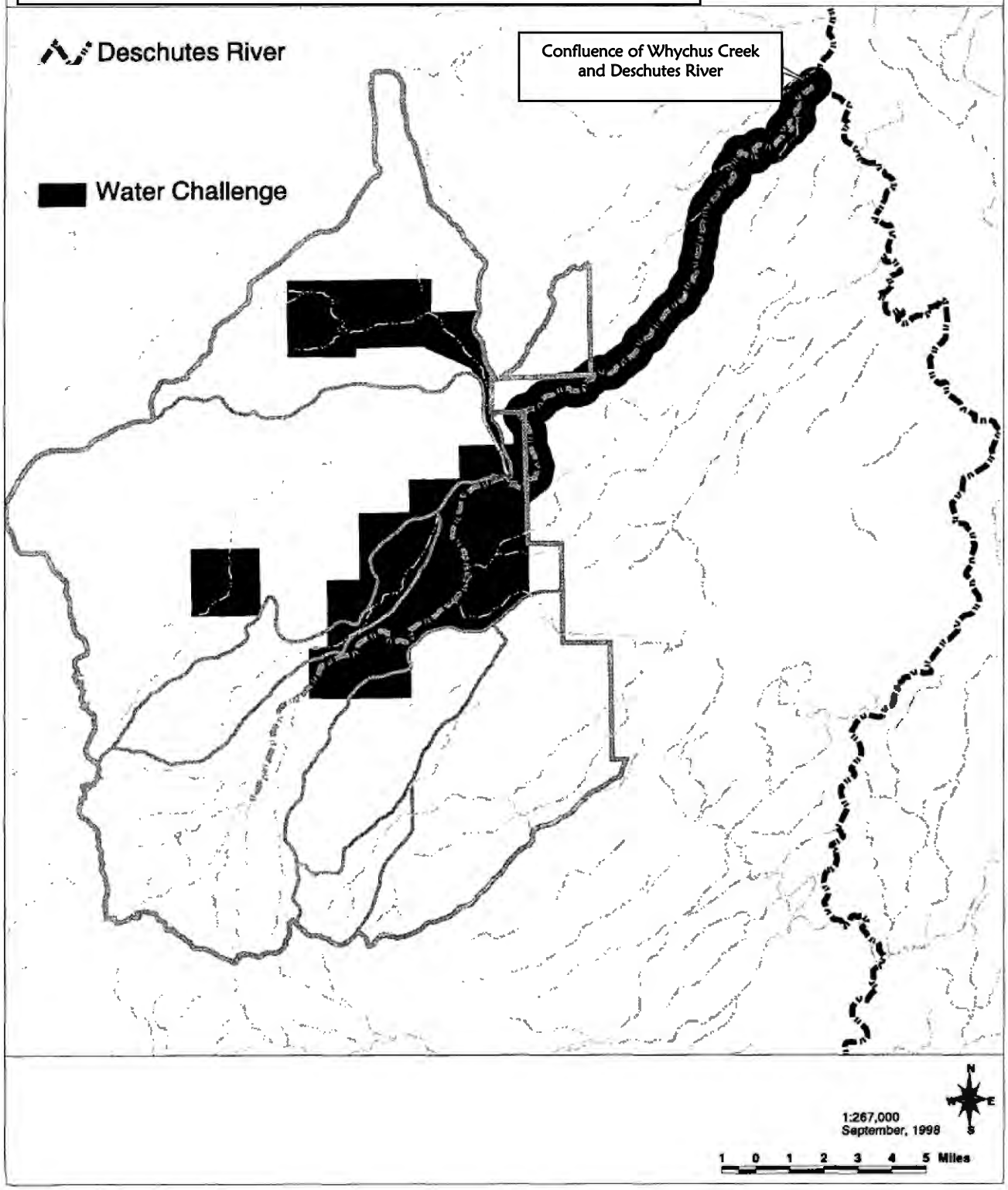
Recommendations to address trends follow. Recommendations common to all landscape areas and found after specific area recommendations.

Many problems will require community based solutions and likely partners are identified. The area was analyzed as one functioning landscape and some recommendations are included that could be implemented on private lands by interested landowners. Private land restoration projects are voluntary.

Landscape Strategy Areas	1998 Ranking	2009 Ranking	Reason for Change
Water Challenges	**Priority- Most Urgent** Feasibility- Most Difficult **#1**	**Priority- Urgent** Feasibility- Difficult **#1**	Excellent progress on water acquisition, restoration, and restoring fish passage. However, much work remains, including more water acquisition and continuing work on fish passage barriers.
Forest Urban Interface	**Priority- Urgent** Feasibility-Difficult **#2**	**Priority- Urgent** Feasibility-Difficult **#3**	Trends are the same but intensified by more development, more urban interface, more people, and more vandalism. Urban interface forest thinning has reduced fire risk in some areas.
Three Creek Lake	Priority- High Feasibility- Moderate **#3**	Priority- High Feasibility-Moderate **#4**	Trends are similar, however tree mortality has increased, affecting scenic quality.
Cascade Forest	Priority- Moderate Feasibility- Moderate **#4**	**Priority- Urgent** Feasibility-Moderate **#2**	10 large wildfires in Sisters since 2002 have caused loss of mixed conifer habitat District-wide, reduced connectivity, and increased the importance of remaining habitat. Endangered Species (Spotted owl) and other late successional species are affected. Area contains 2 Late Successional Reserves. Insect caused mortality has increased risk of a large scale fire and caused a loss of scenic quality.
Wilderness	Priority- Low Feasibility-Moderate **#5**	Priority- Low Feasibility-Moderate **#5**	Trends are similar, however increased damage from visitors in some areas requires attention.

Whychus Watershed Analysis Landscape Strategy Areas

Strategy Area 1- Water Challenges



AREA 1 - WATER CHALLENGES

PRIORITY # 1- *URGENT*
FEASIBILITY- *DIFFICULT*

SUMMARY

2009 Update - There has been significant improvements in water flows, restoring floodplains, and anadromous fish reintroduction through well organized and extensive collaborative work. However, much work remains, including more water acquisition and continuing work on fish passage barriers.

Lack of instream water flows has degraded aquatic systems. This has affected fish, threatens other aquatic and riparian dependent species, and restricts restoration efforts. Water quality is degraded and improvements are federally mandated. Water availability and large areas of riparian habitats are under private control. Improvements will require extensive cooperation. Weakened aquatic systems are inherently more unstable. Housing developments are threatened and restoration projects are complicated. Fixes will be costly.

GOALS:

1) Continue to restore stream flows to Whychus Creek, Indian Ford Creek, Pole Creek, and Trout Creek sufficient to provide connected aquatic habitats to the confluence with the Deschutes River.

2) Recover water quality of Whychus Creek and Indian Ford Creek sufficient to meet State water quality standards and support fish and other aquatic species.

3) Restore riparian habitats on private and public lands to enhance stream stability reduce water temperatures and provide habitat.

4) Continue to reduce conflicts between irrigation needs and aquatic systems and species.

5) Encourage development that is compatible with functioning aquatic systems and that does not limit future restoration options. Support restoration on private lands.

RECOMMENDATIONS:

1) Continue to work collaboratively with key partners and private landowners to restore stream flows, water quality, riparian and floodplain habitats, fish passage, and preserve restoration options.

***Specific Restoration Actions*:**

a. Restore flows on Whychus Creek and its tributaries

- Purchase or lease water rights
- Trade surface water rights for ground water
- Trade effluent for surface water rights
- Return Pole Creek waters to Whychus Creek
- Increase efficiency of irrigation delivery systems to conserve water and make it available for return to streams

- Do a Feasibility Study in cooperation with interested partners to evaluate where water conservation projects would have the greatest effect, i.e., where to trade surface for ground water rights, key surface water areas to improve water quality **(in progress)**

b. Restore water quality on Whychus Creek and its tributaries

- Complete Water Quality Management Plan for Whychus Creek and Indian Ford Creek as required by the Clean Water Act Section 303-D.
- Reduce sedimentation and disturbance (i.e., close ford at Rd 6360)
- Rehab roads, trails, and camps in riparian reserves

c. Restore streambank, wetland, and floodplain habitats

- Remove berms, restore historic channels of Whychus Creek
- Plant cottonwoods and willow on streambanks with permanent flow
- Evaluate opportunities to restore beaver
- Evaluate/restore Pole Creek Swamp
- Evaluate/restore Glaze Meadow, Indian Ford Meadow and Big Meadow
- Thin riparian reserves to develop large tree structure (i.e., Pole Creek area)
- Prevent removal of instream wood (i.e., Pole Creek), restore large wood and log jams in key areas
- Continue rehab and monitoring of roads, trails, and camps in riparian reserves (i.e., Pole creek, Whychus Creek)

d. Restore/disconnect abandoned irrigation ditches on Whychus Creek and its tributaries

- Investigate ownership of historic irrigation ditches and restore/disconnect them from Whychus Creek and other tributaries. Some of these ditches still run water during high flows into residential developments.

e. Restore fish habitat and populations

- Install fish screens on all irrigation diversions
- Provide fish passage at dams
- Protect fish genetics by reducing interaction between wild and domestic populations

f. Limit floodplain development

- Purchase or conserve floodplains
- Work with City and County planners to define safe and appropriate locations for development

g. Manage access and habitat quality for a wide range of species

- Cooperate with private landowners, Ochoco National Forest/ Crooked River Grasslands, BLM, PGE, and Confederated Tribes of Warm Springs to improve habitat effectiveness
- Use land trades, purchases, and conservation easements to "block up" lands as suggested by the Metolius Winter Range Management Plan

KEY PARTNERSHIPS AND PROJECTS:

Deschutes County Watershed Council (DCWC)- Continue to co-sponsor grants for projects that address watershed issues on private and public lands. Emphasis areas include:

- Assist DEQ in the development of a Water Quality Management Plan for Whychus Creek and Indian Ford Creek to comply with the Clean Water Act- Section 303D
- Update agricultural use statistics in the Deschutes Soil and Water Conservation District 1994 Watershed Assessment to better understand agricultural trends in the area and develop opportunities for water conservation
- Continue community education and restoration projects to protect and restore riparian habitats, instream wood adjacent to private housing, and floodplains
- Continue community education to reduce non-point and point source pollution related to agriculture and development
- Continue community education about watershed stewardship including volunteer and school involvement in watershed monitoring and restoration projects
- Continue work in cooperation with irrigators to conserve water and return it to instream use, screen ditches and provide fish passage at diversions
- Continue to facilitate and help fund water and land acquisition, leases, or conservation easements

Deschutes Resource Conservancy (DRC) Continue to facilitate discussions and co-sponsor grants to fund projects that address watershed issues on private and public lands. Emphasis areas include:

- Continue financing and facilitating water acquisition, water leases, and water conservation projects.
- Continue facilitating and financing acquisition of significant riparian and floodplain habitats

City of Sisters- Continue collaboration with the city on the following emphasis areas:

- Exploring opportunities for Sisters Sewer System to benefit and protect Whychus Creek
- Exploring options to return water rights to Pole Creek, re-water Pole Creek Swamp and restore Pole Creek as a tributary of Whychus Creek
- Options to restore large wood which has been removed from Pole Creek
- Education and prevention of non-point and point pollution and riparian habitat protection associated with housing in the Whychus Creek and Indian Ford Creek floodplain
- City planning to protect Whychus Creek floodplain from development
- Improvements to the Sisters City Park to restore habitats and channel stability
- Investigate risks of winter floods and Carver Lake to developments and infrastructure

Three Sisters Irrigation District (TSID)- Continue collaboration with TSID on the following emphasis areas:

- Restoring fish passage through irrigation dams on Whychus Creek
- Conserving Whychus Creek water flows and returning water to instream use
- Explore options for replacing surface water with ground water for irrigation
- Installing fish screens on all irrigation ditches
- Prevent loss of native fish into ditches and prevent fish in irrigation ponds from entering Whychus Creek to preserve genetic integrity

Oregon Department of Fish and Wildlife (ODFW)- Continue collaboration with the ODFW regarding the Whychus Creek fishery and other riparian and aquatic species through the following emphasis areas:

- Facilitate installation of fish screens on all irrigation ditches on Whychus Creek and Indian Ford Creek
- Facilitate restoring fish passage through irrigation dams on Whychus Creek.
- Community education on preventing fish kills related to illegal water diversions and pond chemical treatments
- Community education on importance of protecting genetic purity and health of wild fish by preventing pond fish from entering stream systems
- Resolution of who owns the fish in irrigation canals

Pelton /Round Butte License Holder (FERC) Continue collaboration with license holder regarding Whychus Creek wildlife habitat and fishery through the following emphasis areas :

- Provide and maintain fish passage at Round Butte/Pelton Dam
- Purchase of water rights
- Purchase of riparian or floodplain habitats
- Funding watershed restoration projects

Deschutes Soil and Water Conservation District and National Resource Conservation Service (NRCS)- Continue collaboration with the District and NRCS to implement priority actions identified in the Districts 1994 Watershed Assessment. Priority actions identified in the 1994 report include:

- Bio-engineering projects on Whychus Creek (First stage Sisters City Park streambank stabilization and cleanup, i.e., remove cement blocks from old bridge on Hwy 20, riparian plantings)
- Work to conserve water and improve practices on private lands affecting Whychus Creek, Three Creeks and Indian Ford Creek. Emphasis areas include:
    - Projects to conserve irrigation water and return it to instream use.
    - Improve agricultural practices to reduce point and non-point pollution.
    - Help work with landowners and irrigators to facilitate the development of the Water Quality Management Plan required by the Clean Water Act Section 303-D.

Oregon Water Trust-(OWT)- Continue collaboration with OWT to restore water flows. Emphasis areas include:

- Purchase or lease water rights
- Public education on conservation opportunities through water rights purchase or leases

Deschutes Land Trust (DLT)- Continue collaboration with DLT and private landowners to protect Whychus Creek, Indian Ford Creek, and Trout Creek subwatersheds. Emphasis areas include:

- Land purchases or Conservation Easements to protect significant riparian and floodplain habitats
- Restoration, monitoring, and information and technology transfer on restoration projects such as Camp Polk and Rim Rock Ranch
- Community education regarding protection of riparian , floodplain and other habitats for the future
- Work with Sisters School and Tollgate to enhance and protect Peck's penstemon on the Sisters School/Trout Creek Conservation Easement

Deschutes and Jefferson County – Continue to **c**ollaborate with the Counties on the following areas:

- Education and prevention of non-point and point pollution and riparian habitat protection associated with housing in the Whychus Creek, Indian Ford, and Trout Creek floodplain
- County planning to protect Whychus Creek floodplain from development

Private land owners- Continue collaboration with private landowners on the following emphasis areas:

- Restoring fish passage on private irrigation dams
- Conserving Whychus Creek water flows and returning water to instream use
- Community education on importance of protecting genetic purity and health of wild fish by preventing pond fish from entering stream systems
- Restoring riparian areas on private lands including cottonwood galleries

2) Address listing of Indian Ford Creek under the Clean Water Act Section 303 D List. Work proactively with Deschutes County Watershed Council, NRCS, Deschutes Soil and Water District, Black Butte Ranch and private landowners to increase awareness and improve water quality on Indian Ford Creek.

Specific Restoration Actions

- Continue implementation of updated Management Plan for Indian Ford Grazing Allotment
- Explore options to eliminate point source pollution of Indian Ford Creek by Black Butte Ranch sewage system. The major concerns are winter discharges of nutrient rich effluent and raw sewage spills
- Work with private landowners to restore large areas of riparian habitats along Indian Ford Creek, including Black Butte Ranch's Big Meadow, Indian Ford Meadows, and Glaze Meadow on Black Butte Ranch In these areas, virtually no riparian vegetation remains due to grazing and active removal. Management of as little as a 10 foot riparian zone would improve conditions
- Explore options with landowners for conservation of irrigation water and return to instream
- Explore options with landowners for purchase or lease of water rights and return to instream

3) Trout Creek

- Trout Creek Swamp –Continue monitoring of restoration project and address invasive reed canary grass
- Eliminate horse watering along Trout Creek associated with Whispering Pines horse camp. Design and build a gravity feed horse watering tank.
- Reduce dispersed camping in Riparian Reserves- rehabilitate dispersed roads, trails and camps within reserves
- Work with appropriate agencies regarding protection of Trout Creek floodplain and reducing conflicts with private homes in floodplain without channelization/routing

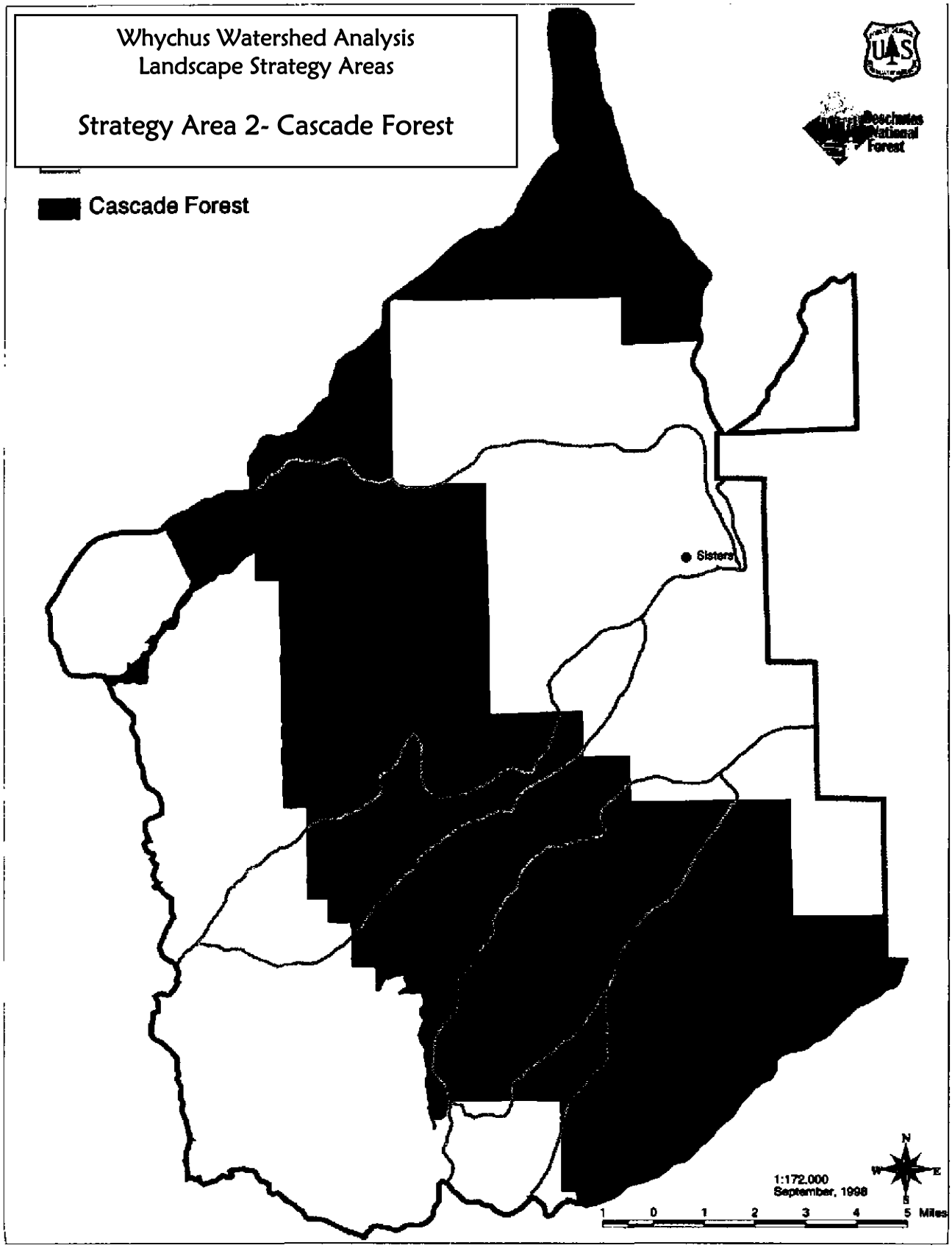
<u>Key Monitoring Actions</u>:

1) **Monitor Water quality on Whychus Creek**
2) **Monitor Water quality on Indian Ford Creek**

<u>Key Data Needs</u>:

1) **Feasibility Study for well sites, water purchase (as discussed above)**
2) **Update Agricultural use statistics in Deschutes Soil and Water Conservation District 1994 Whychus Creek Watershed Analysis to understand agricultural trends relevant to water use.**

3) Resolve ownership of old irrigation ditches (especially those which intercept high flows on Whychus Creek and run into Plainview)- Plainview and Snow Creek Irrigation Districts


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 2- Cascade Forest
Cascade Forest
Sisters
1:172,000
September, 1998
N
W
E
S
1 0 1 2 3 4 5 Miles

AREA 2 - CASCADE FOREST

PRIORITY # 2- *URGENT*
FEASIBILITY- *MODERATE*

SUMMARY

<u>2009 Update</u>- This area has risen in priority from 4th to 2nd. This is because to there have been ten large wildfires in Sisters since 2002 that have caused the loss of mixed conifer habitat, reduced connectivity, and increased the importance of remaining habitat, especially in the two Late Successional Reserves in this watershed. Endangered Species (Spotted owl) and other late successional species have been affected. Insect caused mortality has increased risk of a large scale fire and caused a loss of scenic quality.

Fire suppression, fire exclusion, and past logging have changed forest habitats, reducing connectivity, and removing important habitat components. Although most of this forest is green without widespread mortality, it is vulnerable to future large scale insect and disease outbreaks and higher intensity fires. Late-successional forest areas are fragmented and disconnected. There is a need to accelerate the growth of big trees, especially in late successional reserves and riparian reserves. Favorite scenic vistas and recreation areas are located in this area.

GOALS:

1) Restore forest habitats. Aim for a balance of vegetation within each Plant Association Group resulting in a healthy and resilient forest using the historic range of natural variability as a guideline. This includes consideration of size, structure, species composition, arrangement, distribution, and amount. *These are desired conditions, not static, and will change over time.*

2) Restore late-successional conditions in Late Successional Reserves, typical of eastern Oregon Cascade Province when succession of vegetation occurred under natural fire regimes. Provide late-successional habitat so that Late-Successional Reserves play an effective role in meeting the goals for which they were established.

3) Reduce potential for habitat loss due to stand replacement wildfires in areas where this type of fire behavior is outside the historic natural range of variability and when risks to public safety and large scale loss of property loss are unacceptable. Protect this habitat from loss due to large-scale fires, insects and disease epidemics, and major human impacts so that late-successional ecosystems and biodiversity are maintained.

4) Generate forest commodities as a result of implementing vegetation management opportunities to meet Goals 1, 2 and 3.

5) Use prescribed fire when possible, either in conjunction with other silvicultural treatments such as thinning, or alone, to achieve Goals 1,2 and 3. This benefits many species which have evolved with periodic fire and protects soils.

6) Maintain and restore scenic beauty of the "Front Country"

7) Protect and enhance the outstandingly remarkable resource values of Whychus Creek Wild and Scenic River. Meet our stewardship and legal obligations regarding the river.

8) Restore natural stream flows and protect springs in the Melvin watershed.

9) Protect the unique character, natural resources, and experience in recreational areas.

10) Provide mineral resources as needed with minimal social conflicts

11) Provide special forest products desired by the public without damage to natural resources.

RECOMMENDATIONS:

1) Restore Forest Habitats through Vegetation Management

*****For general applicable silvicultural guidelines by Plant Association Group (PAG) see section under Common to all Landscape Areas)*

Key Habitat Restoration Priorities:

- Promote connectivity between and within Late Successional Reserves (LSR)
- Promote connectivity between known activity centers for the Northern Spotted Owl
- Reduce risk of large scale fires to current owl habitat within the LSR
- Thin along scenic views and urban interface to promote large trees and reduce fire risk
- Aggressively thin plantations to accelerate large tree development, especially next to riparian reserves
- Thin around blocks of forest which are dominated by large trees to accelerate development of larger blocks. Examples are found in the flats between Sisters and Black Butte Ranch and Trout Creek Butte.
- Promote large tree character in ponderosa pine, mixed conifer dry and wet areas along riparian reserves to enhance connectivity

2) Whychus Creek Wild and Scenic River

- **Complete and implement the Whychus Creek Wild and Scenic River Plan**.

*Related actions to consider***:**

- Improvements to Chush Falls access road and trailhead

3) Melvin subwatershed

- Protect springs in the Melvin subwatershed from vehicle and foot traffic.
- Evaluate present irrigation water use in the Melvin subwatershed and work to restore flows to natural channels
- Fix ditch/road interactions
- Repair/ look for opportunities to eliminate Melvin ditch

4) Snow Creek

- Repair/ look for opportunities to eliminate Snow Creek ditch

5) Pole Creek
- Look for opportunities to eliminate Pole Creek ditch
- Thin along riparian areas near Pole Creek to accelerate large tree development

6) Black Pine Springs
- Fence and protect the springs
- Close and rehabilitate Off Road Vehicle Trails and hill climbs in the campground

7) Lava Camp Lake
- Consider how decommissioning the campground may affect resource protection in the area.

8) Cold Springs
- Manage Cold Springs overflow dispersed site. Design site and install barriers to restrict area of impact to protect old growth pine and Peck's penstemon. Rehabilitate compacted areas.
- Construct interpretative trail as planned in Scenic Byway Plans sensitive to heritage resources and rare plants in the area.

9) Skylight Cave
- Assess recreational impacts to the cave environment and sensitive species. Implement seasonal closure if necessary to protect R6 sensitive species
- Consider a trail to the cave**.** Evaluate effects of increased use.

10) Evaluate need for a new Sno-park on Hwy 242. Consider impacts of increased use and disturbance on LSR species and potential for wilderness snowmobile trespass.

11) Reduce road densities in key areas including deer winter range and mixed conifer wet forests used by wolverine

12) Reconstruct Rd 1514, 1608 and other road priorities.

13) Evaluate vacant Garrison Butte and Cache Mountain Sheep grazing allotments for closure and remove fence.

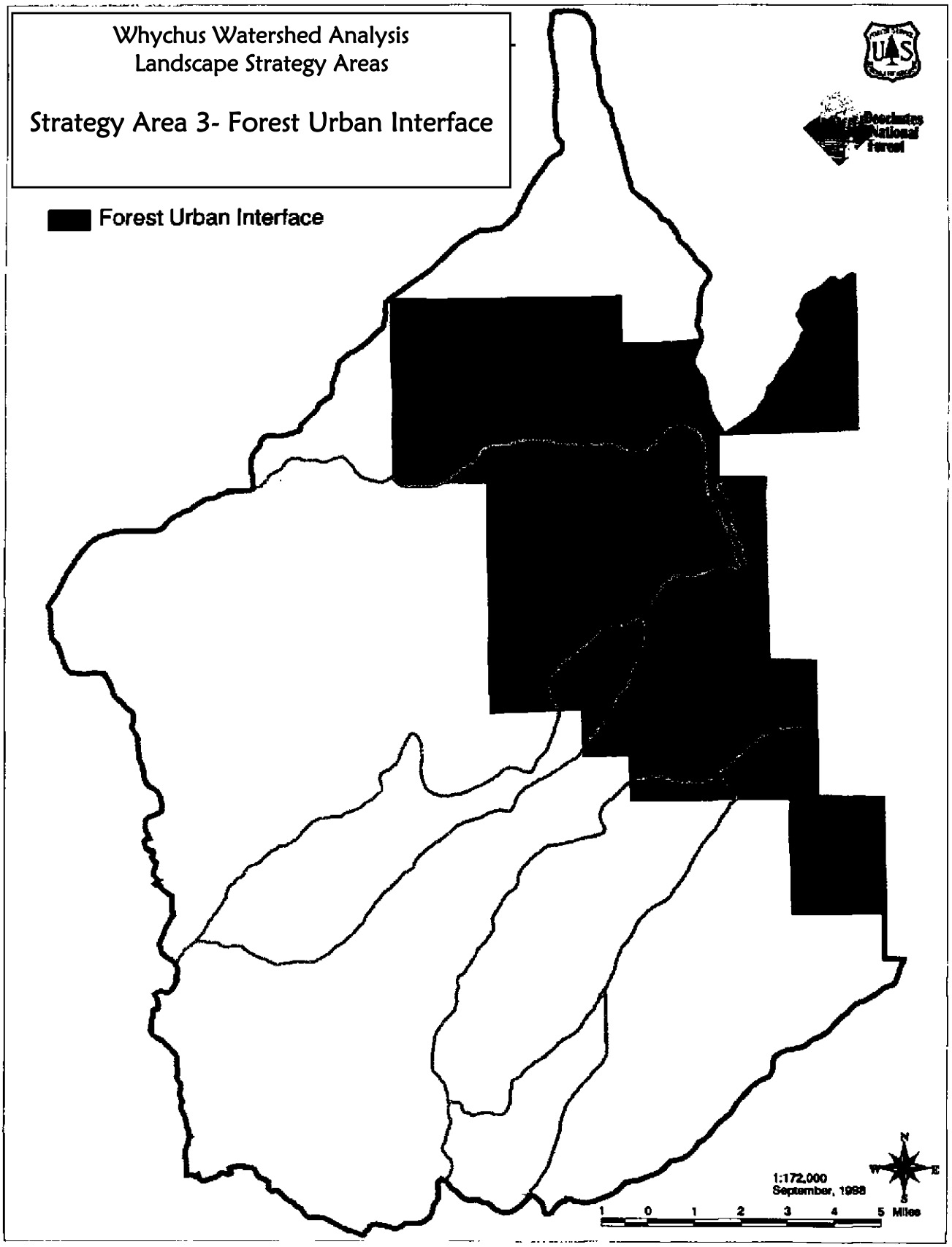
14) Gravel pits
- Evaluate non-active pits for rehabilitation and closure
- Continue to survey pits for noxious weeds
- Evaluate pits as safe sites for target practice, Off road vehicle use

15) Restore Aspen -Look for opportunities to regenerate aspen stands (Also applies to other Strategy Areas)

16) Special Forest Products
- Design firewood units for easy access by public and monitoring

Key Monitoring Actions:
Road inventories
Continue monitoring owl sites

Key Data Needs:
Updated Stand inventories


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 3- Forest Urban Interface
Forest Urban Interface
Deschutes National Forest
1:172,000
September, 1998
N
W
E
S
1 0 1 2 3 4 5 Miles

AREA 3 - FOREST URBAN INTERFACE

PRIORITY # 3- *URGENT*
FEASIBILITY- *DIFFICULT*

SUMMARY

<u>2009 Update</u>- Trends in this area are the same but intensified by more development, more urban interface, more people, and more vandalism. Urban interface forest thinning has reduced fire risk in some areas.

Population growth and development in the Sisters area are directly and indirectly affecting public forest lands and related resources. Most wildfires are started by humans in the pine forest/urban interface area. Most large stand replacement fires are started in this area and threaten homes and forest habitats. Illegal or harmful activities are increasing, including dumping, resource damage by off road vehicles, illegal woodcutting, careless use of firearms, and trespass. Lack of affordable housing for resort workers and low-income families and lack of emergency shelters is leading people to live in the forests for long periods of time. Noxious weed populations are rapidly expanding in this area, helped by ground disturbance associated with road maintenance, construction, and spread by vehicles. Easements and maintenance for utility lines to private in-holdings cumulatively fragment forest habitats and introduce disturbance and weeds.

GOALS:

1) Protect urban forest interface areas to maintain scenic quality, watershed function, and habitat values. Accommodate urban/forest interface users and neighbors while protecting public forestlands.

2) Reduce urban interface fires starts and reduce the risk of high intensity stand replacement fires.

3) Reduce resource damage in the urban interface, i.e. reduce dumping, off-road vehicle damage, illegal tree cutting, trespass, weed spread, and firearm use that threatens forest users or protected wildlife.

4) Reduce non-recreational forest living/camping.

5) Reduce cumulative impacts of utility easements across public forestlands. Maintain scenic quality, reduce maintenance-related disturbance, weed spread and habitat fragmentation.

6) Promote orderly and environmentally benign patterns of development. Look for opportunities to reduce the amount of future forest/urban interface,

RECOMMENDATIONS:

1) Continue to work collaboratively with key partners and private landowners to develop community-based stewardship and protect urban interface forests.

KEY PARTNERSHIPS AND PROJECTS:

a. Collaborate with partners listed below and other landowners to increase awareness of forest /urban interface problems, stewardship, and internal policing.

Public and Agency Partners:

Local Law Enforcement **Deschutes County Watershed Council (DCWC)**
Oregon State Department of Forestry
Oregon Department of Fish and Wildlife
City of Sisters

Homeowners Associations:

Indian Ford Meadow
Pine Ridge,
Starr Ranch
Ridge at Indian Ford
The Hill
Sage Meadow
High Meadow
Squawback Ridge
Squaw Creek Canyon Estates
Buck Run
Pine Meadow Ranch
Trapper Point
Crossroads
Tollgate
Black Butte Ranch
Cascade Meadow Ranch

Specific Restoration Actions:

- Education regarding fire prevention and making homes more fire safe
- Cooperative projects to reduce interface fuels and allow prescribed fire
- Community policing of dumping trash, yard debris, local gravel pit use
- Cooperative cleanup of trash and dumping sites
- Educational and interpretive programs oriented towards residents and tourists, enhancing appreciation of natural resources, native plants, wildlife, forest ecology
- Noxious Weed education, prevention, and control, community weed pulls
- Outreach to Off-road vehicle users regarding appropriate use and preventing resource damage
- Road closures and conversion of roads to trails
- Outreach regarding recreational gun use in populated areas
- Develop partnerships to monitor urban/interface use and impacts

2) Maintain or increase integrated fuels management program in strategic locations to protect urban interface forest habitats and private property from wildfire.

- Emphasize partnerships with homeowners associations to help increase understanding, reduce fire starts, and provide labor or cooperative funding

3) Continue to the implement Cloverdale Bald Eagle Management Plan.

4) Work with resorts and social service agencies to increase awareness about non-recreational forest living/camping. Cooperate on solutions such as affordable low-income housing and emergency shelters.

5) Implement an integrated invasive plant management program emphasizing education, prevention, and control. Support development of volunteer weed control education and control groups.

KEY PARTNERSHIPS AND PROJECTS:

a) City of Sisters- USFS should assist the city in helping improve control and reduce spread of invasive plants from private lands. Specifically:

- Help identify and prioritize weed infested public lands in the urban interface for control
- Provide technical assistance as requested and with education and outreach on noxious weeds
- Work with the City and Oregon Department of Agriculture Weed Control specialists to present a yearly forum on weed prevention and control methods
- Apply "Pulling Together Weed Initiative" Program in highly visible city areas

b) Homeowners groups -USFS should collaborate with homeowners groups. Specifically:

- Prioritize weed infested public lands in the urban interface for control
- Provide weed education articles or information for newsletters
- Provide educational materials as available to meetings
- Attend and help initiate community weed pulls

c) Deschutes County Weed Control, Road Crews and Utility Companies- USFS and other partners should continue educational efforts with the County and utility companies regarding the prevention of noxious weeds. Specifically:

- Support the development of policies and procedures for enforcement to prevent weed spread from private lands
- Work with the County on timing of road maintenance and weed spread.
- Continue and increase outreach to utility companies regarding identification and spread of noxious weeds and the need to clean equipment used in infested areas before entering clean areas
  Work on timing of maintenance for utilities to avoid further weed spread
  Develop restoration actions for targeted areas to reduce or eliminate weed spread

d) Black Butte Stables at Indian Ford- Work with this special use permittee to control knapweed on stables property and adjacent public lands to avoid spreading weeds further into the forest. Enlist the Stables as an active partner in monitoring horse trails for weeds and preventing and controlling spread.

6) Control motorized access in the urban/interface area to reduce fire starts and limit resource damage.

7) Work with the City of Sisters and Deschutes County Planning departments to increase understanding of Forest/urban interface issues and reduce potential for more urban interface. . Consider land exchanges to block up private and public lands or voluntary developmental restrictions in the form of conservation easements to limit development density. Key partners: City of Sisters, Deschutes County, Deschutes Basin Land Trust.

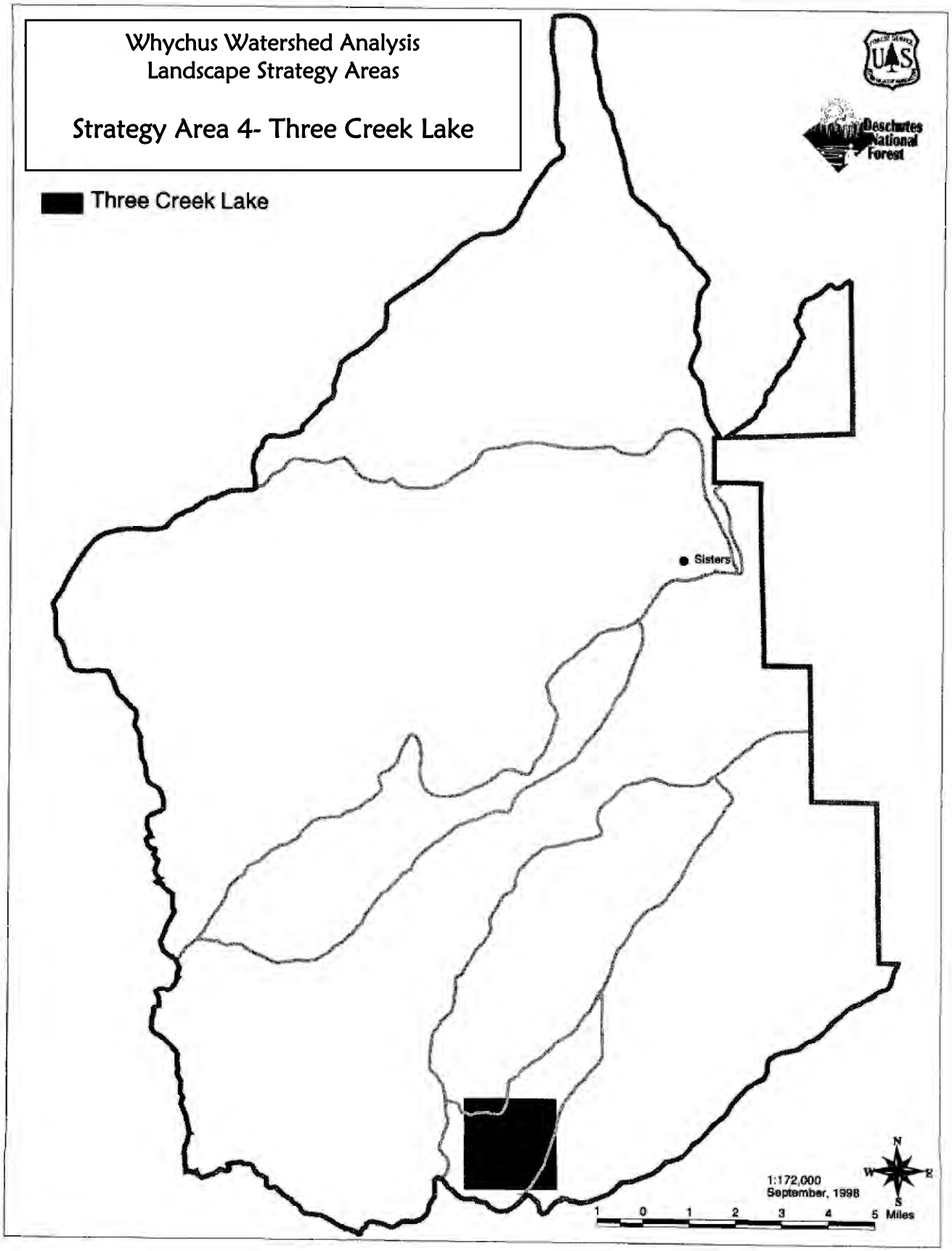
8) Manage day use near town by providing infrastructure and opportunities (Planning should be compatible with Whychus Creek Wild and Scenic River Management Plan). Key Partners: National Forest Foundation City of Sisters, Buck Run, Pine Meadow Ranch, Three Sisters Irrigation District, Deschutes County Watershed Council.

9) Glaze Meadow/ Black Butte Swamp/ Graham Corral

- Continue removal of allotment fences associated with closed Glaze Meadow allotment. Key partner- Sierra Club, Oregon Wild, Black Butte Ranch.
- Evaluate need to rehabilitate ditching on Glaze Meadow to restore wet meadow habitat for Peck's penstemon and other wet meadow species and improve water flows on Indian Ford Creek
- Continue habitat restoration in Glaze Old Growth area to reduce wildfire risk to Black Butte Ranch and restore fire in meadow and forest areas to benefit Peck's penstemon and other species.
- Monitor Glaze Forest Restoration Project implementation and continue tours and discussions
- Evaluate horse trails under special use permit and restore, remove, and reroute problem trails, especially in riparian reserves. Reduce number of trails if possible. Key partners: Black Butte Stables, local horse groups.

Key Monitoring Actions:
1) Develop partnerships to monitor urban/interface use and impacts.
2) Develop partnerships to inventory and control noxious weed infestations

Key Data Needs:
1) More information on urban interface use
2) Invasive plant inventories


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 4- Three Creek Lake
Three Creek Lake
Deschutes National Forest
Sisters
1:172,000
September, 1998
N
W
E
S
1 0 1 2 3 4 5 Miles

AREA 4- THREE CREEK LAKE AREA

PRIORITY # 4- *MODERATE*
FEASIBILITY- *MODERATE*

SUMMARY

<u>2009 Update</u>- Trends are similar as in 1998, however tree mortality has increased, affecting scenic quality.

The Three Creeks area is biologically unique and provides a unique, very popular recreational experience. It is one of the few places where you can drive to sub-alpine meadows and stroll into the wilderness. It was designated a key watershed because of its significance for amphibians. It is the longest known amphibian-monitoring site in the U.S. A unique morph of the long-toed salamander exists in the area, which may be a new endemic species. Many rare fungi have also been found in the area. The area receives high use which is increasing and it is inherently fragile because of the high altitude and short season for vegetation recovery. Horse use has damaged riparian reserves. Some improvements have been made but more are needed.

GOALS:

1) Protect and enhance unique habitats such as amphibian breeding areas (i.e. ponds, lakes, and streams), sub-alpine meadows, and rare fungi sites.

2) Restore, enhance, and protect riparian reserves with special consideration of their importance as amphibian dispersal corridors from known breeding sites to potential habitats.

3) Strive for a balance between recreational use and habitat protection. Maintain the unique recreational experience while limiting human impacts on this special and fragile place. Reduce recreational disturbance in sensitive habitat areas.

4) Restore natural hydrologic regimes at Three Creek Lake, Little Three Creek Lake, associated meadows such as Trapper Meadow, and associated ponds.

RECOMMENDATIONS:

1) Prepare a Master Plan/Site Restoration Plan for the Three Creek Recreational complex. Consider actions to reduce resource damage and improve the recreational experience consistent with Recreational Opportunity Spectrum (ROS). Related actions to consider:

- Winter Use
- Relocation, improvement of Tam McArthur Trailhead
- Additional nordic skiing opportunities at Lower Three Creek Sno-park
- Rehabilitate dispersed roads, trails, and camps in riparian reserve areas
- Wetland restoration, including Three Creek, Trapper Meadow and Little Three Creek
- Work with Mycological Society to map extent of rare truffles and habitat at Three Creeks.

2) Special Vegetation Management guidelines to protect riparian reserves and adjacent forest areas for amphibian breeding and dispersal.

- Leave extra wood on the ground to provide dispersal corridors from known breeding sites to potential habitat.
- Protect riparian reserves to maintain extra wood for amphibian dispersal
- Manage forest vegetation to protect riparian reserves from intense large-scale fires, so that if a fire occurs total loss of habitat may be avoided.
- Salvage opportunities should be light on the land and follow key watershed guidelines
- Restore, enhance and protect riparian reserves as a high priority.

3) Obliterate and revegetate unnecessary roads and trails to reduce effects on amphibian dispersal. They have limited dispersal capabilities and roads are barriers to dispersal.

4) Evaluate effects of fish stocking on amphibian populations- in cooperation with Oregon Department of Fish and Wildlife and amphibian researchers. Work to reduce conflicts.

5) Continue to reduce recreational stock, firewood cutters, and hiker impacts in riparian reserves and wet meadows. Manage horse and other stock use to reduce activity and trails. Of special concern are riparian areas adjacent to the Three Creeks Horse Camp. Move trails and rehab riparian reserves.

6) Continue clean up and remove horse manure dumpsites because of the threat of weed spread**.** Historic dump sites should be relocated and monitored (Bob Hennings knows the location- believed to be on the north side of the 370 Rd across from the salamander pond).

7) Require stock feeds that are certified weed free

8) Rehabilitate areas of high impact including trails and camps around Three Creek Lake and Little Three Creek. Restructure to reduce future impacts.

9) Rehabilitate Snow Creek Ditch

10) Resolve ownership issues on Three Creek dam and repair or remove. Three Creek Lake dam management should be revisited in light of new water right holders and changes in water use. Dam outlet pipe may need maintenance/replacement.

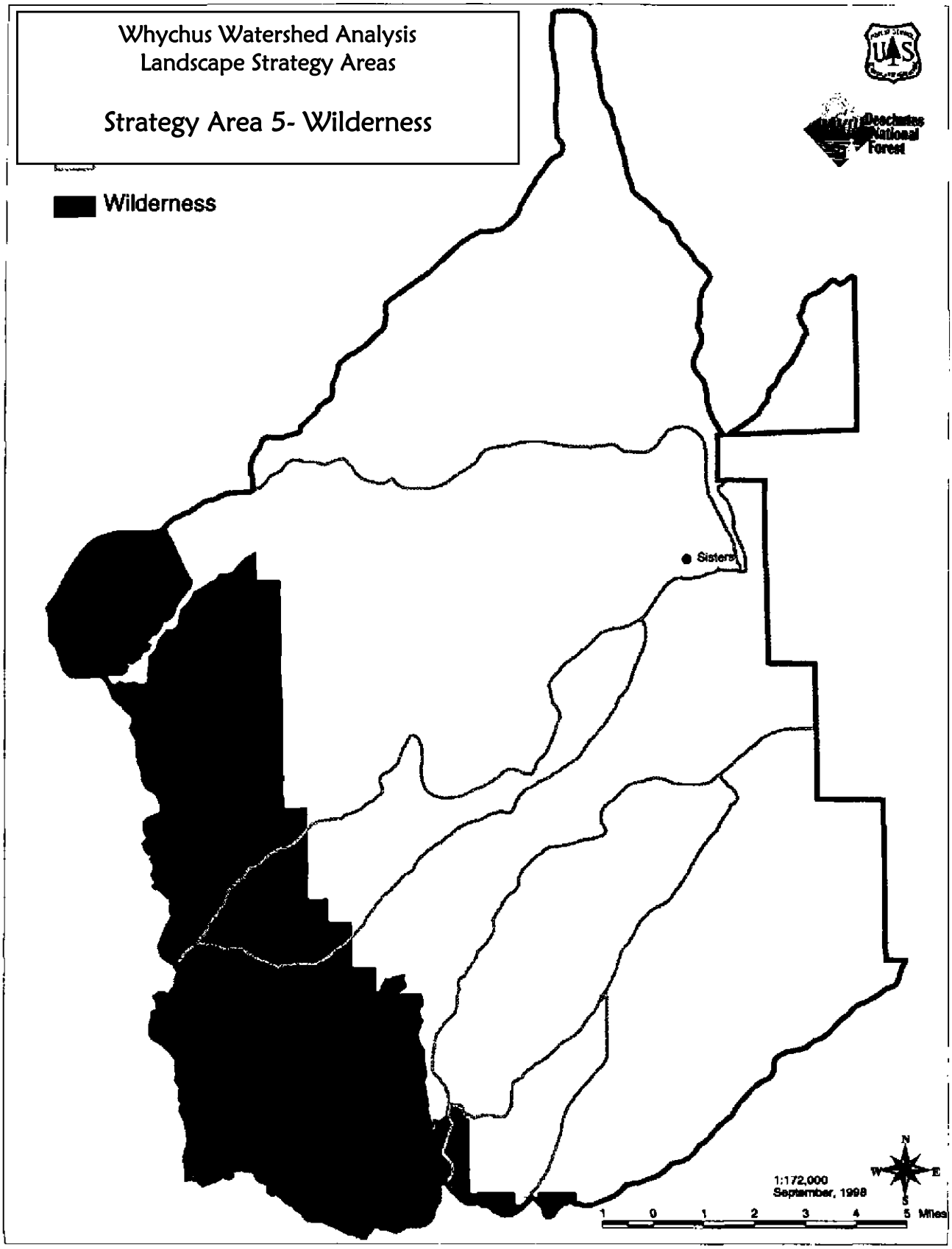
11) Evaluate Little Three Creek dam for possible removal and restoration of natural hydrological regime.

Key Monitoring Actions:

1) Monitor effectiveness of site controls to reduce damage

Key Data Needs:

1) Ownership /legal status of Three Creek and Little Three Creek dam
2) Inventory of riparian areas where ACS objectives not being meet


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 5- Wilderness
Wilderness
Deschutes National Forest
Sisters
1:172,000
September, 1998
N
W
E
S
1 0 1 2 3 4 5 Miles

AREA 5 - WILDERNESS

PRIORITY # 5- *LOW*
FEASIBILITY- *MODERATE*

SUMMARY

2009 Update- Trends are similar, however increased damage from visitors in some areas requires attention. Insects and disease have caused more trees to die.

The wilderness is comprised of high elevation forest, which for the large part have not been affected by forest management practices. Fire exclusion has occurred but because of long fire return intervals vegetation changes are subtle. Stand replacement fires are natural here and a wilderness fire plan is needed to allow natural processes to occur in the future within acceptable risks to public safety and large scale loss of property. Some areas of the wilderness have been impacted by recreational use, including camping, horse use, trespass by snowmobiles and illegal removal of alpine plants. Except for areas of high use, these are pristine environments.

GOALS:

1) Maintain a primitive setting and uncrowded wilderness experience.

2) Diminish human influence on natural processes and allow natural processes to continue.

3) Maintain function and quality of riparian areas.

4) Reduce potential impacts of human use on wildlife and alpine habitats, Restore impacted high use areas.

5) User education emphasizes stewardship and self-discovery.

RECOMMENDATIONS:

1) Develop Prescribed Natural Fire Plan for the Wilderness. -Restore fire to the wilderness.

2) Expand Limited Entry Areas (LEA's) in wilderness from the Willamette National Forest to the Deschutes National Forest. (i.e. expand Obsidian LEA to include Matthieu Lakes). Evaluate need for other use limits to protect recreational experience and resources.

3) **Restore Priority areas**: (i.e., Park Meadow, North and South Matthieu Lakes, Yapoah Lake, and Golden Lake)

- Rehabilitate overused campsites within 100 feet of lakes and waterways. Include rehabilitation of some meadow areas that are devoid of vegetation
- Rehabilitate trails through wet areas, wet meadows, and over steep slopes that channel water, result in multiple trails or unacceptable resource damage.

4) Wilderness lake fish stocking- In coordination with the Oregon Department of Fish and Wildlife develop recommendations for stocking wilderness lakes. Consider suitability of lakes for fish rearing, wilderness opportunity zones (primitive, pristine, etc.) and the importance of the lake to other resources, i.e. amphibians.

6) Continue to work on wilderness stewardship education, where the responsibility of the preservation of the wilderness falls on the wilderness user

7) Post wilderness boundaries to reduce inadvertent snowmobile trespass.

8) Increase Wilderness Ranger presence

9) Chush Falls- Consider changes to trailhead to Chush Falls and address user trails.

<u>Key Monitoring Action and Data Need</u>:
Update LAC (Limits of Acceptable Change) Inventories to monitor effectiveness of current wilderness strategies and detect damaged areas

RECOMMENDATIONS COMMON TO ALL LANDSCAPE AREAS

Riparian reserve guidelines

Riparian Reserve Buffer Distances

Riparian Reserves distances should continue to follow the distances defined by the 1998 (USDA) Whychus Watershed Analysis. These distances meet or exceed those defined by the NWFP and the Deschutes Forest Plan.

Riparian Reserve Widths adopted from the NW Forest Plan ROD C-30

Categories of waterbodies	Riparian Reserve Widths
Fish bearing streams perennial or intermittent	300 feet on either side (600 feet total) or top of inner gorge or outer edge of riparian vegetation or outer edge of 100 year floodplain *whichever is greatest*
Perennial streams without fish	150 ft on either side (300 feet total) or top of inner gorge or outer edge of riparian vegetation or outer edge of 100 year floodplain *whichever is greatest*
Constructed ponds, reservoirs and wetlands greater than 1 acre	150 ft from the edge of the water or wetland or to the extent of seasonally saturated soil or outer edge of riparian vegetation or extent of unstable areas *whichever is greatest*
Lakes and natural ponds	300 ft from the edge of the water or to the extent of seasonally saturated soil or outer edge of riparian vegetation or extent of unstable areas *whichever is greatest*
Seasonal or intermittent streams without fish	150 feet on either side (300 feet total) include unstable areas channel to the top of inner gorge outer edge of riparian vegetation

Site specific assessments should be applied by qualified personnel when delineating riparian reserves on the ground. As a minimum include these factors:

- **Floodplains**- In most cases narrow areas along stream margins and wetlands. However several locations within the watershed have broad floodplains and an intricate network of flood prone channels. Examples include: Low gradient portions of Whychus Creek, Trout Creek, and Indian Ford Creek.
- **Riparian vegetation**- Connect wet meadows to nearby streams where not directly connected. Examples include Three Creek area and Indian Ford meadow. Trout Creek may also have broader extents of riparian vegetation.

- **Stream terraces, benches, and the inner gorge**- Should be included to the outer edge with adequate protection for the slopes leading to the waterbody.
- **Unstable land**- The majority of the area is not prone to slope failures. Highly or moderately erodible soils are present-see Bank Erosion table. Also areas over 30% slope with seeps, example: near Rd 1514 on Whychus Creek, cinder slopes near Snow Creek, Three Creek, and debris flow/moraine areas near Park Creek, Upper Whychus Creek tributaries, Pole Creek and North Pole Creek.
- **Saturated soil and seeps**- Provides areas for wetland vegetation to grow and serve as wildlife and amphibian habitat. Several riparian meadows exist in Upper Whychus Creek, Pole Creek, Trout Creek and Indian Ford Creek. Several of the meadows are of a fen peat nature and have unique wetland plant species (see botany report)
- **Rock outcrops**- included because of their importance for amphibians and other species.
- **Create Riparian Reserve complexes-** Where Riparian Reserve boundaries are very close or overlapping consolidate into one large reserve. Consolidate complexes of meadows, intermittent streams, seeps, wetlands, ponds, rock outcrops, and other unique or special habitats.

Riparian Restoration

Vegetation manipulation within the Riparian Reserves may be necessary to sustain and recover late-successional habitat conditions. The primary objective of treating Riparian Reserves is to establish large tree structure and improve rapid recruitment of large wood to streams at a faster rate than would occur naturally. The effects of the treatment need to be offset by the benefit to the function of the Riparian Reserve. Treatments in the uplands beyond the inner gorge may be most effective at reducing the risk of wildfire and loss of large wood over time.

1) **Riparian Reserve Treatments**- Thin Riparian Reserves to develop large tree structure.
   - Due to advances in light (low psi) harvest equipment and reduced effects, low impact equipment may be used in Riparian Reserves as site conditions and species protections permit. This is a change from 1998 guidelines.
   - Thinning or understory removal can be used to :1) reduce stand densities to help prolong the lives of the medium/large tree components, 2) help desirable tree species in all size classes less than 21" dbh grow faster and move into the medium and large size classes sooner.
   - Thinning can be used to favor desirable tree species.
   - Prevent removal of instream wood, restore large wood and log jams in key areas.

2) Reduce road densities, especially riparian road densities and stream crossings. Rehab roads, trails, and camps in riparian reserves.

3) INFISH Riparian Management Objectives need to be reviewed and modified, if needed, to fit the watershed analysis recommendations.

4) If vegetation manipulation is needed, only treat a portion of the reserve in each entry so that untreated refugia are maintained.

5) Large tree stands are rare in local riparian reserves and those remaining need to be protected. Timber harvest within riparian reserves should not remove any live trees or snags larger than 21" dbh or down logs with an average diameter of 16" dbh or greater. Some exceptions may exist.

- 6) Aggressively thin plantations to accelerate large tree development, especially next to Riparian Reserves.
-
- 7) Promote large tree character in ponderosa pine, mixed conifer dry and wet areas along Riparian Reserves to enhance connectivity

8) Fuel treatments of riparian reserves should be limited to light intensity underburns (primarily in mixed conifer dry and ponderosa pine types).

Soils

General Recommendations To Minimize Soil Impacts

To protect the soil resource, where competing objectives allow, implement a harvest treatment that maximizes the time period between harvest entries. This will reduce soil impacts by reducing entries into a stand. Longer periods between harvest entries can also reduce the need to maintain a transportation system and increase the opportunity to do soil restoration activities such as subsoiling.

Reduce post harvest entries by treating stands as much as possible with the commercial timber harvest rather than post harvest. For example, treatment of material down to a smaller diameter may reduce the post harvest whip falling and thus, may avoid post harvest mechanical fuel treatments such as machine piling. It may also be possible to meet fuel treatment objectives with the timber harvest and, in some cases, avoid the need to treat fuels post harvest.

If possible, use prescribed fire to treat activity fuels rather than mechanical fuel treatments that increase soil compaction and displacement. Prescribed fire can also avoid the larger slash piles associated with mechanical piling, which can result in soil damage when burned.

Whenever possible, integrate less impactive harvest systems such as cable or helicopter into a portion of some sales. It is preferred to avoid soil damage over impacting an area and later rehabing it through soil restoration.

Soil Restoration By Subsoiling

Subsoiling is a restoration tool and should not be used as soil mitigation. Questions are continually raised both internally and outside the agency regarding the appropriateness and effectiveness of subsoiling. Some monitoring and evaluation of the program has been done and more is planned. Minimizing soil compaction through planning and implementation of projects is preferred over restoration through subsoiling.

Recommendation for Prescribed Burn Plans

The following mitigations are intended to be included in prescribed fire burn plans to protect soil and water resources.

1) where organic litter or duff layers exist prior to burning, avoid exposing more than 25-30% bare mineral soil.

Soils in the watershed have a moderate to severe rating for susceptibility to loss of productivity resulting from higher intensity fires (reference). This is mainly due to thin soil "A" surface soil horizons with less than two percent organic matter. Total nitrogen distribution in east side forests show approximately 70% of the nitrogen in the mineral soil and approximately 12% of the total nitrogen in the litter/duff layer (Boyer, 1980). Standards of 25-30% are recommended by (Boyer, 1980); by conserving some of the litter/duff we are assuring some of the nutrients will remain on site. Conserving some of the litter/duff layer on site is also important for preventing soil erosion, increasing nutrient cycling, mitigating soil compaction, and maintaining important soil micro-organisms species.

2) minimize fire line construction by using existing barriers and/or wet line when possible

Construction of fire lines results in the displacement of thin "A" soil horizons which contain most of the soils organic matter and nutrients. These disturbed areas also have the potential to intercept ground water during periods of high soil moisture. Surface flows or water may also be concentrated in fire lines. This results in increased soil erosion and sedimentation to lakes and streams. Fire line construction should be avoided wherever possible by taking advantage of roads, skid trails, subsoiled areas, unit boundaries with limited fuels, riparian areas, and other natural areas such as rock outcrops.

3) do not construct fire lines in riparian areas

Riparian areas are especially sensitive to fire line construction. Ground disturbing activities, such as digging fire line in riparian areas, are almost certain to intercept ground water and concentrate surface flow. Therefore, construction of fire lines needs to be avoided in riparian areas.

4) minimize piling and burning- consider utilization where possible (Biomass removal, Firewood)

Piling of slash before burning can adversely affect site productivity. Because of increased fire intensity, the loss of nutrients is anticipated to be higher than when fuels are broadcast burned. Also, the nutrients that remain after burning are no longer uniformly distributed across the site. This causes micro site differences in site productivity. Other soil characteristics, such as mineral soil organic matter and soil micro-organisms, can also be affected by increased fire intensity under piles.

5) Minimize mop-up to what is necessary to prevent fire spread out of unit.

Unnecessary mop-up activities need to be avoided in prescribed burn operations. Mop-up activities, while sometimes necessary to prevent spread of fire out of a unit, can result in displacement of thin "A" soil horizons which contain most of the soils organic matter and nutrients. It is important for the proper functioning of the soil that horizons remain intact as much as possible.

General Vegetation Management Guidelines by Plant Association Group (PAG)

The following opportunities and recommendations are designed to address the major trends and issues identified earlier in this document and to move the array of vegetation conditions within the watershed toward the midpoints of the historical range of variability in order to provide healthy sustainable ecosystems.

2009 Updates:

1. General:
    a. The recommendation related to vegetation management from the original watershed analysis were reviewed and found to still be valid, especially in areas not involved in recent fires and mountain pine beetle outbreak or, if involved, the areas that burned at low intensity or were unburned, or the areas that experienced low levels of mortality due to mountain pine beetle outbreak.
    b. In areas outside of the recent wildfire and mountain pine beetle outbreak, and in the low intensity wildfire areas and low mortality mountain pine beetle areas, aggressively implement the recommendations from the original watershed analysis to:
        i. Reduce fire hazard in fire regimes 1 and 3
        ii. Maintain and enhance the early seral large tree (21"+ DBH) component.
        iii. Reduce stand densities to more sustainable levels
        iv. Maintain, enhance and move toward desired wildlife habitat objectives
        v. Minimize potential negative environmental effects of vegetation treatments
    c. Incorporate the research community into any restoration or salvage activities to:
        i. Integrate the latest scientific knowledge into project planning.
        ii. Assist in developing appropriate research/project monitoring protocols.

2. Salvage:
    a. Salvage to reduce hazards in areas where human safety may be threatened (e.g., along roads, within campgrounds, etc.).
    b. Outside of wilderness areas consider salvage in fire regimes 1 and 3 (i.e., ponderosa pine and mixed conifer plant association groups). This would have the following objectives:
        i. Reduce future fuel loads to those that are more in line with the historic range of variability.
        ii. Help protect developing stands from future near-term stand replacement events to meet long-term resource management objectives.
        iii. Allow the reintroduction of low and mixed severity prescribed fire and wildfire.
    c. Salvage is very time sensitive related to value and should be accomplished within the first year to maximize value and within the first 2 to 3 years to have any value to offset the cost of the treatments and perhaps provide funding for other restoration objectives.
    d. Salvage should be designed and conducted in such a manner to minimize any potential adverse environmental effects. Fitzgerald, (2002), describes approaches to ensuring salvage harvest success that help avoid or reduce negative environmental effects.

3. Reforestation:
    a. Monitor natural regeneration and do not plant where adequate regeneration of desired species is occurring. The level of natural regeneration will not be completely evident for 2-5 years post fire.
    b. In the absence of natural regeneration, reforest areas in the following order of priority:

i. Previous regeneration harvest units.
ii. Areas with no salvage potential but with sensitive resource concerns.
iii. Areas with salvage potential and sensitive resource concerns that are not likely to be salvaged.
iv. Areas with no salvage potential and no sensitive resource concerns.
v. Areas with salvage potential that are ultimately salvaged.
vi. Areas with salvage potential and no sensitive resource concerns that are not salvaged.

c. Since funding is limited, consider not reforesting areas without sensitive resource concerns that are not salvaged.
d. Since timber production is not an objective of LSR, plant at lower densities such as 100 to 200 trees per acre to reduce the number of future entries needed to meet long-term management objectives.
e. Design in variability in reforestation densities (e.g., limit animal damage control, incorporate natural regeneration, etc.) to mimic historic patterns of variability of reforestation that might have been found in post-disturbance stand replacement events.

Common to all PAGs

Stand Structure:

- Thinning can be used to 1) reduce stand densities to help prolong the lives of the medium/large tree components, 2) help desirable tree species in all size classes less than 21" DBH grow faster and move into the medium and large size classes sooner.

Species Composition:

- Thinning can be used to favor desirable trees species.

Stand Densities:

- Thinning can be used to reduce stand densities. The objective should be to move densities below the upper management zone (UMZ).
- Understory removal could be use in stands in which there is sufficient stocking of overstory trees.
- Tree culturing could be used to reduce densities around individual desirable trees (i.e., medium and large sized trees).

Specific to Individual PAGs

MIXED CONIFER DRY (MCD) PAG

Stand Structure: See, Common to All PAGs.

Species Composition:

- To convert stands where white fir and other climax species are the dominant component, it will be necessary to formulate a strategy of treatments that will incorporate the regeneration of ponderosa pine over time.

Stand Densities**:**

- Thinning can be used to reduce stand densities. This will be most effective in pioneer and mixed species stands where, post thinning, the dominant species is ponderosa pine.
- Thinning of stands that are dominated by white fir is a questionable practice. Except under the best scenarios

or unless done to meet some management objective other than stand heath, thinning white fir should only be done after careful consideration of the management objectives and all the stand variables involved. In most cases, it is best to treat pure white fir stands by regeneration harvests to accomplish species conversion to ponderosa pine.

- Understory removal could be used in stands in which the understories are dominated by white fir and the overstories are dominated by ponderosa pine and stands would be adequately stocked post treatment.
- **Mortality**: See, Common to All PAGs

MIXED CONIFER WET (MCW) PAG

Stand Structure: See, Common to All PAGs

Species Composition:

- Because of the higher site potential of these MCW plant associations compared to the MCD plant associations, the MCW plant associations should be able to carry higher stocking levels of Douglas-fir and true fir, primarily white fir. However, white fir should probably compose less than 30% of tree stocking (personal communication, H. Maffei).
- Thinning can be used to favor desirable trees species, primarily ponderosa pine and other early seral species (including Douglas-fir) to convert mixed species stands to primarily pioneer species stands.
- To convert stands where white fir and other climax species are the dominant component, it will be necessary to formulate a strategy of treatments that will incorporate the regeneration of ponderosa pine over time.

Stand Densities:

- Because of the higher site potential of these MCW plant associations compared to the MCD plant associations, the MCW plant associations should be able to carry higher levels of stocking (i.e., higher UMZs). Prior to treatment, site potentials should be determined on a site by site basis.
- Thinning can be used to reduce stand densities. This will be most effective in pioneer and mixed species stands where, post thinning, the dominant species is ponderosa pine.
- Thinning of stands that are dominated by white fir is a questionable practice. Except under the best scenarios or unless done to meet some management objective other than stand heath, thinning white fir should only be done after careful consideration of the management objectives and all the stand variables involved. In most cases, it is best to treat pure white fir stands by regeneration harvests to accomplish species conversion to ponderosa pine.
- Understory removal could be used in stands in which the understories are dominated by white fir and the overstories are dominated by ponderosa pine and stands would be adequately stocked by trees >20.9" DBH.

Mortality: See, Common to All PAGs

PONDEROSA PINE (PP - Wet and Dry) PAG

Stand Structure: See, Common to All PAGs

Species Composition:

- Thinning and prescribed burning can be used to reduce western juniper and true fir components where they occur.

Stand Densities: See, Common to All PAGs**.**

Dwarf Mistletoe:

- Develop integrated short and long-term plans to manage areas with moderate to heavy infestations of dwarf mistletoe.
- Initiate a program to survey and map dwarf mistletoe infestations and intensities.

LODGEPOLE PINE (LP) PAG

Outside of wilderness areas:

- Opportunities to salvage dead material may exist if a catastrophic mountain pine beetle epidemic or fire occurs.

Stand Structure: See, Common to All PAGs

Species Composition: See, Common to All PAGs

Stand Densities:

- Thinning can be used to reduce stand densities. This will be most effective in young stands (i.e., less than 50 years old).

Mortality: See, Common to All PAGs

In wilderness areas:

- Develop plans to allow the reintroduction of wildfire into wilderness that would duplicate the frequency and intensity of historic wildfire.

HIGH ELEVATION MT HEMLOCK (MH) PAG

Outside of wilderness areas:

Stand Structure: See, Common to All PAGs

Species Composition: See, Common to All PAGs

Stand Densities:

Understory removal could be use in stands in which the understories are dominated by lodgepole pine and the overstories are dominated by Mt. Hemlock and the stands would be adequately stocked by the overstory component**.**

Mortality: See, Common to All PAGs

In wilderness areas:

- Develop plans to allow the reintroduction of wildfire into wilderness that would duplicate the frequency and intensity of historic wildfire.

RIPARIAN PAG

Stand Structure: See, Common to All PAGs

- Thinning or understory removal can be used to 1) reduce stand densities to help prolong the lives of the medium/large tree components, 2) help desirable tree species in all size classes less than 21" dbh grow faster and move into the medium and large size classes sooner.

Species Composition: See, Common to All PAGs

- Thinning can be used to favor desirable trees species.

Stand Densities: See, Common to All PAGs

Fish, Wildlife and Plant Species of Concern – Recommendations Common to all Areas

Fish:

The recommendations for restoration of aquatic and hydrologic systems from the 1998 WA (pages 214-230of that document) are still pertinent and some of these objectives have been accomplished as described above. The priority of projects should still remain the same as stated in the 1998 WA with water challenges as the first priority. Within the water challenges priorities fish passage within Whychus Creek should be a priority in anticipation of reintroduced steelhead and chinook that are projected to start returning in 2011.

Wildlife:

1) Road density currently exceeds Land and Resource Management Plan standards. Evaluate closure and decommissioning of roads including rehabilitation to benefit wildlife habitat and security, particularly for mule deer and elk.

2) Rehabilitate closed roads to enhance forage for big game and prevent noxious weed invasion

3) Evaluate use of thinning or prescribed fire to reduce firs encroaching in meadow habitat that may benefit species including the great gray owl and silver-bordered fritillary.

4) Provide nest structures for great gray owl if large trees are absent and populations are found.

Plants:

1) **Peck's penstemon**- Maintain and enhance Peck's penstemon habitats with proven tools such as prescribed fire. Restore flooding to habitat areas. Prioritize population areas for noxious weed control. Continue to do Management Treatment monitoring to investigate new management techniques to improve habitat.

a. Fire Suppression

- Consider allowing fires to burn through the Peck's penstemon population area and potential habitats for resource benefit.
- Avoid fireline, safety zones, or equipment in population areas.

b. Timber Harvest and Fire Salvage

- Consider machine thinning if appropriate or hand thinning and prescribed fire in the population areas to increase flowering.
- Do not burn concentrations of slash on top of population.

General Timber Harvest and Fire Salvage Guidelines in Peck's penstemon habitat:

- Use low impact equipment or hand thinning when possible.
- Keep equipment on designated skid trails.
- Minimize heavy ground disturbance in population areas (20% of population areas may be impacted in "Managed populations").
- Log over snow or frozen ground in "Protected" populations until studies can be completed which indicate the plant benefits and tolerates ground based equipment over dry ground.
- Utilize prescribed fire whenever possible for it's benefits to the plant.
- Make sure equipment is clean (weed free).
- Keep landings out of population concentrations.
- Monitor after operations are complete to aid in early detection of invasive plants.

c. Recreation Management

- Define and confine parking areas and roads in recreation sites with boulders, bollards or other controls to minimize devegetation in habitat areas.
- Close and rehabilitate user created roads in habitat areas.
- Monitor dispersed camping sites in habitat areas and address problem areas as soon as possible.

d. Invasive Plants

- Utilize prevention measures such as requiring clean equipment, using clean material sources, minimizing ground disturbance, and controlling nearby invasive plant populations which could be spread into Peck's penstemon habitat.
- Prioritize control of invasive plant populations within or adjacent to Peck's penstemon habitat.
- Avoid prescribed fire or ground disturbance from other management activities in known invasive plant populations, especially when coincident with Peck's penstemon populations.
- Monitor Peck's penstemon populations more frequently if they occur near activities which may introduce invasive plants, i.e. vegetation management, wildfires, prescribed fires, popular recreation sites, major roadways, or grazing allotments.
- Raise awareness of invasive plant identification and risks with agency personnel and contractors involved in prescribed fire, wildfire suppression, road work, recreation, and vegetation management.

2) **Fire Suppression**

- Meadows are often targeted as landing areas for helicopters during fire suppression. Use of these high elevation meadows should be highly restricted to emergency use only because of their rare plant populations, fragility, and vulnerability to trampling.
- Do not allow equipment to stage in meadows during fire suppression.
- Avoid fireline or safety zones in meadows.
- Consider allowing fires to burn around and through meadows for resource benefit.

3) **Retention patches for rare fungi and other plants**. To provide a reasonable assurance of the continued persistence of occupied sites consider incorporation of patch retention areas (as described in USFS, 1994, C-41) with occupied sites wherever possible (Region 6 ISSSP, Fungi Conservation Planning Tools, Appendix 2)- outlined below.

- Retain patches of green trees and snags generally larger than 2.5 acres.
- Retain at least 15% of the area associated with the cutting unit.
- In general 70% of the are retained should be aggregates of moderate to larger size 0.2-1 hectare or more) with the remainder as dispersed structures (individual trees and smaller clumps).

4) **Invasive Plants.** Continue to implement integrated invasive plant management with a special emphasis on community education and prevention. Support policies and procedures for Deschutes County Weed Enforcment.

Heritage Resources

1) Identify and evaluate Heritage Resources. Develop management plans for resources that are being damaged. A prioritized list of heritage resources based on significance will aid in developing management plans, protecting significant sites and aid in implementing other activities in the watershed.

2) Continue working with the Confederated Tribes of Warm Springs on resources of interest and in meeting Federal Trust Responsibilities on ceded lands.

Other Social

1) Expand public involvement in volunteer opportunities and planning projects to encourage community-based stewardship and ownership.

2) **Develop natural resource interpretation and education opportunities** oriented towards residents and visitors to expand perceptions of what is "natural", help build understanding and support of restoration projects such as prescribed fire, or hydrological reengineering, and to help the public understand tradeoffs and costs.

3) **Scenery -**Consider opportunities to reduce prominence of old clearcuts by feathering edges during thinning and other vegetation management.

4) **Travel management** - Continue planning to reduce conflicts and resource damage from uncontrolled off road vehicle use.

Recreation

1) Meet the American Disabilities Act requirements in recreational facilities. Provide accessible facilities throughout the watershed.

Data Gaps common to all areas

Forest Vegetation

- Long term salvage studies
- Modeling reburn potential
- Tree mortality in mixed severity
- Fall rates of snags
- Re-evaluate snag and log condition standard and guidelines to provide a revised edition of the WTLIS that better reflects historic conditions.
- Determine levels of snags and down woody material currently on the landscape.
- Determine priority areas for treatment to enhance, create, and maintain late successional conditions in the LSR's.
- Determine if NRF habitat can be attained in the Three Creek LSR.
- Prioritize areas within quarter townships outside wilderness primarily in MCD and PP to enhance dispersal habitat through stand manipulation.
- Use CVS plots for areas in ponderosa pine stands in Melvin, Whychus, and Pole subwatersheds due to the lack of coverage of current stand exam information.
- Determine where encroachment of lodgepole is occurring in meadows and remove to restore habitat.
- Current stand exam data is limited to 11% of the watershed. Older exams can fill some of this gap. However, it will be necessary to develop a long-term plan for data accumulation and maintenance for future landscape analysis and vegetation management projects.
- It is known that dwarf mistletoe infects large acreage in this watershed, however, the locations and intensities are not known. To formulate an integrated strategy for treatment of this disease it will be necessary to survey for and map infected acres.
- Develop current and more reliable estimates of site potential (i.e., GBA) for the various plant associations, especially the major ones, found in the watershed. These would allow managers and decision makers to more confidently determined current stand conditions/site potential and weigh the tradeoffs of different management scenarios.
- The number of acres of old growth in the watershed are only estimates. Old growth stands should be identified and mapped using all the variables in the Region 6 Interim Definitions of Old Growth.
- Sources of historic vegetation information are scarce. Additional sources, such as the maps from the Samuel Johnson Foundation, should be preserved by inclusion into the Forest database/GIS system.

Botany

- Survey and map rare lichens and liverworts in Pole Creek, Snow Creek, and Trout Creek swamp.
- .Complete surveys to establish extent and location of rare plant species

Wildlife

- Surveys are recommended for listed regional forester sensitive species should protocols and funding become available.
- Need stream information on the Three creek Butte subwatershed
- Determine patch size, miles of edge, and interior forest acres by using Fragstats to in evaluation late-successional and old-growth habitat.
- More information is needed on effects of special forest products programs on wildlife and their habitats.
- Determine where high use sites are impacting riparian reserves and habitat and develop measures to reduce degradation.
- Survey suitable habitat and buffer known sites for great gray owls and Townsend's big-eared bats.
- Take advantage of opportunistic sightings of wolverine and other wildlife to gather more information on habitat and occurrence.
- Determine opportunities to re-introduce extirpated species.
- Determine, through surveys, highly used areas by marten and protect habitat elements from wood cutting or other activities (down woody material and snags).
- More information is needed on the ecology of the black-backed woodpecker and its relationship to forest management.
- Assess impacts to deer habitat and the need to reduce fire risks adjacent to urban interface.
- Conduct a winter range analysis and impact of recreational use on winter range and deer.
- Update traffic counts and determine road use and effects to habitat.
- Evaluate closure of vacant stock allotments.

Aquatic Species

- Survey potential habitat to gather more data on amphibian occurrence. Document habitat conditions and where they are degraded. Develop management options to restore habitat.
- Confirm tailed frog sightings.
- Assess recreation damage and determine mitigation to reduce the effects.

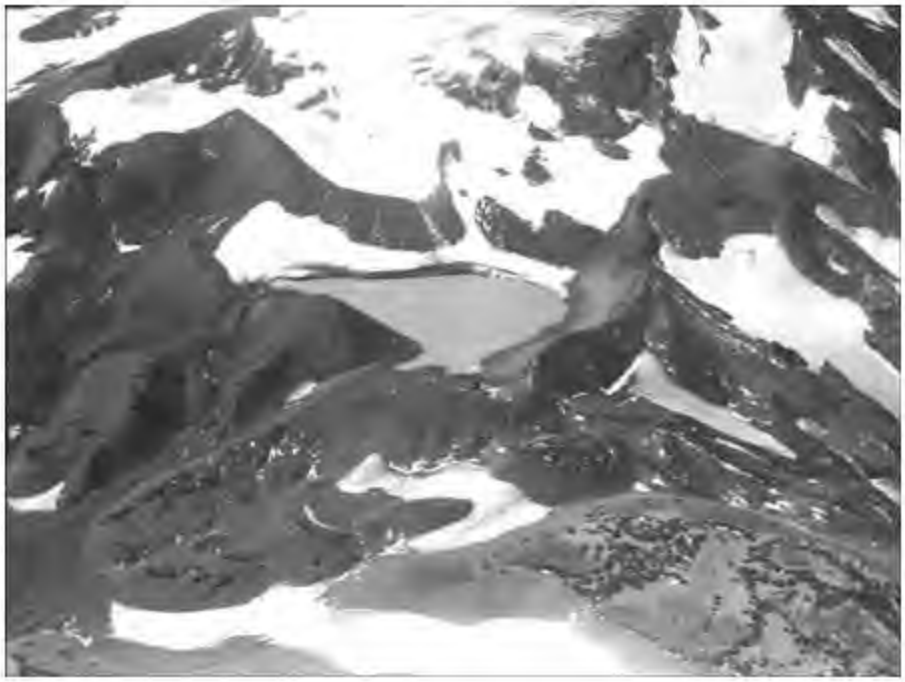
Social

- Identify and evaluate heritage resources.
- Develop management plans for resources being damaged or that can't be avoided.
- Evaluate non-active pits for rehabilitation and closure.
- Survey pits for noxious weeds.
- Evaluate pits as safe sites for target practice, off road vehicle use, use as fire camps, etc.
- ♦ Determine accurate miles of road.
- ♦ Conduct road condition surveys to assess conditions of low use roads and determine if they are hydrologically sound or will need work prior to closing.
- ♦ Evaluate OHV use in the urban interface and consider what type of closure system should be instituted.

Resource Report
GEOLOGY

GEOLOGY

NOTE: The following report is compiled from notes prepared from a January14, 2009 meeting with USGS and other officials regarding volcanic activity and the Carver Lake flood risk, and is included in this document for reference.



Carver Lake Hazard Update

Background:

- Carver Lake is a glacial moraine-dammed lake located at 7,800 feet on South Sister in the Three Sisters Wilderness. It is the largest moraine dammed lake in the Oregon Cascade Range. Lake volume is estimated to be 33,000,000 cubic feet. It is part of the headwaters of Whychus Creek, a designated Wild and Scenic River.
- In 1986, during a research study on volcanoes, the US Geological Survey (USGS) identified Carver Lake as a major flooding threat to the City of Sisters. Carver Lake is 20 miles from Sisters.
- This finding precipitated 3 years of work by Federal, County, and City officials to determine how best to address the threat and included the development of an Action Plan and Interagency Task Force. Political involvement included the Governor of Oregon, State Senators, and Congressmen. See the Carver Lake Timeline Document (USFS 1/16/09).
- In 1988, the Army Corp of Engineers completed an analysis of hazard mitigation alternatives. The ten alternatives included: 1) treatments to the lake inside the wilderness (such as pumping or draining), 2) treatments to stream channels (such as piling dams to slow debris flows or diversions), and 3) non-structural alternatives (such as utilizing Flood Plain zoning).
- The preferred alternative was to construct a piling dam to slow debris flow. The Deschutes National Forest completed an Environmental Assessment and detailed engineering work, with a

goal of construction by Fall 1988. However, core drilling showed conditions requiring prohibitively expensive materials. The City and Forest Service could not find funds to cover the costs estimated to be $150,000 - 205,000.

- The issue faded and the City of Sisters continued to grow along streamside areas with new housing developments. Several additional studies were completed by USGS. The latest report in 2001 downgraded the risk, however uncertainty remains on the potential hazard.
- In the fall of 2008, Agency officials in Sisters began work on the Greater Sisters Emergency Operations Plan. New FEMA Floodplain maps were found to show a "Carver Lake Inundation Zone" in Sisters affecting several hundred homes and buildings. Discussions on hazard mitigation began again.
- City officials, the Forest Service, and USGS scientists met on January 14, 2009 to discuss what is known and not known about the Carver Lake threat and next steps. USGS scientists explained why the risk predicted by earlier studies might not be as great as originally stated, what uncertainty still exists, and suggested options such as improved flow modeling or investigations of moraine dam composition with new technology to obtain further information.
- To proceed further, USGS requested a letter from the City saying the issue is a priority, and that officials would like them to develop cost estimates on additional modeling of debris and water flows from a dam breach.

History of Peak Flow Events on Whychus Creek

- Whychus Creek is known for its wildly fluctuating Flow Regime.
- During flood events the creek moves into its alluvial floodplain into old channels and creates new ones.
- Floods can shape the channel, move a lot of sediment, and cause erosion near structures.
- The main channel has important infrastructure including irrigation diversions, dams, and bridges. Most historical accounts of flooding discuss what bridges were taken out by flood waters.
- The creeks typical hydrograph shows 2 types of flood flows: 1) snow melt causing sustained higher flows, typically in April through July and 2) rain-on snow events of very high, abrupt, short duration flows, typically in Oct to Feb.
- *The highest flood of record was in 1980 and was 2000 cubic feet per second (cfs) at the Peterson* Ridge Gaging Station. The 1964 flood was 1980 cfs at the Peterson Ridge Gaging Station.
- By comparison, the failure of the moraine lake, Diller Lake, on Middle Sister resulted in a flow of 1240 cfs. The remaining 70% of water volume was stored in the sediments and slowly percolated out of the debris fan. Diller Lake was 1/3 the volume of Carver Lake.
    - The Diller Lake moraine failed after a September rain. It rained 1.3" on 9/7, and 3.1" in the previous 5-day period.
    - Water in Whychus Creek at the Peterson Ridge gage rose 2.5 ft in less than 10 min corresponding to a discharge rise of 177 cfs to 1240 cfs. The flow pulse lasted less than an hour.
- A "100 year" flood event has a 1% probability of occurring in a given year. A "500 year" flood event is off the probability chart and beyond our data set - it is a mythical creature we have not seen yet. We have 102 years of flow data from the gage.
- Large, rain-on-snow events are becoming more frequent. The largest recorded peak flows have occurred in the past 50 years.
- Six of the top eleven peak flows during the past 102 years have occurred in the last 10 years, two occurred in November of 2006 and 2007 (both approximately 1,200 cfs).

- The four largest peak flows have all occurred during winter rain-on-snow events and were near 2000 cfs.
- Ice flows and ice dams (like in 2005) also occur. Even with low flows (~300cfs) they have caused local flooding, bank erosion, and damage to streambank vegetation.
- The 1992 Laenen paper estimated a Carver Lake breech would be 13 ft above the streambed at the Peterson Ridge gage, 8 ft above the 100yr flood level, at 21,000cfs. About 2000 cfs was predicted to go down the Lazy Z ditch and 1000 cfs down Three Sisters Irrigation District Canal.
- In Sisters, the 1992 Laenen paper estimated a Carver Lake breech would be 10ft above streambed, 3 ft above the 100 yr flood level at 3900 to 9800 cfs.
- The Carver Lake Flood Zone shown in the 1987 Laenen paper is similar to FEMA mapping for the Carver Lake Inundation Zone. However, the new FEMA mapping does not show water moving to the east in old channels, which would likely carry water.
- The Sisters City gage can be accessed in near real time to check flows.
    - Link is: http://www.usbr.gov/pn-bin/rtgraph.pl/?sta=SQSO&parm=Q
- Normal daily flow in the winter? About 60 cfs.

Review of Carver Lake–Whychus Creek Flood and Debris-Flow Hazards -

By Willie Scott USGS (Cascades Volcano Observatory, Vancouver) and Jim O'Connor, USGS (Oregon Water Science Center, Portland), January 14, 2009 Meeting Notes

- Reviewing types of flows
    - Lahar flows are high impact, low probability, and caused by the swift melting of snow and ice. Water incorporates sediment and is the consistency of flowing concrete. Lahar flows could be caused by eruptions of South or Middle Sister. They could be large flows that reach Deschutes River and beyond.
    - Debris flows are caused by rainfall, snowmelt, or dam failure, they result in rapid erosion of stream banks, moraine dams, and can be dense, boulder-laden flows.
    - Floods are generated by rainfall,especially rain on snow, or can result from dewatering of debris flows.
- The Central Volcano-Hazard Map shows many areas could be affected by lahars or lava flows from volcanoes such as South Sister or Newberry Crater.
- Update on Three Sisters volcano activity- The rate of uplift has been decreasing since 2004. USGS has installed 6 seismometers and 3 continuous GPS stations. Except for a March 2004 seismic swarm, seismicity has been at low levels, and outputs of heat and magmatic volatiles to groundwater are unchanged. It is believed this pulse of magma intrusion has ended or slowed down.
- They showed a video of a dramatic debris flow generated by intense rainfall in volcanic terrain on Semeru Volcano in Indonesia in 2002. The front was 12 feet high, velocity about 17 feet per second with a ~15,000 cfs flow
- Jim O'Connor et. al, (2001) studied past debris flows from four moraine-dammed lakes in the Three Sisters area. They found debris flows traveled less than 6 miles, water flows continued farther.
- Using LAHARZ to modeled debris flows from Carver Lake, they found the largest potential for debris flow was between Carver Lake and the wilderness boundary.
- Carver Lake has 740 acre-feet of water (~900,000 MCM). If you put a wall (1.5 mi2) wide around Sisters and put all this water in, this volume would cover City of Sisters 9¼ inches deep.
- Carver Lake was created by a dammed moraine embankment and formed after 1930. It is subject to sudden partial or total drainage. It is 20 miles from Sisters.

  - 0-8 miles, mountains; steep gradient; debris flow.
  - 8-17 miles, lower gradient, broader channel; flood flow.
  - 17-22 miles, broad alluvial fan, abandoned channels.
  - 22-40 miles, canyon to Deschutes River.
- They have reexamined the 22 year old, 1987 Report on Carver Lake Hazard. It was an early attempt to use models created for dam breaks and clear-water flows for situation in which flows incorporate and deposit large amounts of sediment. Three hypothetical scenarios of dam failure and lake drainage were examined.
  - "Most extreme"=instantaneous total drainage *(unlikely scenario)*
  - "Next extreme"=total drainage over 3 minutes *(very high rate of breach formation)*
  - "Least extreme"=lake level drop of 25 feet over 3 minutes *(realistic scenario)*
- The model assumptions about bulking of sediment and minimum water loss tended to maximize peak flow values, and the results are very much a worst case; perhaps unreasonably so. They believe the risk stated of 1-5% per year probability of dam breaching is too high.
- The least extreme and most realistic scenario modeled in 1987 estimated 10,500 cfs (5 times the volume of the flood of record- 2000 cfs) at the gaging station near Peterson Ridge and 3,700 cfs in Sisters. The time estimated for the flow to arrive was 2.7 hours.
- From Jim O'Connor et. al (2001) study of previous moraine-dam lake failures in the Central Oregon Cascades; 11 historical dam failures (7 partial drainage, 4 total drainages). Most occurred between 1930 and 1950; none since 1970. All occurred during melt season (July-Oct.) in warm rainy weather. Triggers included avalanches or ice-calving causing lake waves to overtopping rim, causing increased outflow and erosion. Also triggered by rapid water inflow by snowmelt or rainfall.
- Potential future failures in Whychus drainage include: Chambers, Carver, and Thayer Lake.
- There are large uncertainties in estimating magnitude of future events.
- Looking at the September 7, 1970 flood from Diller Lake:
  - Lake volume = 260 acre-feet (35% of Carver Lake volume). It drained totally.
  - Debris flow traveled about 5 miles; a sediment-rich flood continued downstream.
  - At Peak discharge at Peterson gage (15 miles) = 1200 cfs (2-foot rise) [flood of record = 2,000 cfs; rain on snow].
  - Only about one-third of lake water passed the gage, the rest infiltrated or was retained in debris flow deposits upstream.
  - A muddy surge of water about 1 foot high passed through Sisters in Whychus Creek.
- Regarding the probability of moraine dam failure events:
  - From 1987 report: In the Three Sisters area, frequency of past dam breaches is >1 every 15-20 yr; annual probability of 5-6%, annual probability of Carver Lake dam breaching is 1-5%. This is not the probability of worst-case scenario.
  - From 2001 report: Past events are not distributed evenly in time. Nine lakes breeched between 1930-1960; two between 1960-1970; none in past 38 years. The annual probability is decreasing.
  - Some moraine dams survive; Camp Lake dam formed about 14,000 years ago.
  - Most historical events resulted in partial, not total lake drainage.
  - Except for 1970; all total breeches occurred within 5 years of lake formation.
  - In the 1970 Diller Glacier event a substantial portion of lake water was retained in the deposits.
- The annual probability of breaching is probably less than that stated in 1987 report; the chance of a worst-case scenario is considerably less.

- In examining the 1987 model assumptions in relation to worldwide examples they suggest starting conditions of 1987 model are extreme and rare.
    - Instantaneous drainage? Of 30 examples worldwide only 2 had substantial immediate displacement by wave; lakes didn't drain entirely.
    - Instantaneous and 34 ft per minute breach rates were considered for the "most extreme" and "next extreme" cases however the few known examples are 1-6 ft per minute (2 natural dams) and 2-10 ft per minute (28 earth-fill dams).
    - Of 18 moraine-dammed lake examples, only 6 emptied completely (all those were less than 100 ft deep).
    - The broad outlet of Carver Lake favors less extreme scenarios with slower erosion rate and less likely total drainage.
- Regarding bulking and water loss, the 1987 model assumes continuous bulking over ~8 miles and doubling of the flow volume, but in 2 historical cases, volume increased by only 25-40%, mostly in first mile.
    - The 1987 model assumes no water loss.
    - In the 1970 Diller event, 65% of water retained in deposits of infiltrated into ground upstream from gage and they would expect greater losses as flow enters fan upstream from Sisters.
- Carver Lake and dam hazard outlook:
    - The moraine dam could fail by a variety of mechanisms.
    - The lake could empty entirely or stop after partial drainage.
    - The character and magnitude of downstream events depend on rate of outflow from lake.
    - The rate of outflow is dependent on numerous variables related to breach formation; too complicated to accurately forecast.
- Hazard outlook- Downstream areas:
    - Areas immediately below Carver Lake, along South Fork of Whychus Creek, and along main stem of Whychus Creek to flats below 1514 Rd bridge are potentially at risk from debris flow.
    - It is difficult to estimate the magnitude of flooding on the alluvial fan through Sisters.
        - As in 1970, will only ~one-third of lake water reach fan?
- Questions include:
    - How much floodwater will divert through abandoned channels and ditches?
    - What is effect of debris jams (constrictions, bridges) on flood levels?
    - The 1987 results serve as worst case, but is it an "unreasonably worst case?"
- Additional Studies that would help:
    - Improve our understanding of moraine-dam structure. Is it buried ice or bedrock? Reveal key weaknesses or strengths.
    - It would also be good to reexamine the depths of the lake to understand how it might empty.
    - Better flow models now available, but breach and debris-flow behavior are still beyond rigorous modeling and subject to substantial uncertainty.
    - There is perhaps some value in new approaches for improved modeling. They require detailed topography of channel, flood plain, and fan
    - What is the risk from Carver Lake floods compared with that from meteorological floods?
- Consider mitigation measures to reduce risk in case of dam failure (zoning, levees, warning)
- Warning Systems such as Acoustic Flow Monitors (AFMs) detect ground vibrations from floods and debris flows, however they can't readily determine size
    - You could monitor lake level to detect a sudden drop

    - Use Pressure transducers and other technology
    - Trigger alert with lake-level decline of predetermined magnitude
    - Used together, detect lake-level drop accompanied by flow
- Neither is greatly expensive (~$25,000), but require maintenance
- The hard part for public officials is how to send out warning and educate the public to insure the proper response from residents and visitors. This is an endless process.
- They showed examples of monitoring and lahar warning systems occurring on Mt St Helens, Mt Rainier, and other locations.

Questions and Comments:

- Can water flows five times the record flow event be modeled?
    - Yes
- It appears that normal flood events or rain on snow events have more probability of happening than a Carver Lake breech.
- You must remember that new channels can form on the alluvial fan near town. No models are well suited to dealing with multiple dynamic channels in an alluvial fan environment.
- Is the 2001 report by Jim O'Connor available? It's on the website in html format only.
- When Larry Chitwood, the USFS Geologist consulted USGS and wrote "the risk of Carver Lake breech has been downgraded" who did he talk to at USGS?
    - Jim O'Connor.

Resource Report
SOILS

Soils

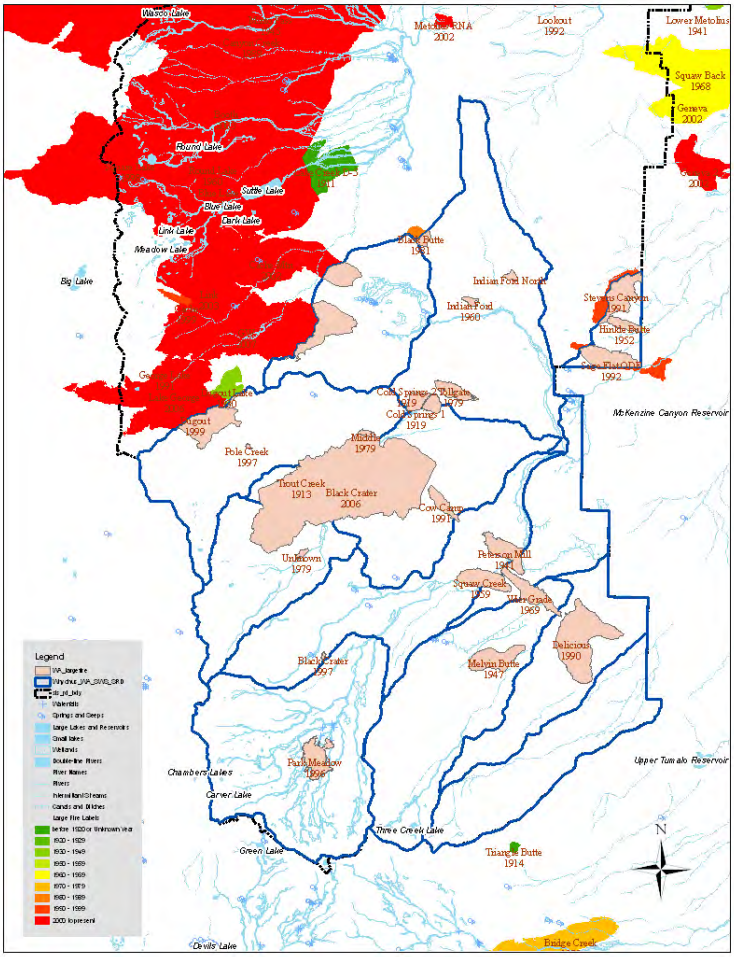
Introduction

Since the completion of the Whychus watershed assessment in 1998 one large fire (Black Crater fire) and portions of three other large fires (Lake George, Cache Mountain, and GW fires) have burned within the Whychus watershed. Table 1 list the acres burned within the Whychus watershed as a result of each of these four large fires and Figure 1 shows the fire history in the Whychus watershed.

Table 1: Recent large fires and portions of large fires within the Whychus watershed since the original watershed analysis of 1998.

Fire Name	Fire Year	Total Acres of Fire	Acres Burned within the Whychus Watershed
Black Crater	2006	9,396	9,396
GW	2007	7,357	1,029
Lake George	2006	5,550	979
Cache Mtn	2002	4,358	485
Total		26,661	12,374

Figure 1: Fire history for the Whychus Watershed on the Sisters Ranger District.



Black Crater fire

On July 24, 2006 the Black Crater fire started in the Three Sisters Wilderness and subsequently burned to the east and outside the wilderness boundary. At the time of containment the fire had burned approximately 9,389 acres, including 4,827 acres of National Forest lands. The Black Crater fire is described as a wind driven surface fire in which three primary crowning runs occurred.

Location

The Black Crater fire is located in the Upper Trout Creek, Lower Trout Creek, and Fourmile Butte 6th Field Subwatersheds. These subwatersheds all fall within the Whychus 5th Field Watershed.

Burn Intensity

Burn intensity is described as the heat pulses from different episodes of fire behavior as reflected by the effects to vegetative characteristics, including tree mortality and consumption of understory vegetation and down wood. Burn intensity was mapped as a part of the post fire Burned Area Emergency Response (BAER) analysis. Acres of different burn intensities are listed in Table 2 and defined below.

- Stand Replacement conditions represent >75% tree mortality and generally consumes the tree crowns.
- Mixed Mortality represents 25 to 75% tree mortality in which tree crowns are generally not consumed.
- Underburned represents <25% tree mortality in which live green tree crowns predominate.

Table 2: Acres of different burn intensities that resulted in different vegetation mortality class within the Black Crater fire.

Vegetation Mortality Class	Acres	% of Fire
Stand Replacement	3,102	33
Mixed Mortality	2,574	27
Underburned	3,713	40

Burn intensity was one of the factors used to determine burn severity as described in the following section.

Burn Severity

Burn severity was also mapped as a part of the post fire Burned Area Emergency Response (BAER) analysis. Burn severity describes the effect the fire had on soil productivity and erosion potential. Burned severity was mapped using field observations of post-fire soil characteristics and slope to adjust burn intensities described by the vegetation mortality map.

Acres of different burn severity are listed in Table 3. Soil characteristics observed in the field generally met low and moderate severity ratings as described by the BAER website. This included the stand replacement areas within the primary runs. Areas described as high factored in slope and/or proximity to stream channels for their rating.

Table 3: Acres within the Black Crater fire having different burn severity, as described by the BAER website.

Soil Effects	Acres	% of Fire
High	103	1
Moderate	5,573	59
Low	3,713	40

Burn severity ratings of low and moderate are expected to fully recover through natural processes within a few years. The relatively small areas of high severity burn areas identified in the BAER evaluation are distributed across a number of relatively small areas where slope and fire intensity created a hot burn.

Areas of high severity burn were further evaluated to assure there would not be confounding factors such as drainage issues that would aggravate the recovery of these sensitive areas. No confounding factors were identified during the field evaluation. It was determined that given time, soils in these areas of high burn severity would also recover back to a productive forest condition.

Suppression Rehab Activities

A suppression rehab plan was developed for the Black Crater Fire during the fire suppression efforts. Some of the activities included in the suppression rehab plan included spreading of breams created by fire suppression dozer lines, construction of water bars in both dozer lines and roads used for fire suppression, rehab of safety zones created during the fire, and the cleaning of forest debris near culverts to prevent plugging of the pipes during storm events. Suppression rehab work is preformed to facilitate the recovery of the burned area. All suppression rehab activities identified in the suppression rehab plan were completed before the first winter following the fire.

Post Fire Salvage Activities

A majority of the private timber lands that burned in the Black Crater fire were salvaged immediately following the fire. On Forest Service (FS) lands around 416 acres of potential salvage opportunities were identified from district stand examination records. Further field reconnaissance of FS lands narrowed this to about 198 acres of economically viable ground-based salvage opportunities. Due to litigation less than 30 acres of the Forest Service lands within the Black Crater fire were salvage logged. This work was completed in 2008. Post harvest soil monitoring was conducted within the approximately 30 acres of FS lands that were salvaged. It was determined that on FS lands the soil disturbance resulting from salvage activities was within the acceptable limits defined by the FS Regional Soil Quality Standards. All of the private and FS lands were reforested following fire salvage activities.

Portions of Other Large Fires

Small portions of the GW, Cache Mtn, and Lake George fires also burned within the Whychus watershed in recent years (Table 1). The GW and Cache Mtn fires are located in the Upper Indian Ford 6th Field Subwatershed and the Lake George fire is located in the Fourmile Butte Subwatershed. Burn intensity and burn severity for each of these fires were mapped during the BAER assessment. The fires were all wind driven from west to east and the relativly small area of these fires that are in the Whychus watershed represent the final runs on the east end of the fires, just prior to containment. Most of the fire burn intensity and or burn severity for the three fires and within the Whychus watershed were mapped at a moderate to low level. Soil productivity within areas of these fires are expected to fully recover within a few years.

Suppression Rehab Activities

Suppression rehab plans were also developed for the GW, Cache Mtn, and Lake George fires. These suppression rehab plans were similar to the one described for the Black Crater fire. Like the Black Crater fire, all suppression rehab work identified for the GW, Cache Mtn, and Lake George fires was completed before the first winter following the fire.

Post Fire Salvage Activities

Approximately 200 acres within the GW fire were salvaged logged in 2008. Only a portion of the salvage units are within the Whychus watershed boundary. The only salvage activities that occurred within the Cache Mtn and Lake George fires were road side removal of hazard/danger trees. Based on past monitoring of hazard tree removal, soil disturbances that result from these types of operations do not exceed Regional Soil Quality Standards.

Resource Report
HYDROLOGY

HYDROLOGY

Whychus Watershed Analysis Area

Watershed boundaries and names were updated multiple times after the original Whychus Watershed Analysis. Currently, some portion of the following subwatersheds are in the Whychus Watershed Analysis update area: 1) Upper Indian Ford, 2) Lower Indian Ford, 3) Fourmile Butte, 4) Upper Trout Ck, 5) Lower Trout Ck, 6) Headwaters of Whychus Ck, 7) Upper Whychus Ck, 8) Middle Whychus Ck, 9) Lower Whychus Ck, 10) Three Creek, 11) Deep Canyon, 12) Triangle Hill.

303(d) Listed Streams

The State of Oregon is required by the Clean Water Act, Section 303(d), to identify waters that do not meet water quality standards. The waterbodies in Table 1 are listed on the Oregon 2004/2006 303(d) list for water quality exceedences above the State standards established in 2004.

The only streams in the Whychus Watershed Analysis area on the 2004/2006 303(d) list are Whychus Creek and Indian Ford Creek (ODEQ 2009a). Both are listed for their entire length for temperature exceedences above the State standard of 18º C for salmon and trout rearing and migration (ODEQ 2009b). Although stream temperatures are not above the State standard along the entire length of these streams, they are listed as impaired their entire length because the listing criteria is based on beneficial uses. Steelhead trout were reintroduced in Whychus Creek in 2007 and efforts are ongoing; however, a state standard for steelhead spawning in Whychus Creek has not yet been set. Therefore, a potential state standard was evaluated by the Upper Deschutes Watershed Council based on the state standard set for the Lower Deschutes River (Hill et al. 2008). Whychus Creek water temperatures do not meet the potential state temperature standard for salmon and steelhead spawning (January 1 through May 15, temperatures not to exceed 13 °C) (Hill et al. 2008).

States are required to develop Total Maximum Daily Load (TMDL) allocations, which include Water Quality Management Plans (WQMP) for 303(d) listed waters. The Upper Deschutes River Subbasin TMDL and WQMP is scheduled for completion in 2009 and covers all the subwatersheds in the Whychus Watershed Analysis area. A Memorandum of Understanding (MOU), signed May 2002, between Oregon Department of Environmental Quality and the U. S. Forest Service (USFS), designated the Forest Service as the management agency for the State on National Forest Service lands. To meet CWA responsibilities defined in the MOU, the Forest Service is responsible for developing a Water Quality Restoration Plan (WQRP), which is now in draft form (USFS 2004).

Table 1. Waterbodies listed on the State of Oregon 2004/2006 303(d) list within the Whychus Watershed Analysis area (ODEQ 2009a).

Waterbodies	Parameter	2003 Standard
Indian Ford Ck – mouth to headwaters (RM 0 – 12.3)	Temperature	18º C
Whychus Ck – mouth to headwaters (RM 0 – 40.3)	Temperature, salmon and trout rearing and migration	18º C

Temperature

Temperature monitoring has continued in the Whychus Watershed Analysis area, but 7-day maximum averages have only been calculated through 2005. All streams in the watershed analysis area meet State water temperature standards except Indian Ford Creek and Whychus Creek (Table 2).

Water temperature in Whychus Creek below the 16 road has been consistently above the State Water Quality standard for salmon and trout rearing and migration. Stream temperatures in Whychus Creek progressively get warmer as water moves downstream from the 1514 rd to the City Park in Sisters. Cold water springs 1.6 miles from the mouth of Whychus Creek lower water temperature in Whychus Creek below the 2003 temperature standard. Temperature monitoring by the Upper Deschutes Watershed Council from 2005 - 2008 also show that temperatures in Whychus Creek do not meet the potential state standard to protect steelhead spawning for nearly 25 miles from Sisters to the Deschutes River (Figure 1) (Hill et al. 2008).

Insufficient in-stream flows have been the main reason for high water temperatures in Whychus Creek. Reduced base flows increase the amount of time water is exposed to solar radiation and reduces the amount of water available for riparian vegetation. The lack of sufficient riparian vegetation also exacerbates channel erosion and widening, leading warmer stream temperatures from increased surface area. Below the Three Sisters Irrigation District Diversion, which is 1.7 miles downstream of the USGS gauge, low flow is significantly reduced, as is riparian vegetation. Average low flow above the diversion in August is 92 cfs and, due to water conservation efforts, low flow below the diversion has been increased from 1 cfs to 15-20 cfs. Target flows for Whychus Creek, based on Oregon Department of Fish and Wildlife instream water rights, is 20 cfs upstream of Indian Ford Creek and 33 cfs downstream of Indian Ford Creek.

Water temperature in Indian Ford Creek immediately downstream of Black Butte Ranch has been consistently near or above the State Water Quality standard. The 2000 Forward Looking Infrared (FLIR) survey shows a dramatic spike in temperature as Indian Ford Creek leaves the private land. Stream temperatures at the headwater springs in Big Meadow were measured at 6.5°C on July 28, 2000, and measured at 19.1°C just 1.3 miles downstream (Watershed Sciences 2000).
Insufficient in-stream flows, water ponding, and willow removal on private land have been the main reason for high water temperatures in Indian Ford Creek. Approximately 8 cfs is diverted during the summer low flow season, reducing water depths and causing the stream to dry up at least 3 miles before it's confluence with Whychus Creek. Stream flow is also heated near the headwaters where streamflow is impounded and water surface area is exposed to solar radiation.

Table 2. Water temperature monitoring in the Whychus Watershed Analysis Area (sites on the same stream listed from upstream to downstream).

Stream	Period of record	Max 7-day ave. max. temperature	2003 Water Temperature standard
Indian Ford at headwater springs	July 28, 2000	6.5º C*	18º C
Indian Ford Ck at Black Butte Ranch	1996-1997	19.3º C	18º C
Indian Ford Ck below Glaze Allotment	1993, 1994, 1996-2001, 2003	20.9° C	18º C
Indian Ford at 025rd at lower end of USFS bdy	2000, 2003	18.4º C	18º C
Indian Ford Ck at 2058 rd	1998 - 2002	19.4° C	18º C
Pole Creek @ 1514 rd	1989-1991, 1995, 1997	12º C**	18º C
Snow Ck @ 1514 rd	1997	11.4º C	18º C
Trout Ck @ 1018 rd upper crossing	2001-2005	10.8º C	18º C
Trout Ck @ 1018 rd, Whispering Pines CG	1996, 2000-2005	13.3º C	18º C
Whychus Ck @ 1514 rd	1997-1999, 2002, 2006	14.4º C	18º C
Whychus Ck @ gaging station	1991, 1994-2000, 2002-2006	16.3º C	18º C
Whychus Ck @ 4606 rd foot bridge	1999 - 2005	20.4º C	18º C
Whychus Ck @ City Park	1997-2006	24.4º C	18º C

* one time recording

**estimate

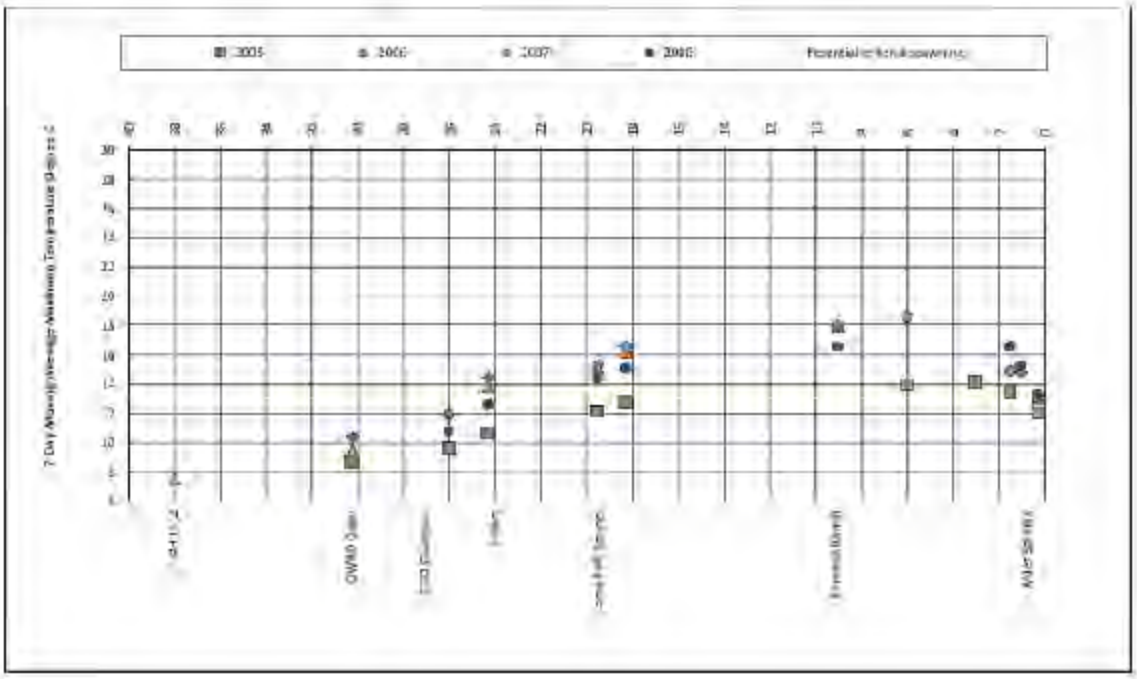


Figure 1. Longitudinal temperatures on the hottest spawning day of the year in Whychus Creek: 2005-2008 (Hill et al. 2008).

Watershed Changes from Recent Fires

The Black Crater Fire (2006), Lake George Fire (2006), and the GW Fire (2007) all burned a portion of the Whychus watershed; however, only the Black Crater Fire burned any riparian areas in the Whychus watershed. Both the Lake George Fire and the GW Fire barely touched the Fourmile Butte subwatershed (Lake George Fire) and the Upper Indian Ford subwatershed (GW Fire). The Black Crater Fire, which started on July 24, 2006, burned approximately 9400 acres primarily in the Lower Trout Creek subwatershed (Table 3). Only 3.8 miles or 20% of Trout Creek flows though the burn area. In addition, Black Crater Lake in the wilderness and another small pond near the wilderness were burned mostly by a moderate severity fire (McCown 2006).

Table 3. Fire severity acres by subwatershed in the Black Crater Fire area.

Subwatersheds	SWS Area	High	Moderate	Low	Total in SWS	% of SWS burned
Fourmile Butte	17544	0	386	288	674	4
Lower Trout Creek	20016	89	4311	2699	7099	35
Upper Trout Creek	12105	14	876	726	1617	13
Total		103	5574	3714	9390	

Forty seven percent of the inner gorge of Trout Creek, which is considered the primary streamflow and sediment contribution area, was affected by a stand replacement fire and most of the ground vegetation in the inner gorge was completely denuded. Two years post-fire, ground vegetation and saplings are evident and sedimentation risk from overland flow is reduced.

Flow Regime

On Whychus Creek, large, short duration rain-on-snow events tend to occur during winter months and lower magnitude, more sustained elevated flows resulting from upland snowmelt occur during the spring months. As a result of these two types of high flow events, the typical hydrograph for Whychus Creek is

bimodal with the snowmelt flow being rather consistent and the rain-on-snow events flashy. Due to the timing of the irrigation diversions (April to Oct), the Three Sisters Irrigation Diversion, approximately 9 miles upstream of Sisters, Oregon, has significantly reduced the longer-duration, spring snowmelt flows downstream of the diversion, but has had little influence on the highest and flashiest instantaneous peak flows, which are often associated with rain-on-snow events. Evaluation of flow records from the upper gage on Whychus Creek (#14075000) dating back to 1906 shows a pattern of large rain-on-snow events becoming more frequent in recent years. Stream flow records show that six of the top 11 peak flows during the past 102 years have occurred in the last 10 years, two of which occurred in November 2006 and 2007 (both approximately 1,200 cfs). In addition, the four largest peak flows have all occurred during winter rain-on-snow events and were near 2,000 cfs.

There are eight water right claims on Whychus Creek between the USGS gauging station and the town of Sisters, and six claims with the highest priority use to dewater the stream between Sisters and Camp Polk during the summer low flow period (U. S. Forest Service 1998b). Since then, water conservation efforts have been implemented such as improving the efficiency of diversions, transferring water rights, and leasing water rights with the goal of increasing low flow to at least 20 cfs.

Carver Lake, a moraine-dam lake formed after 1930, is at the headwaters of North Fork Falls Creek, a headwater tributary to Whychus Creek. A 1987 and 1992 USGS report discussed the risk of a moraine dam failure resulting in a breech of Carver Lake (Laenen et al. 1987, 1992). The risk was further discussed in a recent meeting with the USGS and the City of Sisters on 1/14/09. The USGS explained that while examining the assumptions in the debris flow model used in the 1987 study in relation to worldwide examples from the 2001 USGS study, it appears that the starting conditions of 1987 model are extreme and rare. They believe the "least extreme" scenario in the 1987 study would be the most realistic flow levels. The "least extreme" scenario estimated 10,500 cfs would arrive at the upper gaging station (#14075000) in 2.7 hours and 3,700 cfs would arrive in Sisters shortly there after. The probability of Carver Lake breeching is unknown but is believed to be less than the 1 – 5% stated in the 1987 USGS report because most breeches occur within the first two decades after the lake was formed (See Geology Report).

Approximately 2 cfs of flow has been returned to Pole Creek Swamp from Pole Creek because the City of Sisters has not been using their municipal water right since the construction of their ground wells. However, the Pole Creek ditch is still being utilized to divert flow from Pole Creek to other water users with bigger water rights.

Peakflows in Trout Creek were predicted to increase as a result of the fire. Approximately 46% of the area within the inner gorge of Trout Creek was burned by a stand replacement fire, resulting in a loss of evapotranspiration in an area adjacent to Trout Creek. Likewise, the new openings could accumulate more snow that would be available for runoff during a rain-on-snow event. Numerous stream-road crossings and culverts that were at risk of failure due to the predicted increase in peak flow and the already undersized capacity of the drainage structures were improved along Trout Creek within and downstream of the fire area as part of the Burned Area Emergency Response effort. Unfortunately, culverts on non-USFS lands were not upgraded after the fire and remain at risk for failure (Table 4) (McCown 2006).

Table 4. Culverts on non-USFS reaches of Trout Creek within or downstream of the Black Crater Fire still at risk of failure.

Culvert site	Existing size	Recommendation
1018-990 rd	48” cmp	Concrete box or arch
Hwy. 20	3 – 24” cmps	Concrete box
Pine St. (2058 rd)	2 – 15” cmps	Concrete box
Upper Trapper Point Rd.	27” x 22”	Concrete box
Lower Trapper Point Rd.	2 – 15”	Concrete box
Camp Polk Rd. (2050 rd)	27” x 22”	Concrete box

Winter flooding on Trout Creek 2007

Resource Report
VEGETATION

Tim Lillebo and Brian Tandy at Glaze

VEGETATION

Introduction

For both the 1998 watershed assessment and this update, current vegetation was analyzed on a stand/polygon basis utilizing photo interpreted data. Analysis utilizing other data sources such as continuous vegetation survey may also be utilized and where this is the case it will be noted.

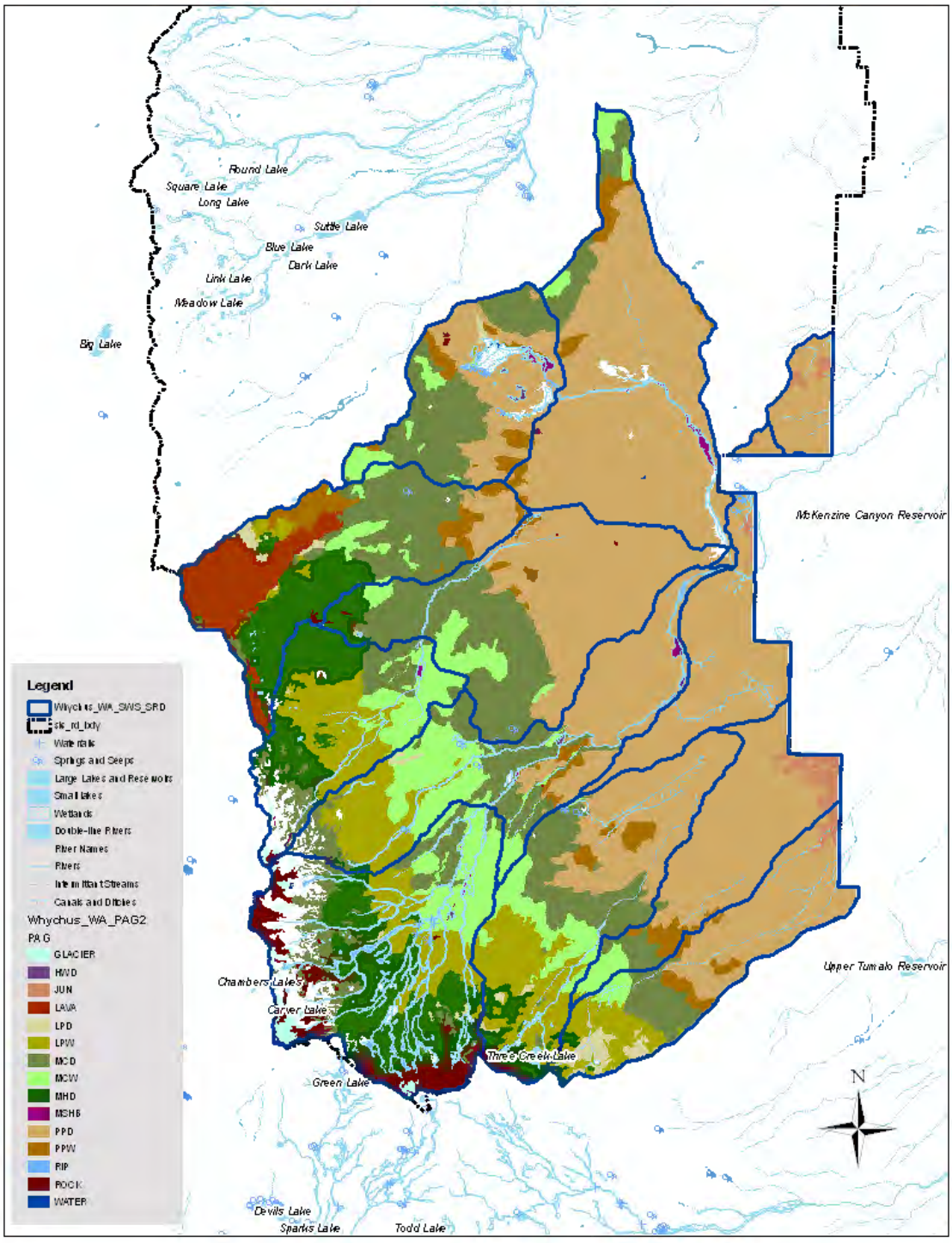
Plant Associations and Plant Association Groups

In the original Whychus watershed assessment, plant associations were determined through field mapping of the potential natural vegetation using the protocol established by Volland (1988), with input from the Area IV Ecologist and other Forest Specialists including silviculturists, ecologists, botanists and stand exam personnel. The associations and series were then grouped by their climax species, site potential, and temperature and moisture similarities into Plant Association Groups (PAGs), using the categories listed in the Deschutes WEAVE document (v.1.12) and are displayed in Table 1.

Table 1 – Plant Association Groups (PAG) for the Whychus Watershed Assessment, updated

PLANT ASSOCIATION GROUPS (PAGs) SUMMARIZED FOR THE ENTIRE WHYCHUS WATERSHED ANAYSIS AREA					
PLANT ASSOCIATION GROUPS (PAGs)			**LUMPED PAGS FOR ANALYSIS (LPAGs)**		
PAG	**CODE**	**ACRES**	**LPAG**	**ACRES**	**PERCENT OF THE WATERSHED**
Ponderosa Pine Dry	PPD	74,464	**Ponderosa Pine**	80,480	45%
Ponderosa Pine Wet	PPW	6,016			
Mixed Conifer Dry	MCD	32,801	**Mixed Conifer Dry**	32,801	18%
Lodgepole Pine Dry	LPD	1,468	**Lodgepole Pine**	16,436	9%
Lodgepole Pine Wet	LPW	14,968			
Mountain Hemlock Dry	MHD	15,852	**High Elevation Mt. Hemlock**	15,852	9%
Mixed Conifer Wet	MCW	15,713	**Mixed Conifer Wet**	15,713	9%
Cinder	CINDER	3,471	**Special (Non-Forest)**	11,548	7%
Glacier	GLACIE	672			
Lava	LAVA	4,146			
Rock	ROCK	3,259			
Riparian	RIP	1,318	**Riparian**	2.391	1%
Mesic Shrub	MSHB	1,073			
Juniper Woodlands	JUN	1,361	**Juniper Woodlands**	1,361	1%
Alpine Meadow	AMDW	56	**Meadow (Non-Forest)**	1,349	1%
Meadow	MDW	1,293			
Water	WATER	230	**Aquatic (Non-Forest)**	230	<1%
GRAND TOTALS		178,161		178,161	100%

Map 1. Plant Association Groups for the Whychus Watershed on the Sisters Ranger District.



Changes to Forest Vegetation

Changes to vegetation within the watershed assessment project area since the original watershed assessment was completed in 1998 have occurred from three primary mechanisms; vegetation management, mountain pine beetle outbreak and wildfire. These mechanisms have worked to change all aspects of vegetation from ground vegetation, fuels and snags to the species composition, density and structure of the standing live trees.

Vegetation Management Activities/Accomplishments

After the watershed assessment was completed in 1998 the District began projects to meet management direction in the Deschutes National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan. The District completed 3 Late Successional Reserve (LSR) Assessments: one for the Metolius LSR, one for the Cache LSR and one for the Whychus LSR. As well as a number of vegetation management projects as displayed in table 2.

Table 2. Vegetation Management Projects initiated by the District since the 1998 Watershed Analysis.

Project	Analysis Acres	Proposed Treatment Acres	Actual Acres Treated to Date
Whychus Late Successional Reserve Assessment	27,433	n/a	n/a
Cache Late Successional Reserve Assessment	7,678	n/a	n/a
Metolius Late Successional Reserve Assessment	4,846	n/a	n/a
Personal Firewood Cutting	7,015	7,015	7,015
Highway 20 Project	9,326	7,763	7,763
Glaze Forest Restoration Project	1,200	1,181	0
Sisters Area Fuels Reduction Project	31,329	17,573	0

The Whychus Late Successional Reserve, Cache Late Successional Reserve and Metolius Late Successional Reserve Assessment do not involve treatment and therefore have not had an effect on the condition of the watershed. Virtually all vegetation management projects have had little, if any affect on species composition, density and structure. The Highway 20, Glaze Forest Restoration and Sisters Area Fuels Reduction Projects are all thinning from below projects so treatments in these areas will change stand structure by removing small size classes, moving more of the area into the small and medium/large size classes. Most of these areas are dominated by ponderosa pine forest types. Within these types the majority of the trees are ponderosa pine, any fire intolerant tree species in the understory, such as white fir and western juniper, will be targeted for removal. Therefore the species composition may change slightly, if at all. The densities of stands will be reduced. Of these projects the Highway 20 project is the only one that has been implemented to date. Only stands within the Highway 20 project area have experienced reduced densities and a slight change in species composition and stand structure. Areas within the Glaze Forest Restoration and Sisters Area Fuels Reduction projects have not been implemented and therefore the existing condition has not changed due to vegetation management since the original watershed analysis.

The 7,015 acres of personal firewood cutting units within the watershed have greatly changed the structure and density of these stands. In areas with mixed species, the species composition has shifted from lodgepole pine to being dominated by ponderosa pine or any other species that occupies the site. A

large percentage of the lodgepole pine has died due to the mountain pine beetle outbreak. Firewood cutters have removed a large percentage of the dead lodgepole from these areas. In areas dominated by lodgepole pine the structure has changed from pole or small size stands to grass/forb/shrub or seedling/sapling, depending on what was present in the stand prior to disturbance. The densities have been greatly reduced. In some cases the density of these stands is well below the lower management zone.

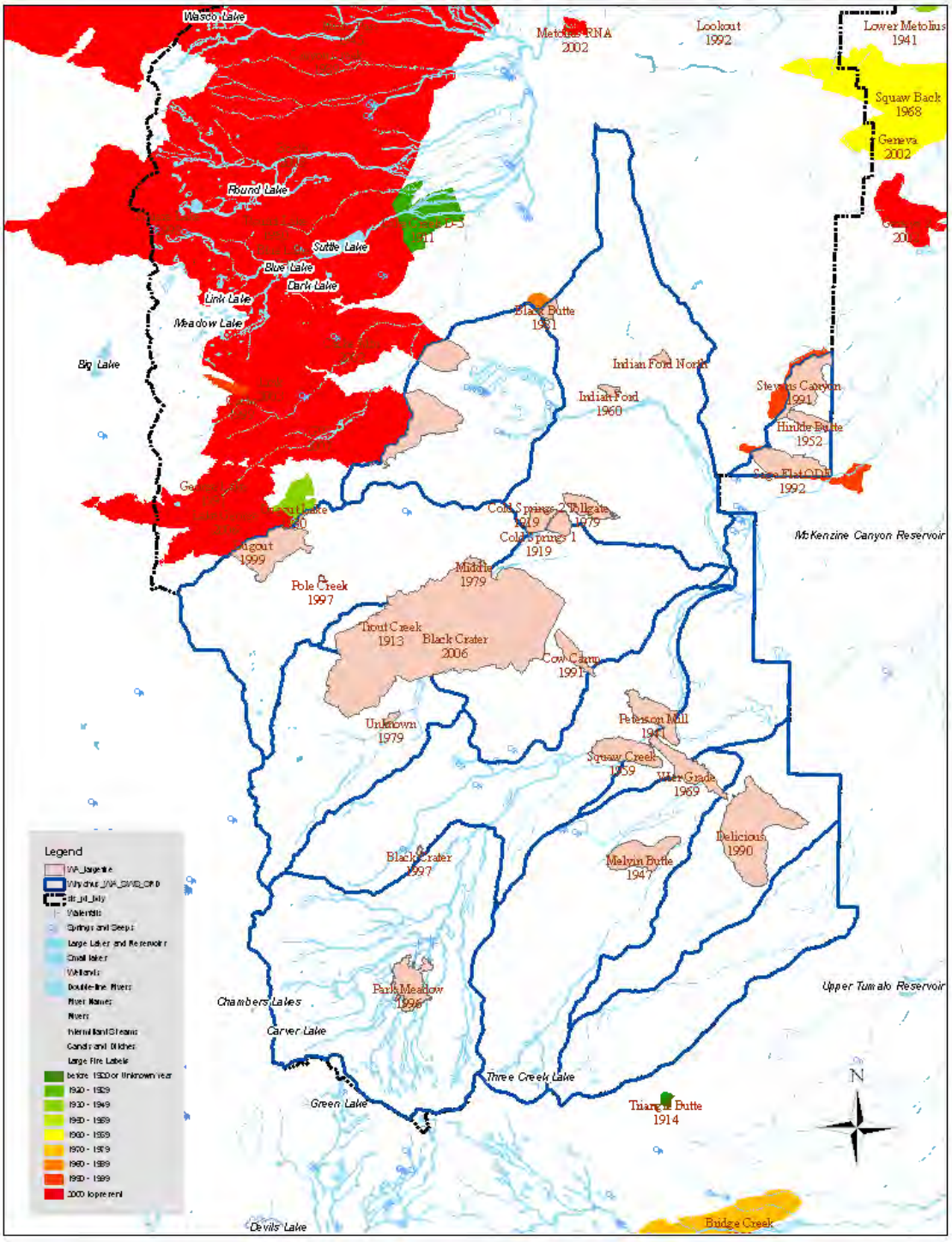
Wildfire

Since the original Whychus watershed assessment there have been four wildfires greater than 10 acres within the project area as displayed in Table 3.

Table 3. Fires greater than 10 acres in the Whychus Watershed project area since the original watershed analysis of 1998.

Fire Name	Year	Total Size (acres)	Watershed Project Area (acres)
Cache Mountain	2002	4,358	485
Black Crater	2006	9,396	9,396
Lake George	2006	5,550	979
GW	2007	7,357	1,029
Total		26,661	12,374

Map 2. Fire history for the Whychus Watershed on the Sisters Ranger District.



The Black Crater fire burned entirely within the project boundary. However, the Cache Mountain, Lake George and GW fires burned both within and outside of the project area boundary. The areas within the perimeter of these fires burned at varying intensities based on the current condition of the vegetation (species composition, structure and density), dead fuel loading (both vertical and horizontal), topography and weather conditions at the time of the fire. The effects of these fires have been classified into 3 categories based on the effect to the forested canopy as follows: low severity, moderate severity and high severity. The acres burned in each category are displayed in Table 4 and the categories are described below.

Table 4. Fire severity to vegetation for the Whychus Watershed.

Vegetation Severity	Acres	% of Watershed
Low	2,899	2%
Moderate	1,508	1%
High	1,814	1%
Total	6,221	4%

*The Black Crater Fire and GW Fire were the two largest fires, making up the majority of the burned acres within the watershed, therefore severity estimates do not include the Cache Mountain and Lake George fires.

Low Severity: These areas generally received a low to severity underburn that resulted in low mortality in the overstory trees (generally less than 25%) and 10% to 90% consumption and perhaps mortality of the ground vegetation and 25% to 75% consumption of the existing down woody debris.

Many of these acres appeared to have experienced a "nice underburn." In some cases this is true, however, in other cases, the underburn was very severe and is likely to result in the loss of most of the white fir and other non-fire resistant components (e.g., lodgepole pine, western white pine, incense cedar, and other true firs), if present. In the areas of severe underburning, it appears that most of the ponderosa pine and Douglas-fir will be able to survive this intense underburn, however, due to the intense heat of the fire at the base of the non-fire resistant components, primarily white fir, it can be expected that white fir and other similar components will continue to be lost over the next 3 to 5 years due to the deleterious effects of the fire. It is expected that the white fir that was killed by the fire, but the crowns have not yet turned brown, will turn brown in the next year or so and trees that have not been killed outright are under stress will continue to die from a variety of factors (fire effects, or insects, or diseases) over the course of the next 5 years.

Some areas within this category may actually be unburned but in general these are isolated areas and are the exception rather than the rule.

Moderate Severity: These areas experienced mixed severity burning where the overstory tree mortality ranges from 25% to 75%. Many areas tend toward the high end of the mortality range with some scattered small patches of 100% mortality. The primary tree species to make it through the fire in these areas are the large overstory ponderosa pine and Douglas-fir. These areas also received a very sever underburn resulting in 90% to 100% consumption of the ground vegetation and near complete consumption of the existing down woody debris. A percentage of these acres may need reforestation.

High Severity: These areas received very high intensity fire that resulted in, for all practical purposes, a stand replacement event. In most areas, the overstory tree mortality is 100% but can be as low as 75%, especially on the edges of these areas. These acres will require reforestation.

Insects and Disease

Since the original Whychus watershed assessment there has been a large mountain pine beetle (MPB) outbreak, affecting mainly the lodgepole pine while taking out the occasional ponderosa pine within the project area as displayed in Table 5.

The mountain pine beetle outbreak has been widespread affecting lodgepole pine both within and outside the Whychus watershed. The severity of the mortality is variable based upon stand density,

stand structure and species composition. Mountain pine beetle generally targets lodgepole pine 8 inches dbh (diameter at breast height) and larger. In areas of high density some lodgepole between 5 and 8 inches dbh have experienced mortality due to the large number of beetles within the area. Mountain pine beetle will also attack ponderosa pine, but generally occurs in isolated tree mortality rather than the widespread mortality seen in the lodgepole pine.

Table 5. Acres of affect Lumped Plant Association Group based on TPA of mortality.

LPAG	Trees Per Acre (TPA) Mortality							
	0	<10	10-19	20-29	30-39	40-49	50-100	Total
MCW	6.309	4,394	1,924	833	652	1,094	506	15,713
MCD	23,670	5,505	1,749	1,073	480	147	176	32,801
PP	76,394	3.982	85	19	0	0	0	80,480
MHD	5,145	3,706	3,148	2,192	1,326	175	160	15,852
LP	456	1,876	2,284	2,959	2,192	2,763	3,905	16,435
JUN	1,361	0	0	0	0	0	0	1,361
NON-FOREST	10,387	1,184	120	36	29	19	4	11,777
RIPARIAN	2,163	693	293	308	198	54	30	3,739
TOTAL ACRES	125,886	21,340	9,604	7,419	4,878	4,252	4,781	178,160

*See Table 1 for PAG descriptions.

The estimated trees per acre (TPA) of mortality are based on aerial surveys done from 1997 through 2008. A map calculator was used to combine estimated TPA mortality for all years to get a total TPA mortality. The TPA were then lumped into categories of 0, <10, 10-19, 20-29, 30-39, 40-49, and 50-100. Personal communication with the local entomologist, Andy Eglitis, suggested based on field experience that only 1/3 to ½ of the dead trees can actually be seen from the aerial surveys. It was suggested to use a multiplier to determine the level of mortality. Based on the multiplier it was determined that 30-100 TPA would represent high level of mortality within a stand, 10-30 TPA would be a moderate level of mortality and anything less than 10 TPA would be low mortality. Table 6 shows the percentage of mortality related to mountain pine beetle in each lumped plant association group.

Table 6. Percentage of mortality in each LPAG.

LPAG	TPA Mortality				
	0	<10 (Low)	10-30 (Moderate)	30-100 (High)	Total
MCW	40%	28%	18%	14%	100%
MCD	72%	17%	8%	3%	100%
PP	95%	5%	0%	0%	100%
MHD	32%	23%	34%	11%	100%
LP	3%	11%	32%	54%	100%
NON-FOREST	89%	10%	1%	0%	100%
RIPARIAN	58%	18%	16%	8%	100%
TOTALS	71%	12%	10%	7%	100%

Based on field observations most of the lodgepole pine has experienced high levels of mortality from the mountain pine beetle. Stands of lodgepole pine that have not experienced high mortality are those with a dominant size class of seedling/sapling or that have low stand densities (although many of these have experienced some mortality) or have not yet been affected by the beetle. Generally outbreaks last around 15 years. The Whychus late successional reserve assessment area is nearing the end of the outbreak, and the majority of the lodgepole within the area have been affected by the mountain pine beetle. There may be some addition mortality in coming years.
The mountain hemlock plant association group has a large component of lodgepole pine, which explains the higher percentage of mortality within this plant association group. Other plant association groups do not have as much, if any lodgepole pine, thus experienced much lower mortality levels from the mountain pine beetle.

Stand Structure and Tree Size

The major changes to stand structure within the Whychus watershed have occurred due to three disturbance events: vegetation management activities, recent wildfires (Cache Mtn. in 2002, Black Crater and Lake George in 2006, and GW in 2007), and the mountain pine beetle outbreak. Within the areas burned by wildfire there was a mix of severities, each of which have had a different effect on stand structure. Within the stands that are high severity or stand replacement, the stand structure would change from seedling/sapling, pole, small or medium/large to grass/forb/shrub. About 1% of the fire area within the watershed that was affected by high severity fire, is assumed to move to the grass/forb/shrub structure. Of the fire area 1% of the area within the watershed was affected by moderate severity fire. Since moderate severity fire is a mix of underburning and stand replacement fire change in stand structure due to the moderate fire severity needs to be analyzed on a project by project basis. Some of this will have changed structure to grass/forb/shrub and some will remain the same as it was pre-fire condition. Areas that were underburned or experienced low severity fire will have little to no change in stand structure. Some of the understory trees and fire intolerant species could experience mortality related to the fire, which will have to be analyzed on a project by project basis. Of the fire area low severity fire affected 2% of the late successional reserve.

The mountain pine beetle outbreak has been wide spread and has affected most of the lodgepole pine within watershed. Of the lodgepole pine LPAG 54% is estimated to have high mortality, which in many cases most if not all the lodgepole pine greater than 8" dbh are dead, 32% of the lodgepole pine LPAG has experienced moderate mortality, 11% low mortality and 3% no mortality. There may be a few scattered mature lodgepole pine remaining throughout the LPAG, but for the most part only seedling/sapling and some pole size lodgepole are remaining. This is true for other LPAGs as well, although there is a greater chance of having isolated live lodgepole pine that has not been affected by the MPB. Stands that have high mortality due to the MPB can be expected to have their stand structure to change from small or medium/large back to seedling/sapling, grass/forb/shrub or pole depending on the structure of the understory prior to the disturbance. Stands with moderate mortality will have varying changes to stand structure. The change in structure to these stands will be analyzed on a project by project basis. Stands with low or no mortality will have little affect on stand structure and thus remain in the same size class as they were prior to the disturbance.

The high elevation mountain hemlock LPAG was heavily affected by the MPB. Many of these stands have a mix of mountain hemlock and lodgepole pine. The stands with high mortality, which is 11% of the LPAG can be expected to change structure from small or medium/large to seedling/sapling or pole or grass/forb/shrub, depending on the structure prior to disturbance and the species composition of the stand. High elevation mountain hemlock stands with moderate, low or no mortality will see little or no change in stand structure.

The mixed conifer wet LPAG experienced the second highest percentage of mortality, next to the lodgepole pine LPAG, with 14% of the mixed conifer wet experiencing high mortality. The stands with high mortality can be expected to change structure from small or medium/large to seedling/sapling or pole or grass/forb/shrub, depending on the structure prior to disturbance and the species composition of the stand. Mixed conifer wet stands with moderate, low or no mortality will see little or no change in stand structure. The percentage of lodgepole pine within all other LPAGs is small enough that the mortality in these stands will have little to no affect on the stand structure.

Potential Old Growth (POG)

Potential old growth (POG) for the watershed was estimated utilizing the photo interpretation data from 1995 aerial photos. Region 6 interim old growth definitions (USDA Forest Service, 1993) were used to classify potential old growth stands for the ponderosa pine series, grand fir/white fir series and lodgepole pine series. For each series, the interim old growth definition contains 6 attributes that are used to assess and classify potential old growth. For this analysis, only 1 attribute, "number of large trees per acre", was utilized. Consequently, because only 1 of the 6 old growth attributes was used, stands that have the minimum number of large trees per acre to qualify as old growth are labeled ***potential*** old growth. Actual old growth should be specifically identified on a project by project basis. The number of large trees per acre was estimated for each stand using percent canopy cover as a surrogate for large trees per acre. The old growth definition for mountain hemlock was not published in the Region 6 interim old growth definitions and was not available at the time of this analysis and there was not an old growth definition developed for the riparian vegetation series. Therefore, the old growth definition for the white fir series was used to identify potential old growth in the riparian and mountain hemlock series (High Elevation LPAG). **Table 7** displays the attributes used to classify potential old growth and **Table 8** displays the percent of the forested acres estimated to be potential old growth by LPAG.

Table 7. Attributes used, by LPAG, to estimate *Potential* Old Growth for the Watershed.

Lumped Plant Association Group (LPAG)	OLD GROWTH ATTRIBUTES		
	Tree Size (DBH)	Approx. Number Trees/Acre	Aerial Photo Percent Canopy Cover
High Elevation*	21"+	15+	15%+
Lodgepole Pine	9"+**	60+	15%+
Mixed Conifer Dry	21"+	15+	15%+
Mixed Conifer Wet	21"+	15+	15%+
Ponderosa Pine	21"+	10+	10"+
Riparian	21"+	15+	15%+

* The old growth definition for mountain hemlock was subsequently obtained after this analysis was completed and this definition identified 10 or more trees per acre for potential old growth in this series. Consequently, this analysis under estimates the amount of potential old growth for the mountain hemlock series.

** Tree size for the lodgepole LPAG was reduced from 12" to 9" based on advice from Hopkins (1998).

Table 8 displays the percent of the forested acres estimated to be potential old growth (POG) by LPAG prior to recent disturbance (i.e., large fire and MPB outbreak) and the percent of the pre-disturbance area involved in each disturbance event. High severity fire is essentially a stand replacement fire; consequently, POG involved in high fire severity is no longer considered POG. Moderate severity fire is a mix of stand replacement fire and non-stand replacement fire, consequently, the POG involved in this type of fire has been altered regarding most, if not all, stand attributes. However, the extent of those alterations is not explicitly known and will need to be verified on a project by project basis. Mountain Pine beetle is assumed to generally attack lodgepole pine trees 8 inches and greater, however in outbreak conditions trees between 5 and 8 inches will be absorbed. It is assumed that areas estimated to have 30

trees per acre (TPA) or greater dead is a stand replacing event, therefore no longer considered POG. Stands with moderate mortality, having between 10 and 30 TPA dead will have to be verified on a project by project basis. These stands may continue to experience mortality as the infestation continues.

Table 8. Estimate of *Potential* Old Growth (POG)by LPAG.

Plant Association Group	% POG of Watershed before Disturbance	% of Current POG involved in Disturbance			% POG of Watershed after Disturbance
		High Severity Fire	Moderate Severity Fire	High Mortality from MPB	
Ponderosa Pine	18	0-2	0-2	0	16-18
Mixed Conifer Dry	22	6-30	3-15	0-4	12-19
Mixed Conifer Wet	30	2-9	1-5	0-3	23-27
Lodgepole Pine	83	0	0	90-100	0-8
High Elevation Mt. Hemlock	29	0	0	50-100	0-13
TOTAL	29	8-39	4-20	28-40	13-25

*No POG experienced any vegetation management that would change the POG characteristics of the stand and therefore was not considered in the evaluation of change in POG due to disturbance.

The original Whychus Watershed assessment stated "Due to its inherent instability, the condition of lodgepole pine old growth tends to be relatively short-lived. Consequently, the amount of lodgepole pine old growth is expected to change significantly within a fairly short time frame, perhaps within the next 20-30 years (Whychus Watershed Assessment, 1998, pg. 51)." Shortly after this assessment was completed a large outbreak of Mountain Pine Beetle occurred within the area, affecting most of the lodgepole pine. Nearly all of the old growth lodgepole pine has been affected by this outbreak and therefore has been set back to early stand structure conditions. In other PAGs that had a lodgepole pine component, the lodgepole pine has experienced high levels of mortality, thus changing the species composition and stand structure, possibly reducing the POG.

Species Composition

Vegetation Management Projects:

In areas treated under vegetation management the species composition has changed slightly, if at all. Treatments involve thinning from below removing small trees, mostly ponderosa pine and white fir within ponderosa pine stands, thus the species composition has remained intact.

Mountain Pine Beetle Outbreak:

In areas affected by the recent mountain pine beetle outbreak, changes in species composition have been significant. In areas with densely stocked small size and larger lodgepole pine stands a large percentage of the lodgepole pine trees have been killed by the MPB, thus changing the species composition from lodgepole pine to other species that occur on the landscape. For the lodgepole pine LPAG there is little shift is species composition as lodgepole pine is the dominant

species. In the high elevation mountain hemlock LPAG there tends to be a high percentage of lodgepole pine mixed in with mountain hemlock and other high elevation species. The stands of high elevation mountain hemlock that have experienced a moderate to high level of mortality will experience a species shift from lodgepole pine to mountain hemlock or any other high elevation species present on the site. The mixed conifer wet PAG will experience a shift in species composition where the mortality was high since these stands were predominantly lodgepole pine, others will see little to no sift in species composition. The remaining LPAGs will experience little to no shift in species composition due to the fact that lodgepole pine is a minor component within the composition of the stand.

Wildfire:

In area affected by wildfire, changes to species composition have been significant. In areas affected by high severity wildfire in which the result was classified as stand replacement (approximately 1,814 acres), species composition has been converted to early seral vegetation and has been classified as grass/forb/shrub.

In areas affected by moderate severity wildfire in which the result was mixed mortality where there is a mix of underburning and stand replacement and all possibilities in between, species composition was variably affected. In these areas, mortality can be expected to be between 25% and 75%, consequently, complete species conversion to early seral species composition can be expected on a portion of the acres, however, a majority of the acres will have some component of the pre-fire stand that will have survived.

In the mixed mortality and underburned areas, the species that were most likely to have survived the wildfires were the fire resistant early seral species such as ponderosa pine and the larger more fire resistant late seral trees (e.g., larger Douglas-fir).

Stand Densities

Vegetation Management Projects:

In areas treated under vegetation management projects stand densities have been reduced. Densities are reduced through thinning, by removing understory trees. This changes the stand structure by moving stands toward larger size classes since the smaller size trees within the stand have been removed, increasing the average tree size within a stand.

Mountain Pine Beetle Outbreak:

In areas affected by the recent mountain pine beetle outbreak, changes in stand densities have been significant. In areas with densely stocked small size and medium/large lodgepole pine stands a large percentage of the trees have been killed by the MPB, thus the densities of these stands will be greatly reduce. The dead trees remain standing for a time and will eventually fall and become down wood, increasing the fuel loading, but are not considered when discussing stand density. Only live trees are accounted for when considering stand density. LPAGs that experience densely stocked lodgepole pine stands include lodgepole pine, high elevation mountain hemlock and some mixed conifer wet, very little mixed conifer dry. All stands that have experienced high mortality can be expected to have greatly reduced stand densities. Stands with moderate mortality will see varying degrees of reduced stand density, most of which will have a significant affect on the stand.

Wildfire:

In area affected by wildfire, changes to stand densities have been significant. In areas affected by high severity wildfire in which the result was classified as stand replacement (approximately 1,814 acres), stand densities have been reduced to zero.
In areas affected by moderate severity wildfire in which the result was mixed mortality where there is a mix of underburning and stand replacement and all possibilities in between, stand density was variably affected. In these areas, mortality can be expected to be between 25% and 75%, consequently, stand density reduction will be variable across stands and in turn the landscape.

In areas affected by low intensity wildfire, some density reduction can be expected, especially in the smaller trees and in the least fire resistant trees (e.g., white fir). However, in most cases, density reduction as a result of low intensity wildfire was probably not significant because a majority of the low intensity fire was a result of burnout/backburning operations that occurred under favorable burnout conditions such as during the night or high humidity/wet/rainy conditions. This type of low intensity burning left the densities in most stands approximately what it was prior to the fires, and for those stands that were at unsustainable densities relative to forest health and fire hazard prior to fire, will remain so post fire.

Updated Conditions and Trends by LPAG

The LPAG summaries in the following sections are updates to the original summaries. They discuss the trends in each LPAG since the 1998, as it relates to the three major disturbance events (vegetation management, large wildfire and MPB outbreak) that have occurred within the watershed.

PONDEROSA PINE (PP) 44% of Total Acres

In this plant association group, ponderosa pine is the main seral and climax species, growing in small, even-age groups. Minor amounts of white fir and Douglas-fir may be present particularly in the ecotones with the mixed conifer plant associations. The ponderosa pine plant association is the most predominant plant association within the watershed. Ponderosa pine is the dominate species, but fir is increasing adjacent to the mixed conifer plant association due to adjacent seed sources and protection from fire.

Trends Since 1998:

- There has been little effect on species composition or stand structure due to wildfire within this PAG in the watershed because there has been very little stand replacement or mixed severity wildfire within this PAG.
- There has been little effect on stand structure or species composition due to the recent MPB outbreak within this PAG in the late successional reserve. There are a few scattered lodgepole pine in areas of higher productivity that were killed from the beetle, as well as a few scattered ponderosa pine. This only occurred within a small area and generally less than 10-20 trees per acres were affected.
- In areas that have been thinned from below the structure of the stands has shifted to the larger size classes, having fewer trees per acre in the seedling/sapling and pole size classes.

LODGEPOLE PINE (LP) LPAG 29% of Total Acres

This vegetation type is commonly found mostly at higher elevations, most within the Three Creeks Management Strategy Area. The areas where lodgepole pine is climax tend to have poor cold air drainage, or soil or moisture conditions that other species can't tolerate.

Trends Since 1998:

- There has been little to no effect on species composition or stand structure due to wildfire within this PAG in the late successional reserve because the fire did not burn there.
- There has been a significant change to the species composition, stand structure and density since the 1997 analysis due to the large MPB outbreak. 54% of the lodgepole pine has experienced high mortality, most of which is small or medium/large size classes. In stands experiencing high mortality the structure has shifted to younger age classes and the density has been greatly reduced. 32% has experienced moderate mortality, which is most likely younger stands with a component of large trees. These stands will shift in age class and have a reduced density. Of the remain lodgepole pine that experienced low mortality (11%) or no mortality (3%) these are most likely seedling/sapling or pole dominated stands and will experience little to no shift in age structure or density.
- The acres estimated to be potential old growth has decreased significantly, due to a loss of most, if not all potential old growth lodgepole pine from the MPB outbreak.

MIXED CONIFER DRY (MCD) LPAG **19% of Total Acres**

Mixed conifer dry plant associations are found on the slopes of the Cascades down to the flatter areas of pure pine stands along the eastern edge of the watershed. Generally these areas have moderate to high productivity. Current tree vegetation consists of true firs, ponderosa pine and small amounts of other species. In these series in the Whychus Waterhed, ponderosa pine (and in some cases Douglas-fir) should be the dominant early seral species.

Trends Since 1998:

- There has been a slight shift in overall size/structure due to the recent wildfire. This has resulted in an increase in the grass/forb/shrub size class and a decrease in all other size classes.
- The acres dominated (canopy cover) by the grass/forb/shrub class has increased within areas affected by high severity, stand replacement fire.
- The medium/large size class has decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The small classes have decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The pole classes have decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The seedling/sapling/pole class has decreased slightly due to high severity fire, but has increased greatly within the lodgepole pine dominated stands due to the MPB outbreak.
- There has been a slight shift in overall species composition due to recent wildfire. The number of acres dominated by climax (i.e., late-seral species) and mixed species decrease and the acres dominated by early seral species (pioneer) increased.
- There has been a slight shift in species composition due to the recent MPB outbreak. Pole size and larger lodgepole pine has been greatly reduced throughout the LPAG.

MIXED CONIFER WET (MCW) LPAG **9% of Total Acres**

The mixed conifer wet plant association also has dominant climax species of grand fir/white fir and Douglas-fir. In mixed conifer wet, the productivity is generally higher than in the mixed conifer dry plant associations. Current vegetation consists of true firs, ponderosa pine, Douglas-fir and lodgepole pine. Spruce can be found in the wetter uplands and riparian areas.

Trends Since 1998:

- There has been a slight shift in overall size/structure due to the recent wildfire. This has resulted in an increase in the grass/forb/shrub size class and a decrease in all other size classes.
- The acres dominated (canopy cover) by the grass/forb/shrub class has increased within areas affected by high severity, stand replacement fire.
- The medium/large size class has decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The small classes have decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The pole classes have decreased slightly due to high severity, stand replacement fire, and decreased greatly where lodgepole pine was the dominated species due to the MPB outbreak.
- The seedling/sapling/pole class has decreased slightly due to high severity fire, but has increased greatly within the lodgepole pine dominated stands due to the MPB outbreak.
- There has been a slight shift in overall species composition due to recent wildfire. The number of acres dominated by climax (i.e., late-seral species) and mixed species decrease and the acres dominated by early seral species (pioneer) increased.
- There has been a slight shift in species composition due to the recent MPB outbreak. Pole size and larger lodgepole pine has been greatly reduced throughout the LPAG.

HIGH ELEVATION LPAG — 9% of Total Acres

Generally, these associations are of low to moderate productivity. This plant association is found at the higher elevations with most of the acres in wilderness and roadless areas. In these plant associations lodgepole pine is the major early seral species and sub-alpine fir, whitebark pine and western white pine are minor early seral species.

Trends Since 1998:

- There has been little to no effect on species composition or stand structure due to wildfire within this PAG in the late successional reserve because the fire burned very little of this area.
- There has been a significant change to the species composition, stand structure and density since the 1998 analysis due to the large MPB outbreak. The change mainly occurs in stands that have moderate and high levels of mortality occurring. In these stands most, if not all of the small and medium/large lodgepole pine component of the stand will no longer exist. This will reduce the stand density, possibly change the stand structure by shifting to a younger age/size class, possibly shift it to a larger size class in stands with large mountain hemlock and other high elevation species remaining, and change the species composition from a lodgepole pine or a mix with lodgepole pine to mountain hemlock or other high elevation species present.
- The acres estimated to be potential old growth has decreased due to a loss of the potential old growth lodgepole pine component of the stand from the MPB outbreak.

RIPARIAN LPAG — 2% of Total Acres

This LPAG includes various plant associations identified by Kovalichiak (1987). Generally, these associations are of fairly high productivity. These plant associations are found at all elevations along a moisture gradient that ranges from less than 25"/year to over 100" of precipitation per year. These associations also span the range of potential natural vegetation of climax species from ponderosa pine to Mt. Hemlock.

Trends Since 1998:

- There has been a very slight shift in overall size/structure due to recent wildfire. This has resulted in a slight increase in the grass/forb/shrub size class and a decrease in all other size classes.
- There is a slight shift in species composition, stand density and stand structure due to the loss of lodgepole pine due to the MPB outbreak.

Landscape Patch Conditions

Prior to 1953 (Historic) Condition:
In general, large unfragmented patches of ponderosa pine-dominated habitats (ponderosa pine, mixed conifer dry and mixed conifer wet) and lodgepole pine and high elevation mountain hemlock habitats dominated the landscape.

The ponderosa pine (45% of the landscape) and dry mixed conifer (18% of the landscape) areas were primarily a large patch of medium/large tree (21"+ dbh) ponderosa pine habitats with open canopies of 1-2 stories. The vertical structure of these stands was probably less complex than today because of low to moderate intensity fires. Wildlife species like the northern goshawk and white-headed woodpecker benefited from these conditions and probably reached high population levels.
The second and third largest patch types were in lodgepole pine and high elevation mountain hemlock habitats, respectively (9% and 9% of the landscape). These were fairly contiguous in nature, except where disturbance factors (i.e., insects, wind-throw, and fire) created smaller patches of early seral grass/forb habitats or dense stands of pole and small tree habitats of lodgepole pine and mountain hemlock.

Mixed conifer wet, the fourth largest patch type (9% of the landscape), was also primarily medium/large ponderosa pine habitats, but also provided a majority of the multi-storied, high canopied patches, however, this habitat condition was probably limited in the watershed. Species associated with late-successional mixed conifer habitats (e.g., northern spotted owl and pileated woodpecker) that were vertically complex, multi-storied, and high canopied may have been less abundant on the landscape than they are today.

Early seral patches and edge habitats were a small percentage of the landscape. The early seral patches, however, were much larger in size because they were created by occasional stand-replacement fires. Early seral wildlife species were probably less abundant than today.
Snags and down woody debris densities were probably lower than today because of the low to moderate intensity fires, and the absence of logging debris.

1953 Condition:
At this point in time, the watershed can be split into two sections, the portion within the boundaries of the old Cascade Forest Reserve (CFR) and the portion east of the CFR. The eastern boundary of the CFR was the boundary between Range 9 East and Range 10 East. Very little timber harvest had occurred in the portion of the watershed within the boundaries of the CFR. However, extensive timber harvest had occurred on the lands east of the CFR.

Within the boundaries of the CFR, habitat conditions were probably similar to those described in the pre-1953 condition, except that years of fire exclusion had increased the amount of mixed species, high canopied habitat. The ponderosa pine and dry mixed conifer areas were dominated by large unfragmented patches of open, medium-large ponderosa pine trees. The lodgepole pine, high elevation mountain hemlock were the next largest habitat patches.

Ponderosa pine patches were few in number but were large in size. A patch size analysis done for the Metolius Watershed Analysis determined that the mean patch size for the Metolius Watershed was 12,000 acres with a standard deviation of 30,000 acres. There were smaller sized patches representing 5% of the watershed interspersed throughout the larger, medium/large habitat. These patches were composed of open, 1-2 storied ponderosa pine habitats. The vertical structure of these stands was probably less complex than today because of frequent low to moderate intensity fires.
Wildlife species such as the northern Goshawk and white-headed woodpecker benefited from these conditions and probably reached high population levels. The amount of multi-storied, high canopied habitat in wet mixed conifer increased from pre-1953 conditions providing additional habitat for species associated with late-successional mixed conifer habitats (e.g., northern spotted owl and pileated woodpecker). As in the historic condition, lodgepole pine and mountain hemlock habitats were fairly contiguous and composed of a few large patches. It can be assumed that similar conditions existed for the Whychus Watershed.

Early seral seedling/sapling habitats were relatively large in size, were few in number and encompassed a small percentage of the landscape. These were generally the result of fire disturbance events.
East of the CFR boundary, approximately two thirds of the ponderosa pine habitats within the watershed boundary had been harvested at least once. Consequently, many of the medium/large ponderosa pine stands in this area had all or a portion of the medium/large overstory trees removed and the stands were thus converted to a variety of smaller tree dominated stands. Approximately one third of the acres were converted to pole-sized stands and one third to small sized stands. Approximately 5% of the stands were seedling/sapling sized with 3% this habitat 5% resulting from a fire event. Most of the mixed conifer stands in this area had not been entered and were similar to the same associations found within the boundaries of the CFR.

1995 Condition:
Landscape conditions have changed dramatically from the historic condition to the present. Currently, the landscape has many more landscape patches of varying sizes and structural stages and is highly fragmented from the historic condition. The most common landscape patch type in all the LPAG's is now the small sized habitats with multi-storied canopies. Fragmentation has resulted primarily from timber harvest activities including road building, but has also occurred as the urban interface gradually expands into forested areas.

The largest unfragmented landscape patch is the small and pole sized lodgepole pine and mountain hemlock habitats located in the wilderness and roadless areas and along the Mckenzie pass (19% of the watershed). This patch type, while not the most common (based on acreage), is the largest contiguous patch type. The pole and medium/large patch types are the third largest patch type while the seedling/sapling patch type is the fourth. The grass/forb/shrub is the smallest patch type and what does exist is classified as non-forest.

Several results of timber harvest are increased miles of edge, higher edge contrast, and a reduction in the size of late successional interior habitats or core area habitats. The increase in early/mid seral patches and edge have probably resulted in higher population levels for species such as mountain bluebirds, white-crowned sparrows, mule deer, and Roosevelt elk.

While interior habitats would not have been a concern in the pre-1953 landscape, they are an important consideration today. The medium/large ponderosa pine stands with less than 40% canopy cover habitat that dominated the historic landscape is now uncommon. In general, both mixed conifer and ponderosa

pine areas contain late-successional interior habitats that are small.

2009 (Present Condition):
The Whychus watershed assessment area for the most part has maintained patch size as assessed in the original assessment. The major difference is the condition in that the small and medium/large lodgepole has been converted to seedling/sapling or pole size.
The wildfires broke up the patch condition within its boundary by changing stand structure, composition and density through varying degrees of fire severity across the landscape.

Potential for Salvage Harvest

Salvage of dead trees within the LSR is based on the standards and guidelines of the Northwest Forest Plan (NWFP) Standards and Guidelines C-13 through C-16 (1994) and is subject to review by the Regional Ecosystem Office. Salvage of dead trees is not generally considered a silvicultural treatment within the context of these standards and guidelines (NWFP 1994).

The recent fires of the last 7 years have presented large blocks of dead and dying trees that could be salvaged to reduce future fuel loads, provide funding for fire related restoration projects, provide economic value to local communities and provide timber resources to help meet the national demand for wood products and as suggested by Berlik and others (2002) lessen the national demand for wood products internationally (i.e., on a global scale). Using aerial photo interpretation data, it is estimated that approximately 1,814 acres were involved in stand replacement wildfire and 1,508 acres were involved in mixed severity wildfire, may be available for salvage harvest, but unlikely to be economically viable due to the amount of time that has passed since the fire occurred. These figures are tentative and are likely to change over time as more site-specific information becomes available.

The recent MPB outbreak of the last 11+ years has presented large blocks of dead and dying lodgepole pine that could be salvaged to reduce future fuel loads, provide firewood to local communities and provide economic value to local communities. Using aerial photo interpretation data and aerial surveys it is estimated that approximately 13,911 acres experienced high mortality from the MPB and 17,023 acres experienced moderate mortality, may be economically viable for salvage harvest. These figures are tentative and are likely to change over time as more site specific information becomes available.

2002 Cache Mountain Fire burned into Black Butte Ranch and destroyed 2 homes

Findings

- 7% (12,374 acres) of the watershed area has been involved in wildfire since 1998.
- 1% (1,814 acres) of the watershed area has experienced stand replacement fire in which virtually all vegetation canopy was consumed/removed.
- 1% (1,508 acres) of the watershed area has experienced mixed severity fire in which 25% to 75% of the vegetation canopy was consumed/removed.
- As a result of the recent wildfires, there has been a shift in size structure across the landscape. The grass/forb/shrub class has increased and the pole, small and medium/large size classes have experienced a slight decrease due to fire.
- Continued mortality can be expected in areas that experienced mixed mortality over the next 3-5 years as severely damaged trees succumb to secondary mortality agents.
- Potential Old Growth has been reduced due to recent large wildfire and the MPB outbreak, with the biggest affect being the large reduction in potential old growth lodgepole pine from MPB.
- 29% (52,274 acres) of the watershed area has been involved in a large scale mountain pine beetle outbreak since 1998.

Resource Report
FIRE/FUELS

FIRE/FUELS

Ponderosa Pine Plant Association Group (PAG)

1998
All of the large fires, over 100 acres that have been recorded this century in this watershed were located within the ponderosa pine PAG.

Update:
Approximately 70% of the fires documented in Forest polygon records (generally greater than 100 acres, but some smaller fires are documented) in this watershed (25 fires) have been located with the ponderosa pine PAG.

TRENDS

- Most fire starts (both human and lightning) are found within this forest type.

Juniper - Pine Interface

1998
Similar to ponderosa pine. Cheatgrass has accelerated fire spread.

Update: Not much change

TRENDS

- Fire regime (size, severity, frequency) conversions are similar to those described in the ponderosa pine PAG.
- Cheatgrass, which thrives after disturbance, has invaded this PAG. Cheatgrass ignites and burns easily when dry, regardless of quantity, and can support a rapid rate of fire spread. Additionally, cheatgrass dries 4 to 6 weeks earlier than perennial grasses, is susceptible to fire 1 to 2 months longer in the fall, and can inhibit the post-fire establishment of native vegetation (Zouhar 2003).

Dry and Wet Mixed Conifer PAG

1998:
Fires are generally lightning caused. There have been no fires greater than 100 acres in size within the last 100 years.

Update:
From 1987 – 2007, fire starts have been nearly equally split between lightning and human-caused. The Black Crater fire (lightning-caused, 2006), a small portion of the GW fire (lightning-caused, 2007), the Trout Creek fire (cause not documented, 1913), the Black Butte fire (cause not documented, 1981), and an Unknown fire (cause not documented, 1979) burned within this PAG within the last 100 years. These large fires account for 20% of the total number of large fires burned and 37% of the acreage burned by large fires within the last 100 years within this watershed.

Lodgepole Pine Fire Return Intervals

1998:
The fire return interval is 100 to 150 years; on the edge of the range, pine beetles often intervene and cause extensive mortality, followed by stand-replacement fire. Patch sizes are usually small, ranging from 10 - 100 acres. Most lodgepole pine stands are in late-successional stages of development and are likely to be altered by insects or fire in the near future.

Update:
The fire return interval is 100 to 150 years; on the edge of the range of Fire Regime IV. Pine beetles often intervene and cause extensive mortality. This can be followed by stand-replacement fire or a new cohort of lodgepole pine. Disturbance patch sizes can be small, ranging from 10 - 100 acres, but a large-scale event would not be uncharacteristic (Personal Communication, Andy Eglitis).
Most lodgepole pine stands have been infested with mountain pine beetle or are in a late-successional stage.

TRENDS

- Most lodgepole pine stands have been infested with mountain pine beetle. Under certain weather conditions, a large-scale fire could occur in the near future.
- Downed woody debris will increase as dead lodgepole pine fall to the ground. With or without fire, a new cohort will establish.

High Elevation Forest PAG

1998:
Lightning was the cause of fire about 62% of the time. Fire occurrence was infrequent with moderate to high fire intensities once they do start. Weather conditions and a short fire season, due to elevation, also reduces the probability of large fire occurrences. As the stand age increases, tree mortality within the stand increases and more trees fall to the ground. This increases the amount of woody debris on the ground. This has the potential to increase wildfire intensity in these stands.

Update:
Lightning starts account for approximately 30% of the fires in this PAG . Weather conditions and a short fire season, due to elevation, reduces the probability of large fire occurrences. As the stand age increases, tree mortality within the stand increases and more trees fall to the ground. This increases the amount of woody debris on the ground. This has the potential to increase wildfire intensity and severity in these stands.

TRENDS

- Fire exclusion has had the least effect because of very long natural fire return intervals.
- Conifer encroachment has lead to a decrease in meadow size.

Human influences on Fire Processes

Forest areas now contain subdivisions surrounded by National Forest. It is unlikely that we will ever be able to let natural fire starts burn near these areas but prescribed burns are being done in the urban interface to reduce fuels and lessen the risk of wildfires which might burn homes. Additionally, the 2009 Greater Sisters Country Community Wildfire Protection Plan establishes and prioritizes communities at risk to wildfire and serves as an education tool to inform the public on the role of fire and living in a fire-adapted ecosystem. Fuels reduction tools such as thinning and mowing are being introduced and often will be followed by fire. Fuels reductions including prescribed fire are also done to

improve safety for fire fighters, and protect important habitats and recreational areas.
Additionally, the Cascade Crest Wildernesses Wildland Fire Use (WFU) Plan was approved in June 2008. This plan provides the authority to manage lightning-caused fires for resource objectives in the Three Sisters Wilderness, which is located at the top of the Whychus Watershed. We now understand that many local species have evolved with the process of fire and benefit from its reintroduction. It is recognized that the scope of these prescribed fires and other fuel modifications needs to occur at a larger scale to mimic historic landscape patterns.

TRENDS

- All human starts will continue to be suppressed. Lightning-caused wildfires can be managed for resource objectives in the Three Creeks Wilderness, if an ignition occurs under conductive conditions.
- Human-caused fires account for nearly half of all starts in the watershed and will likely increase as the population and Forest visitation in central Oregon increases.
- The Greater Sisters Country Community Wildfire Protection Plan establishes and prioritizes communities at risk to wildfire and serves as an education tool to inform the public on the role of fire and living in a fire-adapted ecosystem
- Ecosystem restoration and hazardous fuels reduction projects which include thinning, mowing, chipping and/or burning are a Forest priority and will continue.
- A fire camp, on Forest Service land, is needed.

Fire Risk and Occurrence

There have been 535 fires within the Whychus watershed on National Forest lands between 1980 and 2007 that required suppression action. This more than doubles the numbers of fires documented in the original Watershed Assessment and equates to a fire occurrence of approximately 3 fires per 1,000 acres. However, there is a large area of private land, approximately 44,000 acres, where fire data was not analyzed.
There is an average of 21 fire starts per year in the Whychus watershed ranging from 13 starts in the pine stands to 7 starts in the higher elevation lodgepole and mountain hemlock stands per year.
There have been 280 fires, both lightning and human caused, within the ponderosa pine PAG. Thirty-six percent of these (100) were human caused starts, equating to 63% of the total fires in the watershed. Since the original Watershed Assessment, the amount of human-caused fires in high elevation areas has dramatically increased (19 human-caused fires from 1982 – 1996 compared to 36 human-caused fires from 1987 - 2007). This may be indicative of increased Forest visitation over the last decade in these areas.

Large fires

Large fire occurrences (generally greater than 100 acres, but some smaller fires are documented in Forest records) have been recorded since the early 1900s. Little is known about some of the earlier fires because records did not indicate their cause. There have been 25 large fires since 1900. Of the 25 large fires this century, 17 have been located within the ponderosa pine PAG. Five have occurred in the mixed conifer and only 2 within the lodgepole pine and mountain hemlock PAGs. A quick look at the spatial distribution of large fires shows that most have occurred in the northern and eastern portions of the watershed.

Fuel Loadings

Information about fuel loadings within this watershed is old and inaccurate for specific questions on tons per acre of fuel by size classes. Based on timber sale fuels inventories completed in the late 1980's, relative estimates can be made. No fuel loading information has been collected in the wilderness.

TRENDS:

- Nearly half of all fires are human caused. Most human caused fires are concentrated in the pine forest near the city of Sisters and subdivisions.
- Fire risk and potential has increased with increased fuel loads and stand densities. [no change]
- Most fire starts have occurred in ponderosa pine PAG in the northern and eastern portions of the watershed.

Fire Use

Native Americans used fire to manage landscapes to improve hunting and foraging. After European settlement, humans started putting out fires to protect homes and other resources. This has affected both vegetation and fire behavior. The natural beneficial role of fire is now recognized by fire ecologists and forest managers. In the past 15 years the Forest Service has ignited prescribed fires in this area. However, the benefits and visual effects of fire are still not well understood or accepted by the general public.

Wilderness Fire Re-introduction and Management

Fire has been one of the natural processes that created and maintained ecosystems of the Cascade Crest Wilderness. In 1996, a team from the Deschutes and Willamette National Forests wrote a Prescribed Natural Fire Program Plan for the Mt. Jefferson, Mt. Washington, and Three Sisters Wildernesses. This plan paves the way for the re-introduction of natural fire in the Wilderness. However, a "risk assessment" and "management ignited supplement" must be done before the plan can be implemented.

In 2008, the Cascade Crest Wilderness Wildland Fire Use (WFU) Plan was approved. This plan provides the operational decision-making guidance for managing lightning-caused fires for resource objectives in the Wilderness. An additional plan to allow for management ignited fire in the wilderness is still needed to complement the Cascade Crest Wilderness Plan to strategically reduce fuel loading, restore fire to the wilderness, and minimize the risks associated with future fires for resource objectives

Forest Urban Interface

Projects such as Sisters Area Fuels Reduction (SAFR), will be implemented in the wildland urban interface. Fuels management will continue to focus on projects, such as the future Popper and West Trout planning areas, that reduce risks to public safety and protect forest habitats from uncharacteristic losses.

Recent Fire Activity Related to Fire Regimes and Historic Fires

The following comments regarding fire size and intensity were developed after reviewing "Forest Conditions in the Cascade Range Forest Reserve Oregon" by Langille and others (1903), "Fire History in the Jefferson Wilderness Area East of the Cascade Crest" by Simon (1991) and the results of the original Whychus Watershed Assessment regarding the historic distribution of forest size/structure, species composition and density.

Fire Regimes 4 and 5

Within fire regimes 4 and 5, which are primarily found within the wilderness areas, the intensity of the fire was well within the historic range and would be expected. The size of the stand replacement event should be within the historic range of variability. In Langille and others (1903) numerous large fires are apparent on their maps but none are larger than approximately 10,000 to 15,000 acres and most appear in the high elevation country that roughly corresponds to the current wilderness designations. Langille and others (1903) also attribute a portion, and perhaps a good portion, of these fires as being caused by humans. Consequently, it is difficult to say that the fires mapped in 1903 are a good representation of the "natural" historic range of variability.

Simon (1991) conducted an analysis of the fire history in the portion of the Jefferson wilderness that lies east of the crest of the Cascades. Regarding the extent of historic fires over the last 270 years, Simon identified 3 fires that exceeded 7,000 acres, with the largest at nearly 13,000 acres which he considered conservative because he also identified gaps in the data due to more recent fires that eliminated potential evidence of a possible larger fire. For the 13,000 acre fire, Simon identified 9,920 acres of stand replacement and 3,000 acres of low intensity underburning and that the fire burned most of the acreage below 5,500 feet elevation for the entire length of the wilderness from the north to the south. Simon did not comment on whether any of the wilderness fires left the wilderness and burned additional acres outside of wilderness. Simon also identified 13 other large (i.e., >50 acres) fires and those, 4 were larger than 1,000 acres, and 9 were less than 1,000 acres.

In conclusion, regarding fire regimes 4 and 5, fire intensity was within the historic range of variability.

Fire Regimes 1 (low severity) and 3 (mixed severity)

Historically, in the Whychus Watershed, the ponderosa pine and much, if not most of the mixed conifer plant associations outside of the higher elevations (i.e., wilderness), especially the mixed conifer dry plant associations, burned under fire characteristic of fire regime 1. A portion of the mixed conifer plant associations, especially the wetter/higher site mixed conifer associations, likely burned under fire regime 3.

Evidence for this lies in that there is no evidence that large stand replacement events occurred in these plant associations historically, except, perhaps, at the higher elevations adjacent to fire regimes 4/5. In the 1997 watershed assessment, most of the ponderosa pine and mixed conifer associations were found to be dominated by small and medium/large sized early seral species (this includes large fire resistant Douglas-fir) and this condition is best achieved and maintained by low intensity fire regimes. Maps produced by Langille and others (1903) also do not show evidence of large stand replacement events in the ponderosa pine or mixed conifer plant associations outside of the higher elevations (i.e., >4,500 ft). Most fires mapped by Langrille and others (1903) below about 4,500 feet elevation are in line with what might be expected in fire regime 3. Fire regime 3 likely occurred in specific locations within the mixed conifer plant associations such as on higher sites (mixed conifer wet), on north slopes or at the higher elevations.

In conclusion, the stand replacement events from the recent wildfire are outside the historic range of variability, in both size and intensity, for the ponderosa pine and mixed conifer plant associations.

Resource Report
FISH

FISH

Introduction

The Whychus Watershed Analysis Update covers the upper portion of Whychus Watershed and the Three Creeks Subwatershed. Subwatersheds within the upper portion of Whychus Watershed include: Upper Trout Creek, Lower Trout Creek, Fourmile Butte, Middle Whychus Creek, Headwaters Whychus Creek, Upper Whychus Creek, Lower Indian Ford and Upper Indian Ford. This document is intended to update conditions and recommendations since the (USDA) 1998 Whychus WA (Watershed Analysis) was completed. Subwatershed boundaries and names have been updated since the Whychus WA but streams and drainage areas remain the same as those in the original WA. The entire area will be discussed but data analysis and surveys are focused on National Forest lands. Within the analysis boundary are seven primary perennial stream channels: Trout Creek, Alder Creek, Pole Creek, Whychus Creek, Snow Creek, Indian Ford Creek and Three Creek. Some small unnamed perennial and several intermittent/ephemeral streams also exist.

Whychus Creek, Trout Creek, Snow Creek and Indian Ford Creek contain populations of resident native redband trout (*Oncorhynchus mykiss gairdneri*). Summer steelhead (*O. mykiss)* and spring chinook (*O. tshawytscha)* were historically documented in Whychus Creek. Summer Steelhead are federally listed as threatened and were reintroduced to Whychus Creek in 2007 below the project area but could access the project area once passage is provided around irrigation dams. Spring chinook reintroduction in Lower Whychus Creek is planned for the spring of 2009. Spring chinook EFH (Essential Fish Habitat) is located in Upper Whychus Creek.

Alder Creek is an intermittent stream and is a tributary to Trout Creek. Pole Creek is a tributary to Whychus Creek. Pole Creek has been diverted for the City of Sisters municipal water supply and other water rights holders. Currently, only water from springs in Pole Creek Swamp flow into Whychus Creek. Indian Ford Creek begins as series of springs at Black Butte Ranch and it is heavily used for irrigation and goes dry during the summer in the lower 6 or 7 miles, depending on flow that year. Three Creek is not part of Whychus watershed but was analyzed in the 1998 WA. Three Creek flows out toward the Plainview area, has no surface connection to the Deschutes River and was primarily used for irrigation in the past.

Whychus Creek flows southeast and has several irrigation diversions dams that are located upstream of Sisters. Whychus Creek is designated a Wild and Scenic River upstream of the stream flow gage at river mile 24.7, with a ¼ mile corridor on either side that extends into the project area near Pole Creek Swamp. Whychus Creek and Indian Ford Creek are listed on the Oregon Department of Environmental Quality (DEQ) 303(d) list of water quality limited water bodies for stream temperature from its mouth to near the headwaters.

Management Direction

The WA area includes areas in Deschutes County, Oregon, on the Sisters Ranger District of the Deschutes National Forest (Figure 1). The project area is within the management direction of the Northwest Forest Plan (NWFP; USDA and USDI 1994), Pacfish (xx), Infish (xx), and the 1990 (USDA) Deschutes National Forest Land and Resource Management Plan (DLRMP).

The Whychus Creek Wild and Scenic River Plan includes the Resource Assessment (2007) that identifies the Outstanding Remarkable Values for the river. The following have been identified as outstandingly remarkable values: geology, fisheries, hydrology, ecology, wildlife, scenic resources, cultural prehistory resources, and cultural traditional use. These values need to be maintained and protected.

The Northwest Forest Plan (NFP) has identified the Headwaters Whychus Creek and Three Creeks subwatersheds as Key Watersheds. In the Three Creeks subwatershed this was primarily based on the lakes and ponds that provide habitat for rare endemic amphibian species (USDA 1998, page 24). Within the 1998 (USDA) Whychus Creek Watershed Analysis, the NFP Riparian Reserves were identified as being sufficient for this area. These Riparian Reserves are 300ft for fish bearing streams, both sides, and 150ft for non-fish bearing streams and wetlands on both sides of the stream or wetland. Additional streams were identified through field surveys after the Whychus Watershed analysis was completed.

The desired condition of riparian reserves is outlined in the Northwest Forest Plan Aquatic Conservation Strategy Objectives (Northwest Forest Plan ROD, B-11). Objectives include providing for travel and dispersal corridors for many terrestrial animals and plants and provide for greater connectivity within the watersheds.

The DLRMP (Deschutes Land and Resource Management Plan) identifies riparian areas to be managed for riparian dependent species (USDA 1990). The area of riparian protection was generally 100ft or as defined by riparian plant associations. These areas were to be protected and managed for the benefit of riparian dependent species only and not part of the land base for timber production. Watershed protection was based on the use of BMPs (Best Management Practices) to protect water quality and water related resources.

Recommendations from the Whychus Watershed Analysis (USDA 1998) that relate to Riparian Reserves are as follows:

Vegetation manipulation within the Riparian Reserves may be necessary to sustain and recover late-successional habitat conditions. The primary objective of treating Riparian Reserves is to establish large tree structure and improve rapid recruitment of large wood to streams at a faster rate than would occur naturally. The effects of the treatment need to be offset by the benefit to the function of the Riparian Reserve. Treatments in the uplands beyond the inner gorge may be most effective at reducing the risk of wildfire and loss of large wood over time (page 158).

- If vegetation manipulation is needed, only treat a portion of the reserve in each entry so that untreated refugia are maintained.
- Large tree stands are rare in local riparian reserves and those remaining need to be protected. Timber harvest within riparian reserves should not remove any live trees or snags larger than 21" dbh or down logs with an average diameter of 16" dbh or greater. Some exceptions may exist.
- Emphasis should be small tree understory thinning by hand or full suspension logging.
- Do not drive equipment in reserves during harvest or post harvest to protect soils, survey and manage soil lichens, and mollusks.
- Fuel treatments of riparian reserves need to be limited to light intensity underburns (primarily in mixed conifer dry and ponderosa pine types).

Restore Stream banks Wetlands and Floodplains Habitats (Page 216)

- Thin Riparian Reserves to develop large tree structure (i.e., Pole Creek area)
- Prevent removal of instream wood (i.e., Pole Creek), restore large wood and log jams in key areas

- Rehab roads, trails, and camps in riparian reserves (i.e., Pole creek, Whychus Creek)

Restore Forest Habitats through Vegetation Management (page 227)

- Aggressively thin plantations to accelerate large tree development, especially next to Riparian Reserves
- Promote large tree character in ponderosa pine, mixed conifer dry and wet areas along Riparian Reserves to enhance connectivity
- Protect springs in the Melvin subwatershed from vehicle and foot traffic.
- Thin along riparian areas near Pole Creek to accelerate large tree development

General Vegetation Management by Plant Association Group (PAG) - Riparian PAG (Page 235)

- Thinning or understory removal can be used to 1) reduce stand densities to help prolong the lives of the medium/large tree components, 2) help desirable tree species in all size classes less than 21" dbh grow faster and move into the medium and large size classes sooner.
- Thinning can be used to favor desirable tree species.

Riparian Reserve Buffer Distances

Riparian Reserves distances (Table 1) within the project area will follow those defined by the 1998 (USDA) Whychus Watershed Analysis. These distances meet or exceed those defined by the NFP and the Deschutes Forest Plan.

Table 1. Riparian Reserve Widths adopted from the NW Forest Plan ROD C-30

Categories of waterbodies	Riparian Reserve Widths
Fish bearing streams perennial or intermittent	300 feet on either side (600 feet total) or top of inner gorge or outer edge of riparian vegetation or outer edge of 100 year floodplain *whichever is greatest*
Perennial streams without fish	150 ft on either side (300 feet total) or top of inner gorge or outer edge of riparian vegetation or outer edge of 100 year floodplain *whichever is greatest*
Constructed ponds, reservoirs and wetlands greater than 1 acre	150 ft from the edge of the water or wetland or to the extent of seasonally saturated soil or outer edge of riparian vegetation or extent of unstable areas *whichever is greatest*
Lakes and natural ponds	300 ft from the edge of the water or to the extent of seasonally saturated soil or outer edge of riparian vegetation or extent of unstable areas *whichever is greatest*
Seasonal or intermittent streams without fish	150 feet on either side (300 feet total) include unstable areas channel to the top of inner gorge outer edge of riparian vegetation

Site specific assessments should be applied by qualified personnel when delineating riparian reserves on the ground. As a minimum include these factors:

- **Floodplains**- In most cases narrow areas along stream margins and wetlands. However several locations within the watershed have broad floodplains and an intricate network of floodprone channels. Examples include: Low gradient portions of Whychus Creek, Trout Creek, and Indian Ford Creek.
- **Riparian vegetation**- Connect wet meadows to nearby streams where not directly connected. Examples include Three Creek area and Indian Ford meadow. Trout Creek may also have broader extents of riparian vegetation.
- **Stream terraces, benches, and the inner gorge**- Should be included to the outer edge with adequate protection for the slopes leading to the waterbody.
- **Unstable land**- The majority of the area is not prone to slope failures. Highly or moderately erodable soils are present-see Bank Erosion table. Also areas over 30% slope with seeps, example: near Rd 1514 on Whychus Creek, cinder slopes near Snow Creek, Three Creek, and debris flow/moraine areas near Park Creek, Upper Whychus Creek tributaries, Pole Creek and North Pole Creek.
- **Saturated soil and seeps**- Provides areas for wetland vegetation to grow and serve as wildlife and amphibian habitat. Several riparian meadows exist in Upper Whychus Creek, Pole Creek, Trout Creek and Indian Ford Creek. Several of the meadows are of a fen peat nature and have unique wetland plant species (see botany report)
- **Rock outcrops**- included because of their importance for amphibians and other species.
- **Create Riparian Reserve complexes**- Where Riparian Reserve boundaries are very close or overlapping consolidate into one large reserve. Consolidate complexes of meadows, intermittent streams, seeps, wetlands, ponds, rock outcrops, and other unique or special habitats.

Threatened, Sensitive and Strategic Aquatic Species

Within the project area habitat exists for threatened Middle Columbia River summer steelhead and spring chinook (EFH). Steelhead were reintroduced to Whychus Creek in 2007 and spring chinook are planned for reintroduction in 2009. Redband trout are a Region 6 sensitive species that are present within all streams that originally had native fish populations. Columbia River bull trout are federally listed as threatened. It is unknown if bull trout were present on FS lands in upper Whychus Creek but they do exist several miles downstream below Alder Springs which is located a few miles above the mouth of Whychus Creek.

A new list of aquatic strategic species was put forth by the Regional Forester in 2007 and these include species that have information gaps (i.e. distribution, habitat, threats) resulting in status or taxonomic uncertainties. Many of these species are suspected but have not been documented on federal lands. Some of these suspected aquatic species in Table 2 may be added to the sensitive species list if they are confirmed on federal lands.

Table 2. Strategic aquatic species that are suspected to occur on the Deschutes National Forest. Source: USFS 2008 Region 6 strategic species list.

Scientific Name	Common Name
FLUMINICOLA SP. NOV.	METOLIUS PEBBLESNAIL
JUGA BULBOSA (1)	BULB JUGA
JUGA HEMPHILLIA SP. NOV. (1)	INDIAN FORD JUGA
JUGA SP. NOV.	BLUE MOUNTAINS JUGA
JUGA SP. NOV.	OPAL SPRINGS (CROOKED RIVER) JUGA
OREOHELIX VARIABILIS	DALLES MOUNTAINSNAIL
GOMPHUS LYNNAE	COLUMBIA CLUBTAIL
MOSELYANA COMOSA	A CADDISFLY
NAMAMYIA PLUTONIS (1)	A CADDISFLY

Current Flow Regimes and Fish Populations

The following sections describe general hydrology, flow regimes and current and historical fish populations for all major streams within the project area.

Trout Creek

Trout Creek originates in the Three Sisters Wilderness from snowmelt and springs. Alder Creek contributes flow near the wilderness boundary then Trout Creek drops into a confined steep channel to Trout Creek Swamp. A spring fed tributary joins the creek from the south just upstream from the Swamp and spring-fed seeps rise from the southern end of the meadow. Several ditches were historically constructed to drain the meadow portion of the Swamp. One main ditch drains from the U.S. Forest Service (USFS) 1018 road east to Trout Creek. Another main ditch drains the Trout Creek Swamp in the middle from south to north. Other smaller lateral ditches feed into the central ditch. These ditches lowered the water level of the Swamp and may have reduced late summer flows. The ditches contained redband trout when flowing. A recent restoration project has plugged several of the larger ditches forcing water back out into Trout Creek Swamp.

Trout Creek has perennial flow in the upper six miles of stream. Flow during August of 2001 was 0.34 cfs (cubic feet per second) and measured just below the 1520 road (Dachtler 2001). As the stream nears the community of Sisters it enters the glacial outwash and becomes intermittent prior to crossing State Highway 242. Trout Creek was once diverted just downstream of the Swamp, but this diversion has since been closed. Trout Creek has an ephemeral connection with Indian Ford Creek and may have regained this connection during the 1996 flood.

The connection, although infrequent, between Trout Creek and Indian Ford Creek may be important for redband trout genetic exchange and repopulation if a catastrophic event were to occur. Without this connection the current isolated population of redband trout in Trout Creek remains highly susceptible to loss due to habitat manipulations, catastrophic events, overfishing, exotic species introduction or disease.

USFS personnel conducted a physical and biological survey of Trout Creek in 1990 (Straw and Riehle). Another survey was completed in 2001. A fisheries survey was also conducted in Trout Creek Swamp during 1999 (USFS unpublished data). Redband trout were found throughout the Swamp meadow ditches with sizes up to 20 cm (eight inches). Stream temperatures are within ODEQ (Oregon

Department of Environmental Quality) standards and fish habitat quality remains high on USFS land.

Alder Creek

Alder Creek is a tributary to Trout Creek, entering upstream from the USFS 1018 road crossing. Alder Creek is a fishless stream according to a survey conducted in 1979 (Rankin and Satherwaitte). No fish were observed during a field visit in August, 2001. Flows are low to dry channel in summer.

Pole Creek

Pole Creek originates from springs near the Three Sisters Wilderness boundary. A discharge of 8.4 cfs was measured below the 1514 road in 2001 and the flow above the large spring at the end of reach 2 was estimated to be around 5 cfs (Dachtler 2001). Pole Creek is a City of Sisters municipal watershed. Water from this stream is used by the City of Sisters and other irrigators. The city of Sisters recently switched their water source to wells and does not exercise its water rights at this time. There is no longer a hydrologic connection between Pole Creek and Whychus Creek. Water from springs in Pole Creek Swamp currently drains into Whychus Creek and a six to eight foot waterfall with boulder cascades is present at the mouth. Night snorkel surveys were conducted in 1995 near the USFS 1514 road crossing and no fish were found. The first stream survey was conducted in 1990 (Straw and Riehle). Another stream survey was performed in 2000 from just below the 1514 road to the headwaters. Electrofishing surveys sub-sampled habitat units along the entire stream during the 2000 stream survey and found no fish (Dachtler 2001). Fish have reportedly been stocked and observed in ponds that Pole Creek Ditch runs into on private land.

A patchwork of clear cuts along upper Pole Creek has left portions of the stream open to increased sunlight, reduced wood infall, lower winter temperatures and ice dams. It has been reported that the City of Sisters has cleared wood from the stream to reduce ice dams in winter. Much of the stream is high gradient upstream from the Pole Creek Swamp. The Pole Creek Ditch has been run year around and has developed a narrow band of riparian vegetation, with mosses and riparian sedges. Near sisters the stream often exceeds the capacity of the ditch during the winter time and causes water to run through the forest and down roads. This can create resource damage if four wheelers use these wet areas. From April through November firewood cutting has been allowed to within 300 feet of Pole Creek from Pole Creek Spring downstream to USFS road 1526. Recent firewood cutting activity has been noted within this 300 foot buffer zone adjacent to Pole Creek. Firewood cutting, if concentrated and occurring within this 300 foot buffer, can reduce potential inputs of large wood to the stream channel reducing stream complexity and organic input to the stream food web.

North Pole Creek and Twin Meadows

North Pole Creek drains Twin Meadows, a spring fed wetland at the base of Trout Creek Butte. A stream habitat and fish survey in 2007 using electrofishing techniques found no fish and measured a flow of 0.2 cfs. Although the stream is small, downed wood is abundant and the water is cold and clear. The stream joins Pole Creek 1.6 river miles upstream from Pole Creek Swamp. An abundance of downed and dead large wood was noted in areas adjacent to North Pole Creek and surrounding the Twin Meadows area.

Whychus Creek

The portion of Whychus Creek that flows within the project area is a Wild and Scenic River, with a ¼ mile corridor that extends into the project area on either side of the creek. The stream is generally colluvial, high gradient and confined by bedrock and steep valley slopes. The reach just downstream of USFS road 1514 in less confined, more alluvial in form, contains a gravel stream bed, a wider floodplain with more meanders and more side channels. Wood accumulates at hydraulic nick points in jams or on large boulders. The influence of glacial sediments is seen in the common sand-cobble substrate, turbid

water in the summer and daily fluctuating flows. The flow regime is quite varied, with the low winter flow as low as 40-50 cubic feet per second (cfs), and bankfull flow over 400 cfs. The highest recorded flow was around 2,000 cfs.

Redband trout are native to Whychus Creek and were sampled to up near the wilderness boundary using electrofishing and snorkeling (Dachtler 1997). Mountain whitefish, longnose dace and bridgelip suckers are also native.

Brook trout *(Salvelinus fontinalis)* were introduced by stocking the creek or high lakes and are found within the project boundary. Brook trout are an exotic species of char, and are closely related to bull trout. Although bull trout are not known to spawn in the upper Whychus watershed, bull trout are found to rear in the lower reaches that have spring input. If connectivity between the lower and upper reaches is restored through fish passage projects at irrigation diversions, and flows are restored, the bull trout population might move into the upper reaches and overlap with introduced brook trout. The downstream movement of brook trout is not a result of continued stocking, but the downstream loss of fish from lakes and streams in the upper watershed that have self-sustaining populations. Although numbers of brook trout are low outside of the wilderness, a small population of bull trout could interbreed with a small population of brook trout. This may decrease the potential for bull trout to successfully expand their range into Whychus Creek.

A small unnamed tributary that enters Whychus Creek approximately 0.25 miles downstream of the 1514 road crossing was surveyed for fish and habitat in 2007. Surveyors found redband trout from the mouth upstream 0.2 river miles until the steam constricts and becomes steeper. Flow was measured to be 0.7 cfs during the survey.

Steelhead and spring chinook salmon were blocked from Whychus Creek by failed fish passage at Pelton Round Butte Dams in the late 1960s. Summer steelhead were once present up to the falls in Whychus Creek and were reintroduced downstream of Sisters in the spring of 2007. There are plans to reintroduce steelhead upstream of Sisters once fish passage can be provided on three man made diversion dams above the city of Sisters. Spring chinook were documented in lower Whychus Creek during the 1950's and 1960's (Nehlsen 1995). Chinook could have once been present in the project area but water withdrawals in the early 1900's may have impacted runs in this stretch before the first surveys were conducted. Chinook are planned to be reintroduced in spring of 2009.

Bull trout are found in lower Whychus Creek near Alder Springs upstream of its confluence with the Deschutes River, more than 20 miles downstream of the project area.

No historical or reliable anecdotal evidence indicates that bull trout (S. confluentus) were present above the town of Sisters. However it is possible they were once present and may have been extirpated early in the century due to water withdrawals, diversion dams and loss of anadromous species.

Snow Creek

Snow Creek originates in the Three Sisters Wilderness. It has a fairly stable spring fed flow regime with cold water temperatures. A discharge of 6.8 cfs was measured during the summer of 2007. Higher flows may occur during spring melt off and high elevation rain on snow events. Downstream of the 1514 road the stream is low gradient, sinuous and contains large amount of downed woody debris. Small to medium sized gravels are the dominant substrate. Upstream of the 1514 road the gradient gradually increases into the wilderness where it is dominated by cascading riffles. Some confined reaches in small canyons are present. Past clear cuts adjacent to the Riparian Reserves are now dominated by young 15-30 foot high ponderosa pines. A ditch once diverted water from upper Snow Creek and took it to Three Creek Lake but this has been abandoned for some time.

Fish and habitat surveys were performed on Snow Creek in 1990 and in 2007. The 2007 survey performed electrofishing surveys at selected sites and found redband trout up to river mile 1.6 where a small falls exists that may limit fish migration above this point. No fish were sampled upstream of the falls. Although there is no documentation it is possible that Snow Creek may have once supported populations of steelhead and bull trout. This assumption is based on the fact that the stream is large enough for these species to migrate and spawn in, there is ample spawning substrate and habitat for these species and no migration barrier exist until the small falls located 1.6 river miles from the mouth.

Three Creek

Three Creek originates from Three Creeks Lake which has a small earthen dam built in the early 1900's to increase water storage. Three Creek has been almost entirely diverted for agricultural purposes approximately 3.8 miles downstream from the lake. Three Creek Lake receives additional flow via a ditch from Little Three Creek Lake. The channel from Little Three Creek Lake historically went back into Three Creek near the 16 road crossing but was diverted to Three Creek Lake for additional water storage. Three Creek goes dry on certain years even with additional storage provided by ditches that come from Little Three Creek Lake. Another ditch once carried water from Snow Creek to Three Creek Lake but this ditch has not been used for some time. The current status and use of water rights to Three Creeks Lake appear to be limited and restoration opportunities may exist for restoring flow to wetlands and streams that once flowed from Little Three Creeks Lake. If the Three Creek dam is determined to be stable water storage in the summer would enhance fish production and recreational activities at the lake.

Habitat surveys were performed on Three Creek during 1992 and 2007. Three Creek, Little Three Creek and both lakes were originally fishless. Stocking of rainbow trout and brook trout began in the early 1900's. A self sustaining population of brook trout exists and most likely spawn wherever they can find suitable areas, which may include a few small tributaries and the shoreline. Brook trout have been observed spawning in the Three Creek below the Lake and in the ditch that comes over from Little Three Creek Lake. Catchable rainbow trout are still stocked on a yearly basis in Three Creek Lake.

Some small springs feed Three Creek Lake but most flow comes from snow melt in the spring. A lush riparian meadow with willows and sedges is located from the dam down to the 16 road. This section of stream is highly sinuous has several side channels and some deeper pools with undercut banks. A flow of 1.4 cfs was recorded during the 2007 stream survey. Most of the brook trout population is located in this section of stream. Downstream of the 16 road the stream is more entrenched, higher gradient and has fewer pools. Several small waterfalls and cascade sections are also located in this area.

Indian Ford Creek

Indian Ford Creek is primarily spring fed and has been heavily affected by irrigation diversions. Indian Ford Creek is typically completely dewatered in summer before it reaches Whychus Creek. The streams channel in the meadows around Black Butte Ranch have been altered by ditching and the creation of several large ponds.

No historical information is known to exist about the presence of steelhead or chinook in Indian Ford Creek. However, it is possible that these species were present in Indian Ford Creek. The small size of Indian Ford Creek would have made it more suitable for adult steelhead but chinook juveniles may have historically used the lower portion of Indian Ford Creek for rearing, especially during periods of high flows in Whychus Creek. No releases of steelhead or chinook are currently planned for Indian Ford Creek. Bull Trout may have once been present in Upper Whychus Creek but historical evidence of this is lacking previous to diversions changing the flow regime and water quality. If bull trout once used Indian Ford Creek, it was most likely for foraging. No historical information is known to exist about the presence of bull trout in Indian Ford Creek.

Currently redband trout, longnose dace *(Rhinichthys cataractae)* and bridgelip suckers (*Catastomus columbianus)* are the known fish species present in Indian Ford Creek year round. A USFS stream survey in 1992 sampled redband trout, dace and suckers upstream of Highway 20 (Mullong 1992). The Sisters Ranger District reportedly sampled the allotment area in the mid 1990's and found no fish (Mike Riehle 2007 personal communication). Rearing of redband trout most likely occurs throughout the length of the stream when water is present. Irrigation diversions cause Indian Ford Creek to go dry from the mouth (River Mile 0.0) to somewhere below highway 20 (River Mile 3.0 - 7.0) every summer. This location and duration of dewatering changes yearly depending on water use, snow pack and other factors.

Riparian Reserve Conditions

Riparian vegetation along streams within the project area varies in width from a few feet on smaller forested streams to several hundred feet in wetlands and areas of larger streams with broad floodplains. Often true riparian vegetation exists for only a small portion of the riparian reserve usually directly adjacent to a stream or lake. The remaining Riparian Reserve area consists of tree and plant communities more similar to those found in the surrounding uplands. Usually similar effects from forest insect and diseases outbreaks are also seen in these portions of the Riparian Reserves that more resemble the uplands. The descriptions, amounts and conditions or Riparian Reserves in most areas are similar to what is described in the Whychus Watershed Analysis (USDA 1998).
Areas that have seen change since 1998 include the Riparian Reserves of lower Trout Creek that got burned during the Black Crater Fire reducing shade and creating some streambank instability. Whychus Creek below the TSID diversion has improved since instream flows from purchasing water rights have increased summertime flows creating more favorable growing conditions for riparian vegetations and aquatic species. Above Sisters roads and campsites along Whychus Creek have been closed or improved to reduce impacts on streambanks and riparian vegetation. Trout Creek Swamp has regained water in the swamp from a restoration project that filled and blocked ditches improving function of this wetland.

General description of riparian species, riparian habitats and current riparian condition is presented for each major stream system within the project area:

Trout Creek and Alder Creek

Riparian vegetation is a thin strip of mountain alders, Engelmann spruce and other shrub and grass species. Trout Creek east of the 1018 road was burned at high severity in 2006 by the Black Crater Fire near the private land boundary and on the private land. Vegetative recovery has been slow in the burned area. Up near Whispering Pines Campground fire severity decreases but some impacts from a horse trail crossing exist. Trout Creek Swamp is a peat fen wetland and has a forested spruce wetland at the southern end. Trout Creek above the Swamp is intermittent and has a think strip of mountain alder with Engelmann spruce. The stream splits into two channels near the wilderness boundary. These channels often go subsurface for short distances then reappear again. There are two small fen peat meadows along Upper Trout Creek near the wilderness. No habitat surveys have been performed on Alder Creek but the riparian vegetation is probably very similar to upper Trout Creek.

Pole Creek

A thin strip of mountain alders exists throughout most of the stream. Engelmann spruce is common in the lower half of Pole Creek mixed with white fir, Douglas fir, lodgepole pine and ponderosa pine. Lodgepole pine is the dominant conifer species along the upper half of Pole Creek. Several old clear cuts were located along the stream and now have young pine plantations. Thin to non existent buffer strips were left in several location and these trees have blown down in several locations adding wood to the stream but also causing bank instability and decreasing streamside shade. Firewood cutting of mainly dead lodgepole pine and white fir has caused a reduction in shade and future wood recruitment in upper Pole Creek where a large die off of lodgepole pine has occurred.

North Pole Creek and Twin Meadows

This small stream goes subsurface before it enters Pole Creek. The riparian zone is a thin strip of mountain alder with a thick stand of mostly Engelmann spruce along the valley bottom. The stream originates from several springs in Twin Meadows. One is primarily a fen peat meadow similar to Trout Creek Swamp while the other has a small portion of fen peat habitat in the lower end but is mix of wet and dry riparian meadows in the upper end. Young lodgepole pines are very thick around the perimeter of the upper meadow.

Whychus Creek

Within the project area the riparian species along the stream include, mountain alder, Engelmann spruce, willows, aspen and cottonwood. Below the 1514 road on the west side of the stream an active floodplain exists with a newly forming side channel and there is a large forested wetland that is mainly large spruce with sedges on the ground. There is also a fen peat meadow that is fed by several small springs that originate upslope of the 1514 road. Upstream of the 1514 road the stream is confined in a bedrock canyon and a thin strip of riparian vegetation that is mainly mountain alders and Engelmann spruce run along the stream. Approximately ¼ mile downstream of the 1514 road a small unnamed tributary enters Whychus Creek on the West side and crosses under the 1514 road. A large fen peat meadow exists at the headwaters of this spring fed stream.

Snow Creek

A thin zone of mountain alder runs along the edge of the creek with other riparian shrubs. Thick Engelmann spruce stand dominate the lower part of the stream and transitions to more white fir at higher elevations. Lodgepole and ponderosa pine are scattered along the stream. A few small spring fed wetlands and streams exist along the creek. Some small aspen clumps are present along the creek and on the surrounding hillslopes.

Three Creek

A wetland meadow exists below Three Creek to the 16 road and other wetland meadows exist downstream of Little Three Creek Lake. Meadows downstream of Little Three Creek Lake may have been detrimentally impacted from ditches that removed waters from these wetlands and carried them over to Three Creek. Below the 16 road a thin strip of riparian vegetation exists for a short distance but becomes non existent lower down as the stream becomes more intermittent.

Indian Ford Creek

From Black Butte Ranch, the creek flows east through ponderosa pine plant associations. Riparian vegetation occurs in the floodplain and consists of aspen type woodlands in the upper reaches and willow/sedge plant associations in the lower reaches. Much of the riparian vegetation on private land has been impacted by drying floodplains, past and present grazing, and by the removal of willows and wetlands. Indian Ford Creek flows into Whychus Creek below the boundary of the National Forest near McKinney Butte. Riparian conditions have improved within the old Glaze Allotment since the allotment was closed in 1997. A 10 year grazing permit and allotment management plan was recently approved for the Indian Ford Allotment which is located Southeast of the 2058 road crossing. This allotment is on an intermittent portion of the stream. Active beaver ponds and dams are present in several locations along the creek and are probably the primary natural disturbance factors for this stream system.

EXISTING FISH HABITAT CONDITIONS

Water Temperature

Water temperature is a fundamental parameter affecting a waterbody's ecology (Minshall 1978, Vannote et al. 1980). As a stream moves from headwaters to mouth exposure to solar radiation increases and water warms to near the ambient air temperature (Bartholow 1989). Water temperature is used as a stimulus to salmonid migration, spawning and habitat selectivity. Reduced low flows from diversions increases the amount of time water is exposed to solar radiation and reduces the amount of water available for riparian vegetation. When water is diverted riparian vegetation growth is inhibited. The lack of sufficient riparian vegetation also exacerbates channel erosion and widening, leading to even warmer stream temperatures from increased surface area

Land management activities can significantly affect water temperature. Vegetation manipulation by overstory removal can affect the shade cover and the amount of solar radiation input into the water surface. The water table can be altered by allowing encroachment of upland vegetation into the riparian zone. Creating openings within the riparian zones of streams can lead to increased water temperatures (Chamberlin et al. 1991, Beschta et al 1987).

Water temperatures in Trout Creek ranged from 6 to 14° C during the 2001 stream inventory. Continuous summer water temperature data has been collected below the 1520 road crossing using electronic thermographs during 1996, 2000 and 2001. They were also collected above the 1018 road crossing in 2001. Daily maximums collected with the electronic thermograph below the 1520 road crossing did not exceed 14 °C. Monthly maximum thermograph temperatures during July and August of 2001 at the 1520 road crossing were 1.5 and 3.0 °C higher than temperatures at the 1018 road crossing for the same time period. Water temperatures collected for all years have not exceeded the ODEQ (1996) seven day average maximum of 17.8 °C for salmonid spawning and rearing.

Pole Creek is primarily spring fed with very cold water temperatures ranging from 3 °C to 6 °C during the 2001 (Dachtler) survey and were 3 °C at the headwater springs. Continuous summer water temperature data has been collected at the 1514 road crossing using electronic thermographs during 1995 and 1997. Daily maximums collected with the electronic thermographs in 1995 and 1997 never exceeded 10 °C.

Water temperature data for North Fork Pole Creek is limited but it was collected during the 2007 stream inventory. Temperatures ranged from 10 to 13 °C during July. Most of the flow comes from several small springs in the Twin Meadows area.

Upstream of the Three Sisters Irrigation District diversion, water temperatures in Whychus Creek

remain cold throughout the season because of the high elevation snow and glacier melt that feeds Whychus Creek and its many tributaries. The lower macroinvertebrate densities combined with cold temperatures and habitat fluctuations may help explain why fish are small and grow slowly in these sections of Whychus Creek, with a seven day average max temperature of 14.1 ^{o}C. Below the TSID and Sokol diversions at the 4606 rd, Whychus Creek can reach 18.8 ^{o}C, above optimum temperature for redband trout production and above ODEQ temperature criteria for 303(d) listed streams (7 day average max =18 ^{o}C). The stream is 303d listed for temperature from the mouth to near its headwaters.

In winter, Whychus Creek is cooled by the wide channel profile and the high elevation source of water. Ice can form on the bottom of the streambed in cold periods (anchor ice) and ice dams can form from edge ice breaking loose during freeze thaw cycles. Frequent cycles of this ice formation process can reduce over wintering habitat quality for fish. More riparian cover along the stream banks could reduce effects from this process.

Water temperatures in Snow Creek during the 2007 stream inventory ranged from 5 to 13 ^{o}C using a hand held thermometer. Continuous summer water temperature data was collected at the 1514 road crossing using electronic thermographs from May to September of 1997. Daily maximums collected with the electronic thermograph in 1997 reached a maximum temperature of 12.3 C in August and a maximum of 10 C in September. Water temperatures at the 1514 road crossing have not exceeded the ODEQ (1996) seven day average maximum standard of 17.8 C for salmonid spawning and rearing.

Water temperatures in Three Creek vary depending on flow and time of year. Water temperatures are elevated because surface water from the Lakes are the primary water sources during the summer months. Water temperatures in Three Creek during the 2007 stream inventory ranged from 9 ^{o}C to 20 ^{o}C using a hand held thermometer, with highest temperatures in August.

Indian Ford Creek is on the Oregon Department of Environmental Quality (ODEQ) 303-d list of water quality impaired streams for water temperature along the entire length of stream. USFS water temperature data collected at the 2058 road crossing at the upstream end of the allotment shows the steam has exceeded the 18 ºC seven day average maximum criteria that ODEQ has assigned for Salmon and trout rearing and migration. Temperature data recorded at the downstream end of the old Glaze Allotment for various years from 1993 to 2003 show the ODEQ temperature criteria was exceeded each year.

Water temperature in Indian Ford Creek immediately downstream of headwater springs at has been consistently near or above the State Water Quality Standard. The 2000 Forward Looking Infrared (FLIR) survey shows a dramatic spike in temperature as Indian Ford Creek leaves Black Butte Ranch. Stream temperatures at the springs in Big Meadow were measured at 6.5°C on July 28, 2000, and measured at 19.1°C just 1.3 miles downstream (Watershed Sciences 2000). Insufficient in-stream flows, water ponding, and willow removal on private land have been the main reason for high water temperatures in Indian Ford Creek. Approximately 8 cfs is diverted during the summer low flow season, reducing water depths and causing the stream to dry up 3 to 7 miles before it's confluence with Whychus Creek depending on the year.

Streambed Embeddedness and Fine Sediments

Streams in the project area have not been sampled for embeddedness but during older stream surveys (previous to 1995) embeddedness was estimated as a yes or no if more than 35 % of the cobble or gravel substrate in a habitat unit was embedded with fine sediments. More recent stream surveys (post 1995) used pebble counts in riffles to sample surface substrate at two riffles approximately 1/3 and 2/3 through each reach. The pebble counts were done within the bankfull channel which often reflects more fine sediments than what are on the bottom of the wetted channel. This is because stream banks are often made up of mostly finer silt and sand sized particles. High embeddedness can restrict winter rearing habitat for juvenile trout and salmon by filling in spaces between rocks in the streambed that could be used as cover for fish. Also, macroinvertebrates use the gravel for hiding and feeding and the more fine sediment the less habitat for macroinvertebrates.

Embeddedness in Trout Creek was not an attribute sampled during the 2001 stream inventory. The stream inventory done in 1990 (Straw and Riehle) estimated embeddedness in each main channel habitat and data summaries by reach indicated streambed cobble and gravel was not embedded. Pebble count data from the 2001 stream survey found less than 10 % fine sediments (<2mm) in reach one and the lower part of reach two. Fine sediments reached 59, 23, and 22 % in the upper end of reach two and in the lower and upper parts of reach 3, respectively. Some embeddedness could be occurring in these areas, especially in the upper part or reach 2. Alder Creek has not been surveyed for embeddedness or any other fish habitat attributes.

Embeddedness in Pole Creek was not an attribute sampled during the 2001 stream inventory. The stream inventory done in 1990 (Straw and Riehle) estimated embeddedness in each main channel habitat and found that overall the steambed cobble and gravel was not embedded. Amounts of fine sediments (<2mm) found using pebble counts in 2001 ranged from 6 to 39 % with highest amounts in reaches 2-4. It is unlikely but some areas in reaches 2-4 could be embedded. Amounts of fine sediments decreased near the headwater springs in reaches 5 and 6.

North Fork Pole Creek was not measured for embeddedness during the 2007 stream inventory but visual estimation of substrate found high amounts of sand and fine sediments in the stream bottom. This could cause larger particles to become embedded. High flows needed to flush and distribute sediment to the floodplains probably seldom occur in NF Pole Creek. Two pebble counts were done in the 2007 survey and found 90 % fine sediments (<2mm) in the lower portion of the steam and 30 % in the upper portion of the stream. Some embeddedness may be occurring especially in the lower portions of NF Pole Creek.

Whychus Creek was surveyed for embeddedness during the 1990 stream survey and only one reach located in the Three Sisters Wilderness was found to be embedded but this survey also found sand to be the dominant substrate type in 7 out of 8 reaches Streambed substrate was sampled using pebble count methods during the 1997 stream survey. Whychus Creek had more fine sediment in the two reaches just upstream of Sisters, reflecting some gravel embeddedness may be occurring there. Fine sediment in the upper reaches was nearly half the amounts found near Sisters. Aquatic macroinvertebrate sampling results for Whychus Creek collected near the gauging station during 1989-1999 (Lovtang and Riehle 2000) showed the macroinvertebrate community was not very diverse but had a good representation of water quality sensitive taxa. Clean water taxa richness was reduced at the 4606 rd, likely a reflection of high temperatures and fine sediment.

Snow Creek was not measured for embeddedness during the 2007 stream inventory. The stream inventory done in 1992 (Straw and Riehle) estimated embeddedness in each main channel habitat and found that overall the steambed cobble and gravel was not embedded. Pebble counts performed within

the bankfull channel of riffle habitats found the highest amounts (37-55 %) of fine sediments (<2mm) in the upper half of reach 1 and reach 2. This indicates that larger gravel and cobble substrate could be emdbedded in some habitats units. At pebble count sites in the lower half of reach 1 and in reach 3 less than 20 % of substrate were fine sediments. High flows needed to flush and distribute sediment to the floodplains probably infrequently occur in Snow Creek.

Three Creek was not measured for embeddedness during the 2007 or 1992 stream inventories. Pebble counts performed in 2007 within the bankfull channel of riffle habitats found the highest amounts (23-31 %) of fine sediments (<2mm) in the upper half of reach 2 and reach 3. However, the other 8 pebble counts found amounts of fine sediments less than 20 % and this indicates that substrate embeddedness would be unlikely for Three Creeks.

The last stream inventory for Indian Ford Creek was performed in 1992 and data from this survey is included in the 1998 WA. The 1992 survey found that the gravel and cobble substrates were embedded more than 35 % per habitat unit (Mullong 1992).

Large Wood

Large wood is an important habitat feature for bull trout, chinook salmon and other salmonids. Wood also has a great impact on channel morphology and hydrologic stability (Abbe and Montgomery 1996) and is important for pool formation and pool volume. Wood can also influence the contribution and retention of organic matter and sediment (Fausch and Northcote 1992; Angermeier and Karr 1984; Beechie and Sibely 1997). The importance of these functions enhances fish and invertebrate biomass and production (Dudley and Anderson1982; Bilby and Ward 1989; Fausch and Northcote 1992). Large wood is used as cover for all stages of fish and promotes a more complex environment that produces increased fisheries biomass (Fausch and Northcote 1992; Bisson et al. 1988) and greatly increases the resiliency and resistance of fish species to floods and droughts (Pearsons et al. 1992).

The primary wood recruitment zone for streams which gain most of their wood from tree mortality is within 100ft slope distance from the stream bank (Benda et al. 2002). Benda and others studied wood recruitment rates for streams based on dominant process (i.e. tree mortality, bank erosion or landslide). On a coastal stream in an old growth forest in Northern California, the primary source of wood was found to be bank erosion and mortality. Over 90% of the wood entered the channel from within 30 m slope distance of the stream edge. In the Whychus watershed, the trees are much shorter but bank erosion is active in certain locations. Therefore wood recruitment is expected to approach the Benda et al. (2002) theoretical recruitment prediction for streams in which 100% of the wood is recruited to the channel in less than 100ft (Benda et al. 2002).

The 2001 stream inventory on Trout Creek found Reaches 1 and 2 had more medium and large LWD pieces than small pieces. An abundance of large downed and dead wood was noted adjacent to Trout Creek along its lower section and in areas upstream from Trout Creek Swamp. This is a result of the mature forests around the stream (Table 3). The lower part of reach 1 burned during the Black Crater Fire in 2006 and this most likely changed the amounts of large wood in this section. Reach 3 had an almost equal amount of LWD in the two size categories.

Table 3. Trout Creek large wood attributes from the 2001 stream inventory.

STREAM	REACH	Pieces of Med. and Large LWD Per Mile	Pieces of Small LWD Per Mile	Frequency of Med. and Large LWD	Frequency of Small LWD
Trout Creek	1	87.6	58.9	0.178	0.119
	2	51.6	18.9	0.085	0.035
	3	20.1	21.2	0.025	0.025

All of the reaches in Pole Creek had a high amount of woody debris in all size classes (Table 4). The mixed conifer forests with larger trees has allowed for the recruitment of large and medium sized trees to the stream. Blow down in the buffer strips from past clear cuts along Pole Creek have helped increase instream large wood in certain areas. Future large wood recruitment potential may be limited in some areas because of the young ponderosa pine plantations that have replaced the mixed conifer stands in several areas along the stream.

Table 4. Pole Creek large wood attributes from the 2001 stream inventory.

STREAM	REACH	Pieces of Med. and Large LWD Per Mile	Pieces of Small LWD Per Mile	Frequency of Med. and Large LWD	Frequency of Small LWD
Pole Creek	1	72.2	77.4	0.104	0.111
	2	103.2	173.8	0.188	0.316
	3	155.5	178.9	0.233	0.266
	4	63.4	69.8	0.084	0.093
	5	37.9	108.1	0.070	0.199
	6	98.3	191.7	0.136	0.265

NF Pole Creek had 36 and 30 pieces per mile of medium and large sized wood in reaches 1 and 2, respectively. Because the stream is small and slightly entrenched large amounts of woody debris was noted lying over the bankfull channel. This wood was not counted under the current level II stream inventory protocol. The small size of NF Pole Creek and infrequent high flows do not allow for movement of sizable wood once it is on the ground.

Whychus Creek once had large wood jams in the 2 reaches just upstream of Sisters but due to flooding during the 1964 flood, wood was removed to straighten the channel (USDA 1998). This alluvial reach was potentially an important spawning area for steelhead and chinook salmon due to the lower gradient and pool riffle morphology. Wood may have played an important role in creating this habitat and the complex side channels that were important for rearing fish. The 1997stream survey of Whychus Creek found that wood greater that 12 inches in diameter within the project area ranged from 30.7 to 48.1 pieces per mile (Table 5).

Table 5. Whychus Creek large wood attributes from the 1997 stream inventory.

STREAM	REACH	Pieces of Med. and Large LWD Per Mile	Pieces of Small LWD Per Mile	Frequency of Med. and Large LWD	Frequency of Small LWD
Whychus Creek	1*	19.5	28.5	0.060	0.088
	2*	11.3	9.1	0.059	0.048
	3	30.7	30.9	0.055	0.055
	4	48.1	56.7	0.152	0.180
	5	37.2	39.7	0.148	0.157
	6	46.5	58.1	0.187	0.234

* Denotes reaches outside the project area.

Riparian Reserves (RR) along Whychus Creek contribute to fish habitat by providing shade, large wood and fine organic matter, stable vegetated floodplains and filtering runoff from the uplands. The RR near Sisters along Whychus Creek had nearly 8% dominated by large trees and 29% in medium sized trees. Large trees are important for wood sources to Whychus Creek because of the flashy flow regime and the need for wood to be large to remain in channel. Nearly a quarter of the near stream RR (within 100 ft of channel) was in grass/shrub, water/rock, or developed/agriculture. This is a substantial amount of streamside that is not contributing to fish habitat by providing adequate large wood, functional floodplains, and runoff filtering.

Pieces of medium and large sized woody debris per mile in Snow Creek were high except in reach 3 (Table 6). This may be due to smaller sized lodgepole pine trees that dominate in reach 3. Management activities in this area have not significantly altered amounts of available wood for the stream. Amounts of small sized woody debris were high in all reaches.

Table 6. Snow Creek large wood attributes from the 2007 stream inventory.

STREAM	REACH	Pieces of Med. and Large LWD Per Mile	Pieces of Small LWD Per Mile	Frequency of Med. and Large LWD	Frequency of Small LWD
Snow Creek	1	42.9	111.2	0.097	0.232
	2	45.5	192.7	0.099	0.373
	3	18.6	157.1	0.050	0.295

Pieces of medium and large sized woody debris per mile in Three Creek were high only in reach 1 and 4 and this is most likely due to larger ponderosa pine and spruce in reach 1 and larger spruce and white fire in reach 4 (Table 7). Reaches 2 and 3 were dominated by lodgepole pine and white fir which seldom grow to larger sizes in this area. Reach 3 was noted as having a lot of blow down that was not countable because it was located across and above the bankfull channel. Reach 5 is in a wetland meadow and only a few trees are available for recruitment. Management activities in this area have not significantly altered amounts of available wood for the stream. Amounts of small sized woody debris

were moderate in all reaches except for reach 5 which had none due to the wet meadow.

Table 7. Three Creek large wood attributes from the 2007 stream inventory.

STREAM	REACH	Pieces of Med. and Large LWD Per Mile	Pieces of Small LWD Per Mile	Frequency of Med. and Large LWD	Frequency of Small LWD
Three Creek	1	51.7	47.7	0.083	0.077
	2	2.2	31.1	0.006	0.084
	3	1.1	28.8	0.002	0.049
	4	31.5	12.6	0.033	0.013
	5	5.9	0.0	0.005	0.000

Indian Ford Creek has only been surveyed once, during 1990. Indian Ford Creek had 43 pieces of medium and large wood per mile and 91 pieces of small wood per mile in the reach from the private land boundary (R.M. 6.8) to the lower end of the old glaze allotment (R.M. 10.1).

Pool Frequency/ Pool Quality

Pools provide rearing areas for both juvenile and adult fish. Spawning often occurs in the tail-outs of pools. Pool frequency is based on average bankfull width and not adjusted for channel type and local conditions. Pools per mile are also a good measure of pool habitat but do not take into account stream size as pool frequency does. In general larger streams have larger and deeper pools which account for fewer pools in a given mile of stream while small streams generally have more numerous smaller and shallower pools for a given mile of stream. Stream gradient, geology, and instream wood can all have a large effect on the formation and quality of pools. Pool quality for fish is described as large pools with greater than 3 ft in depth and pools with abundant large wood.

In Trout Creek pools in reaches 1 and 3 had similar residual depth while pools in reach 2 had a larger residual depth and this may be due to the flatter gradient (Table 8). Reach 1 had the highest number of pools per mile while reach 2 had the largest percentage of pools. Pools were mainly formed by large wood and tree roots in all three reaches. No surveys or pool data exists for Alder Creek.

Table 8. Trout Creek pool habitat attributes from the 2001 stream inventory.

STREAM	REACH	% Pool	Pool Residual Depth (feet)	# Pools >3ft Deep	# of Pools Frequency	Pools Per Mile
Trout Creek	1	51.1	0.7	0	0.123	62.8
	2	88.0	1.2	2	0.052	31.4
	3	78.7	0.8	0	0.041	34.8

Pools in Pole Creek were generally shallow and created primarily by wood and boulders (Table 9). Reaches 1, 2 and 3 were dominated by pool habitat but reach 6 near the headwaters had the highest number of pools per mile. The stable spring fed flow regime does not allow for frequent changes in pool locations or attributes. The lack of regular high flows may make pools more susceptible to retaining fine sediments.

Table 9. Pole Creek pool habitat attributes from the 2001 stream inventory.

STREAM	REACH	% Pool	Pool Residual Depth (feet)	# Pools >3ft Deep	# of Pools Frequency	Pools Per Mile
Pole Creek	1	50.1	1.3	0	0.05	36.4
	2	23.3	1.4	0	0.07	38.0
	3	68.9	1.2	0	0.09	57.0
	4	60.3	1.4	0	0.05	34.9
	5	25.1	0.8	0	0.05	24.9
	6	36.2	1.1	0	0.06	41.1

The 2007 stream inventory on NF Pole Creek found 33 pools per mile with an average residual depth of 0.9 feet in reach 2. Pools were mostly formed by wood.

Periodic high flows on Whychus Creek most likely change the locations and amounts of woody debris on a regular basis. This in turn can change the amount and location of pools in lower gradient sections. Pools per mile on Whychus Creek were between 4-16 pools/mile. The highest pools per mile on all of Whychus Creek are found in the upper half of reach 1, upstream of the 4606 road. This is a reach were flood flow can leave the main channel and overflow into a side channel (Dachtler 1997). It is also a low gradient section that still retains good riparian cover and mature riparian trees.

Average pool depth varied between 1.9 and 3.0 feet in Whychus Creek in the project area. Pool depth may be linked to stability of the channel and wood, both features that have been altered since the 1964 flood repair work by the Army Corps of Engineers. Without enough wood and increased instability, the stream may have a reduce its potential to form stable deep pools. Pools are also formed bedrock and boulders especially in reaches 3, 5 and 6. Pool habitat is important to fish production and critical to chinook habitat. The most deep pools (>3 ft) were found in reach 1, just upstream of Sisters.
Pool frequency is low (Table 10) in many of the reaches of Whychus Creek when compared to INFISH RMOs. Pool quality for fish is described as large pools with greater than 3 ft in depth and pools with abundant cover from large wood. Reach 1 has some good quality pool habitat and is located downstream of the project area.

Table 10. Inventoried pools, average residual pool depth, and number of pools with large wood in stream reaches of Whychus Creek within the project area. Reach 1 begins at the Sisters city limits and Reach 3 ends near the upstream project boundary to the west.

STREAM	REACH	Average residual pool depth ft	Pools / mile	Pool >3ft deep/mi	Pools with 1-3 large logs	Pools with > 3 large logs
Whychus Creek	1*	2.3	16.1	10.4	9	3
	2*	3.1	5.4	5.36	1	0
	3	2.9	5.4	5.21	2	2
	4	1.9	4.2	3.8	4	1
	5	2.3	4.0	4.0	2	0
	6	2.0	3.9	3.2	2	0

* Denotes reaches outside the project area.

The 2007 stream inventory data for Snow Creek showed that the number of pools per mile were similar in the first two reaches and much less in reach 3 this is most likely due to the higher gradient in reach 3 (Table 11). The majority of pools for the survey were formed by woody debris with an increase in pools formed by boulders in reach 3.

Table 11. Snow Creek pool habitat attributes from the 2007 stream inventory.

STREAM	REACH	Pools Per Mile	Pool Residual Depth (feet)	Pools >3ft Deep Per Mile	# of Pools Frequency
Snow Creek	1	25.5	1.2	1.0	0.053
	2	29.1	1.3	0.9	0.056
	3	11.2	1.7	0.8	0.021

Pools in Three Creek were generally shallow and only reach 3 had any pools over three feet deep (Table 12). This is most likely due to the small size of the stream which was 1.4 cfs (cubic feet per second) during the stream inventory.

Table 12. Three Creek pool habitat attributes from the 2007 stream inventory.

STREAM	REACH	Pools Per Mile	Pool Residual Depth (feet)	Pools >3ft Deep Per Mile	# of Pools Frequency
Three Creek	1	71.8	1.0	0.0	0.116
	2	32.2	1.1	0.0	0.086
	3	24.5	1.1	0.5	0.042
	4	28.8	0.8	0.0	0.030
	5	17.7	0.6	0.0	0.016

Indian Ford Creek had 3.5 pools per mile but the 1990 survey also found 33 % of the habitats were

glides and some portion of these were most likely shallow pools. The average pool residual depth was 1.0 ft. This survey also noted a large pond in the glaze allotment which increased the amount of overall pool habitat area by 44 % in this reach. This pond was most likely formed by beavers. There are currently several ponds created by beavers in this area.

Off-Channel Habitat

Backwaters and side channels provide important habitat for juvenile redband trout, steelhead and other salmonids in spawning tributaries. Streams with stable flow regimes provide alcove and backwater areas during all seasons. Natural recruitment of trees into unconfined stream sections will increase side channels. Log jams and the flooded areas that result can create side channels and provide important salmonid rearing habitat. Off channel habitat is also created during high flow events in the floodplain. Side channels were the only form of off-channel habitat inventoried through stream surveys except on Whychus Creek where alcoves and backwaters were inventoried.

Side channels in Trout Creek during the 2001(Dachtler) stream inventory were non-existent in reach 3 and accounted for 2-4 % of the available habitat in the remaining reaches. The narrow valley floor and steeper gradients of reach 3 do not allow for the formation of side channels. Off channel habitat within Trout Creek Swamp (Reach 2) may be available during high flows in flooded areas. More side channel formation would be expected within the low gradient Trout Creek Swamp area. It is possible side channels were blocked or modified in this area early in the century to improve grazing. Alder Creek has not been surveyed or sampled for off channel habitat.

Side channels in Pole Creek during the 2001 (Dachtler) stream inventory were non-existent in reaches 2 and 4 and accounted for less than 1% of the available habitat in the remaining reaches. The entrenched channels and steeper gradients on portions of Pole Creek do not allow for the formation of extensive side channel habitats.

No side channels were found in North Fork Pole Creek during the 2007 stream inventory. Other types of off channel habitats were not surveyed for but they are probably very rare to nonexistent due to the channel being slightly entrenched and the stable flow regime.

Off channel pool habitat varied in Whychus Creek in reach 1, near Sisters, depending on water flow. At 29 cfs, the reach had near 4,000ft^2 of off channel habitat, and at 7 cfs the same reach had around 1,400 ft^2 of off channel habitat (Dachtler 1997). Most off-channel habitat was in the form of alcove pools and backwater pools. These habitats are important for fry and small juvenile fish for rearing habitat and also for all fish to escape the high velocities of high flows. Side channels made up less than 7 % of the habitat area of Whychus Creek. Side channels and overflow channels were most likely reduced when the stream was channelized after the 1964 flood. Reach 4 below the 1514 road has a newly formed side channel that is approximately one mile long. During periods of high flow in reach 4 the stream accesses a forested wetland on the west side of the stream.

No side channels were found in the three reaches of Snow Creek. Other types of off channel habitat such as ponds and flooded wetlands are non existent along Snow Creek. This is mainly because the steam is slightly entrenched with narrow floodplains. One small wetland adjacent to the stream is located in reach 2 and it has a very small spring fed stream that feeds into Snow Creek. The wetland itself is perched on a bench above the stream and probably rarely if ever gets flooded.

Side channels were found in reaches 1, 3 and 4 of Three Creek during the 2007 stream inventory. Side channels accounted for 1.7 %, 2.0 % and 0.9 % of the habitat area in these three reaches, respectively.

In reaches 1-3 side channel formation is restricted by a narrow flood plain and valley bottom. Indian ford only had 0.6 % of is habitat in side channels. However other forms of off channel habit may exist in wetland areas during high flow events.

Spawning Gravel Quality

Aquatic habitat is developed and persists around varieties of and scales of disturbances (Swanston 1991). These watershed disturbances recruit and remove a variety of material within the channel acting as resetting and recycling mechanisms. Fine sediment production is one type of respondent of watershed or channel disturbance such as wildfire (Beaty 1994; Minshall et. al 1997; Benda et al 2003; Wondzell and King 2003) floods (Houslet and Riehle 1998) and clear cutting (Hall and Lantz 1969). The amounts of fine sediments in spawning areas can affect the survival of salmonid eggs and alevins during incubation in the redd.

The 2001 Trout Creek stream inventory found gravel and sand were two most abundant substrate types while boulders and cobble were present in all areas except portions of reach 2. Amounts of fine sediments within the channel using pebble counts were low in reach 1 (7-8 %) and then reached a high of 59 % in the upper part of reach 2. Amounts of fine sediments may have recently increased in the lower end of reach 1 as a result of the Black Crater Fire in 2006. High amounts of fine sediment (<2mm) in portions of reach 2 may be natural or a result of past channel modifications to divert Trout Creek around the swamp. Fine sediments in reach 3 were 22-23% of the total substrate sampled. The gradient in reach 2 is low with a wide floodplain and flows high enough to flush out fines are infrequent.

No surveys or substrate sampling has been performed on Alder Creek.

Amounts of in channel fine sediments on Pole Creek ranged from 19 to 40 % using pebble count sampling in riffle habitats (Dachtler 2001). Amounts of fines were greatest in the lower half of the stream and decreased near the headwater springs. Gravel was the dominant substrate type in all reaches with some cobbles and boulders present in certain locations.

Pebble counts were used to sample substrate in NF Pole Creek during the 2007 stream inventory. The two pebble counts found 90 % fine sediments (<2mm) in the lower portion of the steam and 30 % in the upper portion of the stream. At the lower pebble count site a small amount of small sized gravels were present and at the upper site small gravel, medium gravel and cobbles were present.

Quality spawning gravels exist in pockets and in pools throughout the canyon sections of Whychus Creek although it probably only comprises a small portion of the habitat because of the long riffle/rapid sections and the dominance of cobble, boulders and bedrock. The 2.1 mile section below the 1514 road is primarily gravel and cobble substrate with pools separated by long riffles. In the reaches near Sisters, gravel is abundant but spawning quality may be reduced, with fines less than 6.4 mm (1/4 inch) in diameter making up 22 to 28% of the surface of the streambed (Dachtler 1997). This may be a reflection of lower gradient and lowered stream bank stability.

Recently the Sisters Ranger District is implementing the Whychus Creek Riparian Protection Project to reduce impacts to the stream and riparian zone from intensive dispersed recreation along Whychus Creek. This project reduced user created roads and fords that go through the creek, side channels and floodplains. Boulders were placed to restrict off road vehicle use and prevent vehicles from driving in the stream. This project will reduce some of the impacts to streamside vegetation and sources of sediment from riparian roads. Glacial origin fine sediments enter Whychus Creek naturally from tributaries such as North Fork Whychus Creek in the Three Sisters Wilderness.

Visual estimation of substrate in Snow Creek during the 2007 stream inventory found that more sand/silt substrate was present in reach 1 and it decreased moving upstream. Gravel was the dominant substrate in all reaches with more cobble and boulders present in reach 3, which is higher gradient. Pebble counts performed within the bankfull channel of riffle habitats found the highest amounts (37-55 %) of fine sediments (<2mm) in the upper half of reach 1 and reach 2. At pebble count sites in the lower half of reach 1 and in reach 3 less than 20 % of substrate were fine sediments. The pebble counts also found smaller gravels with a few cobbles in reach 1, all sizes of gravels with a few cobbles and boulders in reach 2 and gravels, cobbles and boulders in reach 3.

Pebble counts in Three Creeks performed in 2007 within the bankfull channel of riffle habitats found the highest amounts (23-31 %) of fine sediments (<2mm) in the upper half of reach 2 and reach 3. However, the other 8 pebble counts found amounts of fine sediments less than 20 %. Amounts of gravel from pebble count data in all reaches ranged from 43 % to 77 % of the streambed substrate. Smaller sized gravel suitable for brook trout spawning exists in all reaches.

Spawning gravel is practically nonexistent downstream of Indian Ford Campground and substrate is almost entirely sand and silt. The best spawning gravels exist from Indian Ford Campground up into the lower 1/3 of the old Glaze allotment. The 1990 survey found sand to be dominant substrate in this reach indicating that fine sediments were more prevalent than gravel. Sand and silt are the dominate substrate types upstream of the old Glaze allotment. Redband trout have been observed spawning at the downstream end of the old Glaze allotment.

Fish Passage

Fish passage is anything that prevents fish migration. Most often this is upstream migration but can include downstream migration. There are two categories, man made barriers and naturally occurring barriers. Man made barriers often consist of culverts that are too small or have a perched outlet. Irrigation diversion dams also form barriers as many of these are old and have no fish passage. Natural barriers are often falls, chutes or steep cascades that prevent upstream migration. Streams that go subsurface or intermittent in some sections can also be natural barriers to fish migration. Both natural and man made barriers can be complete barriers, barriers to certain salmonid life stages or can be seasonal barriers depending on flows. Passage of certain amphibian life stages and aquatic insects can also be impaired at fish passage barriers.

On Forest Service lands two culverts exist on Trout Creek, one on the 1520 road and the other on the 1018 road. The culvert on the 1520 was recently replaced to improve fish passage. The culvert on the 1018 road may be a barrier to fish passage because of the culverts length and steep gradient, however there is small natural falls downstream of the 1018 road that also prohibit upstream fish passage. The upper section of Trout Creek is small and goes intermittent in sections which could also make fish migration difficult. Downstream of the project on private land Trout Creek goes intermittent and rarely connects with Indian Ford Creek. This limits potential mixing with other redband trout populations. No fish populations or fish passage issues are known to exist on Alder Creek.

Pole Creek is currently fishless and it is unknown if native fish were ever present. A natural falls and series of boulder cascades are located where Pole Creek enters Whychus Creek and would prohibit upstream fish passage. There are also falls that would be barriers to fish migration in reach 4 found during the 2001 stream inventory. The diversion of Pole Creek for irrigation has also caused a disconnect with the original stream channel and flows that used to go through Pole Creek Swamp. NF Pole Creek is also fishless and the dry channel section near the mouth is a potential barrier to fish but

no fish are present in Pole Creek that could access it. A culvert is present under the 15 road. This culvert does not appear to be a barrier if fish were present.

A culvert along the 1514 road on a small tributary to Whychus Creek is suspected to be partial fish passage barrier. This culvert is located just downstream of the 1514 road bridge on the west side of the creek. Most other crossings on Whychus Creek are bridges or fords. Some bridges restrict floodplains and straighten channel meanders that cause increased stream bank erosion and channel widening downstream of these bridges. In particular, the old bridge at the 4606 rd is a good example of this problem. Fish passage does not currently exist at the TSID (Three Sisters Irrigation District) diversion dam, Sokol diversion dam, Leithauser diversion dam, Fish passage is poor at the old TSID diversion dam and another concrete structure located on private land just upstream of Sisters. The restoration of fish passage and fish screens is currently being designed for the new and old TSID diversion dams. Implementation of this project is planned for 2009-2010. A small falls upstream of the USGS gauge (Road 16-390) is a fish barrier under certain flow conditions. Chush falls located just inside the Three Sisters Wilderness is a natural fish barrier and the upstream extent of redband trout.

The 1514 road culvert that Snow Creek flows under was replaced in the last ten years. However, it is not an open arch culvert, it does not have natural substrate on the bottom and it is slightly perched on the downstream end. It unknown to what extent this culvert may be prohibiting upstream migration of redband trout. Several small falls, a chute and a steep gradient cascade exist in reach 3 and appear to restrict fish passage. No redband trout were found above the falls at River Mile 1.6 in reach 3 during the 2007 fish surveys.

Culverts on Three Creeks under the 16-800 road 16-900 roads and the dam on Three Creeks Lake are fish passage barriers under certain conditions. Natural fish passage barriers also exist at several small falls and chutes in reaches 1-3. The largest falls is located in reach 3 and is 15 to 20 feet tall.
On Indian Ford Creek the lack of instream flow from irrigation diversions is a fish passage barrier from the mouth to River Mile 6 or 7 depending on flow that year. The culvert at the 2058 road crossing is also a fish barrier but since this reach goes dry every summer fish passage is not the primary issue. Another culvert at the old mainline road (205 road) also appears to be a fish passage barrier. Beaver dams along the creek may also create temporary or seasonal fish passage barriers.

Refugia

Refugia are places where fish can escape unfavorable conditions. The most important types of refugia for fish in the Whychus drainage are thermal refugia and high flow refugia. Thermal refugia are areas fish can access to escape elevated water temperatures usually caused by low flows when water is diverted. High flow refugia is the ability for fish to escape high flows in the main channel by moving into areas on the flood plain or in side channels where flows and turbidity are often less. The stream must be functioning properly for fish to access its floodplain

In Trout Creek the main area of refugia would be in Trout Creek Swamp which provides slow water and flooded wetland habitat during high flows. This area may be particularly important for this isolated redband population after habitat was altered downstream during the Black Crater fire in 2006. The upper end of reach two has a unnamed spring fed tributary that contributes approximately half of the base flow to Trout Creek and this would provide a cool water refugia area. Other smaller springs in the vicinity of Trout Creek Swamp may provide similar refugia. Alder Creek has not been surveyed for refugia but is presumed to be spring fed but no fish populations are currently present.

In Pole Creek and NF Pole Creek refugia is currently not an issue because no fish populations are present and natural barrier falls is located near the mouth of Pole Creek. The stable flow regimes and cold temperatures would make for good refugia if fish had access to the stream.

With improved water management in the reaches of Whychus Creek below the TSID diversion, a link between the springs of Camp Polk and the upper reaches of Whychus can be made. The upper reaches of Whychus Creek serve as a summer time thermal refuge and the lower reach may serve as a winter refuge for deeper, slower water. Access to the upper reaches is currently not possible due to several impassable diversion dams. The flats of the reaches near Sisters, and the spring fed reaches near Camp Polk and Alder Springs located near the confluence with the Deschutes River are considered refugia for spawning and rearing trout and salmon. Access to the flood plain during high flows has been restricted due to berms placed along the stream after the 1964 flood, development and channel widening which has impaired the ability of the stream to access its floodplains downstream of the TSID diversion dam. Snow Creek has several small spring fed tributaries that may act as localized refugia during high flows, which are most likely infrequent. Reach one of Snow Creek may act as refugia for redband trout in Whychus Creek during high flow events. High flow events with large amounts of turbidity are common occurrences on Whychus Creek during the winter and spring.

In Three Creek the main area of refugia is in reach 5 up near the dam which usually has water flowing all year. This is where the self sustaining brook trout population are located. Portions or all of reaches 1-3 go dry depending on the yearly precipitation and snowpack. Access to refugia is limited to areas upstream of fish barriers located in reach 3.

Access to the floodplain on Indian Ford Creek during high flows is good with flooded stands of willows and sedges during high flows in the lower portions of the creek. Beaver ponds also serve to create additional habitat during low flows. Refugia from high water temperatures is not available and the connection to the headwater springs has been lost due to ponds and ditches created at Black Butte Ranch.

Streambank Condition and Floodplain Connectivity

Stream surveys after 1995 have measured feet of unstable stream bank located above bankfull. Floodplain connectivity is not measured with stream surveys but is the streams ability to access the floodplain and associated habitats during high flow events.

Streambank condition on Trout Creek may have gotten worse in the lower end of reach 1 and on private land after the Black Crater Fire in 2003. During the 2001 survey 5.3 % of the steambanks in reach 1 were found to be unstable. Much of this was attributed to the horse crossings at Whispering Pines Horse Camp. From Trout Creek Swamp upstream to Alder Creek less than 0.1 % of the stream banks were unstable in 2001(Dachtler). Floodplain connectivity was recently improved in Trout Creek Swamp from a restoration project which recently blocked flows into old ditches that once drained the swamp. No streambank condition or floodplain connectivity assessments have been made for Alder Creek.

On Pole Creek within the project area the stream has access to its natural floodplain. However the floodplain is small and infrequently inundated because of the stable spring fed nature of the stream and the fact that it is confined in certain areas. Width to depth ratios ranged from 6.1 to 12.3 which is slightly high for Rosgen B type channels but this may in part be from the spring fed nature of the stream. Streambanks were typically in good condition except for areas where clear cuts had occurred near the stream and the trees left in buffer zones have blown over causing streambank instability in some locations. Overall, streambanks were found to be less than 0.1 % unstable in all reaches.

The floodplain of NF Pole Creek is small and infrequently inundated because of the stable spring fed nature of the stream and the fact that it is slightly entrenched in certain areas. Streambanks are currently in good condition and had 0.1 % unstable banks during the 2007 stream inventory.

The higher width to depth ratios from 16 to 22 in Whychus Creek and may reflect instability and channel alterations from the past (Dachtler 1997). Water withdrawals reduce the wetted width of the channel and increase stream bank erosion due to a lack of consistent water to support good riparian vegetative cover. Due to the dry, loose soil inherent in the glacial and volcanic deposits of the stream valley, and the flashy flow regime, the stream has some inherent stream bank erosion potential. Deepening of the channel and reduced access to floodplains have resulted from the stream channelization that occurred after the 1964 flood.

Floodplains of Whychus Creek may have been broad and included a large area where flood channels carried water for short time periods. These flood channels may have served to relieve the energy of peak flows and reduce overall stream bank erosion on the main channel. Examples of this are just upstream of the 4606 road and Camp Polk Road. Most of the flood side channels have been cut off or the channel elevation has been lowered during the channelization. These impacts serve to confine the floods to the main channel and concentrate peak flows in one main channel. This has resulted in increased bank instability. Bank instability ranged from 1.6 % to 13 % during the 1997 survey. Amounts of bank instability were highest in the reach from town to the TSID diversion. Reach 5 located upstream of diversions and most human impacts had 6.4 % bank instability indicating that Whychus Creek may have naturally higher amounts of bank instability due to the flashy flow regime and past moraine lake failures in the wilderness.

Snow Creek has access to its floodplain but the floodplain is narrow and most likely seldom inundated. Bank instability accounted for 0.1 % and 0.5 % of the streambanks in reaches 1 and 2, respectively. Streambank instability increased to 1.8 % in reach 3 and surveyors associated this with the Cross District Snowmobile Trail crossing and the Forest Service trail # 99 which parallels this reach. Bank instability was not measured during the 1992 survey on Indian Ford Creek but the stream banks appear to be in good condition and this may have improved some since the Glaze Allotment was closed in 1997. Only a very small amount of instability was noted at the Indian Ford Allotment. Bank instability is most likely higher on private lands downstream of the 2058 road crossing as some of these areas are heavily grazed. On Forest Service lands it appears that the stream has access to the floodplain and utilizes it on a regular basis. This may not be the case in areas where the channel has become entrenched or straightened as a result of grazing practices.

Changes in Aquatic Habitat (1998-2008)

Comparison of stream survey data between surveys conducted in the early 1990's and surveys conducted after 1995 is not possible. Several protocol changes occurred in 1995 which included changes to the way wood, habitat units, substrate and other attributes were collected. Most streams within the analysis area have been only surveyed twice and this occurred before and after the protocol changes. However, observations indicate that more wood may be entering stream reaches that have lodgepole pine and to a lesser extent white fir due to mortality from insects and diseases. It is also likely that reaches with second growth pine are maintaining or slowly losing amounts of wood as a result of decay and the lack of tree mortality in these younger even age stands. In the lower gradient unconfined reaches of Whychus Creek the loss of large wood can result in the loss of pools and high quality pool habitat.

Positive changes to habitat have also been observed in Lower Whychus Creek from more water instream and around small scale restoration projects. Increased use along Whychus Creek, Snow Creek and Indian Ford Creek by hikers, bikers, campers, and Off Highway Vehicles has also been observed. Some of the road closures and dispersed campground closures have offset some of these effects but more work still needs to be done in particular with user created hiker/biker trails and with dispersed camping in the Indian Ford and Trout Creek areas.

Changes to Fisheries, Aquatics and Their Habitats (1998-2009)

The most notable change to Whychus Creek has been the reintroduction of steelhead in 2007 and spring Chinook are planned for the spring of 2009. Middle Columbia steelhead are federally listed as threatened and Essential Fish Habitat is designated for chinook. A large fish passage facility at the Pelton Round Butte Dam is expected to be completed this year. Steelhead fry have been released up to the Sokol Diversion Dam. This diversion dam is one of five diversion structures that currently do not have fish passage. A project to provide passage and fish screens around two of the dams is scheduled to be implemented in 2010. Once passage is achieved around all five dams steelhead and spring chinook will have access to over 12 miles of habitat in Whychus Creek up to Chush falls and 1.6 River Miles of habitat in Snow Creek. Many of the dispersed campsites and user created roads near Whychus Creek have been closed or modified to lessen impacts on the stream and riparian zone. A few selected degraded sites have been actively restored through the planting of both upland and riparian plant species. Another major change in Whychus Creek has been the acquisition of instream water rights secured for the stream. This has started to improve the survival and growth of riparian plants, fish and aquatic insects. Whychus Creek had previously gone dry during the summer through the town of Sisters. A project is currently underway to pipe canals from the TSID diversion to help with water conservation. A large scale restoration project is planned for 2009 in Camp Polk Meadow where the stream was previously straightened and since has become entrenched.

On Trout Creek Swamp a restoration project was completed that filled ditches and flooded the wetland. This will help with the function of this wetland, reduce conifer encroachment and may help to store additional water during the summer months. Downstream of the 1520 road Trout Creek got burned during the Black Crater Fire. This most likely reduced shade, increased streambank instability and may have burned up some wood near the stream. Woody debris inputs in the next 10 years are expected to increase on Forest Service lands due to the fire mortality. On private lands this may not be the case because much of the land is young ponderosa pine plantations. Several roads that are near or within riparian reserves have been closed in the Upper Trout Creek subwatershed on FS lands.

The recommendations for restoration of aquatic and hydrologic systems from the 1998 WA (pages 214-230) are still pertinent and some of these objectives have been accomplished as described above. The priority of projects should still remain the same as stated in the 1998 WA with water challenges as the first priority. Within the water challenges priorities fish passage within Whychus Creek should be a priority in anticipation of reintroduced steelhead and chinook that are projected to start returning in 2011.

Resource Report
WILDLIFE

WILDLIFE

Threatened, Endangered, and Sensitive Species

Peregrine Falcon The American peregrine falcon was delisted (removed) from the Endangered Species Act on August 20, 1999. It is a Regional Forester Sensitive Species and a Deschutes LRMP Management Indicator Species (MIS). There are no known historic nest sites in the watershed. Some habitat may exist. Three peregrine falcon observation were documented in 1994 outside the watershed along Green Ridge by Hawk Watch International, Inc.

Bald Eagle The bald eagle was delisted (removed) from the Endangered Species Act on August 9, 2007. It is listed as a Regional Forester Sensitive Species and as MIS under the Deschutes LRMP.

TREND: Stable in the watershed. All recovery goals for the High Cascades Recovery Zone 11 were met prior to delisting. Large nest trees are at risk from human-caused fires and replacement trees are needed.

Pages 112-116

Northern Spotted Owl The northern spotted owl is a federally threatened species and a Deschutes LRMP Management Indicator Species. The U.S. Fish and Wildlife Service (FWS) identified threats to the owl as previous and ongoing loss of suitable habitat from harvest and catastrophic unplanned fires and competition with barred owls in the May 16, final recovery plan (USDI FWS 2008a). The west half of the watershed is within the range of the spotted owl (USDA FS 1994).

Spotted owls generally require mature or old-growth coniferous forest with complex structure including multiple canopy layers, large green trees and snags, heavy canopy habitat, and coarse woody material on the floor. Functional nesting, roosting, and foraging (NRF) habitat occurs in multi-storied canopies in mixed conifer stands and in riparian areas. The canopy cover is typically greater than or equal to 40% with an overstory comprised of at least five percent of trees greater than 21 inches diameter breast height (dbh). Habitat that meets nesting and roosting requirements also provides foraging habitat, although a wider array of forest types are used for foraging, including more open and fragmented habitat.

Approximately 33,075 acres of the Sisters Ranger District are mapped as spotted owl NRF habitat (10% of the district). Approximately 11,692 acres of GIS-mapped NRF habitat occur in the Whychus watershed, although not all of these acres have been ground-truthed to determine if they function as NRF habitat. Of these, 5,674 acres occur in wilderness and 3,371 acres occur in late-successional reserves (LSRs).

Due to unplanned fires and vegetation management projects, the number of activity centers across the District was reduced from 21 in 2001 to 9 in 2009. Of these nine, only Black Crater is considered potentially active. Black Crater is one of three known spotted owl activity centers in the watershed. The other two are Bluegrass Butte to the north of Black Crater and Trout Creek to the south. The Bluegrass Butte and Trout Creek activity centers are considered potentially viable but inactive. All three home ranges contain less than 40% suitable NRF habitat (1,158 acres) within 1.2 miles of the activity center, the minimum amount of habitat considered necessary to ensure viability of a pair (Table 1). However, owls on the Forest have routinely nested and reproduced in home ranges with less than 40% suitable habitat. Estimated suitable habitat within home ranges can be misleading due to the delineation of home ranges as circles. In reality, owls are likely to use habitat outside the delineated radius depending on

topography, fragmentation, and availability of suitable habitat. For home ranges to considered viable post-fire, there needs to be inclusions of nesting habitat with proximity to the historic activity center to account for site fidelity and connectivity between patches of suitable habitat.

Table 1. Habitat Conditions for the Three Owl Pairs in the watershed.

Spotted Owl Pair	Acres NRF within 1.2 Mile Radius	% NRF within 1.2 Mile Radius
Trout Creek	586	20%
Black Crater	277	10%
Bluegrass Butte	314	11%

TREND: At risk due to habitat fragmentation and loss from harvest, insects and disease, increased stand densities and loss of large trees from overstocking (white fir), and large-scale fires. Barred owls have not been detected in the watershed.

Late-Successional Reserves (LSRs) and Owl Habitat

The intent of LSRs is to protect and enhance late-successional/old-growth forest ecosystems, which serve as habitat for dependent or old-growth associated species including the spotted owl. Thining or other silvicultural and non-silvicultural treatments such as prescribed fire may occur if beneficial to creation, enhancement, and maintenance of late-successional conditions. Management to reduce risk of large-scale fire and treatments to accelerate develop of late-successional habitat is recommended. The watershed contains the southern portions of the Metolius and Cache LSRs, and all of the Trout and Three Creeks LSRs (Table 2, Figure 1).

Table 2. LSRs and NRF in the watershed.

LSR Name	Total acres of LSR	Acres of LSR in watershed	NRF acres in LSR in watershed
Metolius	75,774	4,846	1,520
Cache	16,931	7,672	862
Trout	11,836	11,836	1,349
Three Creeks	3,077	3,077	0
Total	107,618	27,431	3,731

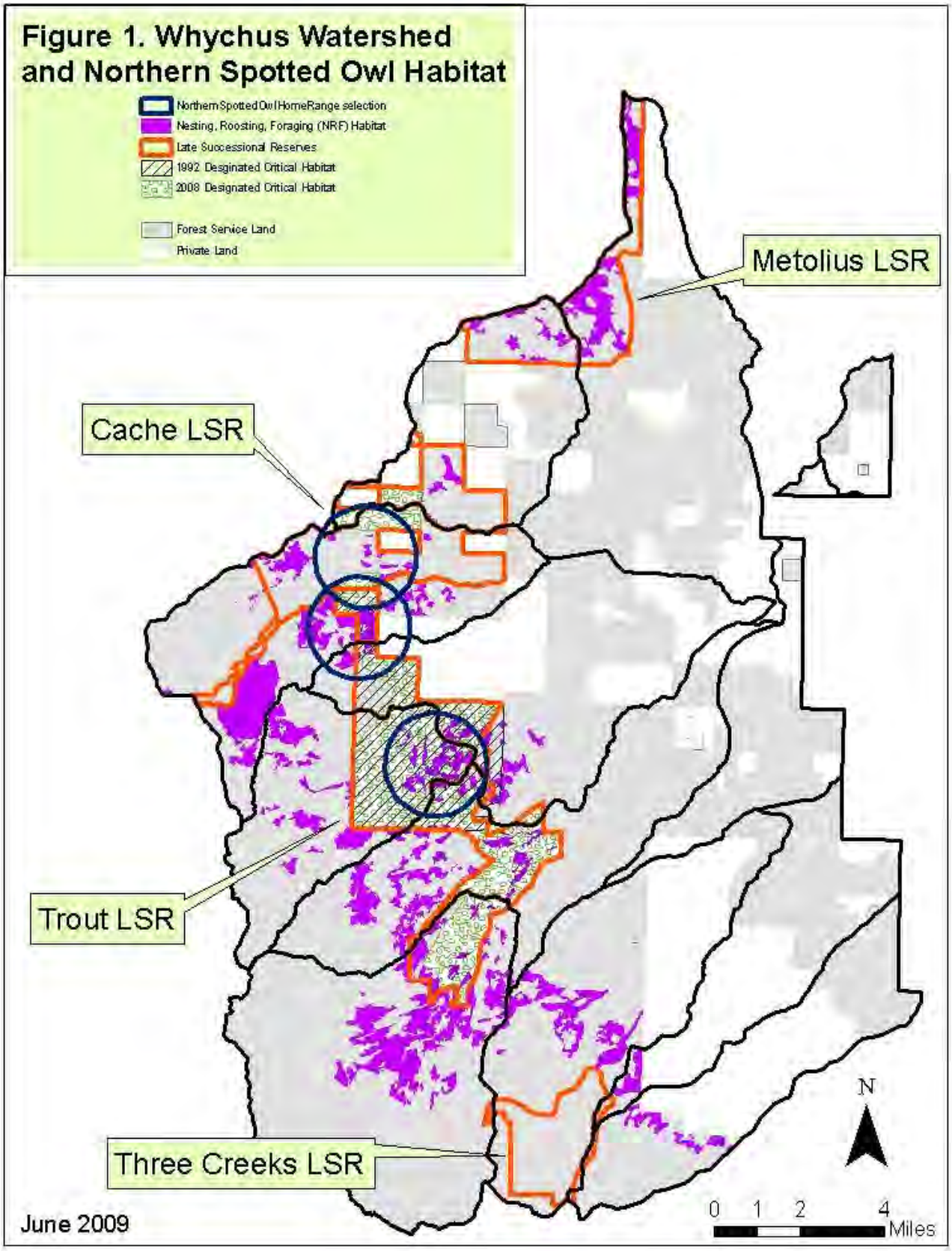


Figure 1. Whychus Watershed and Northern Spotted Owl Habitat
Northern Spotted Owl Home Range selection
Nesting, Roosting, Foraging (NRF) Habitat
Late Successional Reserves
1992 Designated Critical Habitat
2008 Designated Critical Habitat
Forest Service Land
Private Land
Metolius LSR
Cache LSR
Trout LSR
Three Creeks LSR
N
0 1 2 4
Miles
June 2009

Both the Metolius and Cache LSRs have undergone habitat loss and fragmentation due to insect, disease, and large-scale fires, although these impacts are more significant in the northern portions of these LSRs outside the watershed.

The Trout LSR is approximately 11,843 acres or 5% of the District. It is connected to the Cache LSR to the north but is effectively separated by Highway 242. It is bordered by the Three Sisters Wilderness to the west and south, borders matrix lands to the west and south, borders matrix lands to the west of Whychus Creek and to the east, and private lands to the northeast. Mixed conifer wet and dry are the dominant plant association groups (PAGs) with Douglas fir and white/grand fir the dominant climax species. In these series, ponderosa pine and lodgepole pine (and in some cases Douglas-fir) should be the dominant early seral species but they are not subordinate to true firs. Higher levels of mortality can also be found in the north portion of the LSR due to the effects of an epidemic spruce stands in the Cache and Metolius LSRs to the north. The southern extent of the outbreak affected the Cache/Trout LSR, south to approximately Trout Creek Swamp. Currently there is an outbreak of mountain pine beetle in lodgepole stands at the southern end of the Trout LSR and mortality is increasing annually at a rapid rate.

In the Trout LSR, NRF habitat is patchily distributed, except for the very southern end which is comprised primarily of the ponderosa pine PAG and does not produce NRF habitat. Connectivity exists both to the north and south as well as east and west to the Three Sisters Wilderness. Although there are no large tracks of continuous NRF habitat, there are habitat blocks that provide stepping stones across the LSR. There are 1,349 acres of NRF habitat in this LSR. These acres were ground-truthed in fall of 2008.

The Three Creeks LSR is the southernmost LSR in the watershed and on the District. It is approximately 3,077 acres of primarily lodgepole pine dry and mountain hemlock dry PAGs. It was originally designated for rare amphibians. There are no owl home ranges and it does not produce NRF habitat for spotted owls. It has limited habitat suitability for north-south connectivity and dispersal functions. The closest LSR to the south is 14 miles in the Sheridan Mountain LSR on the Bend-Ft. Rock Ranger District.

TREND: Suitable spotted owl associated with mixed conifer stands in LSR will continue to be impacted by insects and disease, loss of large trees, and is at risk of large-scale loss from unplanned fires.

Critical Habitat and Recovery Plans

Critical habitat for the spotted owl was designated on January 15, 1992 and revised on August 12, 2008. The 2008 revised critical habitat designation changed some of the boundaries of the 1992 designation and grouped the previous individual units into one Eastern Oregon Critical Habitat Unit (CHU) number 11. CHU 11 encompasses all of the Forest (106,600 acres). Critical habitat boundaries roughly follow the LSRs. Under the 1992 rule, 8,748 acres are designated critical habitat in the watershed and under the 2008 rule, 11,309 acres are designated critical habitat in the watershed.

The 2008 critical habitat designation was based on both the 2007 draft recovery plan (for the eastside forests) and the 2008 final recovery plan (for the westside forests). East of the Cascades, the recommended management approach in the recovery plan calls for maintaining shifting spotted owl habitat patches over an entire landscape over time, focusing on maintaining and developing large, older trees. As individual habitat patches are lost to fire or insect damage, nearby habitat patches that could develop large tree and associated habitat components would be maintained or enhanced. The landscape management approach for the eastside provinces was not incorporated into the revised 2008 critical

habitat designation because regulations require the delineation of specific geographic boundaries for critical habitat. Therefore, the 2008 critical habitat designation for eastside forests was based on the Managed Owl Conservation Areas (MOCAs) delineated in the 2007 draft recovery plan habitat. In April 2009, both the 2008 final revised critical habitat and 2008 final recovery plan were remanded to court for further review. Until a court decision is made, the Forest will evaluate project impacts to critical habitat under both the 1992 and 2008 designations.

TREND: Suitable spotted owl associated with mixed conifer stands in LSR will continue to be impacted by insects and disease and are at risk of large-scale loss from unplanned fires.

Dispersal Habitat and Connectivity
Dispersal habitat is important for spotted owls to move from one territory to another, find food, and for young to move away from natal areas. Poor dispersal habitat puts the young and adults at risk of predation and reduces their ability to secure prey. Maintaining and enhancing dispersal habitat is critical to increasing the number of breeding pairs and recovery of the species. Dispersal habitat is defined as a minimum of 30% canopy closure and minimum average dbh of 11 inches for mountain hemlock, ponderosa pine, and mixed conifer dry PAGs and 7 inches dbh for lodgepole pine PAGs. In mixed conifer wet and riparian PAGs, a minimum of 40% canopy closure can often be met. North-south connectivity is primarily along the western third of the watershed in wilderness areas.

TREND: Decreasing due to previous harvest, insects and disease, and large-scale unplanned fires. NRF habitat that no longer supports suitable NRF functions will be managed to provide dispersal habitat and north-south connectivity to the extent possible.

Canada Lynx In 2003, the Forest determined that no lynx habitat or self-maintaining lynx populations were present on the Forest (Jeffries and Zalunardo 2003). This rationale was based on the best available science, guidance, and 1999-2001 field surveys conducted on the Forest. The FWS concluded in 2003 that lynx occurred in Oregon as dispersers and never maintained resident populations due to limited verified records of lynx, correlations of these records with cyclic highs of populations to the north, and lack of evidence of lynx reproduction (USDI FWS 2003). Neither the November 9, 2006, final rule designating critical habitat for lynx (USDI FWS 2006) nor the February 24, 2009 final revised critical habitat designation included any area in Oregon (USDI FWS 2009).

Survey and Manage Species
Survey and Manage is no longer a category used under the Northwest Forest Plan. Two previous Survey and Manage species are now considered Regional Forester Sensitive Species for the Forest—the Crater Lake tightcoil and the Great gray owl.

Sensitive Species

Crater Lake Tightcoil: The Crater Lake tightcoil is a minute subspecies of land snail sparsely distributed throughout the Oregon Cascades at elevations of 2,750 to 6,400 feet. It is found in perennially moist conditions in mature conifer forests and meadows among rushes, mosses, and other surface vegetation or under rocks and woody debris within 30 feet of open water in wetlands, springs, seeps and streams, generally in areas which remain under snow for long periods (Gowan and Burke 1999). Essential habitat components are uncompacted soil, litter, logs, and other woody debris in a perennially wet environment. Natural porous soils and litter are important for providing cover for temperature and humidity fluctuations and protection from predators. Riparian sites which experience periodic flooding or large fluctuations in water level are not suitable habitat. Green understory and

overstory vegetation that provide shading is important in maintaining temperature and humidity requirements at ground level. Xeric areas and permanent water bodies are barriers to movement. Tightcoils occur in the watershed based on surveys conducted in 2000-2002. Most individuals were found within 10 feet of the streambank.

TREND: This species is assumed to be declining in the region due to loss or degradation of riparian/wetland habitat. Activities that compact soils or snow, disturb ground vegetation and/or litter, remove woody debris, alter temperature and/or humidity of the microsite, or alter the water table could be deleterious to the species' habitat of this species. These activities include water diversions and improvements, timber management, recreation (i.e., camping, ORVs), burning, heavy equipment operation, construction activities, and livestock grazing.

Great gray owl The great gray owl is no longer a Regional Forester Sensitive Species but is a Deschutes LRMP MIS.

California wolverine The wolverine is not a federal candidate species. It is a Regional Forester Sensitive Species and a Deschutes LRMP MIS.

Northern goshawk The northern goshawk is no longer a federal candidate species. It is a Regional Forester Sensitive Species and a Deschutes LRMP MIS.

Fisher The Pacific fisher is a federal candidate species and a Regional Forester Sensitive Species.

Townsend's big-eared bat The Townsend's big-eared bat is a Regional Forester Sensitive Species and a Deschutes LRMP MIS.

TREND: This species continues to decline at sites monitored on the Forest and across the region due to disturbance at hibernacula and maternity sites (primarily at caves). Specific information on occurrence or decline is not known for caves or other sites in the watershed.

Black-backed woodpecker The black-backed woodpecker is a Regional Forester Sensitive Species and a Deschutes LRMP MIS.

TREND: This species' habitat has likely increased in the watershed and across the Sisters Ranger District over the past 10 years, due to creation of snag habitat from insects, disease, and several large-scale fires. It is declining across the region. Snag requirements will likely continue to be met.

White-headed woodpecker The white-headed woodpecker is a Regional Forester Sensitive Species and a Deschutes LRMP MIS.

Pileated woodpecker. The pileated woodpecker is no longer considered a Regional Forester Sensitive Species but is considered a Deschutes LRMP MIS.

TREND: Unknown for the watershed but likely has declined across the Forest and region due to loss of large-diameter snags.

Williamson's sapsucker The Williamson's sapsucker is a Deschutes LRMP MIS.

American marten The Williamson's sapsucker is a Deschutes LRMP MIS.

The following species are also considered Regional Forester Sensitive Species (USDA FS 2008).

Bufflehead The bufflehead is a diving duck that nests at high elevation-forested lakes in the central Cascades using tree cavities or artificial nest boxes close to water, preferably using northern flicker or pileated woodpecker holes. They inhabit lakes, reservoirs, and slow-moving streams and rivers. Buffleheads are migratory, generally arriving on breeding territories in March-April; nesting is usually completed by the end of June. Potential habitat exists in the watershed.

TREND: Once considered one of the most ubiquitous ducks in Oregon, populations have undergone steady declines in recent decades due to hunting pressure, recreational disturbance, and lack of suitable natural nesting cavities.

Harlequin duck The harlequin duck breeds mostly west of the Cascades along third to fifth order streams with rapidly moving water, simple channels, and abundant in-stream rocks for "loaf sites." They usually nest on the ground but will also nest in tree cavities or in cliff faces. It is unlikely they would occur in the watershed due to the lack of loafing sites.

TREND: Declining in region.

Horned grebe The horned grebe breeds from central Alaska and northern Yukon to northern Manitoba south to eastern Washington, central Wisconsin, and extreme western Ontario. It winters from the Aleutian Islands and southern Alaska along the Pacific Coast to southern California and along the Atlantic Coast from Nova Scotia to southern Florida. It inhabits ponds, marshes, sloughs, backwaters of streams and rivers, shallow bays of large lakes, and flooded places with some open water. The strongest Oregon habitat association is along lake and pond shorelines and islands and the edges of freshwater marsh. They show a preference to nest in small ponds with open water where territory can be observed visually.

In Central Oregon, it is an uncommon spring and fall migrant at larger lakes and reservoirs throughout the region. It is regularly found at Wickiup and Tumalo reservoirs as a migrant on the Bend-Ft. Rock Ranger District and Hatfield Lake. A few summer breeding records exist for the region, with the closest confirmed breeding in Sycan Marsh (Lake and Klamath counties) and lower Silver Creek Valley (Harney County). Breeding has not been documented on the Forest.

TREND: Declining in region.

Red-necked grebe The Red-necked grebe breeding habitat consists of extensive clear, deep-water marshy lakes and ponds in timbered regions with emergent vegetation. Sites protected from wind and strong wave actions (either small ponds or buffered areas in lakes or bays) are preferred. Individuals arrive to breeding areas between April and May and young hatch by end of June. They migrate to coastal wintering grounds in September and October. The only consistent breeding population in Oregon consists of five to twenty birds at Upper Klamath Lake. However, individuals have been observed on several lakes near the Cascade Lakes Highway on the Bend-Ft. Rock Ranger District further south. Occurrence in the watershed is not known but potential habitat exists in the watershed.

TREND: Unknown.

Tri-colored blackbird The tricolored blackbird is a non-territorial colonial breeder that is primarily endemic in the lowlands of Central Valley and southern California. Tricolored blackbird breeding sites

occur in Oregon primarily in the Rogue Valley (Jackson County) and Klamath Basin (Klamath County). They are uncommon to rare in fall and winter in Crook and Deschutes County. They breed in hardstem bulrush, cattail, nettles, willows and blackberries. It is unlikely they would occur in the watershed.

TREND: Dramatic decline across range (primarily in California) due to wetland/riparian habitat loss and alteration. Populations outside of California in Oregon, Washington, and Nevada account for < 5% of total population.

Yellow rail The yellow rail is a small, secretive wading bird that inhabits freshwater marshes and shallowly flooded sedge meadows in southern Canada and north-central U.S., primarily east of the Rockies. Historical populations in southern Oregon and eastern California existed in the early 20th century; however, they were thought to be extirpated from Oregon and California by 1983. Beginning in the late 1980s, breeding locales were again documented in Klamath and Lake Counties, which now represents a disjunct breeding population. Their habitat includes shallowly flooded sedge meadows at 4,100-5,000 feet. There have been no documented sightings of yellow rails on the Forest or in Deschutes County. It is unlikely that this species would occur in the watershed.

TREND: Unknown due to the difficulty of detection but likely declining due to loss of wetland habitat.

Northern waterthrush The northern waterthrush is a warbler that inhabits dense riparian willows (5-8 feet in height), often in standing or slow-moving water with surrounding conifer forests. The nest is usually on the ground, tucked under an upturned tree root, along a bank, in a fern clump, or up to two feet off the ground in a moss-covered stump. In Oregon, an isolated population has bred since 1977 along the Little Deschutes River north of Gilchrist (Klamath County), south near Highway 58, west along Crescent Creek and to Salt Creek east of the Falls in Lane County. There is a low potential for occurrence in the riparian areas in the watershed due to lack of suitable habitat.

TREND: Unknown.

Johnson's hairstreak
The Johnson's hairstreak is a three-quarter inch uncommon butterfly that ranges from southern British Columbia, south through Washington and western Oregon, to central and south California. Isolated populations exist in northeastern Oregon to central Idaho. In Oregon, it has been found sparsely in the Cascades, Coast Range, Siskiyou Mountains, Blue Mountains and Wallowa Mountains. Elevations range from sea level to 6,000 feet.

This butterfly species is dependent on dwarf mistletoes (genus *Arceuthobium*) and other mistletoes including *Arceuthobium tsugense as host plants in* coniferous forests. These mistletoes occur mainly on western hemlock and occasionally true firs. Peak conditions exist in old-growth and late-successional second growth forests although younger forests that contain dwarf mistletoe may also support Johnson's hairstreak populations. This species may be a primary herbivore of dwarf mistletoe plants. This species typically spends much of its time in the top of the forest canopy which may contribute to the rarity of sightings. The larvae feed on and mimic the aerial shoots of mistletoes, making observation very difficult. Conservation issues include loss of late-successional habitat, stand treatments to reduce dwarf mistletoe, insecticide and herbicide applications, and hybridization/competition with the thicket hairstreak.
In 1990, dwarf mistletoe was present on an estimated 34 percent of the inventoried acres of ponderosa pine type, 73 percent of the mixed conifer type, and 66 percent of the lodgepole pine type across the Forest (USDA FS 1990). Johnson's hairstreak has been detected at Black Butte and Suttle Lake to the

north of the watershed. Potential habitat likely exists in the watershed due to the occurrence of mistletoe in mixed conifer PAGs.

TREND: Unknown.

Silver-bordered fritillary
The silver-bordered fritillary ranges from Central Washington south along the Rocky Mountains to northern New Mexico and east to Illinois, Virginia and Maryland. They inhabit wet meadows, bogs, and marshes as well as forest openings in mountainous areas, and spring-fed meadows in dry prairies. Two primary colonies exist in Oregon: one at Big Summit Prairie on the Ochoco National Forest and one in the Strawberry Mountains in the Malheur National Forest (Miller and Hammond 2007). Adults lay eggs singly near host plants of the violet family including *Viola glabella* and *V. nephrophylla*. Caterpillars that develop from the eggs feed on these host plants and overwinter by hibernating, emerging as adults in the spring. Favored nectar sources for adults are composite flowers including goldenrod and black-eyed susans. Adults fly May to July with a second generation flying from August into September. Threats to this species include livestock overgrazing, wetland loss, and woody vegetation encroachment of willows and hawthorns from wildfire suppression (Miller and Hammond 2007).

TREND: Declining across region.

Pygmy rabbit The pygmy rabbit is closely associated with habitat supporting tall, dense clumps of Great Basin or big sagebrush. This species is restricted to the northern parts of the Great Basin and is potentially found east and possibly on the eastern edge of the Forest. There is no suitable habitat for this species in the watershed.

TREND: Large decline across the region from loss of habitat, food, and increased predation due to agricultural and urban development.

Greater sage grouse The greater sage grouse inhabits sagebrush shrub-steppe and meadow-steppe habitats east of the Cascades for food and cover through the year. They are typically found in areas with low, rolling hills adjacent to valleys. Sage grouse occur on the eastern edge of the Bend-Ft. Rock Ranger District of the Forest. There is no suitable habitat for this species in the watershed.

TREND: Large decline across the region from loss of habitat due to livestock grazing, roads, agricultural, urban, and energy development, drought, and invasive plants.

Page 124
Neotropical Migratory Birds
The Forest addresses impacts to migratory birds through the Forest Service Landbird Strategic Plan (January 2000), the Conservation Strategy for Landbirds of the East-Slope of the Cascade Mountains in Oregon and Washington (Altman 2000), and the Birds of Conservation Concern (USDI FWS 2008b).

The goal of the Forest Service Landbird Strategic Plan is to maintain, restore, and protect habitats necessary to sustain healthy migratory and resident bird populations. The purpose is to provide guidance for the Landbird Conservation Program and focus efforts in a common direction. On a more local level, the (Altman 2000) outlines conservation measures, goals and objectives for specific habitat types found on the east-slope of the Cascades and the focal species associated with each habitat type. The Forest is in the Central Oregon subprovince. Table 3 lists specific habitat types, the habitat feature conservation focus, and the focal bird species for each. All of these species have potential habitat in the watershed.

Sandhill cranes likely do not nest but may migrate through the watershed.

Table 3. Priority habitat features and associated focal landbird species for Central Oregon.

Habitat	Habitat Feature	Focal Species for Central Oregon
Ponderosa Pine	Large patches of old forest with large snags	White-headed woodpecker
	Large trees of old forest with large snags	Pygmy nuthatch
	Open understory with regenerating pines	Chipping sparrow
	Large trees of old forest with large snags patches of burned old forest, cottonwoods	Lewis' woodpecker
Mixed Conifer (Late-Successional)	Large trees	Brown creeper
	Large snags	Williamson's sapsucker
	Interspersion grassy openings and dense thickets	Flammulated owl
	Multi-layered/dense canopy	Hermit thrush
	Edges and openings created by wildfire	Olive-sided flycatcher
Lodgepole Pine	Old growth	Black-backed woodpecker
Meadows	Wet/dry	Sandhill Crane
Aspen	Large trees with regeneration	Red-naped sapsucker
Subalpine fir	Patchy presence	Blue grouse

The Birds of Conservation Concern (*BCC*, USDI FWS 2008b) identifies species, subspecies, and populations of all migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973 (ESA). The goal is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservations actions. Bird Conservation Regions (BCRs) were developed based on similar geographic parameters. BCR 9 (Great Basin) encompasses the District. Table 4 lists BCC species, preferred habitat, and potential habitat in the Whychus watershed for BCR 9.

Table 4. 2008 Birds of Conservation Concern, BCR 9 (Great Basin).

Bird Species	Preferred Habitat	Potential Habitat in the Whychus Watershed
Greater Sage Grouse	Sagebrush dominated Rangelands	No
Eared Grebe	Lakes, ponds, large pools in rivers and streams	Yes
Bald eagle	Lakes	Yes
Ferruginous Hawk	Elevated Nest Sites in Open Country	No
Golden Eagle	Elevated Nest Sites in Open Country	Yes
Peregrine Falcon	Cliffs	Yes
Yellow Rail	Dense Marsh Habitat	No
Snowy Plover	Dry Sandy Beaches	No
Long-billed Curlew	Meadow/Marsh	No
Marbled Godwit	Marsh/Wet Meadows	No
Sanderling	Sandbars and beaches	Yes
Wilson's Phalarope	Meadow/Marsh	Yes
Yellow-billed Cuckoo	Dense riparian/cottonwoods	No
Flammulated Owl	Ponderosa pine forests with meadows	Yes
Black Swift	Cliffs associated with waterfalls	Yes
Calliope Hummingbird	Mountain meadows, coniferous forest	Yes
Lewis's Woodpecker	Large diameter ponderosa pine, cottonwoods, burned and insect-killed forests	Yes
Williamson's Sapsucker	Mixed conifer forests	Yes
White-headed Woodpecker	Large diameter open ponderosa pine forests	Yes
Loggerhead Shrike	Open country with scattered trees or shrubs	No
Pinyon jay	Juniper, Sagebrush	Yes
Sage thrasher	Arid scrub habitat	No
Green-tailed towhee	Ponderosa pine, desert sagebrush	Yes
Virginia's Warbler	Scrubby vegetation in arid montane woodlands	No
Brewer's Sparrow	Sagebrush clearings in coniferous forests/bitterbrush	Yes
Black-chinned sparrow	Arid scrub habitat	No
Sage Sparrow	Sagebrush	No
Tricolored Blackbird	Cattails or Tules	No
Black rosy-finch	Alpine habitat	Yes

Non-Native Species *Invasive plants*

Effects occur but extent unknown. Invasive plants can create adverse effects to wildlife including loss of habitat (both terrestrial and aquatic), reduction in quantity and quality of native forage, and changes to soil properties, water quality, and the intensity and frequency of wildfire which can degrade or eliminate wildlife habitat.

Other Human Influences on Wildlife

Roads and Trails

- reduces habitat
- increases habitat fragmentation
- increases disturbance (noise from motorized traffic, recreational use)
- facilitates recreational access (motorized and non-motorized)into wilderness and core habitats
- reduces connectivity for dispersal
- increase in edge habitat beneficial for a few species
- facilities competition with non-native species
- results in vehicle-strike injury and mortality
- facilitates legal and illegal hunting
- increases habitat degradation through soil and water contamination

New Recommendations

- Road density currently exceeds LRMP standards. Evaluate closure and decommissioning of roads including rehabilitation to benefit wildlife habitat and security, particularly for mule deer and elk.
- Evaluate use of thinning or prescribed fire to reduce firs encroaching in meadow habitat that may benefit species including the great gray owl and silver-bordered fritillary.

Accomplishments of Recommendations

The Whychus Creek Allotment of approximately 45,000 acres was closed from grazing on April 3, 2009, to protect wilderness values. This allotment is located to the west and south of Sisters. Although there was little competition for browse between livestock and ungulates and the allotment was last used in 1983, the remaining 26 miles of unmaintained fencing and several cattleguards present a safety hazard for mule deer and elk moving through the area. Officially closing the allotment will allow opportunities to remove these wildlife hazards and improve ungulate habitat.

Data Gaps Common to All Areas

Data gaps remain valid with the exception of survey and manage species, a category no longer used in the region. Surveys are recommended for listed regional forester sensitive species should protocols and funding become available.

Resource Report
BOTANY

BOTANY

Introduction

The purpose of this report is to update information on plant species in the Whychus watershed and provide management recommendations. This report updates the Botanical information provided in the 1998 Sisters/Whychus Watershed Analysis. Since 1998 there have been numerous changes in species status and surveys have located new rare plant sites.

Tables outlining known and potential species are included as Table 1 and 2 at the end of this report.

Threatened or Endangered Plants

There are no Threatened or Endangered plants known to occur in the LSR.

Region 6 Sensitive Plants

The following plants listed as "Sensitive" on the Pacific Northwest Region 6, Regional Foresters Special Status Species List for Sensitive Vascular Plants (January 2008) are known to occur in the Whychus Watershed:

Newberry's gentian (*Gentiana newberryi*).
Peck's penstemon (*Penstemon peckii*)
Elfin Saddle Sac Fungus (*Helvella crassitunicata*)
Woolly Feather-moss (*Tomentypnum nitens*)
Lesser Bladder Wort (*Utricularia minor*)

1) Newberry's Gentian *(Gentiana newberryi)*

This species is associated with high elevation wet or moist meadow habitats. Meadows are naturally rare on the landscape and often are hot spots of biological diversity. These habitats are associated with and influenced by surrounding late successional habitats.

Status: Newberry's Gentian is classified as "sensitive" on the Regional Foresters Sensitive Plant List. Trapper Meadow, Little Three Creeks, Three Creeks Meadow, several other unnamed meadows, and the "salamander pond" are the northern-most occurring populations of Newberry's gentian on the Deschutes National Forest. The species is a regional endemic found in Oregon and California . There are 20 known sites in the LSR.

Habitat: Newberry's gentian is found in mesic to moderately well drained meadows or mesic grassy borders adjacent to streams and lakes. It is not found in boggy areas.

Changes to Habitat/Threats: Cattle, sheep or horse grazing occurred historically in high elevation

meadows, but not in the past 30 or so years. Some horse grazing may occur associated with recreational horse use at Three Creeks Lake. Grazing can change species composition. Some protective measures have improved conditions at Trapper Meadow Horse Camp (water troughs, fencing).

Meadows are favorite recreational areas for camping and vulnerable to off road vehicle use. Several mud bogging incidents have occurred at Trapper Meadow. Flower picking can be problem in the Three Creeks area. Excessive recreational use can cause trampling, devegetation, introduce invasive plant species and change species composition.

The high elevation meadows in the watershed appear to have generally intact hydrological regimes. Some meadows were kept more open by periodic fires and are now being invaded by trees. Wildfires in the area may change meadow hydrology, making them wetter as evapotranspiration by trees ends if they die. Large stands of insect killed trees will also lead to wetter conditions for the same reason.

Potential Management Conflicts and Recommendations:

1) Fire Suppression

- Meadows are often targeted as landing areas for helicopters during fire suppression. Use of these high elevation meadows should be highly restricted to emergency use only because of their rare plant populations, fragility, and vulnerability to trampling.
- Do not allow equipment to stage in meadows during fire suppression.
- Avoid fireline or safety zones in meadows.
- Consider allowing fires to burn around and through meadows for resource benefit.

2) Recreation Management

- Recreation management in the Three Creeks Lake Complex should continue to monitor and detect problem spots and adjust and maintain site controls such as fencing and watering troughs.

2) Peck's penstemon (*Penstemon peckii*)

This species is associated with open canopied pine and dry mixed conifer forests and meadows, fire maintained habitats, seasonally moist areas with high water table or intermittent and ephemeral stream channels. Peck's penstemon functions as a colonizer of bare mineral soil created by disturbance.

Status: This rare endemic wildflower is classified as "sensitive" on the Regional Forester's Sensitive Plant List. It is only found on approximately 485 square miles centered around Black Butte on the Sisters Ranger District. Most known populations are on National Forest Lands. Approximately 34% of the global population is associated with the Whychus Creek watershed.

Habitat: Peck's penstemon is an indicator of fire maintained habitats, including open canopy patch patterns, meadows, and the integrity of seasonally moist habitats or channels. It is closely associated with pine-dominated, open-canopied forests with early seral understories. These habitats were historically maintained by a low intensity fire regime. The plant has wide genetic amplitude and can be found persisting in a variety of habitats, including early seral habitats such as plantations, skid trails, and roadsides. Some unsurveyed high probability habitat also exists associated with floodplains of Whychus, Pole and Trout Creek.

A new large population (9000 plants) of Peck's penstemon was found in 2007 on the southern edge of the plants range. The population is unusual in that it occurs under a dense lodgepole and spruce canopy and appears more mat-like than usual.

The plant often occurs in high water table areas or in intermittent and ephemeral stream channels. Populations display a patchy distribution, with greatest concentrations of plants found at lower ends of watersheds on level ground with relatively high water retention. The Peck's penstemon Species Conservation Strategy Update (Pajutee 2009) identifies the five most important abiotic and biotic variables involved in the plant's viability as abundant moisture, light (required for flowering), abundant pollinators, periodic fire, and flooding (seed dispersal).

Changes to Habitat/Threats:

In examination of twenty four "protected" Peck's penstemon populations to assess trends, Pajutee (2009) found that in the past 17 years Peck's penstemon populations have been reduced in size or rarely extirpated because of changes to habitat due to successional changes due to lack of fire, invasive plants, or damage from unmanaged recreation or new user roads. About 17% of the global population habitat had been invaded by invasive plants.

Exclusion of fire from pine and dry mixed conifer forests has been the biggest factor in reducing habitat quality for the plant. Pajutee (2009) found five large populations appeared to have reductions in numbers of plants by 40-60% due to successional changes from lack of fire. A small population found 1 mile east of the Late-Successional Reserve near Whychus Creek had been invaded by lodgepole trees and could not be relocated. Management Treatment studies have shown that the plant benefits from low intensity prescribed fire with increased flowering and seed production. Disturbance patches of mineral soil created by fire or rodents provide seedling establishment areas.

Severe ground disturbance can uproot plants and destroy populations. Pogson (1979) observed populations in otherwise contiguous habitat ending at private land boundaries where the soil was severely disturbed. Mowing has been observed to have little effect on flowering plants.

Timber harvest Timber harvest is a threat to penstemon populations when the type of the treatment involves heavy soil disturbance, heavy fuels are left behind the treatment, the timing of the treatment ignores the condition of the population and plant phenology, or when a majority of the plants are not preserved during the treatment. The potential for introduction of invasive plants on logging equipment or support vehicles and the spread of existing invasive plants into newly disturbed areas is also a risk.

Ground disturbing activities during timber harvest such as machine piling and burning of slash, site preparation, machine skidding, and pulling line for large diameter trees can uproot adult penstemon plants, reducing the population's ability to reseed after the disturbance.

As discussed above, Ingersoll (1993) found that harvest activities which involve heavy soil disturbance caused a decline in populations of Peck's penstemon. Logging operations which uproot and destroy parent plants can risk extirpation of the population when: 1) the whole population lies within the treatment and 2) the seed bank is low because reproduction has been depressed after prolonged canopy closure before harvest. Loss of populations on private timber lands in this manner were reported by Pogson (1979). It is the hypothesis of this guide that heavy ground disturbance in penstemon populations that are under closed canopy conditions before treatment may fragment or permanently

destroy the population because the soil seed bank is low and conditions that allow successful germination and seedling survival may be rare.

Timber harvest activities which occur before yearly seed dispersal may lower the recovery rate of the population if slash is not cleaned up. This is because there are known chemical inhibitors for Peck's penstemon seed germination in pine needle litter slash left behind timber harvest. This indicates slash from timber harvest activities should be burned or removed to benefit the plant.

Not all timber harvest has resulted in loss of penstemon plants or populations. Field observations have shown that Peck's penstemon tolerates select harvest, thinnings, overstory removals, and even fire salvage that causes light ground disturbance and does not obliterate plants. When parent plants are not uprooted, the species has been observed reseeding and proliferating in adjacent bare soil areas and skid trails. It is speculated that silvicultural treatments which open closed canopies, reduce soil litter, reduce vegetative competition, and retain penstemon parent plants will benefit the species in forested habitats. These treatments have not yet been tested in controlled situations and the effects of new logging equipment, which causes less soil disturbance needs to be studied.

Field observations also support the notion that Peck's penstemon can sometimes readily reseed bare compacted soils caused by forest treatments, but this is highly dependent on soil moisture (high water table or especially wet weather conditions). Several large Peck's penstemon populations are known from old clearcuts or landings with high water tables. Plants in compacted skid trails have also been commonly observed. Standing water in the upper layers of compacted soil may promote seed germination. Tillage of compacted soils in roads at Riverside Campground (#500054- Riverside) resulted in new penstemon plants growing in the loose soil. The majority of Peck's penstemon plants survived subsoiling and increased in size at the North Shackle Monitoring project described under Management Treatment Monitoring Results.

Recent salvage of fire killed timber has occurred in Peck's penstemon habitat area under the guidelines of this plan. Besides heavy ground disturbance which can uproot plants, the most serious risks of this activity are the potential for invasive plant introduction and spread in the disturbed soil. Preventing large future fuel loads by removing some dead trees is hypothesized to provide long term benefits to Peck's penstemon by allowing the future reintroduction of prescribed fire in salvaged and replanted areas as long as the majority of plants are conserved, but this has not been tested (USFS 2005a). Many portions of the B&B Fire Recovery salvage were logged over snow and this greatly reduces ground disturbance and protects vegetation.

Monitoring in a B&B Fire Salvage Unit (Booth 128) in October of 2006 detected a proliferation of seedlings in skid trails within the unit. Peck's penstemon seedlings are rarely seen and a study to follow the survival of the seedlings was designed and implemented by Ecologist Reid Schuller. At this writing, the newly established plants have survived for 2 years, doubled in number, and are flowering at a higher rate than commonly seen (95% flowering). Schuller concluded that habitat manipulation to provide sustainable penstemon populations is not to be ruled out as an option based on this data, however cautioned that other factors seem to be at play such as substantial year to year variation in recruitment, individual vigor, and seed production. The role of the fire in stimulating this population surge is also a factor. It is recommended this study be continued to observe how these plants fair over time as competition from vegetation increases.

Invasive plants are spreading into forest areas along major roads and are introduced by vehicles and equipment. Few invasive populations are known from within the LSR but a high potential for

introduction and spread exists with activities which open forest canopies, use prescribed fire, and utilize heavy equipment.

Permanent habitat loss is of concern because of the finite amount of habitat for this endemic species. This needs to be analyzed under project level cumulative effects. Several populations outside the LSR have lost federal protection through land exchanges or have been altered by adjacent gravel mining and others are likely to exchanged at some point in the future. Several large habitat areas on private lands that are housing developments or golf courses (Metolius Meadows, Black Butte Ranch) retain traces of the plants and it can be assumed they supported larger populations, which have been lost. The Conservation Strategy recommends efforts be made in increasing awareness and voluntary protection of the plant on private lands.

Potential Management Conflicts and Recommendations:

1) Fire Suppression

- Consider allowing fires to burn through the Peck's penstemon population area and potential habitats for resource benefit.
- Avoid fireline, safety zones, or equipment in population areas.

2) Timber Harvest and Fire Salvage

Specific management for the Whychus LSR Peck's penstemon population:

- Consider hand thinning and prescribed fire in the population are to increase flowering.
- Do not burn concentrations of slash on top of population.

General Guidelines:

- Use low impact equipment or hand thinning when possible.
- Keep equipment on designated skid trails.
- Minimize heavy ground disturbance in population areas (20% of population areas may be impacted in "Managed populations").
- Log over snow or frozen ground in "Protected" populations until studies can be completed which indicate the plant benefits and tolerates ground based equipment over dry ground.
- Utilize prescribed fire whenever possible for it's benefits to the plant.
- Make sure equipment is clean (weed free).
- Keep landings out of population concentrations.
- Monitor after operations are complete to aid in early detection of invasive plants.

3) Recreation Management

- Define and confine parking areas and roads in recreation sites with boulders, bollards or other controls to minimize devegetation in habitat areas.
- Close and rehabilitate user created roads in habitat areas.
- Monitor dispersed camping sites in habitat areas and address problem areas as soon as possible.

4) Invasive Plants

- Utilize prevention measures such as requiring clean equipment, using clean material sources, minimizing ground disturbance, and controlling nearby invasive plant populations which could be spread into Peck's penstemon habitat.
- Prioritize control of invasive plant populations within or adjacent to Peck's penstemon habitat.
- Avoid prescribed fire or ground disturbance from other management activities in known invasive plant populations, especially when coincident with Peck's penstemon populations.

- Monitor Peck's penstemon populations more frequently if they occur near activities which may introduce invasive plants, i.e. vegetation management, wildfires, prescribed fires, popular recreation sites, major roadways, or grazing allotments.
- Raise awareness of invasive plant identification and risks with agency personnel and contractors involved in prescribed fire, wildfire suppression, road work, recreation, and vegetation management.

3) Elfin Saddle Sac Fungus (*Helvella crassitunicata*)

This mycorrhizal fungi species is associated with Abies spp found in mixed conifer and high elevation forests.

Status: This rare fungus is classified as "sensitive" on the Regional Forester's Sensitive Plant List. It is also considered a rare and uncommon species which requires management of known sites. It is an endemic species of Oregon and Washington. Within Northwest Forest Plan lands there are only 10-50 known sites. There is one known site in the Whychus LSR in the forest on the west shore of Three Creeks Lake.

Habitat: As a mycorrhizal species, Helvella crassitunicata forms symbiotic associations with the fine root systems of plants, growing out into the soil matrix. It fruits from August to October.

Changes to Habitat/Threats: This species is at risk from activities that remove mycorrhizal tree hosts or disturb soil. Of concern are actions that disrupt stand conditions, particularly those which damage host tees and soil occupied by host tree roots. Logging that removes host trees is reported as the most serious threat. Soil disturbing activities include road, trail, and campground construction. Fires that destroy host trees are also a potential threat, depending on fire severity (Castellano & O'Dell 1997).

Potential Management Conflicts and Recommendations:

A potential management conflict is that late successional plant species, such as bryophytes, fungi, and lichens may have very limited dispersal capabilities and have less ecological amplitude (require specific habitat conditions). These species may be restricted to protected micro sites in previously treated stands and be limited in their ability to recolonize areas due to fragmentation of forest habitats, ie. large cleared areas of unsuitable habitat. Managing for more open forest conditions typical to Fire Regimes 1 and 3, or for fire adapted species such as Peck's penstemon, may reduce viability and habitat in remnant populations of these species.

To provide a reasonable assurance of the continued persistence of occupied sites consider incorporation of patch retention areas (as described in Standards and Guidelines 1994, C-41) with occupied sites wherever possible (Region 6 ISSSP, Fungi Conservation Planning Tools, Appendix 2)- outlined below.

- Retain patches of green trees and snags generally larger than 2.5 acres.
- Retain at least 15% of the area associated with the cutting unit.
- In general 70% of the are retained should be aggregates of moderate to larger size 0.2-1 hectare or more) with the remainder as dispersed structures (individual trees and smaller clumps).

4) Woolly Feather-moss (*Tomentypnum nitens*)

This moss species is associated with montane fens and wet meadows.

Status: This moss is classified as "sensitive" on the Regional Forester's Sensitive Plant List. It is circumboreal. There are 6 known sites for this species in fens and wet meadows in the LSR including :

Trout creek Swamp, Headwaters of Alder Creek, Alder Creek Swamp, Twin Meadows, the 1526 fen and in Heidi's fen above Three Creeks Lake.

Habitat: The wooly feathermoss is found in montane fens, typically dominated by mosses and sedges often with lodgepole or Engelmann spruce, blueberry, resin birch, and willows.

Changes to Habitat/Threats:
Direct threats to the woolly feather moss include hydrologic impacts, especially degradation of water quality and hydrologic alteration, habitat loss, and invasive species. Indirect threats include land use practices that can impact water quality or habitat integrity. Its primary habitat, the montane fens are very sensitive to environmental change, limited in distribution and abundance.

Potential Management Conflicts and Recommendations:

1) Disturbance or effects to water quality

- Meadows are often targeted as landing areas for helicopters during fire suppression. Use of these high elevation meadows should be highly restricted to emergency use only because of their rare plant populations, fragility, and vulnerability to trampling.
- Avoid retardant drops in fens and wet meadows or immediately adjacent forest stands.
- Avoid fireline, safety zones, or equipment in fens and wet meadows.
- Avoid actions which would lower the watertable.
- Do not allow equipment to stage in meadows during fire suppression.
- Consider allowing fires to burn around and through meadows for resource benefit.

2) Invasive Plants

- Monitor habitats and control invasive plants

5) Lesser Bladder Wort (*Utricularia minor*)

This aquatic plant species is associated with montane fens.

Status: This small aquatic carnivorous plant is classified as "sensitive" on the Regional Forester's Sensitive Plant List. It is known from 2 sites in the LSR, both montane fens.

Habitat: The Lesser Bladderwort is found in montane fens, typically dominated by mosses and sedges often with lodgepole or Engelmann spruce, blueberry, resin birch, and willows. It is found in Trout Creek Swamp and the 1526 fen.

Changes to Habitat/Threats:
Direct threats to the Lesser Bladderwort include hydrologic impacts, especially degradation of water quality and hydrologic alteration, habitat loss, and invasive species (Neid, 2006). Indirect threats include land use practices that can impact water quality or habitat integrity. Its primary habitat, the montane fens are very sensitive to environmental change, limited in distribution and abundance.

Potential Management Conflicts and Recommendations:

1) Disturbance or effects to water quality

- Meadows are often targeted as landing areas for helicopters during fire suppression. Use of these high elevation meadows should be highly restricted to emergency use only because of their rare plant populations, fragility, and vulnerability to trampling.
- Avoid retardant drops in fens and wet meadows or immediately adjacent forest stands.
- Avoid fireline, safety zones, or equipment in fens and wet meadows.
- Avoid actions which would lower the watertable.
- Do not allow equipment to stage in meadows during fire suppression.
- Consider allowing fires to burn around and through meadows for resource benefit.
- Avoid actions which would lower the watertable.

2) Invasive Plants

- Monitor habitats and control invasive plants

Rare and Uncommon Lichen Species

The following rare and uncommon lichen species is also known to occur in the watershed:

1) Foliose lichen (*Cladonia norvegica*)

Status: *Cladonia norvegica* is a "Strategic Species*"* for which surveys are being planned and executed at a Regional level. About 30 Pacific Northwest populations are known (**Oregon Natural Heritage Information Center** Website, http://oregonstate.edu/ornhic/documents/survey/cladonia_norvegica_global.pdf. It is known from 1 site near Whychus Creek.

Habitat: Lichens are important as food, shelter, and nesting material for wildlife, including invertebrates. Lichens also play a role in mineral and nutrient cycling. This species is found on rotten wood and tree bases in humid forests. It's specific habitat requirements are not well understood but in general it is found in late-successional forests in areas with sheltered microsites, complex canopy structure, leaning tree boles, increased humidity and sometimes the presence of hardwoods. Potential habitat for rotting wood lichen species is more likely in riparian areas with abundant down wood material (McCune and Geiser, 1997).

Changes to Habitat/Threats: Many moist forest habitats have been altered by harvest, which reduces shading and warms and dries microclimates. Thinning of riparian areas can also alter stand microclimates. Lichen species may disperse only over small distances (e.g. 6 feet). Fragmentation within riparian habitats may affect lichen dispersal to suitable adjacent habitats, since they are known to be dispersal limited. Some species may be restricted to remnant habitats.

Potential Management Conflicts and Recommendations:

1) Forest management in riparian forests

- Retain patches of unthinned forest in riparian areas in the population area.

Rare and Uncommon Fungi Species

The following rare and uncommon fungi species are also known to occur in the LSR. Their status and habitat are addressed separately. The discussion of changes to habitat, threats and recommendations is combined. See the **Interagency Special Status / Sensitive Species Program (ISSSSP) webpage at** http://www.fs.fed.us/r6/sfpnw/issssp/planning-tools/#fungi for more information. All fungi photos are from the Forest Mycology and Mycorrhiza Research Team Website at http://mgd.nacse.org/fsl/survey.

1) Club fungus (*Clavariadelphus ligula*)

Status: Rare and uncommon, manage known sites.

Habitat: *Clavariadelphus ligula* grows scattered to gregarious on soil or duff, under coniferous or mixed coniferous associated with *Abies, Calocedrus, Pinus, Pseudotsuga, Thuja, Tsuga, Umbellularia, Arbutus* and *Castanopsis.* It fruits between July-December. It is found in a portion of the Northwest Forest Plan area in Washington, Oregon and California. Within the Northwest Forest Plan area, there are 51-100 known sites. There is one known site in the LSR south of Lava Camp Lake.

2) Truffle (*Gastroboletus turbinatus*)

Status: Rare and uncommon, manage known sites.

Habitat: *Gastroboletus turbinatus* grows in lowland forests of *Picea sitchensis-Tsuga heterophylla* to montane and subalpine forests of *Abies, Picea*, and *Pinus* spp. It fruits in July-November. There are 10-50 known sites within a portion of the NWFP area in Washington, Oregon and California. There is 1 known site site in the LSR near Lava Camp Lake.

3) Sequestrate club fungus *(Gautieria magnicellaris)*

Status: Rare and uncommon, manage known sites.

Habitat: *Gautieria magnicellaris* grows associated with the roots of *Abies concolor* above 5300 feet. It fruits in July-October. There are less than 10 known sites known from within a portion of the NWFP area in Oregon. There is 1 known site in the LSR near Lava Camp Lake.

4) Sequestrate club fungus (*Gymnomyces abietis*)

Status: Rare and uncommon, manage known sites.

Habitat: *Gymnomyces abietis* grows associated with roots of *Abies* species and *Pinaceae* above 3250 feet. It forms sporocarps beneath the soils surface. It fruits in July-October. There are 10-50 known

sites within a portion of the NWFP area in Washington, Oregon and California. There is 1 known site in the LSR near Lava Camp Lake.

5) Coral fungus (*Ramaria rubrievanescens*)

Status: Rare and uncommon, manage known sites.

Habitat: *Ramaria rubrievanescens* occurs on soil, litter and humus, associated with Pinaceae spp. It fruits in late spring and autumn. It occurs in a portion of the Northwest Forest Plan area in Washington, Oregon and California, primarily in high elevation forests. Within the Northwest Forest Plan area there are 51-100 known sites. There is 1 known site within the LSR near Lava Camp Lake.

General Discussion of Changes to Habitat/Threats. These uncommon fungi species are at risk from activities that remove mycorrhizal or saprophytic tree hosts or disturb soil. Of concern are actions that disrupt stand conditions, particularly those which damage host tees and soil occupied by host tree roots. Logging that removes host trees is reported as the most serious threat. Soil disturbing activities include road, trail, and campground construction. Fires that destroy host trees are also a potential threat, depending on fire severity. Saprophytic fungi are also affected by removal of large woody debris (Castellano & O'Dell 1997).

Potential Management Conflicts and Recommendations:

Timber Harvest and Fire Salvage
A potential management conflict is that late successional plant species, such as bryophytes, fungi, and lichens may have very limited dispersal capabilities and have less ecological amplitude (require specific habitat conditions). These species may be restricted to protected micro sites in previously treated stands and be limited in their ability to recolonize areas due to fragmentation of forest habitats, ie. large cleared areas of unsuitable habitat. Managing for more open forest conditions typical to Fire Regimes 1 and 3, or for fire adapted species such as Peck's penstemon, may reduce viability and habitat in remnant populations of these species.

To provide a reasonable assurance of the continued persistence of occupied sites consider incorporation of patch retention areas (as described in Standards and Guidelines 1994, C-41) with occupied sites wherever possible (Region 6 ISSSP, Fungi Conservation Planning Tools, Appendix 2)- outlined below.

- Retain patches of green trees and snags generally larger than 2.5 acres.
- Retain at least 15% of the area associated with the cutting unit.
- In general 70% of the are retained should be aggregates of moderate to larger size 0.2-1 hectare or more) with the remainder as dispersed structures (individual trees and smaller clumps)

Invasive Plants

Noxious weeds are now called "invasive plants" and they are expanding in the watershed, especially on private lands. Invasive plants such as diffuse knapweed and dalmation toadflax are found in low levels scattered along roads in the watershed. Weed populations from adjacent lands closer to population areas are slowly expanding into the watershed (Rd 16, Rd 15, McKenzie Highway), continuing control efforts are critical. Management activities that disturb the ground or open stands by thinning or prescribed fire, have a risk of creating more habitats for weed invasion.

Invasive populations of knapweeds and other non-native plants are increasing near some new housing developments and have worsened on most private parcels since 1998. There is no enforcement actions procedures for infested private lands because Deschutes County has no official enforcement policies. Worst problem areas include:

- The section of Whychus Creek between the irrigation dam and the city of Sisters.
- The Sisters Airport (Private land).
- The Reed Ranch (Private land).
- The Sisters Industrial Park (Private land).
- McKinney Butte Road (Private land).

A New partnership with the City of Sisters and Deschutes County has begun to raise awareness and address some invasive weed areas inside City limits.

Invasive plants in fire camps at area schools and rodeo grounds, airports, and in the parking areas of private contractors continue to be an issue as they can spread seed on vehicle tires and shoe treads into wildfire areas and throughout the forest. Some work has been done by Deschutes County, the Rodeo Grounds and the Sisters Schools to improve conditions but continued work is needed.

Diffuse Knapweed Infestation at Sisters Airport

Reed canary grass is a serious threat to wet meadows and fens such as Trout Creek Swamp. Continue control efforts as through the Forest Invasive Plant Program.

Table 1 Plant Species of Concern
Known to occur within the Whychus Watershed

Notes:

- The Status categories "Sensitive" and "Strategic" are derived from the R6 2008 Sensitive/Strategic Species Lists.
- The category rare or uncommon was formerly "S&M, Cat. B" is derived from the 2001 Survey and Manage species list, as amended by the 2003 Annual Species Review.
- The number of GIS sites included within Analysis area is noted following Taxon name.

Taxon	Group	Status	Range	PAG	Habitat Notes
Clavariadelphus ligula (1)	Club fungus	Rare or uncommon	Widespread in North America and Europe	MHD	Scattered to gregarious on soil or duff, under mixed conifers. McKenzie Pass area.
Cladonia norvegica (1)	Foliose lichen	Rare or uncommon/ Strategic	AK to OR	MCW	Rotten wood and tree bases.in humid forests.
Gautieria magnicellaris (1)	Sequestrate club fungus	Rare or uncommon	OR, CA, MI, NY, Europe, Mexico	MHD	Forms sporocarps beneath the soil surface associated with the roots of *Abies concolor* in the western North America above 5300 feet elev.
Gastroboletus turbinatus (1)	Truffle	Rare or uncommon	Coastal and Cascades of WA, OR; CA Cascades and Sierra Nevada.	MHD	Hypogeous to emergent, scattered to grouped in lowland forests of *Picea sitchensis-Tsuga heterophylla* and *Pseudotsuga menziesii* to montane and subalpine *Abies, Picea* and *Pinus* spp. McKenzie Pass area.
Gentiana newberryi (20)	Vascular plant	Sensitive	Regional endemic	Ripari an	Moist subalpine and alpine meadows in the Three Creeks Lake area and nearby.

Taxon	Group	Status	Range	PAG	Habitat Notes
Gymnomyces abietis (1)	Sequestrate club fungus	Rare or uncommon	PNW endemic	MHD	Forms sporocarps beneath the soil surface associated with the roots of *Abies* spp. and possibly other Pinaceae above 3250 feet elev. McKenzie Pass area.
Helvella crassitunicata (1)	Elfin saddle sac fungus	Rare or uncommon	Endemic to OR and WA	MHD	Scattered to gregarious on soil, especially along trails, in montane regions with *Abies* spp. Three Creeks Lake area.
Penstemon peckii (1)	Vascular plant	Sensitive	Sisters endemic	PP, MCW, MCD	Patchy distribution, at lower ends of watersheds, Larson soil type 8 is often an indicator.
Ramaria rubrievanescens (1)	Coral fungus	Rare or uncommon	OR, WA, CA, eastern North America	MHD	Fruits in humus or soil and matures above ground, associated with Pinaceae spp. McKenzie Pass area.
Tomentypnum nitens (6)	Moss	Sensitive	Circumboreal; in North America, south in Rocky Mtns. to New Mexico; in PNW, known from AK, BC, WA, ID, MT, OR.	Meadow, wet	In fens typically dominated by mosses and sedges, often with PICO, PIEN, *Vaccinium uliginosum, Betula glandulosa, Salix* spp.
Utricularia minor (2)	Insectivorous vascular plant	Sensitive	Western, northern and northeastern U.S., Canada	Meadow, wet	In fens typically dominated by mosses and sedges, often with PICO, PIEN, *Vaccinium uliginosum, Betula glandulosa, Salix* spp.

Table 2- Plant Species of Concern which have potential to occur within the Whychus Watershed

SPECIES	TYPE	STATUS	OCCURRENCE	PAG	HABITAT NOTES
Agoseris elata	Vascular plant	Sensitive	PNW endemic	PP	Meadows and open woods, dry edges of moist ecotones. Metolius River.
Alpova alexsmithii	Sequestrate club fungus	Sensitive, SM B	Cascades; central OR to central WA	Variety of coniferous forest types	Forms sporocarps beneath the soil surface associated with various Pinaceae spp., particularly *Tsuga heterophylla* and *T. mertensiana* from 3900 - 10,000 ft.+. Near Cabot Lake in the Mt. Jefferson Wilderness.
Anastrophyllum minutum	Liverwort	Strategic	Circumboreal; in PNW, AK to CA.	Tsuga mertensiana zone	On peaty soil at >5500 ft. Typically with other bryophytes in tight mats on ledges or at the base of cliffs.
Andreaea nivalis	Moss	Strategic	Greenland, Europe, Japan, Russia; in PNW, AK to CA	Alpine to subalpine	Forming mats on damp or exposed rock or sandy soil over rock; boulders, outcrops, cliff faces.
Anomobryum julaceum	Moss	Strategic	Temperate N and S Hemispheres; in PNW, AK to CA	Apparently at moderate range of montane elevations	Earthen and rock cliff crevices, granitic outcrops, tussock tundra associated with seeps and late snow melt.
Arnica viscosa	Vascular plant	Sensitive	OR and CA	High elev. forest &, lava	Rocky places, scree and talus slopes, at or above timberline.
Barbilophozia lycopodioides	Liverwort	Sensitive	Circumboreal; in PNW known from south to OR and ID.	Wet mixed conifer, TSME.	Forming mats on peaty soil on damp ledges of rock outcrops and cliffs at elevations of 3400-7500 ft.
Brachydontium olympicum	Moss	Sensitive	North Pacific rim; Japan to OR.	MCW and above timberline with *Phyllodoce* and *Cassiope*	Forming loose mats on exposed acidic boulders or soil in rock crevices. In boulder fields, moraines, and ledges of cliffs, often in areas of late snowmelt at 5000 ft. + elev.
Bruchia bolanderi	Moss	Strategic	Western NA endemic; CA and OR in PNW	Montane to subalpine with TSME, ABCO and PICO.	On disturbed, moist organic soil along roadside ditches, fallow fields, montane meadows and stream banks, root wad of upturned tree, 3500-5000 ft. elev. in Cascades.
Buxbaumia aphylla	Moss	Strategic	Circumboreal, CA, OR, WA, Cascades and Blue Mtns.	With ABCO, ABMAS, PICO, PSME, TSHE, TSME	On dry, mineral-poor soil and well-decayed wood, exposed to shady sites along trails, cutbanks, recovering burns at 4000-6000 ft. elev.

SPECIES	TYPE	STATUS	OCCURRENCE	PAG	HABITAT NOTES
Calliergon trifarium	Moss	Sensitive	Circumboreal; in PNW known from BC, AL, MT, OR	Adjacent forest likely to be MCW or LPW	Montane medium to rich fens, submerged to emergent on saturated peat at 5000 ft. + elev.
Carex lasiocarpa var. americana	Vascular plant	Sensitive	Central and northern North America; all PNW provinces and states + CA	Adjacent forest likely to be MCW or LPW	Montane fens and bogs at 4700 ft. + elev.
Carex livida	Vascular plant	Sensitive	Great Lakes states, all PNW states, USA Rockies, Canada, AK	All forest types	Peatlands including fens and bogs; wet meadows with still or channeled water at 3500 - ? ft. elev..
Cephaloziella spinigera	Liverwort	Strategic	Circumboreal; CA, OR (Lane and Klamath Cos. only)		Associated with bogs and fens and the moss genera *Warnstorfia, Drepanocladus, Tomentypnum, Meesia*.
Chiloscyphus gemmiparus	Liverwort	Sensitive	AK, OR, UT	Riparian in ABAM, ABLA, TSME	Forming small turfs or clumps on rocks in beds of cold montane streams, submerged or emergent in splash zones at 5000-7000 ft. elev.
Collomia debilis var. larsenii	Vascular plant	Watch list	Cascades WA to CA	Lava rock	Talus slopes on the high peaks of the Cascades. Cache Mountain.
Conostomum tetragonum	Moss	Sensitive	Circumboreal; in PNW known from BC, MT, WA, OR, CA	Likely above timberline with *Phyllodoce* and *Cassiope* or with PIAL, TSME, ABLA or ABAM	Occurring as small sods or inconspicuous individual shoots intermixed with other bryophytes, on soil in rock crevices in boulder fields, moraines, and ledges of cliffs.
Cynodontium jenneri	Moss	Strategic	Western Europe and the PNW; CA, WA, OR (Clackamas Co. only)		On peaty slopes, shaded rocks, outcrop crevices and shelves, humus of cliff terrace slopes; sea-level to subalpine.
Cypripedium montanum	Vascular plant	SM C	Within the range of the NWFP	MCD, PP	Can be found in scattered sites on both sides of the Cascades. Mainly in moist woods. Abbot Creek.
Dermatocarpon meiophyllizum	Aquatic lichen	Sensitive	Central Europe, Scandinavia, British Isles; in North America, Minnesota, Colorado, OR, CA, WA.	Riparian	Submerged or emergent on sunny bedrock or otherwise immobile rocks in perennial or nearly perennial streams; often found above water line and dry during summer months.
Elaphomyces anthracinus	Rare truffle	Strategic, SM B	Sisters	PP	One known site in N America, near the Metolius River, associated with old growth ponderosa pine.

SPECIES	TYPE	STATUS	OCCURRENCE	PAG	HABITAT NOTES
Elaphomyces subviscidus	Rare truffle	Strategic, SM B	Deschutes and Jackson Counties, OR; ID	LP, near Dry/Wet interface, within larger area of MHD	Deschutes Co. site about 180 m south of project boundary., and 0.5 mile SE of Three Creeks Lake, on Bend Fort Rock Ranger District at 7120 feet elev.
Gastroboletus ruber	Rare Boletus fungi	SM B	Cascade endemic	High elevation forest	Above 4,000 ft with the roots of conifers, esp. mountain hemlock, silver and noble fir and western white pine. Near Cabot, Carl and Shirley Lakes in the Mt. Jefferson Wilderness.
Grimmia anomala	Moss	Strategic	Circumboreal; AK to CA.	*Quercus garryana*, PSME, TSHE, ABAM, ABCO	Small cushions on igneous or serpentine rocks, shaded or in crevices of exposed rocks, 4000-7000 ft. elev.
Gymnomyces abietis	Sequestrate club fungus	SM B	Endemic to PNW	Variety of coniferous forest types	Forms sporocarps beneath the soil surface associated with the roots of *Abies* spp. and possibly other Pinaceae above 3200 ft. elev.; Shirley Lake, Mt. Jefferson Wilderness Area.
Haplomitrium hookeri	Liverwort	Strategic	Temperate and boreal in N and S Hemispheres; OR (Lane Co. only, including site in Three Sisters WA)		At TSWA site, on soil in full sun, intermixed with other liverworts. Around the edge of boulders in the Mt. Baker region of WA.
Harpanthus flotovianus	Liverwort	Strategic	Boreal and montane in N Hemisphere; OR (Lane, Klamath and Union Cos.)		Associated with bogs and fens and the moss genera *Warnstorfia, Depanocladus, Tomentypnum, Meesia*.
Helodium blandowii	Moss	Sensitive	Circumboreal, south in Rockies to AZ, in the Cascade-Sierra ranges to CA	Adjacent forest types include ABAM, ABCO, ABMAS, TSME, PICO, PIEN	Forming mats and small hummocks in medium to rich montane fens at 4700 - 6000 ft. elev. Associated plants may include Betula glandulosa, Salix *geyeriana, Carex limosa, Eleocharis quinqueflora, Scheuchzeria palustris*.
Hygrophorus caeruleus	Uncommon gilled mushroom	Sensitive, SM B	PNW endemic	MCW	Mid-elevation to montane conifer forests. May be restricted to *Abies.* Jack Creek.
Hydnotryna inordinata	Rare truffle	Strategic,	Rare local endemic	High elevation forest	With the roots of silver fir, Douglas fir, lodgepole, and mountain hemlock. Shirley Lake, Mt Jefferson Wilderness.
Lobelia dortmanna	Vascular plant	Sensitive	1 known site in OR Sisters RD	Lake, Riparian	In shallow water.

SPECIES	TYPE	STATUS	OCCURRENCE	PAG	HABITAT NOTES
Lophozia gillmanii	Liverwort	Strategic	Boreal and montane in the N Hemisphere; OR (Baker Co. only)		On peaty soil, usually on cliffs or ledges; an obligate calciphile.
Marsupella emarginata var. aquatica	Aquatic Liverwort	Sensitive,	1 known site Waldo Lake/ Central Cascades	Aquatic	Submerged in shaded, cold perennial streams.
Marsupella sparsifolia	Liverwort	Strategic	Polar and alpine areas of N and S Hemisphere; OR (Hood River Co. only)		Alone or intermixed with other bryophytes on occasionally flooded sand, sandy soil along streams or on acidic soil in late snow areas, on siliceous cliffs and rocks subject to occasional wetting.
Nardia japonica	Liverwort	Strategic			
Pohlia tundrae	Moss	Strategic	Western N America; AK to CA	With *Phyllodoce*, *Cassiope*, PIAL, TSME, ABLA, possibly ABAM	Forming dense sods or intermixed with other mosses on wet, acid soil or along snowmelt streamlets in subalpine and alpine habitats; less frequently on banks of roads and trails below tree line.
Polytrichum sexangulare	Moss	Strategic	N Pacific arc, Europe; AK to OR (Clackamas and Lane Cos.)		On damp gravelly soil and rocks in areas of late summer snowmelt in alpine and subalpine regions.
Polytrichum sphaerothecium	Moss	Sensitive	Iceland, NE Asia, North Pacific Rim; in PNW known from high elevations in Cascades	Subalpine, alpine, likely with PIAL, TSME, ABLA, *Phyllodoce*, *Cassiope*	Forming green to brown sods on igneous rocks in exposed or sheltered sites, subalpine parkland to alpine krummholz.
Rhizomnium nudum	Moss	Sensitive,	NE Asia, North Pacific rim; in PNW known from AK, BC, MT, ID, WA, OR	PICO, PIEN, TSME, PIMO	On moist soil or humus in seepages, vernally wet depressions or intermittently wet, low gradient channels.
Scheuchzeria palustris ssp. americana	Vascular plant	Sensitive	In USA, AK, northern tier (WA to ME), OR, CA	Variety of adjacent coniferous forest types	Open canopied bogs, fens and other wetlands where often in shallow water.
Schistostega pennata	Moss	Sensitive,	Circumboreal; Europe, eastern Asia, North America; in PNW known from AK, BC, AL, MT, WA, OR	Often in ABAM, TSHE, TSME or PICO near water	On mineral soil in damp caves and crevices and on the soil-bearing root masses of fallen trees. Requires humid, heavily shaded microsites.
Schofieldia monticola	Moss	Strategic	Russia, PNW from AK to OR (Lane Co.)	With *Cassiope*, *Phyllodoce*.	On peaty soil under heather or beside small streams in subalpine and alpine areas.

SPECIES	TYPE	STATUS	OCCURRENCE	PAG	HABITAT NOTES
Scouleria marginata	Moss	Strategic	Western North American endemic, BC to CA	Riparian; variety of adjacent coniferous forest types	Submerged or emergent on bedrock or other generally immobile rock surfaces in perennial streams.
Splachnum ampullaceum	Moss	Sensitive	Circumboreal; in PNW known from AK, BC, AL, WA, OR	Adjacent forest may include ABAM, ABLA, ABCO, PICO	Forming green sods on old dung of herbivores, or on soil enriched by dung, in peatland or other wetlands. Known sites in OR are at 5000 ft. elev.
Thamnobryum neckeroides	Moss	Strategic	Scattered locations in Europe, Asia; in PNW from AK to OR (Josephine, Klamath, Lane, Linn and Multnomah Cos.)	PSME/TSHE with *Acer macrophyllum*	On both rock and trees, often in damp, shaded locations from lowlands up to 6600 ft. elev.
Tomentypnum nitens	Moss	Sensitive	Circumboreal; south to NM in Rockies, and OR in Cascades	Adjacent forest may include ABAM, ABCO, ABLA, PICO	Forming loose or dense sods or intermixed with other bryophytes in medium to rich montane fens where it favors slightly elevated sites such as logs, stumps or hummocks formed by *Vaccinium uliginosum* and *Betula glandulosa*.
Trematodon boasii	Moss	Sensitive	In the PNW, known from BC, OR, CA; also known from Japan, Newfoundland	TSME, ABLA, ABMA, *Phyllodoce*, *Cassiope*	Forming loose mats on moist bare soil along the edges of trails, streams and ponds in the subalpine zone. Soils usually with some organic content and moistened by late-season snowbed meltwater.
Tritomeria exsectiformis	Liverwort	Sensitive, SM B	Circumboreal; in PNW known from AK, BC, ID, WA, OR	Riparian	On damp to wet rotting wood or less often, peaty or humic soil at springs and seeps with perennial, low gradient, low volume flowing water..

* Sensitive= 2008 USFS Region 6 Sensitive and Strategic Species Lists, Watch List = 2007 Oregon Natural Heritage Information Center Database List.

Resource Report
CULTURAL RESOURCES

CULTURAL RESOURCES

Overview-
The Cultural Resource trends and recommendations from the 1998 Sisters/Whychus Watershed Analysis are generally still the same. There is more information about more sites within the Watershed after surveys for SAFR and West Trout Projects. Some changes in conditions and facilities have occurred and are noted below.

Place Name Changes

Name Changes - Name changes were implemented in 2006 that changed all Squaw place names in the watershed to comply with State Law and remove a word considered derogatory by many Native Americans.

Whychus Watershed Place Name Changes
Approved by the National Geographic Names Board in 2006

Old Name	New Name	Word Origin/Meaning	Location
1) Squaw Creek	**Whychus Creek** ***Pronounced "Why- choose"***	*Historic*- Earliest recorded name from 1855 Pacific Railroad Reports. Derived from Sahaptin language. Meaning: "The place we cross the water"	Sisters Ranger District /Crooked River National Grasslands/BLM/Private *Deschutes & Jefferson County*
2) North Fork of Squaw Creek	**North Fork of Whychus Creek**	***Historic*- see above**	**Sisters Ranger District** ***Deschutes County***
3 South Fork of Squaw Creek	**South Fork of Whychus Creek**	***Historic*- see above**	**Sisters Ranger District** ***Deschutes County***
4) Squaw Creek Rim	**Whychus Creek Rim**	***Historic*- see above**	**Private/Sisters Ranger District** ***Deschutes County***
5) Squaw Creek Falls	**Upper Chush Falls**	***Native American*- Sahaptin word for water**	**Sisters Ranger District** ***Deschutes County***

Administrative Name Changes (4 changes):

- Squaw Creek Irrigation District Dam, Canal, and Reservoir were changed to ***Three Sisters Irrigation District Dam, Three Sisters Canal, and Watson Reservoir.*** These changes were made at the request of the Irrigation District.
- Squaw Creek Trailhead *changed to* ***Chush Falls Trailhead***,

- **New Name (1 new name)**

Chush Falls- The waterfalls commonly known as Squaw Creek Falls was actually unnamed. Because of high recreation use, safety, and administrative reasons this waterfall was given a name. Chush means “water” in the Saphaptin language. The feature named Squaw Creek Falls is located upstream and was renamed *Upper Chush Falls*.

Resource Report
RECREATION

RECREATION

Overview

The Recreation trends and recommendations from the 1998 Sisters/Whychus Watershed Analysis are generally still the same. Some changes in conditions and facilities have occurred and are noted below.

Population Growth and Unmanaged Use

In the past decade unmanaged, careless, and illegal uses in the Whychus watershed area have accelerated with population growth. The populations of Sisters and Deschutes County have increased greatly in the past decade and continue to grow.

In 1990, 708 people lived in Sisters and in 2008 that increased to 1,910. Population growth rates have varied from a high of 32% increase in 2003 to 4.7% increase in 2008. In addition 6-10,000 people live in subdivisions near Sisters. There are an additional 990 unbuilt platted lots in Sisters (Julber, 2008). Deschutes County continues to grow at a faster rate than other Oregon counties, having the highest percent change from 2007-2008 of any county in Oregon; and having the third largest population change, behind only Washington and Multnomah counties. In 1990 the population was 74,958 and in 2008 it was estimated at 167,051. (Porter, 2009 Growth Data).

Areas near the City of Sisters or with good road access, have been subject to repeated vandalism and misuse including dumping, shooting trees and wildlife, partying and leaving trash, graffiti, driving vehicles through and up the creek, and illegal road and trail building.

Some illegal user-made mountain bike trails have been developed along the creek. Restoration closures have been breeched and educational sign removed, defaced or destroyed. Public comments recognized that the area needs more recreation management and some developed facilities, especially close to the city, because people are building their own trails and creating networks of user trails. Some felt that making the area more accessible for low impact, responsible users would help monitor and displace irresponsible users.

Changes to Recreation Facilities

New additions to the Peterson Ridge Mountain Bike Trail system have increased mountain bike use in the creek area. With growth in Sisters there are more horse users in the area and some conflicts with mountain bikes. Off Road vehicle use is also increasing, with more user trails, breeching of restoration closures, and damage to resources.

Public and Tribal comments expressed concern that recreation use levels could increase and impacts of unmanaged use would grow. People recommended not over promoting or over developing the area with recreation facilities but providing facilities primarily for resource protection and low impact uses. Increased enforcement, volunteer stewardship, and management will help address the effects of increased population growth and use.

There are a few changes under recreation with the Peterson Ridge Trail being built recently. Black Pine Springs has been decommissioned and is now a dispersed camping area. Lava Camp Lake CG is proposed to be decommissioned to a dispersed site but is still being managed as developed for now. ADA standards are improving with accessible toilets recently installed at Three Creeks Lake, Three Creeks Meadow, and Whispering Pines CGs.

- Improvements to Tam McArthur and Little Three Creek Lake THs did not occur in 1998. Planning and implementation still needs to occur for these sites as well as the overnight facilities here.

- Some improvements were made to Pole Creek TH (new toilet and perimeter fencing) that has helped to direct use patterns and reduce impacts to vegetation at this site.

- The Recreation Enhancement Act fee program (formerly fee demo) is not providing relief in the way of trails maintenance as funds are have not been used to maintain trails since the early 2000's. As such, much of the trails maintenance is done with support from various volunteer groups and individuals.

- Non-Wilderness summer trails: new mountain bike trail has increased use in the area. Also, the popularity of OHV within the last 10 year's has also increased motorized use of the area. This has resulted in many user-made trails and play areas, resulting in damage to vegetation, soils and riparian resources.

- For the trends, need to add that OHV and off-road motorized use has increased and has caused resource damage.

Kids enjoy Glaze meadow

Resource Report
ROADS

ROADS

Existing Trends – Unchanged since 1998 WA

- Current Road Densities exceed recommended densities
- Only 7-10% of roads receive any type of annual maintenance
- Some localized erosion problems exist
- Logging use on roads continues to decline
- Majority of current road use is for recreation
- No current traffic counts on forest roads
- New user created roads are a problem

New Trends/Transportation Issues since 1998 WA

- Road Analysis is currently being prepared for the Popper planning areas
- Travel Management Plan to be implemented 2010. This will present big changes to allowed vehicle uses on forest.
    - In 2005, the Forest Service published a new rule for providing motor vehicle access to the national forests and grasslands. The purpose is to adapt Forest Service travel management policies to:
        - ✓ Provide consistency for motor vehicle use across the nation.
        - ✓ Enhance & secure recreational opportunities for public enjoyment for both motorized & non-motorized users.
        - ✓ Better protect natural & cultural resources
        - ✓ Address use conflicts.

      Currently, a Travel Management Environmental Impact Statement (EIS) is being written to implement the travel management rule (prohibiting motorized travel off of existing designated routes where it is not currently prohibited). This EIS will incorporate options and criteria for continuing to provide motorized access for dispersed camping.

- OHV use increasing, more trails, damage to resources.
- More road pioneering in firewood cutting areas
- Glaze Meadow Special Closure Order – Oct 4, 2000.
- New Acro bridge constructed for Glaze Meadow Stewardship.
- Wildlife Road Closures (approx 11.3 miles of decommissioned or closed) in Black Crater/Trout Creek areas in 2002? Nepa done with Oct 31, 1997 road closure EA by Jeff Grenier.
- Black Crater Fire Area Closure Order – Des-2006-023. Closed numerous roads within Black Crater Fire perimeter. Note – this order may be rescinded when Travel Management Plan in implemented.
- Black Crater Fire BAER work – including installation of Bottomless Arch Culvert at Trout Creek on Road 1510400, Rock Ford Crossing of Trout Creek at 1008 Road, and Upsized CMP at Trout Creek Tributary on Rd 1018.

REFERENCES

Abbe, T. B. and D. R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. Regulated Rivers Research and Management 12:201-221.

Altman, B. 2000. Conservation Strategy For Landbirds of the East-Slope of the Cascade Mountains in Oregon And Washington. Oregon-Washington Partners In Flight.

Angermeier, P. L. and J. R. Karr. 1984. Relationships between woody debris and fish habitat in a small warm water stream. Transactions of the American Fisheries Society 113: 716-726.

Bartholow, J. M. 1989. Stream temperature investigations: field and analytical methods. Instream Flow Information Paper Number 13. U.S. Fish and Wildlife Service Biological Report 89 (17), Washington D.C.

Beaty, K.G. 1994. Sediment transport in a small stream following two successive forest fires. Canadian Journal of Fisheries and Aquatic Sciences. 51:2723-2733.

Beechie, T. J. and T. H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society 126:217-229.

Benda, L. and six others. 2003. Wood recruitment processes and wood budgeting. Pages 49 –74 *in* S. Gregory, K. Boyer, and A. Gurnell editors. The ecology and management of wood in world rivers. American Fisheries Society, Symposium 37, Bethesda, Maryland.

Berlik, Mary M., David B. Kittredge and David R. Foster. 2002. A Global Environment Argument for the Local Production of Natural Resources. Harvard Forest Paper No. 26. Harvard Forest, Harvard University, Petersham, Massachusetts. 23 pp.

Bestcha, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat In: Streamside management, fisheries and forest interactions. University of Washington Institute of Forest Resources. No 57. Seattle, WA.

Bilby, R. E. and P. A. Bisson. 2001. Function and distribution of large woody debris. Pages 324-346 *in* R. J. Naiman and R. E. Bilby editors. River ecology and management lessons from the pacific coastal ecoregion. Springer, New York.

Bilby, R. E. and J. W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118:368-378.

Castellano, M. and T. O'Dell, 1997. Handbook of ROD Strategy One Fungi. Forest Mycology and Mycorrhiza Research Team Website. http://mgd.nacse.org/fsl/survey.

Chamberlin, T.W., Harr, R.D. and F.H. Everest. 1991. Timber harvesting, silviculture, and watershed processes. *In:* Influences of forest and rangeland management of salmonid fishes and their habitats. American Fisheries Society special publication. 19:181-205.

Dachtler, N. 2001a. Pole Creek level II stream inventory. Sisters Ranger District, Sisters, Oregon.

Dachtler, N. 2001b. Trout Creek level II stream inventory. Sisters Ranger District, Sisters, Oregon.
Dachtler, N. 1997. Squaw Creek level II stream inventory. Sisters Ranger District, Sisters, Oregon.

Dudley, T. and N. H. Anderson. 1982. A survey of invertebrates associated with wood debris in aquatic habitats. Melanderia 39: 1-12.

Eglitis, Andy. 2009. Personal Communication.

Eglitis, A. 1990. USFS Entomologist, Personal Communication with Russell G. Mitchell, PNW Research Entomologist.

Fausch, K. D. and T. G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fish and Aquatic Science 49: 682-693.

Fitzgerald, Stephen A. 2002. Post-Fire Salvage Cutting and Rehabilitation Treatments. In: Fire in Oregon's Forests: Risks, Effects, and Treatment Options – A synthesis of current issues and scientific literature. Oregon Forest Resources Institute. Pages 108-115.

Gowan, D. and T. E. Burke. 1999. Management Recommendations for *Pristiloma arcticum crateris* Crater Lake Tightcoil. Reconfigured 2004 by N. Duncan. Conservation Assessment for *Pristiloma arcticum crateris* Crater Lake Tightcoil. USDA Forest Service Region 6 and USDI Bureau of Land Management, Oregon and Washington. 17 pages.

Hall, J. D. and R. L. Lantz. 1969. Effects of logging on the habitat of coho salmon cutthroat trout in coastal streams. Pages 355- 375 *in* T. G. Northcote editor. Symposium on salmon and trout in streams. H. R. Macmillan Lectures in Fisheries, University of British Columbia, Vancouver.

Hill, C., M. Logan, and L. Jones. 2008. Whychus Creek Temperature Summary: 2005-2008. Upper Deschutes Watershed Council Technical Report. Bend, OR.

Houslet B. S. and M. D. Riehle. 1998. Trends in fine sediment in bull trout spawning and rearing streams of the Metolius River Basin, Oregon, from 1988-1997. Deschutes National Forest. Sisters Ranger District. Sisters, Oregon.

Interagency Special Status / Sensitive Species Program (ISSSSP) webpage at http://www.fs.fed.us/r6/sfpnw/issssp/planning-tools/#fungi Region 6 ISSSP, Fungi Conservation Planning Tools, Appendix 2.

Jeffries, S. Deschutes Forest Biologist and D. Zalunardo. 2003. Ochoco Forest Biologist Letter dated June 19, 2003 to File Code: 2670; Subject: Canada lynx (*Lynx canadensis*) habitat mapping; To: District Wildlife Biologists, Deschutes and Ochoco National Forest and the Crooked River National Grassland.

Julber, S. 2008. Residential Inventory Analysis and Update. A Component of the Sisters Housing Plan. City of Sisters.

Kovalchik, B. 1987. Riparian Zone Associations. Deschutes, Ochoco, Fremont, and Winema National Forests. PNW R6 Ecol TP-279-87.

Langille, H. D., Fred G. Plummer, Arthur Dodwell, Theodore F. Rixon and John B. Leiberg. 1903. Forest Conditions in the Cascade Range Forest Reserve Oregon. USDI United States Geological Survey. Professional Paper No. 9, Series H, Forestry. 298 pp.

Lovtang J. and M.D. Riehle. 2000. Squaw Creek education and restoration project 1998-1999. Deschutes National Forest. Sisters, OR.

McCown, C. 2006. Black Crater Fire BAER Hydrology Report. Sisters Ranger District. Deschutes National Forest, Sisters, OR.

McCune,B. and L. Geiser, 1997. Macrolichens of the Pacific Northwest. Oregon State University press, Corvallis, Oregon. 386 pp.

Miller, J.C. and P.C. Hammond. 2007. Butterflies and moths of Pacific Forests and Woodlands: rare, endangered, and management-sensitive species. Forest Health Technology Enterprise Team Technology Transfer Species FHTET-2006-07, Sept. 2007.

Minshall, G. W. 1978. Autotrophy in stream ecosystems. Bioscience 28: 767-771.

Mullong, B. 1992. Indian Ford Creek survey summary. Sisters Ranger District. Sisters, Oregon.
Nehlson, W. 1995. Historical salmon and steelhead runs of the upper Deschutes River basin and their environments. Portland General Electric Company. Portland, Oregon.

Neid, S.L. (2006, May 15). *Utricularia minor* L. (lesser bladderwort): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/utriculariaminor.pdf

ODEQ (Oregon Department of Environmental Quality). 1996. Procedural Guidance for Water Temperature Monitoring. DEQ. Portland, OR.

ODEQ (Oregon Department of Environmental Quality). 2009a. Final 2004 303(d) database. www.deq.state.or.us/wq/assessment/rpt0406/search.asp

ODEQ. 2009b. Oregon Administrative Rules, Chapter 340, Division 41-Department of Environmental Quality, State-Wide Water Quality Management Plan; Beneficial Uses, Policies, Standards, and Treatment Criteria for Oregon. http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html

Oregon Natural Heritage Information Center Website, http://oregonstate.edu/ornhic/documents/survey/cladonia_norvegica_global.pdf

Pajutee, M. 2001. Whychus Late Successional Reserve Assessment Botany Report. 2001. Specialists Report. Project File, Sisters Ranger District.

Pajutee, M. 2009 Species Conservation Strategy for Peck's penstemon Update. Sisters Ranger District, Deschutes National Forest.

Pearsons, T. N., H. W. Li., and G. A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Transactions of American Fisheries Society 121:427-436.

Porter, E. 2008. City of Sisters and Deschutes County Growth Data. Personal Communication.
Straw, D and M. Riehle. 1992. Snow Creek level II stream inventory. Sisters Ranger District. Sisters, Oregon.

Simon, Steven A. 1991. Fire History in the Jefferson Wilderness Area East of the Cascade Crest. USDA Forest Service. Deschutes National Forest Report. Unpublished Report. 122 pp.

Straw, D and M. Riehle. 1990a. Trout Creek level II stream inventory. Sisters Ranger District. Sisters, Oregon.

Straw, D and M. Riehle. 1990b. Pole Creek level II stream inventory. Sisters Ranger District. Sisters, Oregon.

Sussmann, P. 2006. Black Crater Fire BAER Soils Report. Sisters Ranger District. Deschutes National Forest, Sisters, OR.

Swanston, D. N. 1991. Natural processes. American Fisheries Society Special Publication 19: 139-179.

USDI FWS. 2003. Federal Register (68 FR 40076). Notice of Remanded Determination of Status for the Contiguous United States Distinct Population Segment of the Canada Lynx; Clarification of Findings; Final Rule. Pp. 40076-40101.

USDI FWS. 2006. Federal Register (71 FR 53355). Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of Lynx. Pp. 53355-53361.

USDI FWS. 2008a. Final Recovery Plan for the Northern Spotted Owl, *Strix occidentalis caurina.* U.S. Fish and Wildlife Service, Portland, Oregon. xii + 142 pp.

USDI FWS. 2008b. Birds of conservation concern. Division of Migratory Bird Management, Arlington, Virginia. U.S. Fish and Wildlife Service.

USDI FWS. 2009. Federal Register (74 FR 8616). Revised Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of the Canada lynx (*Lynx Canadensis*). Pp. 8616-8702.

USFS. 1990. Deschutes National Forest Land and Resource Management Plan, Deschutes National Forest. Bend, OR.

USFS, 1993. Region 6 Interim Old Growth Definitions. Pacific Northwest Region. Portland, Oregon.

USFS and USDI Bureau of Land Management. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl. Portland, Oregon.

USFS. 1998. Sisters/Whychus Watershed Analysis. Deschutes National Forest Sisters Ranger District. Sisters, Oregon.

USFS, 2002. Cache Mtn Fire, Burned Area Emergency Response (BAER). Sisters Ranger District. Deschutes National Forest, Sisters, OR.

USFS. 2004. Draft Upper Deschutes and Little Deschutes Subbasins Water Quality Restoration Plan. Deschutes National Forest, Bend, Oregon.

USFS, 2006. Black Crater Fire, Burned Area Emergency Response (BAER). Sisters Ranger District. Deschutes National Forest, Sisters, OR.

USFS, 2006. Lake George Fire, Burned Area Emergency Response (BAER). Sisters Ranger District. Deschutes National Forest, Sisters, OR.

USFS. 2006. Joint aquatic and terrestrial programmatic biological assessment August 2006 – August 2009 for federal lands within the Deschutes and John Day River Basins administered by the Deschutes and Ochoco National Forests. Bend, OR.

USFS, 2007. GW Fire, Burned Area Emergency Response (BAER). Sisters Ranger District. Deschutes National Forest, Sisters, OR.

USFS. 2007. Whychus Creek Wild and Scenic River Resource Assessment. Sisters Ranger District. Deschutes National Forest. U.S. Forest Service. Sisters, OR.

USFS. 2008. Update of the Regional Forester's Sensitive Species Lists and Transmittal of Strategic Species List. January 1, 2008. Pacific Northwest Region. Portland, OR.

Vannote, R. L, G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of the Fish and Aquatic Sciences 37:130-137.

Watershed Sciences. 2000. Aerial surveys in the Upper Deschutes River Basin. Unpublished report prepared for the Upper Deschutes Watershed Council. Bend, OR.

Wondzell, S. M. and J. G. King. 2003. Post fire erosional processes in the Pacific Northwest and the Rocky Mountain regions. Forest Ecology and Management 178:75-87.

Zouhar, Kris. 2003 Bromus tectorum. In: Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/fis/ [2009 February 4]

Whychus Watershed Analysis Update Team

Watershed Analysis Update Interdisciplinary Team:

- **Terry Craigg - Soils**
- **Cari Press- Hydrology**
- **Roberta Rankin Bates -Silviculture**
- **Mike Riehle – Fish**
- **Julie York- Wildlife**
- **Jinny Pitman- Fire and Fuels**
- **Lauren Miller- Fire Ecology**
- **Don Zettel - Heritage**
- **Leslie Moscoso- Recreation**
- **Chad Houchin– Engineering**
- **Maret Pajutee – Botany/Ecology/ Team Leader**

Team Consultants:

- **Monty Gregg- Wildlife**
- **Barton Wills- Geology**
- **Larry Chitwood - Geology**
- **Jeff Sims, Special Uses**
- **Michael Keown- Environmental Coordinator**
- **Willie Scott- USGS Cascades Volcano Observatory, Vancouver**
- **Jim O'Connor –USGS Oregon Water Science Center, Portland**