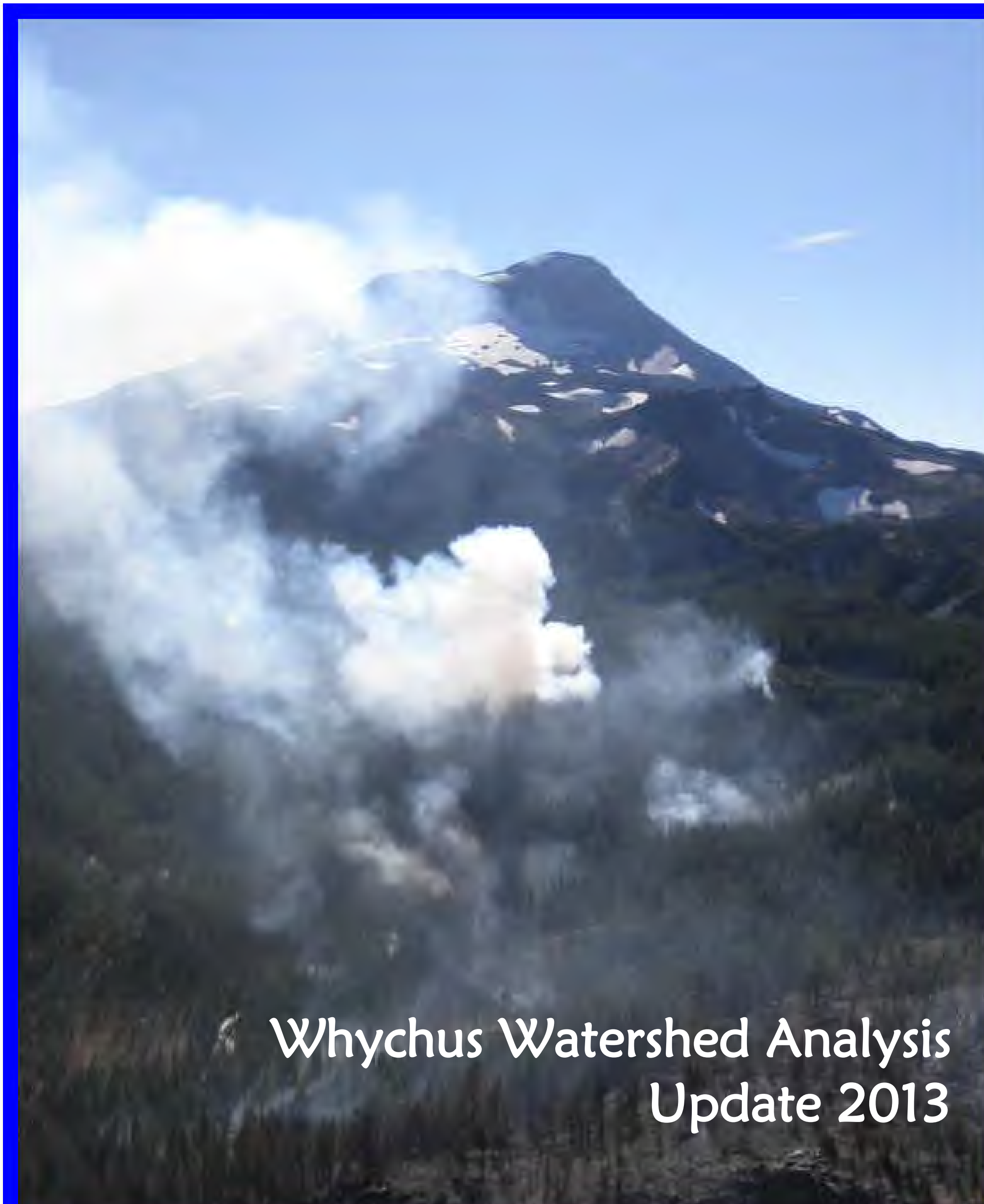

US Forest Service
Sisters Ranger District,
Deschutes National Forest, Oregon

Whychus Watershed Analysis Update 2013

US Forest Service
Sisters Ranger District
Deschutes National Forest
August 2013

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RESOURCE REPORTS

Watershed Analysis Update Interdisciplinary Team:

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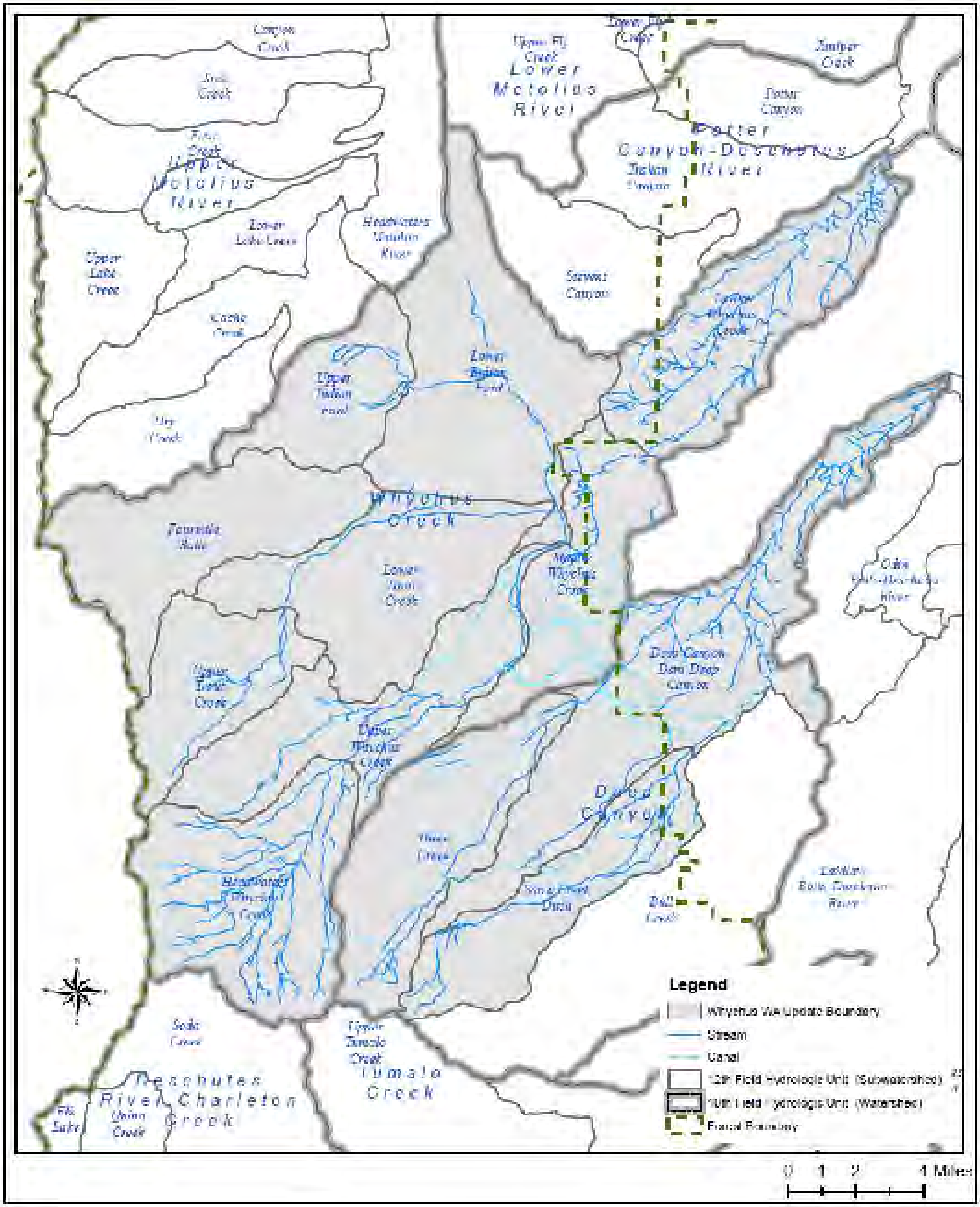

Figure EX-1- Whychus Watershed Analysis Update Area

Whychus Watershed Analysis Update 2013

Executive Summary

Purpose and Scope of this Document


Pole Creek Fire 2012

- Updates the 1998 and 2009 Sisters/Whychus Watershed Analyses
- Analyzes effects of changes in the watershed since 2009, especially in relation to the 26,000 acre Pole Creek Fire of 2012.
- Identifies trends of concern
- Prioritizes areas to guide future management
- Provides recommendations
- Identifies data gaps and monitoring needs
- Provides information for cumulative effects analysis

Major changes in the Whychus Watershed since 2009 include:

❖ **Anadromous fish are back.** Steelhead and spring Chinook salmon have been reintroduced to Whychus Creek. The first returning adults were found in 2011 at Pelton Round Butte Dam. The first spawning steelhead was seen in Whychus Creek this spring.

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❖ **Collaborative Watershed Restoration has continued to rapidly improve conditions.** Concerted efforts by many agencies, groups, and individuals have continued to increase water flows in Whychus Creek, restored channels and floodplains, conserved large blocks of habitat, closed roads, and increased educational efforts. Several large restoration projects improving wetland, floodplain, and riparian habitats have been completed and more are underway.

❖ **The Whychus Wild and Scenic River Plan is complete and is being implemented.** High priority management in the lower river corridor is almost complete and includes: Implementing the Whychus Portal project with road closures and decommissioning around the river, user trail decommissioning, trail construction, parking management, and monitoring to record Limits of Acceptable Change baseline information.

❖ **A Treasured Landscape-** The "Tale of Two Rivers" Whychus/Metolius Conservation Campaign is a partnership with the National Forest Foundation (NFF). The campaign draws additional awareness and raises 1.7 million dollars for a suite of watershed restoration, recreation enhancement, and community engagement projects on Whychus and the Metolius Wild and Scenic Rivers. The campaign goal is 76% fulfilled. Eight of ten projects have been completed and the campaign is in its final year.

❖ **Four large wildfires have burned into the watershed since 2009** These include the 2012 Pole Creek Fire, the 2011 Alder Springs Fire, the 2010 Rooster Rock Fire, the 2009 Black

Butte II Fire. Approximately 34,724 acres or 15 % of the watershed has burned since 2009.

- **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.
- **Slowing of population increases in Sisters and Deschutes County.** After decades of being one of the fastest growing areas in Oregon, growth has slowed with economic downturn. However, growth at a higher rate than the State average is expected to resume over time.
- **New science and data -** Many resource areas have new data, studies, and analysis approaches, including Fire Regime and Climate Change 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: increased requests to approve recreation events and increasing concern about smoke from prescribed fire. There is also increased use of Whychus Creek above Sisters by campers and long term forest residers.

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 (USFS 1994).

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* (USFS 1990) 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 (*USFS 1994). 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 module* (USFS 1995).

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 for Ecosystem Analysis at the Watershed Scale 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 Sisters Whychus Watershed Analysis (USFS 1998) or the Whychus watershed Analysis Update (USFS 2009). 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 October 2012 and August 2013. This is a dynamic document that may be updated and modified as needed.

Some resource areas have both summaries and full reports. Others (Climate Change, Geology, Heritage Resources, Roads, and Recreation) have only summaries.

Public Involvement and Scoping

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

- Whychus Wild and Scenic River Public Field Trips
- Whychus Portal Project Scoping
- Popper Vegetation Management Project Scoping
- The Deschutes Collaborative Forest Project Meetings and Field Trips
- Information provided by Agency partners

Pole Creek Fire Public Field Tour June 2013

Chronology:

1994	The Record of Decision for the Northwest Forest Plan amended local Forest Plans and requires Watershed Analysis is 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	Cache Mountain Fire (4,358 acres) is started by lightning (43 acres in the watershed)
2005	The U.S. Board on Geographic Names approves 16 name changes and one new name for Central Oregon landscape features that use the word "Squaw", including Whychus Creek and Chush Falls.
2006	Black Crater Fire (9,411 acres) is started by lightning (9,396 acres in the watershed)
2006	Lake George Fire (5,537 acres) is started by lightning (1,857 acres in the watershed)
2007	GW Fire (7,349 acres) is started by lightning (954 acres in the watershed)
2007	Steelhead are reintroduced to Whychus Creek
2008	Implementation of the Glaze Forest Restoration Project begins. This partnership project with Conservation and Forest Industry partners demonstrates innovative new thinning techniques to restore historic structure and uses 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 completed.
2009	Black Butte 2 Fire (578 acres) is started by lightning- (559 acres in watershed)
2009	Restoration of instream flows above 20 cfs to Whychus Creek below the Three Sisters Irrigation Dam Diversion
2009	Spring chinook reintroduction in Lower Whychus Creek begins
2010	The Whychus Creek Wild and Scenic River Management Plan is completed
2010	Three Sisters Irrigation District (TSID) Fish Passage and Channel Restoration completed
2010	Rooster Rock Fire (6,119 acres) is started- cause is undetermined but is likely human caused.
2011	Whychus Creek Restoration and Management Plan for lands in the City of Sisters completed
2011	Alder Spring Fire (1,449 acres) is started by lightning (1,052 acres in watershed)
2012	Whychus Creek Restoration at Camp Polk Meadow Preserve completed
2012	Pole Creek Fire (26,578 acres) is started by lightning
2012	Whychus Portal Project is implemented to protect Whychus Creek Wild and Scenic River and manage access with road closures, restoration, and a river trail.
2012/2013	Forty nine adult Chinook and 111 adult steelhead return to Pelton Round Butte Dam on the Deschutes from fish reintroduction.
2013	One radio tagged steelhead was found in Whychus Creek and a redd (a spawning nest) was found
2013	The Whychus Watershed Analysis Update is completed in this document

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 volcanically active in the past 11 years with activity centered around South Sister**.** New monitoring has been tracking volcanic activity which has slowed**.** The area has highly permeable outwash plains of sand and gravel left by glaciers.
- **Subwatersheds:** The Whychus watershed analysis area includes 12 subwatersheds within two watersheds; Deep Canyon and Whychus Creek.
- **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 3,200 feet near Fremont Canyon.

Biological

- **Important Fishery-** Whychus Creek once supported large steelhead runs**.** Reintroduction of Steelhead and Chinook 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-** Five Fire Regimes are present. Much of the area historically experienced frequent low – moderate 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.
- **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-** 71% Public lands (66% USFS, 5% BLM), 29% Private
- **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.
- **Coming out of an era of rapid growth in Deschutes County with many new housing 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 was completed and signed in 2010.
- **Valued scenic vistas-** The Three Sisters and front country are viewed from across Central Oregon.
- **Management Allocations:** Public lands include both Northwest Forest Plan and Eastside management areas

Land Allocations	Acres
Northwest Forest Plan	
Administratively Withdrawn Areas	1,596
Congressionally Reserved	42,221
Late-successional Reserves	26,652
Matrix	21,538
Eastside	129,871
Other ownership *(Private)*	8,278
TOTAL	230,155

Key Questions- Focus Of Analysis

1) How have wildfires in the past 4 years affected the watershed and it's processes?

2) What other important new information or changes have emerged?

View of the Pole Creek Fire plume from other side of Broken Top photo taken 5:30 pm 9/14/12

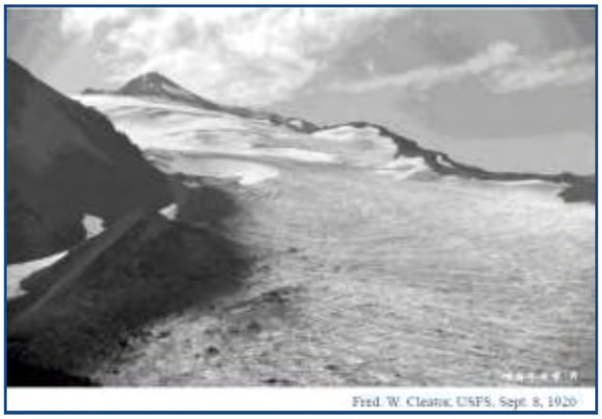
Matthew Noble/INCIWEB

http://www.inciweb.org/incident/photograph/3244/32/

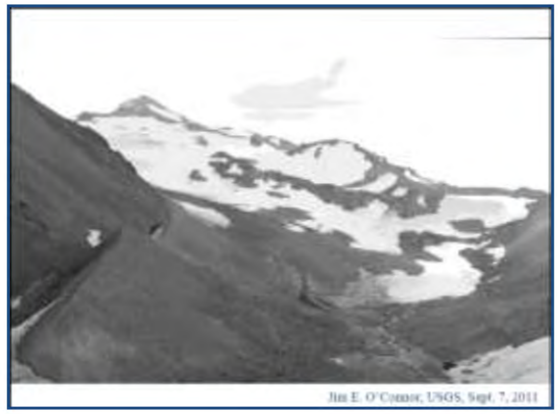
Key Findings- By Resource Area

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

Climate Change



Collier Glacier North Sister 1920



91 years later
Collier Glacier North Sister 2011

New assessments and local research on climate change continue to inform us on expected trends.

- **Key expected environmental trends due to climate change are**: (from Vose, et.al 2012):
  - Increased temperatures
  - Longer growing seasons
  - Less snow and
  - More frequent drought
    - These effects are expected to increase plant stress and decrease plant survival in the drier, warmer, and lower elevation portions of species' ranges.
  - Higher atmospheric concentrations of carbon dioxide (CO2), and higher nitrogen (N) deposition are likely and these may lead to changes in ecosystem structure and function.

- **"At Risk" Snow-** Snow found at elevation ranges of 3,500-5,500 feet has been found to be "at risk" because it accumulates at temperatures close to the ice-water phase transition. This means it is at greater risk for climate warming than cold climate snowpacks. Under a climate-warming scenario, areas in the Central Oregon Cascades are at risk of converting from a snow-dominated to a rain-dominated winter precipitation regime. Approximately 51% of all at-risk snow in the Pacific Northwest is in the Oregon Cascades, and 21.8% of all snow-covered area in the Oregon Cascades falls into the at-risk snow class (Nolin and Daly 2006).

- **Declining Snowpack** – Long term snowpack records from 1940 to 2010 at Santiam Junction near Sisters show there has been a 0.8 mm yearly reduction of snow accumulation and a 10% per decade decline in the peak amount of snow (Nolin 2013).

- **Snow/Wildfire Interactions-** Wildfire activity is strongly associated with changes in spring snowmelt timing, which in turn is sensitive to changes in temperature. More wildfires occur with early snowmelt and with declining snowpacks (Westerling et.al 2006).
    - **Charred forests reduce snow duration because they absorbed more solar energy**. A new study in progress on the Shadow Lake Fire in Sisters found "dirty" snow melts earlier in recently burned forests because of the charred debris and ash on the snow surface which absorbs more heat. Snow melted 23 days earlier in the recently burned forest and was much more open (20% canopy closure versus 52% closure) than the unburned forest. This effect is expected to last for 1-4 years after wildfires. Snow melt may affect post-fire vegetation recovery (Nolin 2013).

- **Altered disturbance regimes**: The most significant short-term effects of climate change on forest ecosystems is expected to be caused by altered disturbance regimes (below trends from Vose, et.al 2012).
    - **Wildfires** – Area burned is expected to double by the mid -21st century.
    - **Insects,** such as such as the current advance of bark beetles in western forests are expected to expand, often affecting more land area per year than wildfire.
    - **Pulses of erosion and flooding** will be caused by higher rain: snow ratios in mountainous regions and more burned area.
    - **Drought-induced tree mortality**.
    - **Invasive species** will likely become more widespread, especially in areas of disturbance and in dry forest ecosystems.
        - Plant invasions can be influenced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, changes in fire regimes, elevated N deposition, and elevated CO2 concentrations.
        - Invasive species common to the Sisters Ranger District, such as the Knapweeds

Cheatgrass invasion after the Black Crater Fire

(*Centurea* sp.), Canada thistle (*Cirsium arvense*), and cheatgrass (*Bromus tectorum*) show increased productivity in response to elevated CO2 under controlled conditions.

  - Risk of exotic invasive plants entering forests is likely highest in mountainous ecosystems, where historically cooler temperatures and closed-canopy forests may have limited invasives.
  - Wildfire increases the susceptibility of habitats to invasive plants.

- **Spatial Shifts in Forest Types and loss of high elevation meadows**: Higher temperatures and fire frequencies are predicted to lead to significant spatial migration of forest types across the landscape by 2100. Plant communities at the highest and lowest elevations are expected to be particularly affected. Most models predict that species habitat will move upward in elevation and northward in latitude and habitats at lower elevations and lower latitudes will be reduced (Vose, et.al 2012). However, Crimmins, et.al (2011), found climates change has led to significant downhill shifts in optimum elevations for some species, due to extra water availability from increased rain.

  - **A simulation landscape for the Deschutes National Forest (Greaves 2012) over the next 500 years showed:**
    - **Mountain hemlock and high elevation cool, wet conifer forests** are expected to contract.
    - **Lodgepole pine** occupies a unique niche in East Cascades forests, as an early seral dominant following stand-replacing disturbance, and persists in extreme environmental pockets that discourage other species, such as cold –air drainages in flats and hollows. Warming is likely to decrease the prevalence of these cold pockets, leading to more competition with warm-adapted species and potentially a decline of lodgepole pine;
      - Coops and Waring (2011) estimate that lodgepole distribution may decline to 17% of its current range by 2080.
    - **Dry Mixed Conifer and Ponderosa Pine**- Warming led to an upslope shift of warm mixed conifer and ponderosa pine forests.
      - Greaves suggests that although restoration of open, park-like stands of ponderosa pine and dry conifer may be desirable for safety, recreation, and to control fire behavior, it may prove difficult to maintain such stands in their present locations because warming temperatures will shift the location of suitable environments and potentially replace them with shrublands and juniper.
    - **Grass and shrublands**- In lower elevations, warming and fire contributed to significant expansion of open (<10% tree canopy cover) forest and grass- and shrubland.

- **Studies near Mt Jefferson on subalpine meadows** found temporal patterns of tree invasion were correlated with climate. Trees occupied 7.75 % of the total meadow landscape in 1950, increased at an average rate of 0.49 % year-1, with 34.71 % occupied in 2008. Tree invasions were found to be correlated with spring temperatures, spring snowfall, maximum annual snowfall, and mean summer temperatures (Zald, et al. 2012)

- **Climate Change Planning on the Deschutes-** The Deschutes and Ochoco National Forest and Crooked River National Grassland are working with other agencies and scientists to proactively address climate change and has begun drafting recommendations for management and monitoring actions (Vora 2012). *Also see Recommendations section of this report.*

NOTE: References for the Climate Change Summary can be found on page 101.

Geology

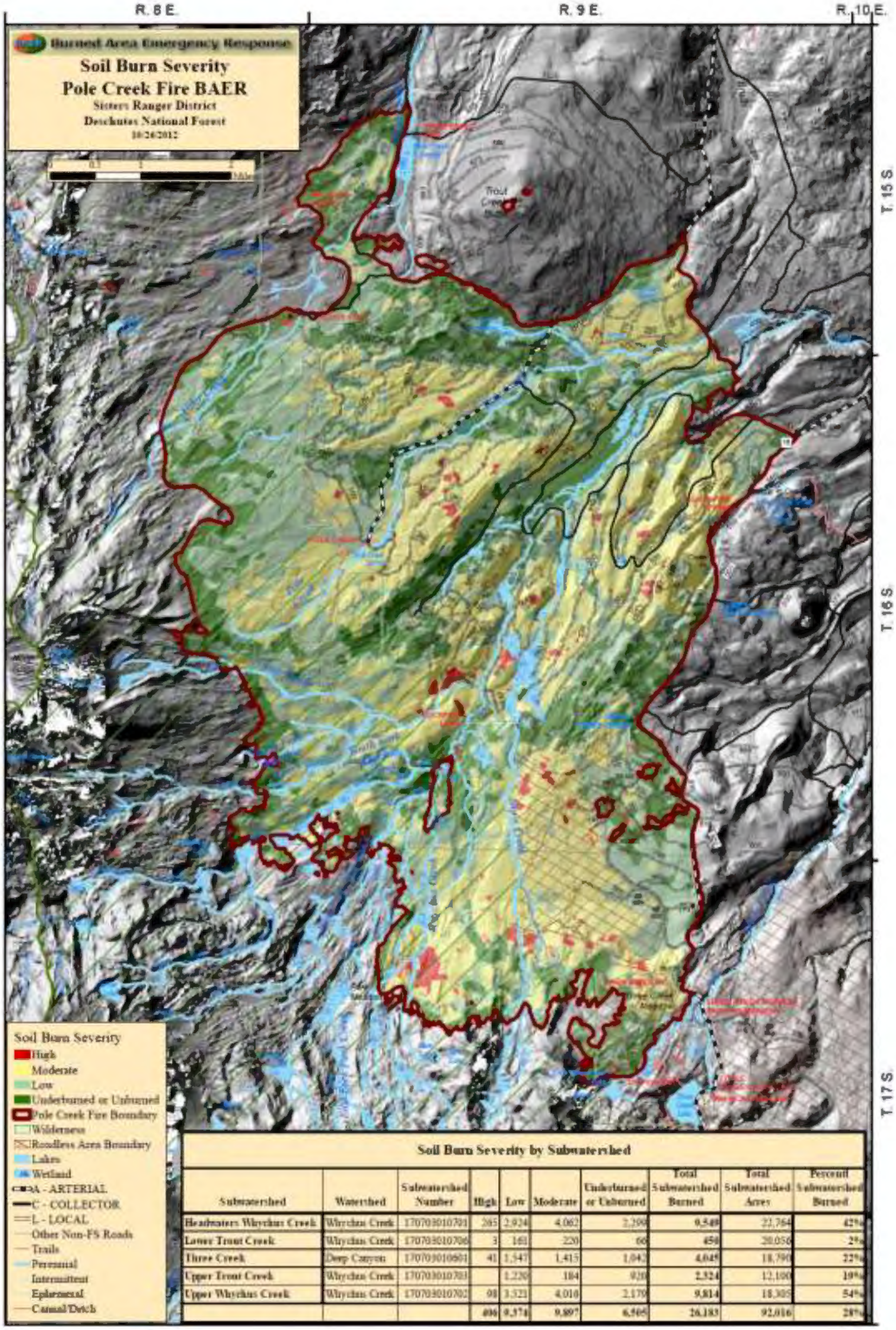
Geological formations were revealed by the Pole Creek Fire

Geological Oddities

- This striking formation is located between roads 1514-600 and 750 spurs between Whychus and Snow Creek. It appears to be the toe of a lava flow lobe that was later carved flat by a glacier but left the lobe shape at the edges (reference: Barton Wills, Deschutes NF Geologist).
- The surface rocks appeared to be more abraded than till. The shallow skeletal soil at the top was dominated by large, flat, sharply angular, flagstone shaped rocks. Minor amounts of till were present.

Volcanic Activity/Carver Lake

- There has been no change or new information. South Sister volcanic activity has slowed. For a discussion on Carver Lake see Whychus Watershed Analysis Update (USFS 2009).



Soil Burn Severity by Subwatershed

Subwatershed	Watershed	Subwatershed Number	High	Low	Moderate	Underburned or Unburned	Total Subwatershed Burned	Total Subwatershed Acres	Percent Subwatershed Burned
Headwaters Whychus Creek	Whychus Creek	170703010701	265	2,924	4,062	2,299	9,549	22,764	42%
Lower Trout Creek	Whychus Creek	170703010706	3	161	220	66	450	20,056	2%
Three Creek	Deep Canyon	170703010601	41	1,547	1,415	1,042	4,045	18,790	22%
Upper Trout Creek	Whychus Creek	170703010703		1,220	184	920	2,324	12,100	19%
Upper Whychus Creek	Whychus Creek	170703010702	98	3,521	4,016	2,179	9,814	18,305	54%
			406	9,374	9,897	6,505	26,183	92,016	28%

Figure EX-2 Soil Burn Severity in the Pole Creek Fire

Soils

- **The 2012 Pole Creek fire** burned approximately 26,584 acres, entirely within the Whychus Watershed.
  - It caused moderate soil damage on 38% of the area, low on 61% and high on less than 1%.

Stand replacement burn
Pole Creek Fire, Upper Whychus 6th Field Watershed

- **The 2010 Rooster Rock fire** burned approximately 6,119 acres, also entirely within the Whychus Watershed.
  - The majority of the acres burned in the Rooster Rock fire were mapped at a moderate to low level and most of the burn occurred on private lands.

- **Salvage opportunities** within the Pole Creek Fire are being analyzed but to date no salvage has occurred. The only salvage activities that occurred on USFS lands within the Rooster Rock fire were road side removal of danger trees.
- Prior to 2010 the earlier Black Crater Fire and small portions of earlier GW, Cache Mountain, and Lake George fires also burned within the Whychus watershed. Most of the fire burn severities for the three fires were mapped at a moderate to low level.
- 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 GW salvage and other road side salvage operations determined that the soil disturbance resulting from salvage activities was within the acceptable limits defined by the FS Regional Soil Quality Standards.

The new stream channel at Camp Polk was activated in 2012 by the Deschutes Land Trust, restoring Whychus Creek to its former location, improving floodplain function, and restoring the water table in Camp Polk meadow

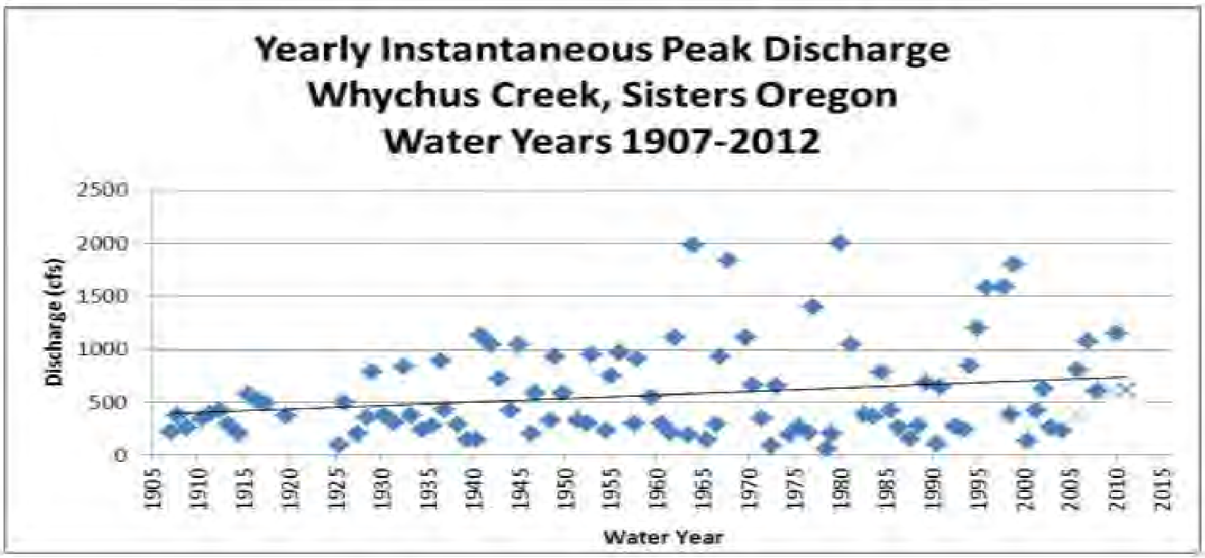
Hydrology

There has been a continuing improvement in flows in Whychus Creek

- Concerted water conservation efforts by many agencies and organizations have improved the efficiency of irrigation diversions and transferred and leased water rights. Median low flow of Whychus Creek from 2009-2012 averaged 27 cfs in Sisters.
- 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.

Whychus Creek is experiencing higher flows

- Average bankfull flows (approximately 1.5-year return interval) in Whychus Creek are occurring with greater frequency.
- In the last 20 years, flows around 300 cfs are occurring almost yearly and are now associated with a 1.15 recurrence interval, while flows associated with the 1.5 recurrence interval have increased to approximately 500 cfs.
- Rain-on-snow events, resulting in higher streamflows, are becoming more frequent in the Whychus Creek watershed. This increase corresponds to the period when a large area of lodgepole pine in the watershed was killed by mountain pine beetle and this could have reduced interception and increased snow pack due to less interception in tree canopies.



Pole Creek Fire Effects to Hydrology

- The Pole Creek fire burned in the Headwaters Whychus, Upper Whychus, Upper Trout Creek, Lower Trout Creek, and Three Creek subwatersheds.
- Effects from the Pole Creek Fire were greatest in the Upper Whychus and Headwaters Whychus subwatersheds.
- Effects to Hydrology from the Pole Creek fire include:
    - increased sediment from upland erosion,
    - channel instability
    - erosion,
    - increased peak flows,
    - increased stream temperatures
    - Effects have the potential to be greatest in Whychus Creek, Pole Creek, and Snow Creek because these waterbodies experienced the highest burn

severities, with channels burning to the water's edge. Little to no vegetation was left unburned along Pole Creek and Snow Creek.

- Peak flows in Whychus Creek are expected to increase from the Pole Creek Fire.
  - Areas within the rain on snow zone (ROS) of 3,500-5,000 ft elevation that have experienced stand replacement fire conditions or have high mountain pine beetle mortality have the greatest risk of flashy runoff during rain on snow events.
  - These risks are greatest in the Headwaters Whychus Creek subwatershed where 97% of the ROS zone was either burned by stand replacement fire in the Pole Creek Fire or experienced high mountain pine beetle mortality.
  - Risk is also high in the Upper Whychus subwatershed. The Upper Trout Creek subwatershed is also at increased risk based on high mountain pine beetle mortality; however, Trout Creek is only ephemerally connected to Whychus Creek.
- Two storms moved over the Pole Creek Fire area closely following the burn. Runoff from these storms damaged a number of roads and stream crossings. Field observations following these storms indicate that ephemeral drainages across the burned area with no evidence of recent scour conveyed water and moved sediment during the storm.
- 175 acres of severely burned along Whychus, Snow and Pole Creeks were aerially mulched in the early summer of 2013. Treatments should help reduce sediment yield transported to Whychus Creek and its tributaries.

Snow, Climate Change and Fire

- Snow conditions are expected to change in the Whychus Watershed in response to climate change and fire effects.
  - Measurements of April snow water equivalent (SWE) dating back to 1950 show that the Pacific Northwest has experienced the largest decline in snowpack in the western United States (Mote et al, 2005), This change is primarily attributed to increases in winter temperatures (Mote, 2003, Mote et al, 2005, Nolin and Daly, 2006).
  - The Pacific Northwest has experienced a 9-11 day earlier snowmelt runoff since 1950 (Stewart et al, 2004 and 2005).
  - Snow in maritime climates falls at temperatures close to 0°C, making accumulation of snow versus rainfall highly sensitive to temperature increases (Sproles et al, 2012). Nolin and Daly (2006) mapped areas at risk of transitioning from a snow-dominated to a rain-dominated winter precipitation regime ("at risk snow") with minor increases in winter temperatures. Mapping indicates that the ROS zone in the Whychus WA area is at risk of transitioning from a winter snow to rain precipitation regime (Nolin and Daly, 2006).
  - Emerging research in the nearby McKenzie basin indicates that wildfire-derived black carbon sloughing from burned trees onto snowpack increases absorption of solar energy (albedo) and results in loss of snowpack up to 23 days earlier than in unburned forest (Nolin et al., 2012, Nolin, 2013).

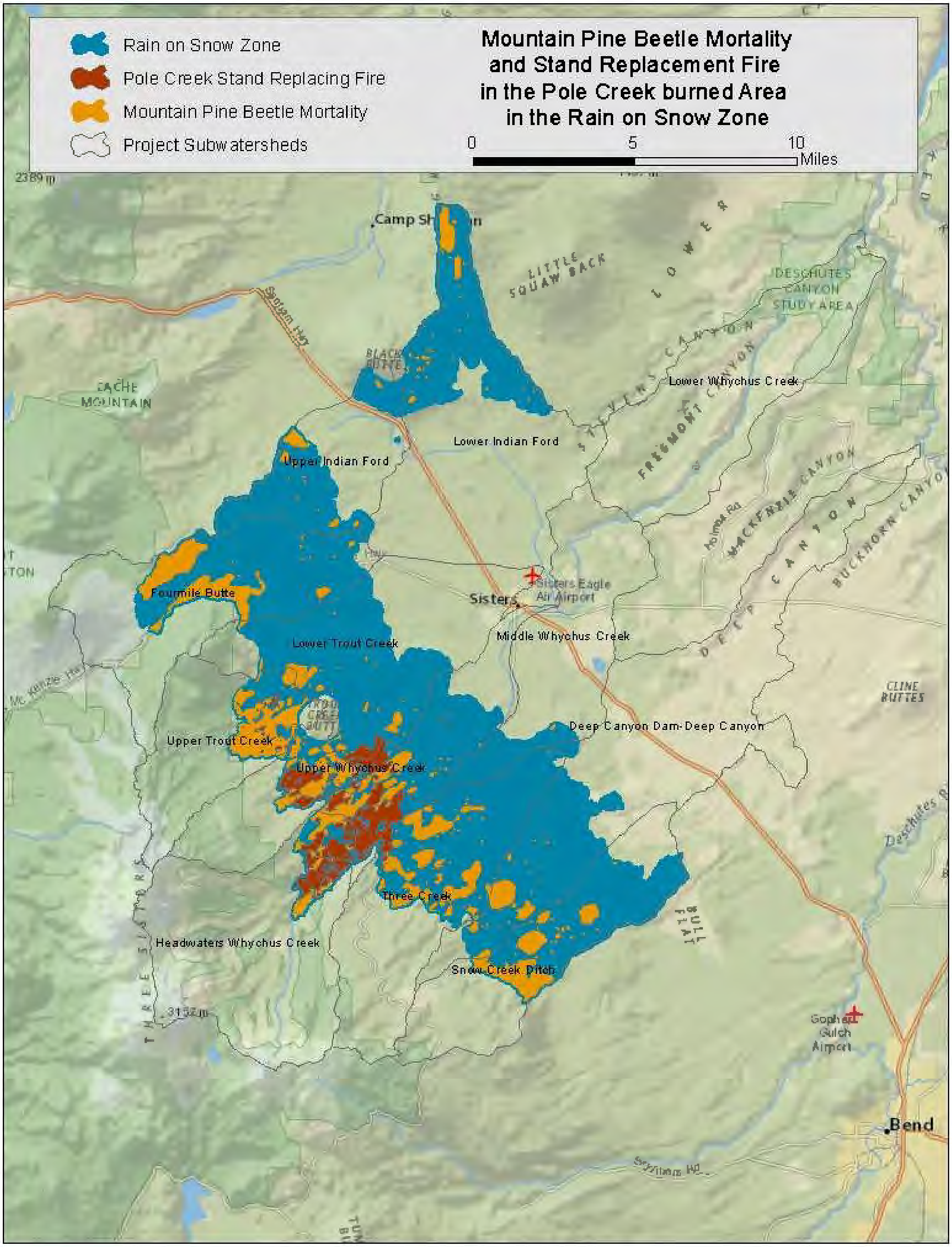


Figure EX-3 Mountain pine beetle and Pole Creek stand replacement fire in the rain-on-snow zone

Effect of Roads on the Watershed

- Roads in the watershed are a primary source for concentration of overland flow and potential erosion and sedimentation; the Pole Creek Fire has exacerbated these effects. Road densities are high in most subwatersheds outside the wilderness in the Whychus WA area.
  - Riparian road densities are highest in the Deep Canyon Dam-Deep Canyon, Lower Trout Creek, and Snow Creek Ditch subwatershed.
  - Lower Trout Creek, Middle Whychus Creek, Three Creek, and Upper Whychus Creek have a high number of road stream crossings.
  - Roads within the Headwaters and Upper Whychus subwatersheds are at greatest risk from increases in road/stream/fire interactions. These two subwatersheds have the highest riparian road density and number of road/stream crossings.
  - Several roads and crossings in the Pole Creek Fire were identified through the BAER process as being at increased risk from fire effects. Many of these roads were damaged in the storms closely following the Pole Creek fire. Treatment of these roads will continue using BAER funds and other funding sources.

Post-fire- Road 1526-200 Before storm event

Post-fire- Road 1526-200 After storm event which overtopped culverts and washed out road bed

Watershed Restoration

Forest Service Fish Biologist Mike Riehle surveys the new stream channel, fish passage, and restoration at Three Sisters Irrigation Dam 2012

- Numerous large restoration projects have occurred in the past 4 years to address multiple limiting factors to aquatic health (See Hydrology Report in this document) . Restoration work continues at a rapid pace in the Whychus WA area, upcoming projects include:
    - Leithauser Dam Removal (Implementation expected 2013)
    - Whychus Canyon Stream Restoration (Implementation expected 2015)
    - Whychus Floodplain Stream Restoration (Implementation expected 2014)
    - Screening of diversion pipes along Whychus Creek (on-going)
    - Additional restoration projects are planned to improve conditions in Indian Ford Creek and Three Creek
- The **2010 Watershed Condition Framework** process identified the Upper Whychus Creek subwatershed as a National Priority subwatershed. The Upper Whychus Creek Action Plan outlines nine essential projects that address limiting factors to watershed condition, and would improve condition class from functioning at risk to functioning properly once completed. The Watershed Condition Framework was updated for the Whychus WA area to evaluate changes in conditions resulting from the Pole Creek Fire.

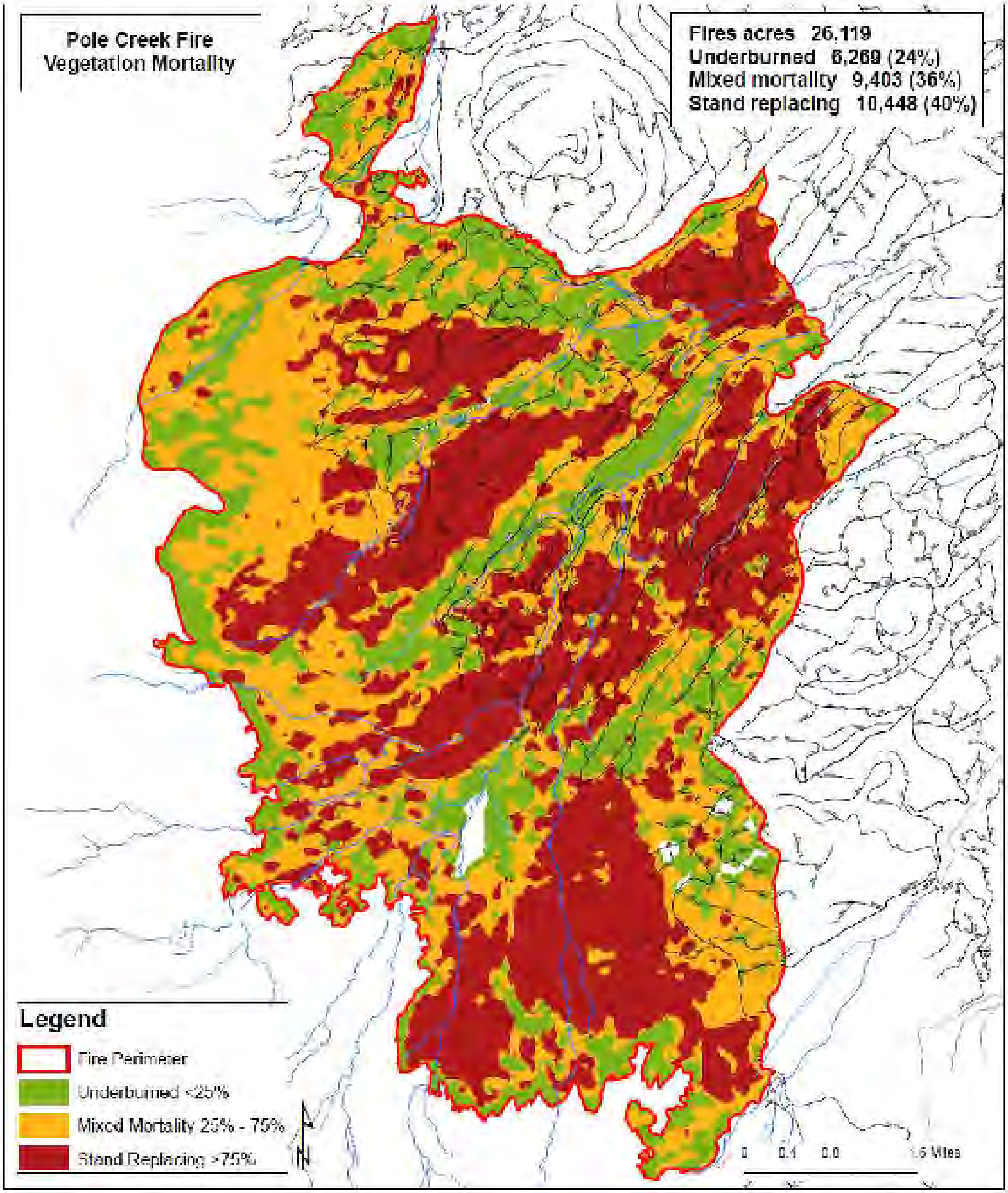


Figure EX-4 Burn severity to Forest Vegetation in the Pole Creek Fire

Forest Vegetation

Wildfire has affected forests

- 25% (45,319 acres) of the watershed area has been involved in wildfire since 1998.
- 11% (19,974 acres) of the watershed area has experienced stand replacement fire in which virtually all vegetation canopy was consumed/removed.
- 8% (14,499 acres) of the watershed area has experienced mixed severity fire in which 25% to 75% of the vegetation canopy was consumed/removed.

High elevation fire mosaic where the Pole Creek Fire (on right) met the 1996 Park Meadow Fire (on left)

- 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.
- **Loss of large old trees**- The largest changes are the loss in potential old growth lodgepole pine from mountain pine beetle and loss of old trees in High Elevation forests due to the Pole Creek Fire.

- **Even more dead trees**- There was been a watershed level mortality event beginning in 1998, which created 60, 000-70,000 acres of dead trees, mostly lodgepole pine. Much of this area and many adjacent live forests burned during the Pole Creek Fire.
- **Continued successional changes from fire suppression-** The trends discussed in the 1998 Watershed Analysis are still happening and are a bit farther along.
- **Little Vegetation Management in this watershed since 1998**- Vegetation management priorities have been: 1) Thinning in the Metolius Basin, because of public concern, 2) Fire salvage of a series of large wildfires since 2002. Recent thinning includes:
  - Glaze Forest Restoration Project – in progress, collaborative restoration project.
  - Sisters Area Fuels Reduction Project (SAFR) -in progress, urban interface fuels reduction.
- **Collaborative Forest Restoration Project expanded in 2013** These proposed changes will allow the project to adjust National Environmental Policy Act (NEPA) implementation time frames and proposed treatments in response to the Pole Creek Fire. The modified project will maintain the intensity of treatment on the acres in the originally proposed landscape that were not impacted by this fire and will add additional treatments adjacent to the original landscape that include more acres in the wildland-urban interface.

Fire

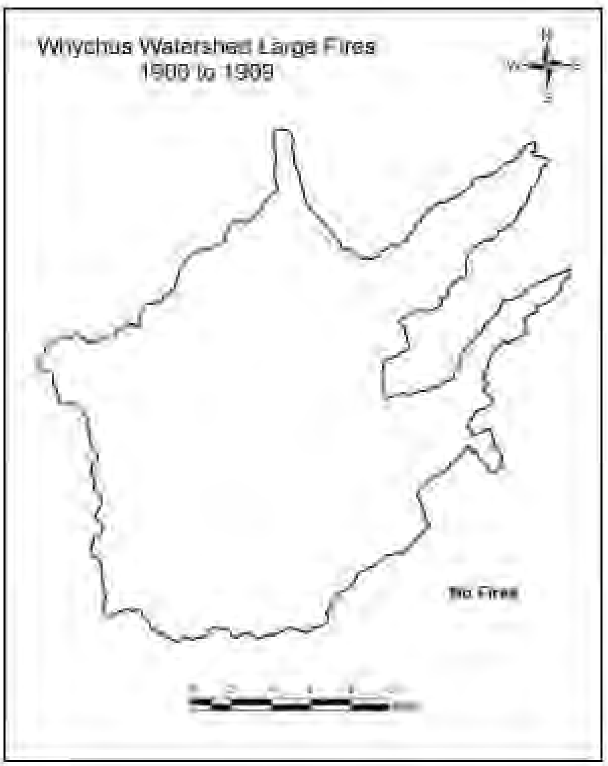
Wildfires are increasing in size and frequency

- **In the last 12 years (since 2000), 4 times as many acres burned as in the previous 100+ years**
  - From 1900-1999, 9,915 acres burned
  - From 2000- 2012- 46,634 acres burned

- Since the last watershed analysis in 2009, four fires totaling 34,724 acres (15% of the watershed) have burned equating to 41% of all watershed acres burned in the past 100+ years.

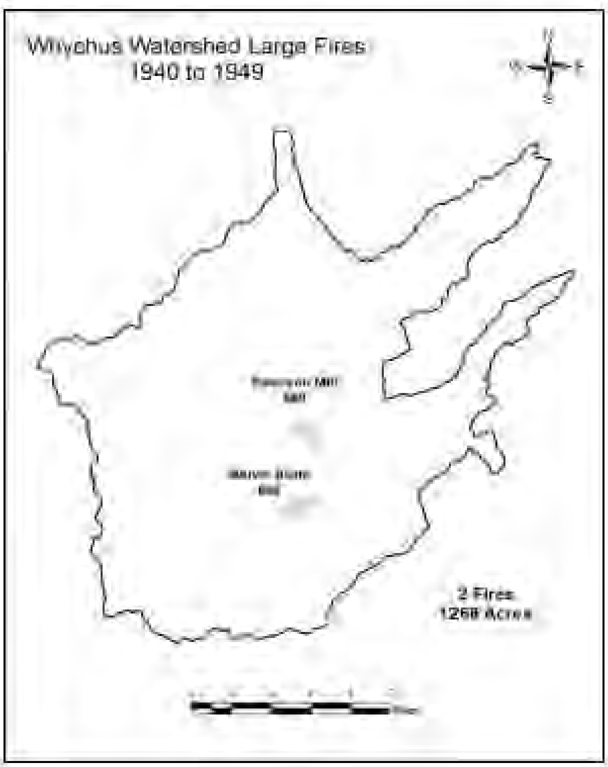
- Within the past 12 years, there are 9 notable fire incidents. The majority of this activity has occurred within the Wildland Urban Interface as mapped through the Greater Sisters Country Community Wildfire Protection Plan (See Fire and Fuels Report in this document).

Large Fire Overview by Decade

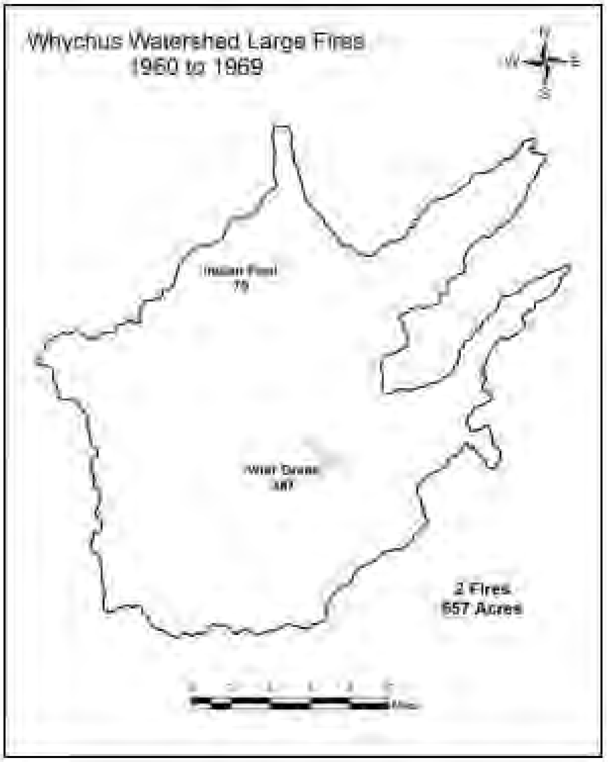



Whychus Watershed Large Fires
1920 to 1929
No Fires

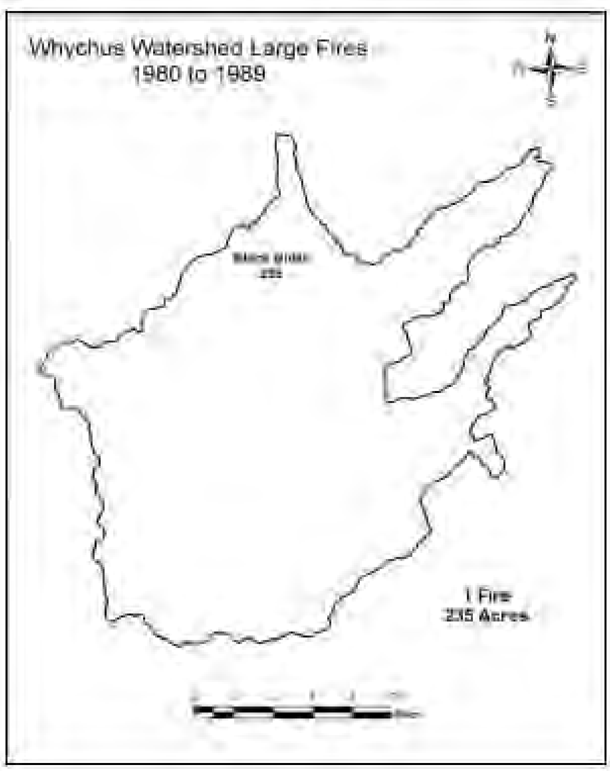

Whychus Watershed Large Fires
1930 to 1939
1 Fire


Whychus Watershed Large Fires
1940 to 1949
2 Fires

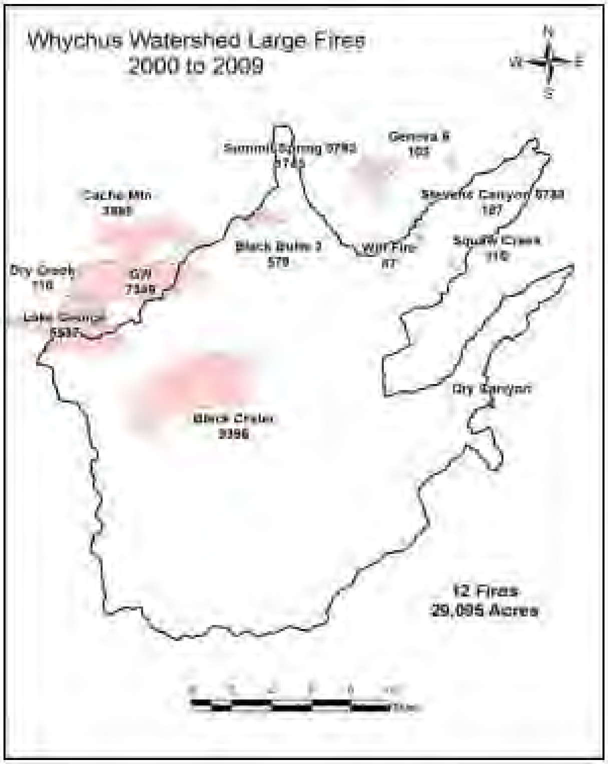

Whychus Watershed Large Fires
1950 to 1959
2 Fires

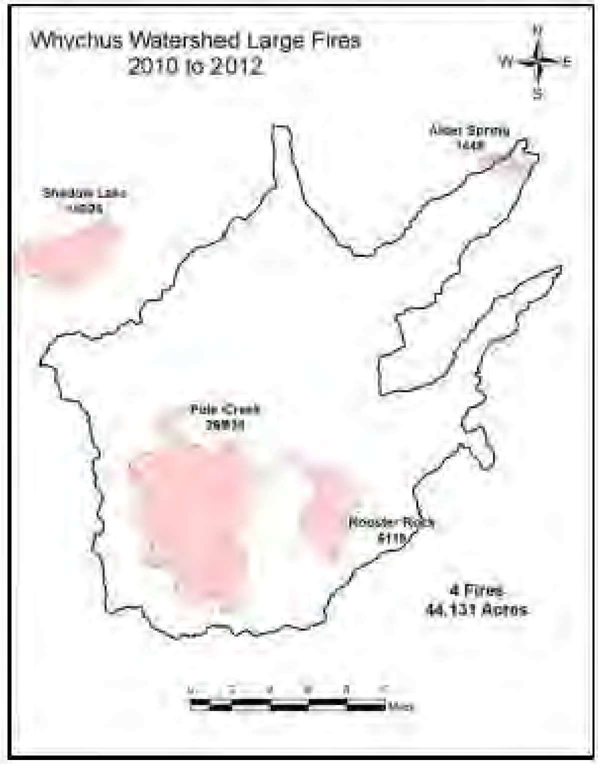

Whychus Watershed Large Fires
1960 to 1969
2 Fires
657 Acres

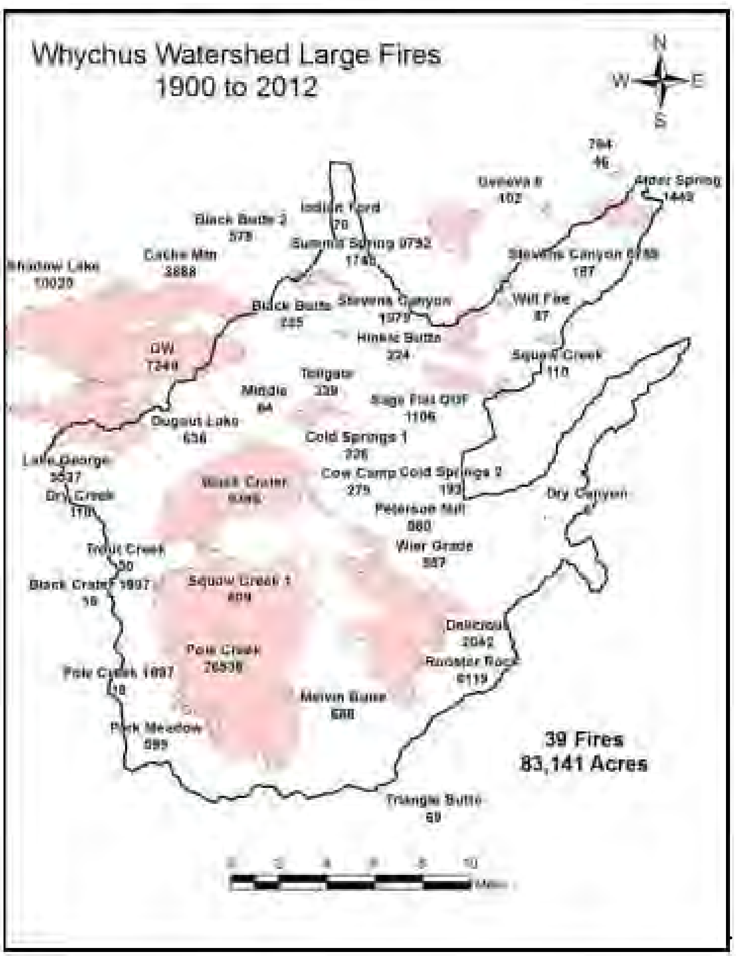

Whychus Watershed Large Fires
1970 to 1979
3 Fires
453 Acres


Whychus Watershed Large Fires
1980 to 1989
1 Fire
235 Acres

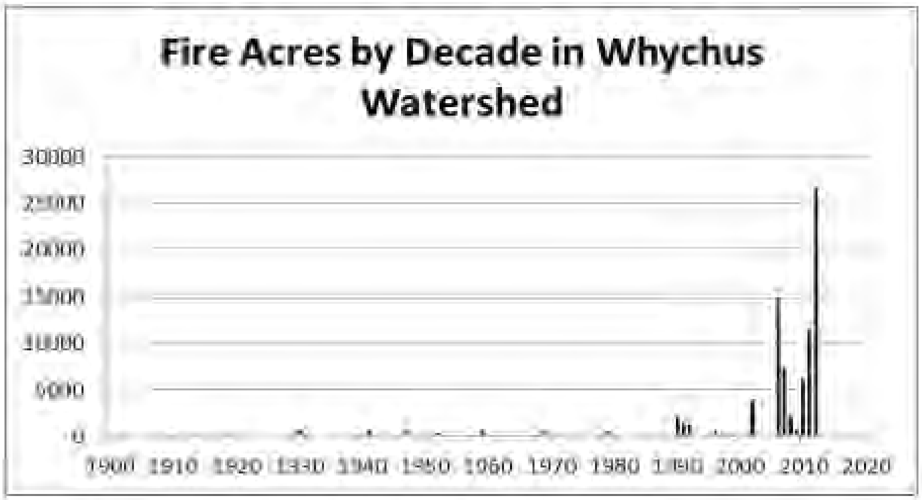

Whychus Watershed Large Fires
1990 to 1999
8 Fires
5345 Acres







Available historic fire polygons were compiled from Deschutes National Forest, Ochoco National Forest, Crooked River National Grasslands, Oregon Department of Forestry, and Prineville Bureau of Land Management. Individual fire polygons from 2012 were downloaded from the National Interagency Fire Center - Incident Specific Data



Trends in large fire size in the Whychus Watershed and within 2 miles.

Pole Creek Fire Size versus Historic Fire Sizes

The Pole Creek Fire was unprecedented in size, compared to fires in the past 500 years in the Sisters area. The following summary includes fire history information from both the Whychus and the Metolius watersheds.

- **Whychus Watershed** - Between 1900 and 2012, 39 large fires have burned 83,141 acres or 36% of the landscape within the Whychus watershed. Before 2000, the largest fires seen were 1,000-2,000 acres (Delicious and Sage Flat) in lower elevation pine forests and 600 acres (Park Meadow) in high elevation forests.

- **Metolius Watershed - Mt Jefferson Wilderness Fire History**- Between 1518 and 1991, 17 wildfires burned in the high elevation forests of the Mt Jefferson Wilderness and nearby fir dominated forests. In 469 years, 30,020 acres burned (Simon 1991).
  - Three of those fires exceeded 7,000 acres in size.
    - The largest fire in 1871 was estimated to be 13,000 acres in size and burned nearly all the forest zone below 5,500 feet elevation. It had 9,920 acres of stand replacement and 300 acres of underburn.
    - The second largest fire in 1814 fire burned 8,170 acres
    - The third largest fire in 1724 burned 7,325 acres.

- **Metolius Watershed Fire History** - Between 1990- 2012, 31 large fires burned in the Metolius Watershed. Before 2000 all fires were less than 5,000 acres in size. Since 2000, three of those fires have exceeded 7,000 acres in size,
    - The largest fire was the 2003, 90,769 acre B&B Fire. Approximately 26% of the fire burned stand replacement, 11% was mixed, and 63% was low severity or underburn.
    - The second largest fire was the 2002, 23,573 acre Eyerly Fire
    - The third largest fire in 2006, was the 7,357 acre GW Fire.

Burned Area Emergency Rehab Team surveys the Rooster Rock Fire in 2010

The Rooster Rock Fire

- The 2010 Rooster Rock Fire (6,119 acres) is suspected to be a human caused fire, which began off a user created route in the Whychus Creek Wild and Scenic River Corridor.
- The fire began in August during a period of high fire danger and burned at moderate to high intensities in a high frequency low intensity Fire Regime I, on 4,632 acres or 75% of total fire size.
- Approximately 75% of the fire burned onto previously treated private lands within the watershed.

Fuels Management

- **Management emphasis** has occurred in the watershed through the following lowland project analysis: Hwy 20, Sisters Area Fuels Reduction (SAFR), and Glaze.
    - Since 2009, these projects have resulted in mechanical treatments such as thinning, mowing, and prescribed fire on approximately 24,000 acres or 12% public lands within the watershed.
- Adding together management treatment acres plus wildfire acres occurring in 2009-2012 there are 57,849 or 25% of the Whychus Watershed acres that have been touched by fire or treatment during the past 4 years.

Fish

Instream Flows

- Increased flows in Whychus Creek have improved fish habitat and riparian conditions (See Hydrology section).
- Flows in Indian Ford Creek have also increased during the last five years. One diversion was converted to ground water wells and this may have had an effect but it is possible less water is being used at Black Butte Ranch where the stream originates.
- Trout Creek has also increased the frequency that it flows to connect with Indian Ford Creek. This is likely due to the Black Crater Fire.

New stream channel at Three Sisters Irrigation Dam

Fire Disturbances

- The Pole Creek fire and other large fires have changed hydrology and riparian conditions along Whychus Creek, Snow Creek, Pole Creek and Trout Creek.
- Amounts of large wood and sediment are expected to increase.
- Lack of streamside shade in burned areas may raise water temperatures and increase algae growth for several years.
- Fish populations may be affected by:
    - more frequent high flows,
    - scouring redds and
    - reducing the survival of eggs in the gravel to the fry stage.

Fish reintroduction –

- Steelhead reintroduction started in 2007 and spring chinook in 2009. Fry outplants of these species have occurred annually to Whychus Creek.
- On Oct. 6, 2011 the first returning upriver steelhead made it to Pelton Round Butte Dam on the Deschutes River. The fish was clipped and could be identified as originating upstream of Pelton Round Butte.
- Forty nine adult Chinook and 111 adult steelhead returned from these introductions in 2012/2013. One adult steelhead was confirmed spawning in Whychus Creek in 2013.

Fish Screening

- Screen installations on small diversions on Whychus Creek are in progress by the Upper Deschutes Watershed Council.
- A large fish screen with a by bypass was installed on the Three Sisters Irrigation Dam (TSID) which is the largest diversion on the stream. Historically up to 5,000 fish would be lost in the TSID canal each season.

Oregon Department of Fish and Wildlife biologist Mike Gauvin holds a steelhead that made Deschutes passage history, completing a round-trip to the Pacific Ocean on Oct. 6, 2011. It was the first returning adult steelhead from fish stocked and reared upstream of the Pelton Project that migrated downstream through the Round Butte Dam Selective Withdrawal Fish Transfer Facility. (http://www.deschutespassage.com/news/?p=83)

Fish Barriers and Habitat Improvement

- Only the Sokol Diversion Dam remains a fish barrier on Whychus Creek and a fish passage solution at this location is being worked on.
- All other major diversion dams and culverts on Whychus Creek have been modified to include fish passage.
- The culvert on Snow Creek at the 1514 road will be replaced in 2013.
- On Indian Ford Creek the culvert at the Old Brook Scanlon Mainline Road was removed in 2013 and the stream channel was restored.
    - Remaining barriers on USFS lands include the culvert at the 2058 road crossing and at a small irrigation diversion dam upstream of Hwy 20.
- To improve fish habitat a large scale restoration project was recently completed at Camp Polk on Whychus Creek.
- Other large scale restoration projects are planned above the city of Sisters on USFS land and on private lands downstream of Camp Polk (see Hydrology Section).
    - Monitoring of fish populations in relationship to these projects is planned to start in 2013. Pre-project fish population estimates were conducted for the Camp Polk Project in 2006.

Non-Native fish and Invasive Aquatic Species

- Brook trout are still entering into the Whychus system from self-sustaining populations in Wilderness Lakes.
- The range of Brown trout has increased. This species is now documented up to the Three Sisters Irrigation Dam Diversion.
- Introductions or the discovery of new invasive aquatic species is a concern in all areas.

Wildlife

Threatened, Endangered, and Proposed Species under the Endangered Species Act

Gray wolf - Endangered

- The Gray wolf was added to terrestrial species analysis list for the Forest– Potential dispersal habitat exists in the Whychus watershed but no denning or rendezvous site habitat exists

Northern Spotted Owl - Threatened

- New 2011 final revised recovery plan: Spotted owl continues to be at risk due to habitat loss and fragmentation from harvest and overstocking, competition with the barred owl, and fires
- Barred owls have not been detected in the Whychus watershed analysis area
- New 2012 final critical habitat designation increased the number of acres in the watershed by 59% to 27,837 acres
- 2012 Pole Creek fire resulted in the loss of 2,280 acres of spotted owl nesting, roosting, and foraging habitat, most of the Snow Creek owl activity center established in 2009, and a small number of acres in the Trout Creek owl activity center were lost.

Spotted owl on the Deschutes National Forest. Photo by Shane Jeffries.

North American wolverine – Proposed

- North American wolverine proposed for listing as Threatened under the Endangered Species Act on February 4, 2013; Final listing likely will occur in 2014

Regional Forester Sensitive Species

- Three new Regional Forester Sensitive Species designated in 2010 have habitat in the watershed: Fringed Myotis, Evening fieldslug, and Western bumblebee

Survey and Manage Species

- Requirements for Survey and Manage species under the Northwest Forest Plan were reinstated based on the January 2001 Record of Decision as modified by a 2011 Settlement Agreement. Two species—Crater Lake tightcoil and Great gray owl—have habitat in the watershed.

Botany- Rare Plants and Invasive Plants

Botanists check a fen habitat for Capitate sedge during the Pole Creek Fire

Sensitive Plant Species

- The Region 6 Sensitive Plant Species known to occur within the Pole Creek Fire perimeter are: Peck's penstemon, Newberry's gentian, Elfin saddle fungus, Tomentypnum moss, Lesser Bladderwort, Capitate sedge, and the Pumice grapefern. These species appear not to have been impacted by the fire due to the patchiness of the fire and/or because their moist or rocky habitats did not burn.

- The Region 6 Sensitive Plant Species White bark Pine was affected by the Pole Creek fire. There are 18 known sites within the fire perimeter including Select trees identified for seed collection and 1-7 permanent plots. The population area needs to be revisited and assessed.

Survey and Manage Plant Species

- Survey and Manage species known to occur within the Pole Creek Fire perimeter are: Foliose Lichen, Pin Lichens, and the truffle *Rhizopogon evadens var. subalpinus.* These sites need to be revisited and assessed to determine fire effects.

Invasive Plant Species

- There are 11 species of invasive plants within the watershed analysis area. The total mapped infested area is 1684 acres. Infestations within this area are light.

Bitterroot by Rebecca Brown -Thompson

Heritage Resources/Tribal Concerns

- **Cave Closure.** A significant rock shelter has been closed to camping, campfires, and climbing for the purpose of resource protection. In addition, user created trails to the shelter have been rehabilitated to discourage frequent use of the area. A closure order is complete however, signs need to be posted at the shelter to educate the public on appropriate use of the area.

- **Rooster Rock and Pole Creek Fire Effects.** At this time, effects to cultural resources resulting from both the Rooster Rock Fire and Pole Creek Fire (herein referred to as "fire areas") are unknown. However, a number of cultural resource sites, both historic and pre-contact, have been documented within the fire areas. Very few of these sites have been evaluated for their National Register of Historic Places (NRHP) significance, but sites that are eligible for listing on the NRHP do exist within the fire areas.

  The Deschutes National Forest Cultural Resource Database indicates that areas likely to contain cultural resource sites, or high probability areas, do exist within the fire areas. Only minimal amounts of these high probability areas have been inventoried to determine the presence or absence of cultural resources. It is likely that additional cultural resources are located within the fire areas.

  Cultural resource sites subjected to fire can be directly or indirectly affected depending upon the site type and fuel conditions within and adjacent to the site. Low intensity fires do not usually affect pre-contact lithic sites, but they may severely affect historic resources that are more flammable in nature. High intensity fires can affect pre-contact lithic sites and historic sites, as well as rock art sites. Other indirect effects that may compromise cultural resources are soil instability, erosion, and artifact visibility due to denuded vegetation.

- **Cultural Resources are being damaged by unmanaged use, education in progress**. Graffiti, rock climbing and associated chalk trails are affecting some sites. Local climbing groups have been working with the Forest Service to encourage stewardship of climbing areas to comply with the Whychus Wild and Scenic River Plan.

Volunteers from Central Oregon Rock, INC clean chalk at Whychus Rock Shelter

- **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 needs improvement. Information about resources of Tribal interest remains fragmentary and incidental.

Recreation/Special Uses

Three Creeks Meadow and retardant applied to prevent burning east of Rd 16 on Park Meadow trailhead (Red retardant is visible in middle of photo)

The Pole Creek Fire affected Recreation Facilities and will change patterns of use.

- **Chush Falls Trailhead Move**- The trailhead access road has hundreds of hazard trees within riparian reserves for Whychus Creek Wild and Scenic River. To minimize impacts to the Wild and Scenic River and protect public safety, the trailhead has been moved back 2 miles. Trail access has been changed to a lower severity burned route. The extra distance is likely to reduce visitors to the Chush Falls area.
- **The Park Meadow Trailhead** area burned. It will remain open and was evaluated for hazard trees.
- **Loss of signs**- Most of the signs for the Three Creeks Nordic system and many wilderness boundary signs burned and need to be replaced.
- **Loss of the Snow Creek Snowmobile Bridge**- A bridge used by snowmobiles on the Cross District Snowmobile Trail was burned in the fire. It is unknown at this time whether funds are available for it to be replaced.

- **Decommissioning of the Snow Creek Ditch**- This informal travel route into the Snow Creek Basin and Wilderness was used as a fireline and closed during postfire rehab. Management of this access point was a recommended action of the Whychus Creek Wild and Scenic River Plan to protect river values in the wilderness.
- **Loss of small wilderness bridges-** Several small wood bridges in the Three Sisters wilderness were burned and will likely not be replaced. Fords will be with stepping stones.
- **Jeff View Shelter did not burn and views are improved.** This shelter on the Three Creeks Nordic System was protected by a fuel break cut around the shelter before the fire front came through.
- **Expected increased use in unburned area-** Scott Pass Trailhead and Lava Camp Lake were not burned and can expect increased use by those preferring unburned forest.
- **Pole Creek Trailhead Facilities did not** burn in the Pole Creek Fire. Four vehicles burned and many wilderness hikers were evacuated.

Improved views at Jeff View Shelter

- **Increased Hazards and Risks to Public Safety**- There will be increased risks to public in the Pole Creek Fire area from falling trees, road damage, and blocked access. Hazard trees will be treated along major roadways and trailheads. Many other areas, including the wilderness, will have more risks for many years to come.

Burned vehicles at Pole Creek Trailhead

Signboards, fences and restrooms were not burned

The Whychus Wild and Scenic River Plan has been completed and is being implemented.

Actions include:

- **The Whychus Portal Project** was planned and approved. It develops facilities and implements a number of actions to manage access and recreational use and restore habitat, in the lower 3 miles of the Wild and Scenic river corridor. These actions were identified as an immediate need to protect river values because of damaging use.
    - A 3 mile river trail has been built and 4 miles of user created trails have been closed and rehabilitated.
    - 6.5 miles of system roads have been decommissioned (ripped and planted) and 0.5 miles of system roads have been closed to date.
    - A "Roads to Trails" conversion for a bike trail is in progress
    - Two small parking areas have been created. The parking areas are not signed to help maintain lower use.
    - Approximately 3 acres of riparian/forest areas have been rehabilitated and planted with native plants.

COIC Youth Crew constructing the Whychus Creek Trail

Decommissioning of Rd 390 helps protect Whychus Creek

Road to Trail conversion near Whychus creek

Monitoring on Whychus Creek Wild and Scenic River

- **Limits of Acceptable Change Monitoring** for baseline data and to establish key indicators was been completed for Whychus Creek in 2012.
- **A Parking Lot Counter for the Lower Whychus Creek trail was established in February 2012**. (N*eed to check function- appears to be double counting some cars)*
- **River stewards program and monitoring has begun (Sisters Trails Alliance partners)**

Stewardship and Partnerships

- **Volunteer stewards** have been monitoring the new Whychus Creek trail and other sites to remove trash and monitor trail use.
- **Rock Climber Collaboration-** Work with Central Oregon Rock, Inc. began in 2012 to raise awareness of climbing impacts to the geology resources of the Wild and Scenic River and help restore user created trails. Visible climbing chalk use is still an issue.
- **Youth engagement-** Youth groups including Central Oregon Interagency Council, Sisters High School, and the Boy Scouts have been engaged in restoration including user trail and road decommissioning, planting, seeding and trail building in the Whychus Portal project.
- **The trailhead move for Chush Falls** will help reduce user created impacts as recommended by reducing use.
- **Petersen Ridge Mountain Bike Trail**- Has seen steady and increasing use by individuals and in requests for events. Events have been limited by the Forest Service to protect wildlife habitat and reduce impacts on the other users.
- **Requests for new trails, trail connections, and expansions of facilities near the City of Sisters continue**.

Other

- **Harmful unmanaged use varies** – This includes vandalism and misuse such as: dumping, shooting trees and wildlife, partying and leaving trash, graffiti, driving vehicles through and up the creek. Restoration closures have been breached and educational sign removed, defaced or destroyed.

- **Facility improvements**- Some recreational facility improvements have been completed
    - Park Meadow Trailhead was moved *(Recommendation of 1998 WA).*
    - 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.*
    - Accessible toilets were installed at Three Creeks Lake, Three Creeks Meadow, and Whispering Pines Campgrounds

- **Winter Backcountry Outfitter Guides at Three Creeks Lake /Snow Creek basin have increased use** in the area and displaced some skiers s looking for solitude.

- **Forest Service Field Rangers** provide more field presence and help with enforcement and monitoring.

- **The new 14 day camping limit** helps reduce non-recreational residers. But residers and impacts from dispersed camping continue to occur and appear to be increasing.

- **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.
- **Increased need and demand for firewood** as energy costs have climbed.
- **Cone collection and mushroom harvesting** have increased.

Roads -

- **Current road densities still exceed guidelines**. Some road closures have been accomplished.
- 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. Extensive road pioneering has occurred in firewood cutting areas.

- **A Travel Management Plan** Subpart A of Travel Management ROD has been signed. Motor Vehicle Use maps have been printed and available to the public. Additional carsonite road number signs have been purchased and implementation is occurring. As of January 2013, Subpart B of Travel Management, Sustainable Roads Analysis is being done at the District level.

- **OHV use is still increasing and** there are more trails and damage to resources.
- **Use on Highway 20** has stabilized over the past 10 years and traffic counts are slightly down.
  - Average Annual Daily Traffic Counts on Highway 20
    - 2006 – 6,800 vehicles
    - 2009 – 7,600 vehicles
    - 2011 – 7,500 vehicles
- **Alder Springs Crossing 2013–** Currently FS Road 6360 fords the Whychus Creek near the Alder Springs trail. This road is within the Crooked River National Grassland and is actually a Jefferson County Road. There are Forest Service Gates to close the road during the winter

wildlife closure. It is possible Jefferson County could order the Forest Service to remove the gates since there is not written agreement between the two agencies. Most roads in the Alder Springs Canyon are Jefferson County Roads.

- **Sisters Trails Alliance Bike Trails 2013 –** A roads analysis was recently completed along the west side of the Highway 20 Corridor for the project. Several roads were recommended for closure, decommissioning. Additional, several user created roads were recommended to be included in the current road system.

- **Collaborative Partnership 2013** – The Forest Service is currently partnering with the largest private landownership in regards to yearly maintenance of specified roads within the watershed.

- **Pole Creek BAER** 2013– Progress was made in 2012 with drainage issues within the Pole Creek Fire area. Improving drainage along roads, unplugging and installing vented ford across Pole Creek, and installing drivable water bars/ cleaning culverts along Forest Road 15. The culvert at the Rd 1514 road crossing was replaced and upsized in 2013.

- **Road 1610 ownership–** This road was believed to be on public land but during the Rooster Rock Fire in 2010 it was determined to be on private land and privately owned.

Washout of Rd 1526-200 after a storm event in the Pole Creek Fire Area

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.

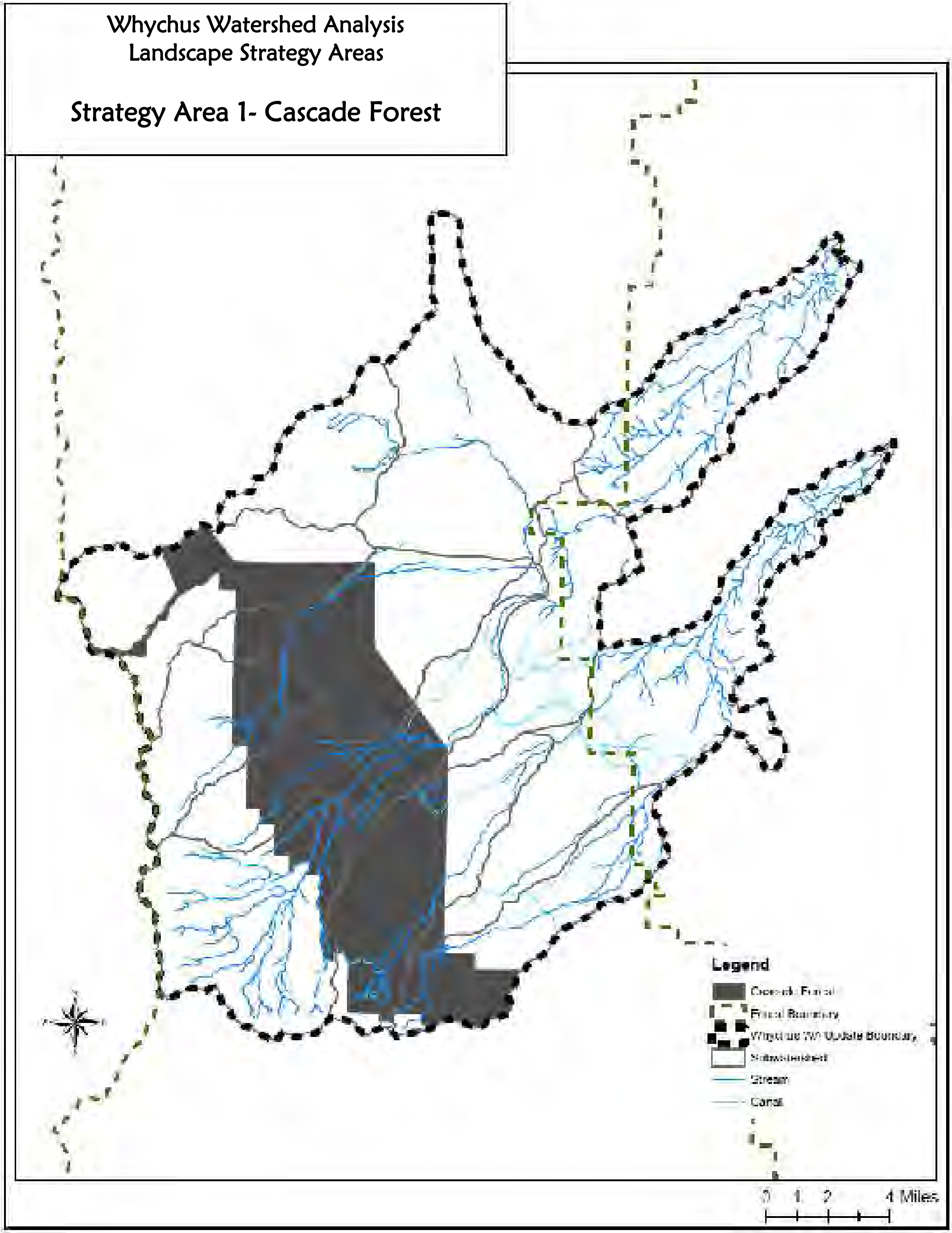
Priority was determined by evaluating significance in terms of connectivity to other areas outside the analysis area, importance to humans and other species, legal requirements, and effects to rare or fragile components. Priorities in order of importance were Most Urgent, Urgent, High, Moderate, and 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. Progress in reducing damaging trends changed some rankings.

In 2013 the Interdisciplinary Team found significant changes in trends and ecosystem risks. Continued progress on cooperative watershed related issues has been so rapid that Landscape Strategy Areas were reprioritized to reflect progress, fire effects, and risks. The rankings are compared in the table below. *The complete Trend Table Analysis can be found in Appendix 1.* Recommendations to address trends follow. Recommendations common to all landscape areas and found after specific area recommendations.

Many problems will continue to 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	2013 Ranking	Reason for Change
Cascade Forest	Priority- Moderate Feasibility- Moderate **#4**	**Priority- Urgent** Feasibility- Moderate **#2**	**Priority- Urgent Feasibility- Moderate #1**	13 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.
Three Creek Lake	Priority- High Feasibility- Moderate **#3**	Priority- High Feasibility- Moderate **#4**	**Priority- Urgent Feasibility- Moderate #2**	The expanse of dead trees will eventually burn and is connected to the Bend Watershed. Recreational impacts increasing. Post fire landscape is vulnerable to vehicle trespass, erosion, invasive plants.
Water Challenges	**Priority- Most Urgent** Feasibility- Most Difficult **#1**	**Priority- Urgent** Feasibility- Difficult **#1**	**Priority- High Feasibility- Moderate #3**	Excellent progress on water acquisition, restoration, and restoring fish passage. Most work will be complete within 5 years
Forest Urban Interface	**Priority- Urgent** Feasibility- Difficult **#2**	**Priority- Urgent** Feasibility- Difficult **#3**	**Priority- Moderate Feasibility- Difficult #4**	Urban interface issues continue but funding/personnel for enforcement or to coordinate with private landowners is lacking. Much of the urban interface near Sisters has been treated for fuels reduction.
Wilderness	Priority- Low Feasibility- Moderate **#5**	Priority- Low Feasibility- Moderate **#5**	**Priority- Low Feasibility- Moderate #5**	Fire intensity was within range of historic variability Trends are similar, however increased Wilderness Ranger presence and temporary closures damage from visitors in some areas requires attention.


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 1- Cascade Forest
Legend
Stream
Canal
0 1 2 4 Miles

AREA 1 - CASCADE FOREST

PRIORITY # 1- *URGENT*
FEASIBILITY- *MODERATE*

SUMMARY

<u>2013 Update</u>- This area has risen in priority since 1998 from 4th to 2nd to 1st . This is because there have been 13 large wildfires in Sisters since 2002 which have caused the loss of mixed conifer habitat District-wide, reduced connectivity, and increased the importance of remaining habitat. Habitat for Endangered Species (Spotted owl) and other late successional species has been lost or altered and will take many decades to recover. The area contains 2 Late Successional Reserves. Part of the Pole Creek Fire is within this area and the landscape is vulnerable to erosion, vehicle trespass, and invasive species for a number of years (highest risk in the next 5 years until substantial vegetation recovery).

Fire suppression, fire exclusion, and past logging have changed forest habitats, reducing connectivity, and removing important habitat components. 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. Consider the potential effects of climate change. 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) Reduce roads to meet Forest Plan Guidelines.

11)Provide mineral resources as needed with minimal social conflicts

12) Consider timber salvage opportunities in appropriate land allocations. 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.
- Promote connectivity between known activity centers for the Northern Spotted Owl.
- Reduce risk of large scale fires to current owl habitat within the Late Successional Reserves.
- Thin along scenic views and urban interface to promote large trees and reduce fire risk.
- Replant burned plantations. 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 - Continue to implement the Whychus Creek Wild and Scenic River Plan which was completed in 2010.

*Related actions to consider from the Whychus Creek Wild and Scenic River Plan***:**

IMMEDIATE ACTIONS

- Complete and file legal description of the Wild and Scenic River corridor.
- Complete changes to the Chush Falls access road and trailhead to address river protection, public safety and use (*in progress)*.

- Install a sign for the completed closure order for Whychus House Cave to prohibit rock climbing, campfires, and camping (no additional NEPA required, closure order is done and signed).
- Continue to identify unneeded roads and decommission or close. Monitor roads and prioritize road maintenance to protect river values.

HIGH PRIORITY ACTIONS

- Develop a volunteer river stewards program to assist with monitoring and restoration (*in progress).*
- Work with law enforcement to identify priority patrol areas where resource damage is occurring from off road vehicles, residers, or vandalism.
- Engage youth in restoration activities and teach low impact recreation techniques (*in progress*).
- Begin education on low impact recreation technique with general public (*in progress*).

MODERATE PRIORITY ACTIONS

- Begin collaboration with rock climbing community to implement "Leave No trace " rock climbing standards (*in progress*).
- Begin collaboration with kayaking/creek boating community on low impact boating including prohibition on instream wood manipulation.

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
- Revisit closed areas to detect new issues.

4) Snow Creek

- Repair/ look for opportunities to eliminate Snow Creek ditch (*completed during Pole Creek Fire as to rehab suppression damage)*

5) Pole Creek

- Look for opportunities to eliminate Pole Creek ditch
- Reforest/plant riparian areas near Pole Creek to accelerate forest recovery

6) Black Pine Springs

- Fence and protect the springs (*completed)*
- Close and rehabilitate Off Road Vehicle Trails and hill climbs in the campground

7) Lava Camp Lake

- Harden/boulder camping sites and install a new toilet.(*completed*)

8) Cold Springs

- Restore and 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.
- Consider Aspen restoration
- Construct interpretative trail as planned in Scenic Byway Plans sensitive to heritage resources and rare plants in the area.

9) Skylight Cave and White-nose Syndrome Monitoring

- Increase monitoring of seasonal closure order violations (October 1- April 30)
- Continue monitoring of bats at the cave for white nose syndrome.
- Improve educational signage.

10) Re-evaluate recreational opportunities of the Cross District Snowmobile trail and bridge which was destroyed by the Pole Creek Fire. Consider impacts of increased use, wilderness snowmobile trespass, and disturbance in the Snow Creek subwatershed and Whychus Wild and Scenic River.

11) Reduce road densities in key areas including deer winter range and mixed conifer wet forests used by wolverine. Road reduction was implemented in 2010 with Whychus Portal Project. Roads Analysis was completed for West Trout, Popper, and Sisters Trails Alliance Trail Projects. The Minimum Roads Analysis Process will be completed in 2013.

12) Reconstruct Rd 1514, 1608 and other road priorities. Forest Road 1514 and 16 were reconstructed since the last Watershed Update. Portions of Forest Road 15 will be reconstructed due to washouts after the Pole Creek Fire 2012.

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

14) Whychus Creek Grazing Allotment- All of the fencing on federal lands in the closed Whychus Creek Grazing Allotment has been removed. An estimated 5 miles of fencing in this allotment is on private land.

- Coordinate with private landowners to potentially remove fencing on private land to remove hazards and connectivity barriers to wildlife.

15) Gravel pits- Travel Management has been evaluated and implemented gravel pits for OHV use.

- Evaluate non-active pits for rehabilitation and closure
- Continue to survey pits for invasive plants.

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

17) Special Forest Products

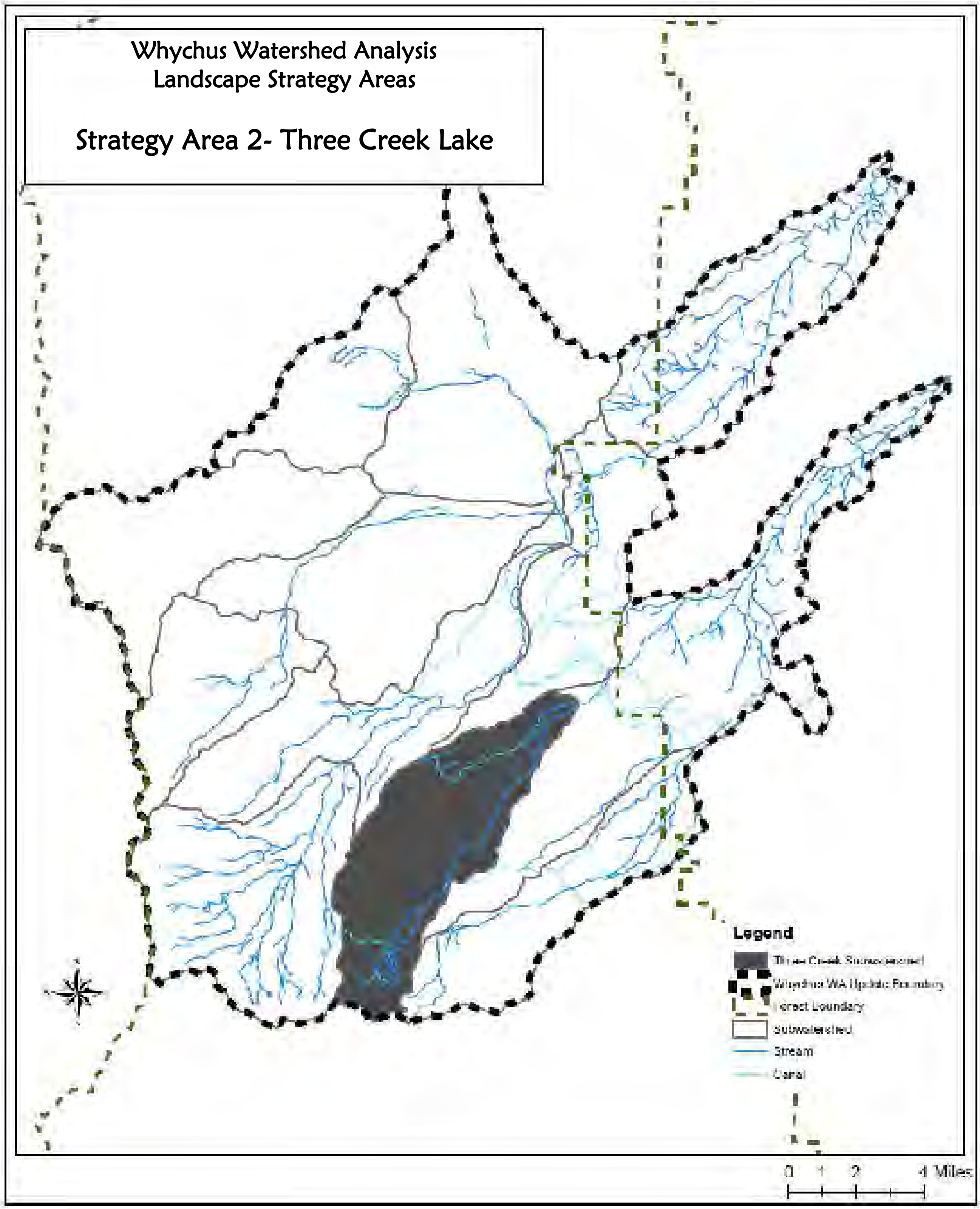
- Continue to look for firewood units for easy access by public and monitoring
- Continue to manage mushroom harvest in the Pole Creek Fire Area.

<u>Key Monitoring Actions</u>:

Road condition/sediment risks
Updated Stand inventories
Continue monitoring owl sites
Invasive plant control, inventory, and prevention

<u>Key Data Needs:</u>

- Whychus Creek Wild and Scenic River- Continue to collect baseline data on water quality, riparian roads and trails, riparian wetland inventory, invasive plants, and cultural resource sites.
- Stream surveys in areas impacted by recent fires.


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 2- Three Creek Lake
Legend
Stream
Canal
0 1 2 4 Miles

AREA 2- THREE CREEK LAKE AREA

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

SUMMARY

<u>2013 Update</u>- The remaining expanse of dead trees in high elevation and lodgepole forests will eventually burn. This is a part of this forest's regeneration and will provide habitat for many dependent species. However, these areas are connected to and threaten the Bend Watershed in the case of a large wind driven wildfire. Recreational impacts are increasing and a Master Plan needs to be completed and implemented. The post fire landscape is vulnerable to vehicle trespass, erosion, and invasive plants and dead trees will pose a hazard to recreationists. *Hydrological Restoration of Three Creek is discussed under the Water Challenges Strategy Area.*

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. Some improvements have been made but more are needed.

GOALS:

1) Protect the post fire landscape and the people who recreate here. Continue to address public safety issues for fire evacuation

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

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

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

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

6) Monitor for carnivores (marten, wolverine, fisher) in wilderness areas.

RECOMMENDATIONS:

1) Enforce Fire Closures to reduce erosion, prevent invasive plant spread, and protect public safety.

2) Consider actions to provide safe egress from the area in case of a wildfire and to protect firefighter safety such as fuel breaks along Rd 370.

3) Complete the Master Plan/Site Restoration Plan for the Three Creek Recreational complex. A conceptual plan was completed in 2011. 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 Upper Three Creek Sno-park
- Decommission Lower Three Creeks Sno-park due to lack of snow.
- Rehabilitate dispersed roads, trails, and camps in riparian reserve areas
- Wetland restoration, including Three Creek, Trapper Meadow and Little Three Creek
- Horse use and impacts
- Work with Mycological Society to map extent of rare truffles and habitat at Three Creeks.
- Maintain split rail fences on Trapper Meadow to reduce vehicle trespass
- More toilets. There are 3-4 potty potties at the lake. Some pit toilets may need replacement.

4) 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.

5) 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 firewood cutting, recreational stock, and hiker impacts in riparian reserves and wet meadows. Manage horse and other stock use to reduce impacts off trails. Of special concern are riparian areas adjacent to the Three Creeks Horse Camp. Maintain trails and rehabilitate riparian reserves.

6) Evaluate Three Creeks Firewood cutting area to assess resource damage outside of cutting areas, user roads, and needs for resource protection.

7) 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).

8) Rehabilitate areas of high impact including trails and camps around Three Creek Lake and Little Three Creek. .

9) Rehabilitate Snow Creek Ditch (*Completed in 2012***)**

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.

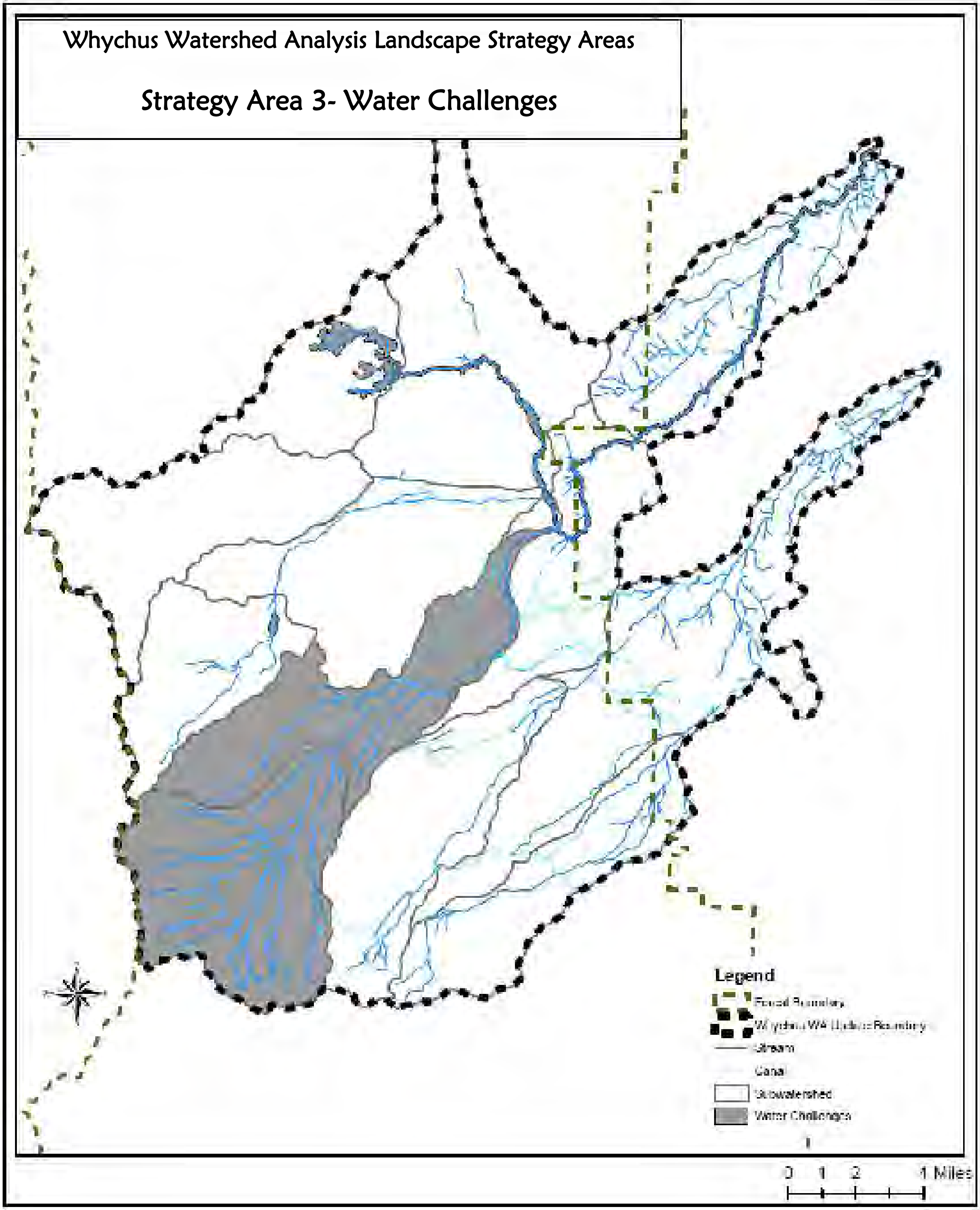
11) Evaluate Little Three Creek dam for possible removal and restoration of natural hydrological regime.

Key Monitoring Actions:

1) Monitor effectiveness of site controls to reduce damage
2) Monitor to ensure that stock feeds and hay used in the area are certified weed free

Key Data Needs:

1) Ownership /legal status of Three Creek and Little Three Creek dam
2) Inventory of riparian areas where Aquatic Conservation Strategy Objectives are not being met.


Whychus Watershed Analysis Landscape Strategy Areas
Strategy Area 3- Water Challenges
Legend
Canal
Subwatershed
Water Challenges
0 1 2
Miles

AREA 3 - WATER CHALLENGES

PRIORITY # 3- *HIGH*
FEASIBILITY- *MODERATE*

SUMMARY

<u>2013 Update</u> – Excellent progress has been made on water acquisition, watershed restoration, and restoring fish passage through well organized and extensive collaborative work. The first adult steelhead returned to the watershed in 2013. More water acquisition is needed but most restoration work will be complete within 5 years.

Through the 2011 Watershed Condition Framework process, the upper Whychus Creek subwatershed was identified as a National Focus Subwatershed. The Upper Whychus Creek Action Plan outlines essential projects to improve conditions from "functioning at risk" to "functioning properly".

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, Trout Creek and Three Creek sufficient to provide connected aquatic habitats.

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.

6) Reduce riparian road density and stream crossings. Decrease hydrological connectivity and stabilize open roads and trails with high sediment delivery potential. Increase capacity of culverts to accommodate increased flows and debris.

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
- Return Pole Creek waters to Whychus Creek (*Headgate to regulate flow installed in 2010 and flow restored to original Pole Creek Channel in 2013)*
- Increase efficiency of irrigation delivery systems to conserve water and make it available for return to streams (*Three Sisters Irrigation District and Uncle John Ditches piped in 2012 to reduce water loss and return some conserved water to Whychus Creek)*
- 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 **(***Done by Deschutes River Conservancy***)**
- Form partnership with ODOT, Deschutes County, Oregon Water Resources Dept, and Plainview Ditch owners to evaluate the old Three Creek channel below Highway 20 to determine infrastructure concerns with potential flow restoration.

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 (priority to close the ford at Rd 6360). Work with Crooked River National Grassland.
- Rehabilitate roads, trails, and camps in riparian reserves (*Some work done through the Whychus Portal project in 2012 and Whychus Protection project in 2009 but more work is still needed*).

c. Restore streambank, wetland, and floodplain habitats

- Remove berms, restore historic channels and floodplains of Whychus Creek (*Camp Polk and Three Sisters Irrigation dam stream channel reconstruction and floodplain restoration is complete. Whychus Floodplain and Whychus Canyon Project planning in progress)*
- Plant cottonwoods and willow on streambanks with permanent flow
- Evaluate opportunities to restore beaver to historic habitats.
- Evaluate/restore Pole Creek Swamp
- Evaluate/restore Glaze Meadow, Indian Ford Meadow and Big Meadow, Three Creeks Meadow, and meadows near Little Three Creeks which have been dried by ditching or irrigation structures.
- Thin riparian reserves to develop large tree structure (i.e., Pole Creek area)
- Prevent removal of instream wood (i.e., Pole Creek), and wood in riparian reserves. Restore large wood and log jams in key areas

- Continue rehabilitation and monitoring of roads, trails, and camps in riparian reserves (i.e., Pole creek, Whychus Creek)

d. Restore/disconnect abandoned irrigation ditches on Three Creek, Whychus Creek, Trout Creek, and Indian Ford Creek

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

e. Restore fish habitat and populations

- Install fish screens on all irrigation diversions
- Provide fish passage at dams (*Most dams now have fish passage with one dam left on Whychus Creek and one on Indian Ford Creek)*
- Replace or remove culverts that are barriers to fish passage.
- Protect fish genetics by reducing interaction between wild and domestic populations.

f. Limit floodplain development

- Purchase or conserve floodplains (*In progress, by Deschutes Land Trust*)
- 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

h. Decrease and improve road/stream interactions

- Continue to reduce riparian road density through closure and decommissioning.

KEY PARTNERSHIPS AND PROJECTS:

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

- Habitat restoration on Whychus Creek and Indian Ford Creek.
- 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 River 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 options to return water rights to Pole Creek, re-water Pole Creek Swamp and restore Pole Creek as a tributary of Whychus Creek (*partly completed in 2012/2013*)
- Options to restore large wood and fish habitat near town
- 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
- Continue to investigate risks of winter floods and Carver Lake moraine dam failure to developments and infrastructure

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

- Restoring fish passage through remaining barriers on irrigation dams of Whychus Creek
- Conserving Whychus Creek water flows and returning water to instream use (*in progress*)
- Explore options for replacing surface water with ground water for irrigation
- Installing fish screens on all irrigation ditches (*in progress*)
- Prevent loss of native fish into ditches and prevent fish in irrigation ponds from entering Whychus Creek to preserve genetic integrity (*TSID ditch received fish screens in 2011*)

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 (*TSID ditch received fish screens in 2011*)
- Facilitate restoring fish passage through irrigation dams on Whychus Creek and Indian Ford 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

Pelton /Round Butte License Holder (Portland General Electric) 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
- Reintroduction of steelhead and Chinook salmon and the monitoring of these species
- 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)- Renew 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, Rim Rock Ranch, Whychus Canyon, and other properties
- 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 in intermittent channels of Trout Creek 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
- Invasive Plant control

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

- Restoring fish passage on private irrigation dams
- Conserving 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 function on private lands including restoration of aspen and cottonwood galleries and control of invasive plants and invasive aquatic species
- Investigate solutions to flooding of Plainview Ditch and Three Creek from increased flows.

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. **(***Indian Ford was added to the Collaborative Forest Landscape Restoration Act boundary in 2013- this provides a new funding source for collaborative work***)**

Specific Restoration Actions

- Reexamine the culvert/road on the Pine Street crossing of Indian Ford Creek. Restore channel if possible.
- 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

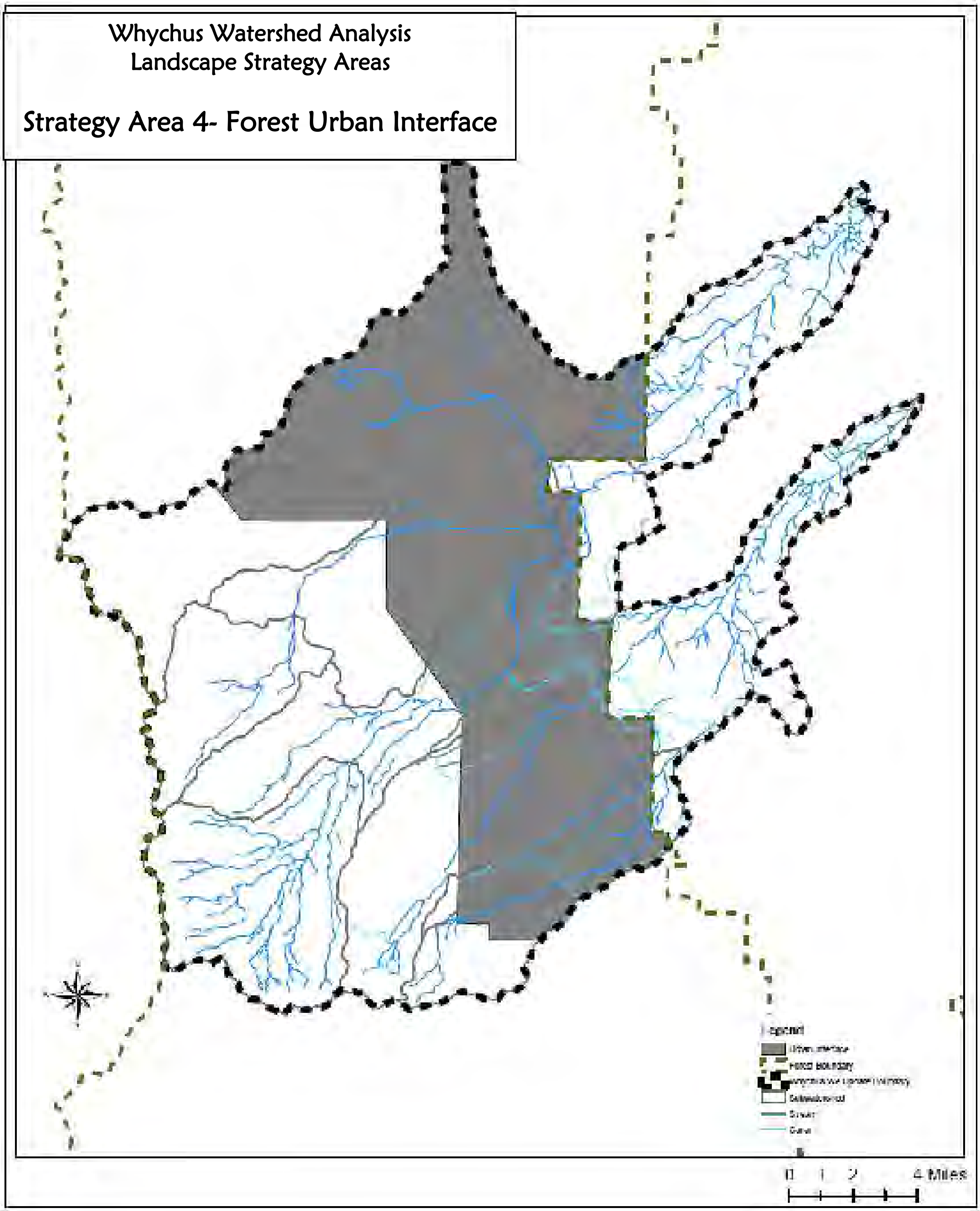
- Work with appropriate agencies regarding protection of Trout Creek floodplain and reducing conflicts with private homes in floodplain without channelization/routing

Key Monitoring Actions:

1) Monitor Water quality on Whychus Creek
2) Monitor Water quality on Indian Ford Creek
3) Look at wilderness riparian impacts

Key Data Needs:

1) Feasibility Study for well sites, water purchase (as discussed above)
2) Updated Agricultural use statistics such as those found in the Deschutes Soil and Water Conservation District 1994 Whychus Creek Watershed Analysis to better understand agricultural trends relevant to water use.
3) Resolve ownership of old irrigation ditches (especially those which intercept high flows on Whychus Creek and Three Creek)- Plainview and Snow Creek Irrigation Districts.
4) Survey of infrastructure concerns with increased flows in lower Three Creek
5) Collect comprehensive data on culvert and road conditions.



Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 4- Forest Urban Interface
0 1 2 4 Miles

AREA 4 - FOREST URBAN INTERFACE

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

SUMMARY

<u>2013 Update</u>- Urban interface issues continue but funding/personnel for enforcement or to coordinate with private landowners is minimal. Much of the urban interface near Sisters has been treated for fuels reduction in the past 4 years.

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. Invasive Plant 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.

7) Provide non-motorized recreational opportunities in urban interface setting to enhance communities and encourage sustainable recreation. Reduce habitat fragmentation and disturbance to wildlife by integrating wildlife connectivity design with trail design.

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
Greater Sisters Country Community Wildfire Protection Plan partners

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
Coyote Creek
Coyote Springs

Specific Restoration Actions:

- Education regarding fire prevention and making homes more fire safe (***see Greater Sisters Country Community Wildfire Protection Plan)*** ***http://www.projectwildfire.org/images/uploads/2009%20Sisters%20CWPP%20Final.pdf***
  - 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
- Invasive plant education, prevention, and control, community weed pulls
- Water quality education related to point source pollution from herbicide, fertilizers near creeks
- 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 and point source pollution of Whychus Creek 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 invasive plants
- 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
- Water quality education related to point source pollution from herbicide, fertilizers near creeks (*Some work has been done-Ongoing)*

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, Gravel mines, 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 and gravel mines 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

6) Control motorized access in the urban/interface area to reduce fire starts and limit resource damage. (*In progress- implementation of Motorized Vehicle Use Strategy*)

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 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.
(*In progress- Portions of the Whychus Portal Project incorporate the use on new trailhead parking lots, a proposed Scenic Overlook and parking area.)*

- Integrate design of wildlife habitat connectivity needs and proposed recreational trails.

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.
- Restore wet meadow habitat in Glaze Meadow for Peck's penstemon and other wet meadow species and to 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 (*In Progress).*
- Monitor Glaze Forest Restoration Project implementation and continue tours and discussions

(*In Progress)*

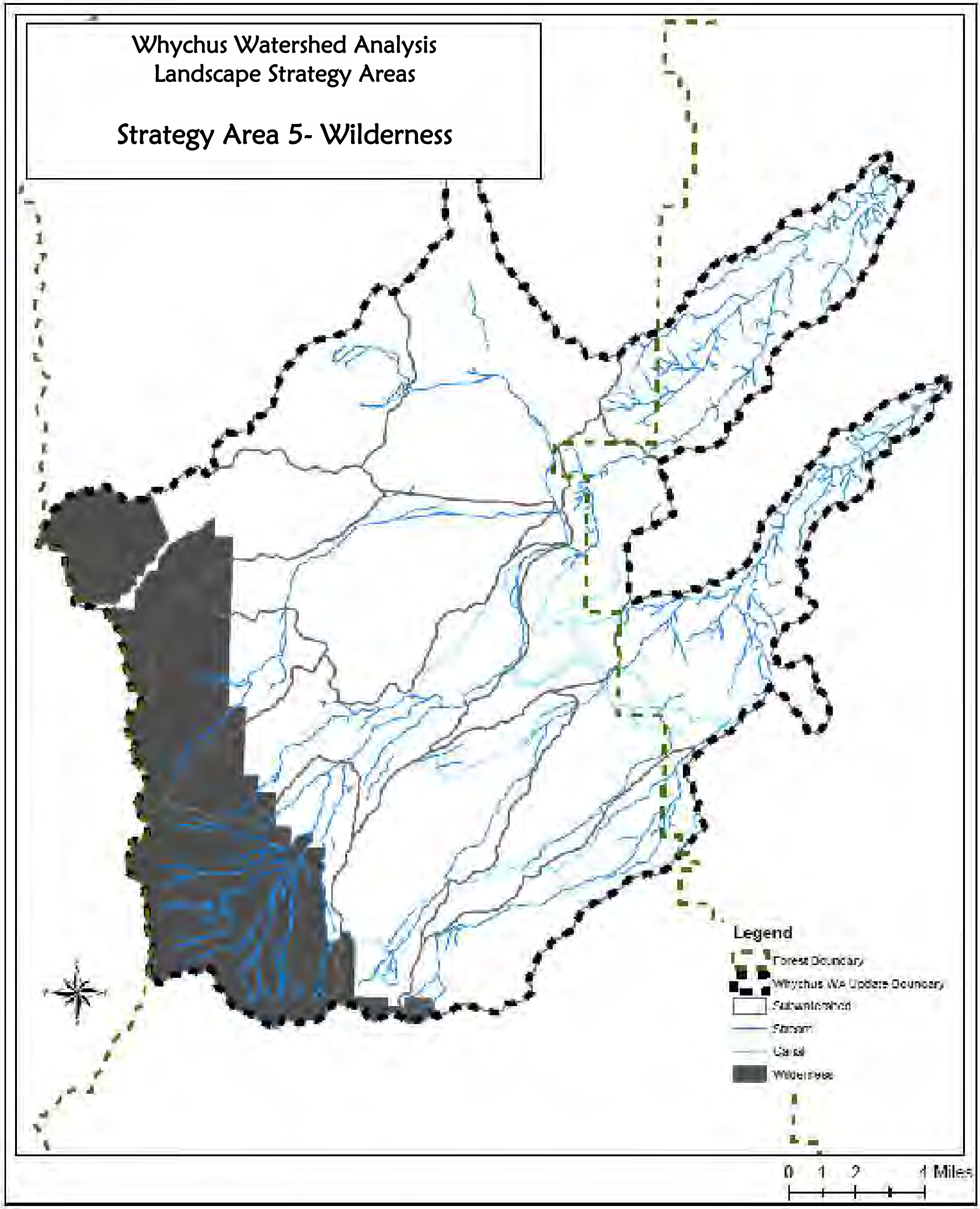
- Continue to monitor horse trails under special use permit and restore, remove, and reroute problem trails, especially in riparian reserves. Reduce number of trails if possible. Key partners: Black Butte Stables, local horse groups.

Key Monitoring Actions:

1) Develop partnerships to monitor urban/interface use and impacts.
2) Develop partnerships to inventory and control invasive plant infestations

Key Data Needs:

1) More information on urban interface use
2) Invasive plant inventories
3) Evaluate dispersed camping issues on Whychus Creek as they relate to degradation of riparian habitat and the nutrient inputs from unchecked human waste. If needed, consider option such as closing Whychus Creek above Sisters to dispersed camping or develop a fee based campground with sanitation facilities.


Whychus Watershed Analysis
Landscape Strategy Areas
Strategy Area 5- Wilderness
Legend
Forest Boundary
Whychus WA Update Boundary
Subwatershed
Stream
Canal
Wilderness
0 1 2 4 Miles

AREA 5 - WILDERNESS

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

SUMMARY

<u>2013 Update</u>- The Pole Creek Fire burned a portion of this area. The fire intensity (stand replacement) was within range of historic variability for forests in this fire regime however the size of the fire was probably larger than historic fires because of the suppression of lightning fires over the past 100 years. Trends are similar to 2009, however the fire closure will reduce use because of increased distances for access. Increased Wilderness Ranger presence and temporary closures should help reduce user trail development

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, however mortality has increased due to insects and disease. 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) Complete Prescribed Natural Fire Plan for the Wilderness. -Restore fire to the wilderness. (*In progress)*

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 further changes/restoration to Chush Falls to address user trails.

10) Carnivores- Continue monitoring of forest carnivores in wilderness areas.

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

RECOMMENDATIONS COMMON TO ALL LANDSCAPE AREAS

Climate Change

Hydrology/Watershed

1) **Continue watershed restoration and water acquisition** to maintain more water and cold water refugia on the landscape in late summer.

2) **Encourage Beaver**- Maintain and/or restore beaver (assisted migration[1]) to increase water storage at sites and restore watershed function. Consider assisted migration if ecosystem consequences are understood. Partner with ODFW.

3) **Reduce road densities** as supported by sustainable roads analysis and increase road maintenance to minimize stream/road interactions.

4) **Prepare roads for higher water flows**- Reduce impacts on roads and infrastructure from higher winter to early summer flows by identifying watersheds that may have higher flows than present and replace culverts with larger size water passage structures when scheduled for replacement, or earlier if supported by climate change effects analysis.

Forest Ecosystem Management:

1) **Store more carbon on the landscape**.

a) **Maintain and protect** old growth trees, grasslands, and wetlands.
b) **Decrease carbon outputs in the form of harvest**. Potential carbon mitigation includes longer harvest intervals.
c) **Decrease carbon outputs in the form of disturbance.** Maintain and increase forest resilience to drought, insects and disease, and wildfire.
d) **Continue to investigate how to influence carbon inputs through active management**. How wildfire and thinning influence carbon sequestration on the eastside of the Cascades is unclear. Some recommendations suggest active management by thinning trees to lower basal areas to reduce water demand, drought stress, and help trees to grow more vigorously. However, Campbell et.al. (2011) found high carbon losses associated

[1] "Assisted Migration" is the act of deliberately helping plant and animal species colonize new habitats when driven out of their historical habitats due to rapid environmental change, especially climate change.

with fuel treatments and only modest differences between combustive losses of high versus low intensity fires. They concluded it was unlikely that forest fuels reduction treatments increase carbon storage by reducing combustive losses or increasing storage.

e) **Restore historical functionality to fire suppressed ecosystems.** There is broad agreement that fire exclusion has affected forests structurally and compositionally and that thinning and prescribed fire can restore resilience and reduce risks to public safety and forest resources provided by mature forests (Campbell et.al. (2011)).

2) **Accelerate or augment natural forest recovery** after wildfires by planting trees where seed sources were lost and natural regeneration will be slow to recover carbon storage capacity.

3) **Maintain or enhance plant genetic diversity** to facilitate adaptation to climate change. Plant seedlings from a broader seed zone including lower elevation or from south.

a) Maintain Whychus Seed Orchard as an economical source or genetically diverse seed and research opportunities.

4) **Conserve genes from vulnerable plant and animal species and populations for the future.**

a) **Whitebark Pine**- Continue monitoring and seed collection from Whitebark Pine in the watershed.

b) **Peck's penstemon** Continue working with private land owners to conserve the plant.

Dead whitebarkpine near North Sister

5**) Support and expand internal and external partnerships** that will improve our response to climate change.

a) Initiate and expand partnerships with other land owners to broaden the portfolio of on site and off site (*ex situ* and *in situ)* gene conservation resources.

b) Initiate and expand partnerships with other land owners to cooperatively address invasive plants.

6) **Limit spread of invasive plants (noxious weeds).** Use integrated techniques as approved by the Deschutes Ochoco Invasive Plant Treatments EIS to contain, control, and reduce populations and prevent new infestations.

7) **Continue to provide/utilize logging slash utilize wood as biomass energy**, in place of fossil fuel.

Hydrology

Watershed Restoration Projects

An extensive list of watershed restoration projects can be found in the Hydrology Resource Report.

Recommended Project Design Features within the Pole Creek Fire area

To protect areas within the Pole Creek burn that may be susceptible to increased erosion, future projects will be designed to mitigate hydrologic concerns. Potential design features include:

- Expansion of riparian buffers to include sensitive areas upslope of riparian reserves if they are determined to have potential hydrologic connectivity to the stream system.
- Previously unmapped ephemeral draws may be buffered or excluded from ground-based activities.
- Log haul on hydrologically connected road segments may need to be limited to dry season, frozen ground, or logging over snow.
- Avoid treatments in areas that were mulched through the BAER process.

Riparian area next to Snow Creek off Rd 1514- October 2, 2012

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. Rehabilitate or close 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).

9) When thinning consider leaving more trees around road closures or sensitive resource areas so new user created roads are less likely to be created.

Soils

General Recommendations to Minimize Soil Disturbance

Project Design Criteria and Best Management Practices

Project design criteria provide operational guidelines for equipment use in salvage operations and other ground disturbing activities, including prescribed fire. These operation guidelines include options for limiting the amount of surface area covered by logging facilities and controlling equipment operations to locations and ground conditions that are less susceptible to soil impacts. In addition, guidelines are provided to assist with the design and implementation of prescribed fire.

Best Management practices (BMPs) apply to all ground disturbing management activities, as described in the National Core BMP Technical Guide (US Forest Service BMP, 2012). The Deschutes National Forest Land Resource Management Plan (US Forest Service LRMP, 1990) states that BMPs will be selected and incorporated into project design criteria in accordance with the Clean Water Act for protection of waters of the State of Oregon (LRMP 4-69). The following guidelines will be used during project design to develop site-specific BMP prescriptions for the salvage operation as appropriate or when required. These BMPs are tiered to the Soil and Water Conservation Practices (SWCP) Handbook (US Forest Service FSH 2509.22), which contains conservation practices that have proven effective in protecting and maintaining soil and water resource values. They are also tiered to the LRMP direction, BMP monitoring information, and professional judgment.

Project Design Criteria – Ground-based Skidding and Yarding Operations

Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during ground-based skidding and yarding operations.

Practices: Specific measures used to minimize the effects of ground-based skidding and yarding operations must include the following:

- Use ground-based yarding systems only when physical site characteristics are suitable to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources (BMP Veg-4).
    - Avoid equipment operations on slopes greater than 30 percent (LRMP SL-2).

  - Assess sensitive soils to determine if equipment operations can occur without causing excessive soil disturbance (LRMP SL-3).
- Use suitable measures during felling and skidding operations to avoid or minimize disturbance to soils and water bodies to the extent practicable (BMP Veg-4).
  - Use directional felling techniques from pre-approved skid trails, and suspend the leading end of logs during skidding operations.
  - On steep pitches within a harvest unit (slopes of 30 percent or steeper) and less than 100 feet long, directional felling of trees to skid trails and/or line pulling should be utilized to salvage trees. This method applies to salvage units with small areas of steeper slopes (e.g. less than 5 percent of the unit area).
  - Stop harvest operations when soils become too wet to operate on without causing excessive soil disturbance.
- Use existing roads and skid trail networks to the extent practicable (BMP Veg-4).
  - Use old landings and skidding networks whenever possible. Assure that water control structures are installed and maintained on skid trials that have gradients of 10 percent or more. Ensure erosion control structures are stabilized and working effectively (LRMP SL-1).
- Design and locate skid trails and skidding operations to minimize soil disturbance to the extent practicable (BMP Veg-4).
  - In all proposed activity areas, locations of new yarding and transportation systems will be designated prior to the logging operations. This includes temporary roads, spur roads, log landings, and primary (main) skid trail networks (LRMP SL-1 & SL-3).
  - Designate locations for new trails and landings so that they properly fit the terrain and minimize the extent of soil disturbance (LRMP SL-3)
  - Restrict skidders and tractors to designated areas (i.e., roads, landings, designated skid trails), and limit the amount of traffic from other specialized equipment off designated areas. Harvester shears will be authorized to operate off designated skid trails at 30 foot intervals and make no more than two equipment passes on any site specific area to accumulate materials.
  - When using conventional harvest equipment that include harvester shears and rubber tired or tracked skidders, maintain spacing of 100 to 150 feet for all primary skid trail routes, except where converging at landings. Closer spacing due to complex terrain must be approved in advance by the Timber Sale Administrator and Soil Scientist. Main skid trails have typically been spaced 100 feet apart (11% of the unit area). For larger activity areas (greater than 40 acres) that can accommodate wider spacing distances, it is recommended that distance between main skid trails be increased to 150 feet to reduce the amount of detrimentally disturbed soil to 7% of the unit area (Froehlich 1981, Garland 1983).

- When using harvester forwarder equipment space trails a minimum of 60 feet apart. Make use of ghost trails as much as possible on which the harvester makes only one pass and positions harvested materials so they can be reached from alternate harvester forwarder trails.

- Use suitable measures to stabilize and restore skid trails after use (BMP Veg-4).
  - Evaluate soil conditions and identify soil restoration opportunities (subsoiling) on skid trails post-harvest.

Project Design Criteria – Road Operations and Maintenance

Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling road use and operations and providing adequate and appropriate maintenance to minimize sediment production and other pollutants during the use.

Practices: Annual road maintenance plans must include the following.
Develop and implement annual road maintenance plans for projects where contractors or permittees are responsible for maintenance activities (BMP Road-4).
Conduct regular preventive maintenance to avoid deterioration of the road surface and minimize the effects of erosion and sedimentation (LRMP).

Project Design Criteria – Construction and Use of Temporary Roads

Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from the construction and use of temporary roads.
Practices: Consider the following when designing and installing temporary roads to access vegetation management activity areas.

- Use applicable practices of BMP Road-2 (Road Location and Design) to locate temporary roads (BMP Road-5).
- Routinely inspect temporary roads to verify that erosion and storm water controls are implemented, functioning, and appropriately maintained (BMP Road-5).
- Maintain erosion and storm water controls as necessary to ensure proper and effective functioning (BMP Road-5).
- Schedule temporary drainage crossings suitable for the expected uses and timing of use (BMP Road-5).
- Use applicable practices of BMP Road-6 (Road Storage and Decommissioning) to obliterate the temporary road and return the area to resource production after the access is no longer needed (BMP Road-5).

Project Design Criteria – Minimizing Effects of Prescribed Fire on Soil and Water Quality

Objective: Avoid, minimize, or mitigate effects of prescribed fire and associated activities on soil, water quality, and riparian resources that may result from excessive soil disturbance as well as inputs of ash, sediment, nutrients, and debris.

Practices: Consider the following when planning and implementing prescribed burns.

- Conduct the prescribed fire in such a manner as to achieve the burn objectives outlined in the Prescribed Fire Plan (BMP Fire-2).
    - Protect soils and water during prescribed burn operations – a Prescribed Fire Burn Plan addressing compliance with all applicable LRMP standards and guidelines and BMPs will be completed before the initiation of prescribed fire treatments in planned activity areas.
    - Prescribed burn plans need to include soil and forest duff moisture guidelines to minimize the risk of intense fire and adverse impacts to soil and water resources (LRMP SL-1 & SL-3).
- Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives (BMP Fire-2).
    - Manage fire to maintain some of the duff layer – strive to maintain fine organic matter (organic materials less than 3 inches in diameter; commonly referred to as the duff layer) over at least 65 percent of the activity area (pertains to both harvesting and post-harvest operations). If the potential natural plant community (i.e., site) is not capable of producing fine organic matter over 65 percent of the area, adjust minimum amounts to reflect potential vegetation site capabilities (LRMP SL-6).
    - Coarse woody debris/down wood – assure that on Ponderosa Pine sites, a minimum of 5 to 10 tons on average per acre of large woody debris (greater than 3 inches in diameter) is retained within activity areas to provide organic matter reservoirs for nutrient cycling and mitigation of accelerated soil erosion. On Mixed Conifer sites, large wood retained should be increased to a minimum of 10 to 15 tons per acre (LRMP SL-1).
- Construct fireline to the minimum size and standard necessary to contain the prescribed fire and meet overall project objectives (BMP Fire-2).
    - Locate and construct fireline in a manner that minimizes erosion and runoff from directly entering water bodies by considering site slope and soil conditions, and using and maintaining suitable water and erosion control measures.
    - Consider alternatives to ground-disturbing fireline construction such as using wet lines, rock outcrops, roads, trails, or other suitable features for firelines.
    - Rehabilitate or otherwise stabilize constructed fireline after completing a prescribed fire.

Recommendations for Future Large Fire Incidents

Between 2002 and 2012 nine fires occurred within the Whychus watershed which required extended attack and involvement from various levels of Incident Management Teams (IMT). The following recommendations are based on experiences of those involved in past fires and are provided to act as a check list and to assist those individuals involved if future incidents. The primary goal of these recommendations is to assure good communications between the Line Officer, Resource Advisor (READ), and the IMT.

Line Officer

- Outline clear expectations for roles and responsibilities between READ and IMT which are announced verbally and in writing during team in-brief. Stress the expectation of close coordination and good communications between READ and Operation section of the IMT.
- Assure that the WFDSS process is completed and that both the IMT and the READ have reviewed the document.

Resource Advisor

- The READ is responsible for representing all District/Forest resource specialists. It is important that this person knows who to contact for clarification on specific resource concerns.
- Review WFDSS resource advisor check list to become familiar with specific resource concerns.
- To be effective it is important that the READ establish a good working rapport with the Operations section of the IMT. Good communications is key.
- Attend regular morning briefings and provide feedback about resource concerns through the briefing to firefighters and overhead.
  - Emphasis significant resources in the fire such as Wild and Scenic river corridors and Wilderness Values.
  - Reinforce any mitigation measures and or recommendations associated with these significant resources.
  - Invasive plants are common in private land fire camps. Work with Botanists and IMT to reduce risks of bringing weed seeds into fire areas.
- Within the first few operational periods determine location & coordinate weed wash stations along with an accountability plan.
- Identify current pre attack information.
  - Dip sites, draft sites, and mitigations such as fish screens and water utilization levels that will not affect aquatic habitat.
  - Assure that retardant avoidance GIS layers are available to air operations.
  - Become familiar with any wildlife concerns.

    - Know the locations of cultural sites in the area and desired mitigations.
- Become familiar with heavy equipment work on the incident and work with operations to help coordinate use across the fire area.
    - Ensure all vegetation management tactics are coordinated with other District staff. If harvesters are being used to pretreat containment lines coordinate with the District Silviculturist to determine desired harvest prescriptions along with the District Sale Administrator for advise on efficient harvest system layout.
- Attend daily IMT strategy meetings and provide input based on experience from past fires in the area.
- Work with the IMT to develop a suppression rehab plan. Utilize past rehab plans located in District corporate database, Burned Area Emergency Response (BAER) folders as a reference.
- Assist in the development of clear turn back standards with Line Officer and District staff. This should be carried out through the WFDSS process.
- Assist with the transition into the BAER process by briefing the BAER team on fire progression and suppression rehab efforts.

Fuels Management

General

- Achieve a mosaic of landscape-scale treatments managed to reduce fire hazard and threat to facilitate the suppression of human-caused wildfires, protect valuable resources, and allow the re-introduction of fire as a disturbance process.
- Stands should have a height to live crown that is well above the shrub and seedling components. Shrubs should be maintained at a height and continuity that would reduce the potential for rapid rates of spread and crown fire initiation. Dead and downed materials should not be overly extensive. Large trees that are more resistant to fire-induced mortality should be maintained.
- Encourage the use of prescribed fire to meet resource goals (e.g., timber and forage) and to reduce hazardous fuels. In areas dominated by ponderosa pine and in the WUI, this translates to canopy characteristics and a fuel profile that do not support extreme fire behavior (i.e., crown fire, high resistance to control, high flame lengths) under severe fire conditions.
- Locate and schedule hazard fuel reduction and underburning activities in alignment with wildlife habitat protection and improvement strategies, reducing risk of loss to key habitats.
- Restore and maintain old growth characteristics using mechanical fuels treatments and prescribed fire in Ponderosa and Mixed Conifer plant associations. Reduce canopy structure and surface fuel configurations in line with historical range.
- Reduce risk to private lands within and adjacent to USFS boundaries from fires initiating on federal land through strategic placement of treatments and fuel breaks. Create and maintain 600 foot shaded fuel breaks along all private property boundaries.

- Prevention of human caused wildfire in areas identified as high use and high risk including; major travel ways, firewood cutting areas, and dispersed camping and hunting corridors.
- Identify major travel corridors (scenic, recreation, forest products) and treat appropriately to increase ingress/egress and fire break feasibility in wildfire scenario. Create and maintain 300 to 600 foot shaded fuel break buffers on either side of four digit travel routes.
- Strategic planning should be utilized to identify and treat areas for habitat restoration, fire prevention and protection, and suppression success in the event of future unplanned ignitions.

Pole Creek Fire Area

- Consider allowing natural disturbances to influence the future character of the landscape and develop fire management plans that provide guidelines for the use of natural fire. Consider the analysis and associated compartmentalization of the fire area into fire units allowing for natural fire and/or prescribed fire activity.
- Allow for prescribed restorative fire to be utilized across the fire area to maintain and enhance forested ecosystems where appropriate, considering historical fire frequency and history.

Recommendations specific to Fire Regime IV and V

Promote research and monitoring opportunities. A majority of the watershed is classified as fire regime IV and V is in the Three Sisters Wilderness. Wilderness areas provide a unique opportunity to study the effects of fire across the landscape and serve as a biological benchmark for natural processes. Identify opportunities to work with universities to study the effects of fire and recovery in the plant association groups represented by fire regime IV and V.
See:

> 2008 Cascade Crest Wilderness Wildland Fire Use Guide.
> O:\NFS\OchocoDeschutes\Program\Fire-5100\COFMS-CentralFiles\cascade_crest_fire_use_guide\Crest_wfu_guide

Useful fire/fuels monitoring and research is currently underway. Contact Travis Woolley, OSU Research.

In non-wilderness areas develop opportunities to create landscape level fuels treatment zones along roads, ridges, and other natural features that could assist in managing future fires to protect life, ecosystems and habitat. Continue collaboration with partners and public education whenever & wherever possible as it pertains to fire use potential for this area. Support vegetation monitoring wherever possible.

Recommendations specific to Fire Regime III + IV

Look for opportunities to mechanically treat and reintroduce fire within this area. Support vegetation monitoring wherever possible.

Recommendations specific to Fire Regime I

Continue monitoring and maintenance on treated acres. Continue to reduce surface fuel loading and canopy structure to set the stage for reintroduction of low intensity fire. A methodical research based approach of management will help to maintain and restore critical habitat within the historic range of variability. Manage adjacent stands so fires originating in these fire regimes will be controllable before they can spread into stands being managed towards long term habitat conservation strategies. Support vegetation monitoring wherever 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.

2013 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 used 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, Deschutes NF Pathologist).
- 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, after 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 214-230 of that document) are still pertinent and some of these objectives have been accomplished as previously described. Within the Water Challenges Landscape Strategy Area priorities, fish passage within Whychus Creek should be a priority to create passage for steelhead and chinook.

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 opportunities to inventory high probability areas within the Rooster Rock and Pole Creek Fires. Maximize inventory strategies through timber salvage and abatement projects to assist in identifying newly discovered cultural resources, as well as resources in need of stabilization or mitigation.

2) Manufacture and install camping, campfire, climbing closure sign at Whychus House Cave.

3) 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.

4) 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

- Plant association mapping needs to be continuously refined and improved.
- Continue to refine estimates of site potential (e.g., management zones for maintaining healthy densities) for the various plant associations, especially the major ones, found in the watershed. This would allow managers and decision makers to more confidently determine current stand conditions/site potential and weigh the tradeoffs of different management scenarios.
- The numbers 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 and the "Forest Conditions in the Cascade Range Forest Reserve, Oregon 1903" should be preserved by inclusion into the Forest GIS/database system.
- Accurate estimates of current levels of snags and down wood material are not currently available. It will be necessary to develop a long-term plan for data accumulation and maintenance for future landscape analysis and vegetation management projects.

- Further analysis is needed to determine the extent of salvage harvesting opportunities.
- The use of fire regimes and fire hazard condition class is relatively new and at a point there is some controversy at the local level as to how fire regimes should be mapped. Fire regimes is a broad concept used to describe broad landscapes and does not lend itself to site specific acre by acre type applications. Consequently, the development of fire regime concepts and maps needs to be done in a multidisciplinary way and at the local level.
- *Monitoring*- Monitoring of the post-wildfire landscape would be beneficial to learn how the landscape responds to both passive and active management.

Fire and Fuels

Fuel loading- 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. Very little fuel loading information has been collected in the wilderness.

Fire Regimes- Several varying descriptions of Fire Regime conditions exist. A corporate GIS layer identifying Central Oregon Fire Regimes with descriptions validated by field going personnel would be a useful report writing and analysis tool. The ultimate goal is to provide for consistency across the landscape during NEPA analysis.

Watershed Analysis information to Wildfire Decision Support System -Watershed analysis can be a useful tool for district specialists and Incident Management Teams during a large fire event. Information from this document can be entered into the Wild Fire Decision Support System (WFDSS). Watershed modeling with tools such as Flam Map to assist with determining rates of spread, flame length and crown fire potential on any given portion of the landscape. For an accurate assessment in Flam Map, grid data with recent wildfire activity and hazardous fuels treatments would need to be completed for sound outputs. FSPro can be a useful decision support tool to determine probability on any given landscape. Pre attack, pre suppression information such as pre-approved helicopter dip sites, pump drafting sites, fire camp locations, and the like identified within a GIS layer developed prior to wildfire season to expedite a more organized approach to fire suppression during campaign type events.

Plot locations- Monitoring plots and research study plots have been established within this watershed. It would be useful for planning purposes to have access to an integrated location of all observation plots established with any particular watershed

Wildlife

- Surveys are recommended for listed regional forester sensitive species should protocols and funding become available.
- 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.

Botany

♦ Re-Survey rare species in areas affected by the Pole Creek Fire.
♦ Continue surveys to establish extent and location of rare plant species and invasive plants.

Heritage

- Identify sites in need of stabilization treatments.
- Identify and evaluate heritage resources.
- Develop management plans for resources being damaged or that can’t be avoided.

Recreation

- Continue monitoring of the Whychus Creek Wild and Scenic River Plan.
- Continue assessing impacts of recreation to wilderness
- Monitor use in all developments/trails/parking lots .

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Other References are found in after each Resource report

Resource Report
SOILS

Soils

Introduction

Since the completion of the Whychus watershed assessment in 1998 three large fires (Pole Creek fire, Rooster Rock Fire, and the 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 a more complete fire history within 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
Pole Creek	2012	26,795	26,795
Rooster Rock	2010	6,119	6,119
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		59,575	45,288

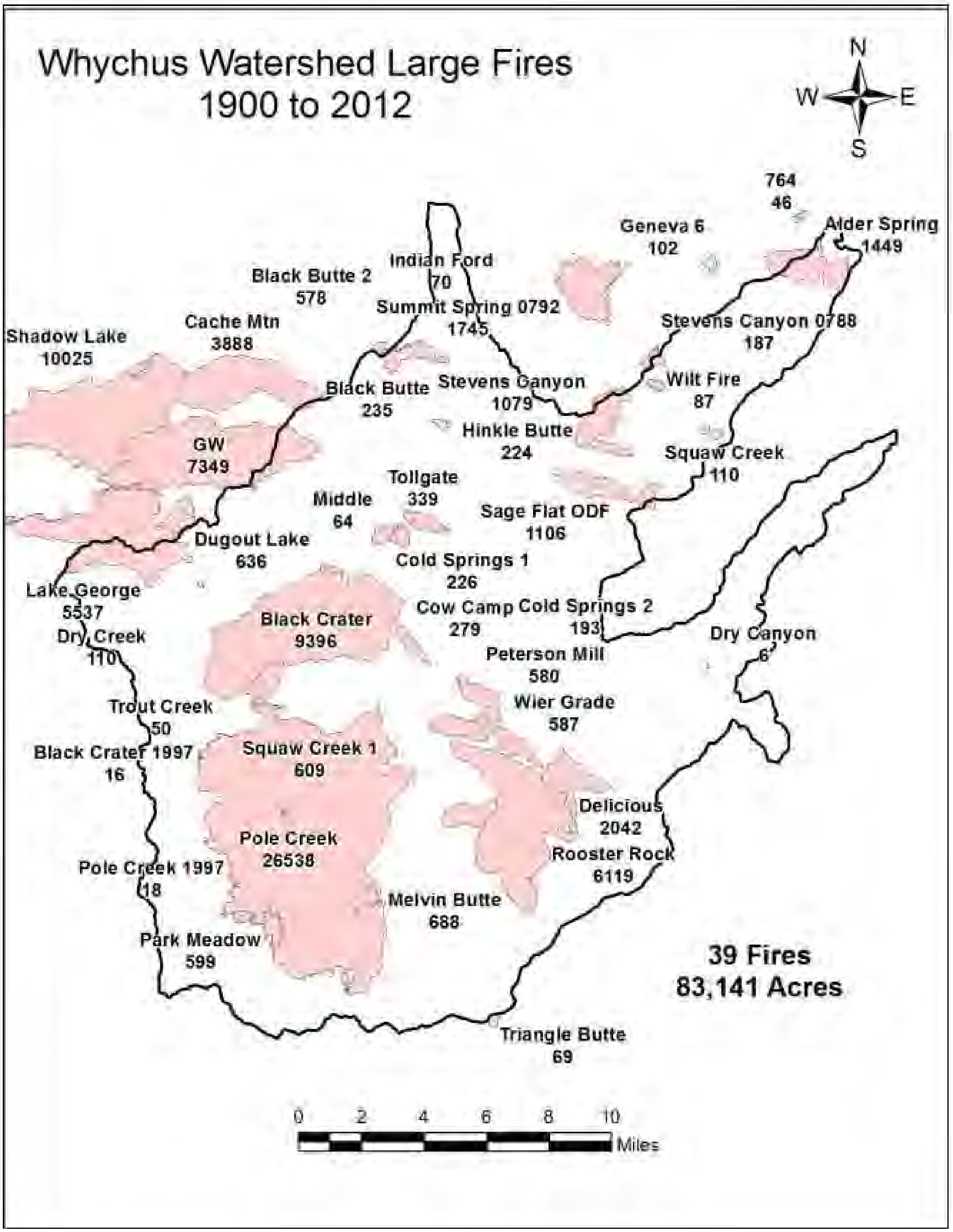
Pole Creek fire

The Pole Creek fire began on September 9, 2012, in the Three Sisters Wilderness and subsequently burned to the north, south, and east outside the wilderness boundary. At the time of containment the fire had burned approximately 26,795 acres of National Forest lands. The Pole Creek fire is located in the Headwaters Whychus Creek, Three Creek, Upper Trout Creek, Lower Trout Creek, and Upper Whychus Creek 12th Field Subwatersheds. These subwatersheds all fall within the Whychus 10th Field Watershed.

Rooster Rock fire

The Rooster Rock fire began August 9, 2010, adjacent to Whychus Creek and burned approximately 6,119 acres, entirely within the Whychus Watershed. Most of the Rooster Rock fire burned on private lands with only 1,378 of the fire occurring on Forest Service lands. Resource concerns associated with the Rooster Rock fire were minor compared to the Pole Creek fire primarily because the fire occurred on relatively flat ground, in a lower precipitation zone, and burned less than 80 acres in riparian reserves associated with Three Creek, the majority of which is intermittent within the boundary of the fire.

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



Burn Intensity within the Pole Creek fire

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 3 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 3: Acres of different burn intensities that resulted in different vegetation mortality class within the Pole Creek fire.

Vegetation Mortality Class	Acres	% of Fire
Stand Replacement	10,303	39
Mixed Mortality	9374	36
Underburned	6505	25

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

Burn Severity within the Pole Creek fire

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 4. 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 4: Acres within the Pole Creek fire having different burn severity, as described by the BAER website.

Soil Effects	Acres	% of Fire
High	406	1
Moderate	9,897	38
Low	15,879	61

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.

Suppression Rehab Activities

A suppression rehab plan was developed for both the Pole Creek and Rooster Rock fires 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.

Burned Area Emergency Response Treatments

The following Pole Creek fire BAER treatments were approved and funded through the BAER process in 2013 and ether have already been implemented or will be implemented within the next year.

Landscape Treatments

L1: Aerial Application of Biomass – During the BAER assessment 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. As a result of this analysis approximately 300 acres having moderate to high burn severity ratings on slopes that are greater than 20% and adjacent to intermittent or perennial streams were identified for wood chip mulch applications. The purpose of this treatment is to help mitigate overland flow and sediment delivery in these highly sensitive areas.

L2: Weed Detection and Early Treatment – Funding approval for assessing new areas with invasive weeds within the fire perimeter and treating them prior to spread. Work is ongoing at this time.

Channel Treatments

C1: Water Supply Protection – Treatments to stabilize the channel where water is diverted into Pole Creek Ditch. Work was completed in the fall of 2013.

Road and Culvert Treatments

R1: 16 Road – Storm proofing of drainage culverts and reshaping ditches.

R2: 1600700 Road – Instillation of water bars, improvement of cross drain ditches, reshaping of ditches along 16 road, and instillation of a cross drain culvert on the 16 road.

R3: 15 Road – Storm proofing of drainage culverts and reshaping ditch, installation of armor dips, install armored low water ford at Forest Road 1526200 and the Pole Creek crossing, installation of one 24 inch culvert across 15 road.

R4: 1514 Road at Pole Creek – Replacement of existing undersized culvert with a 16 foot box culvert.

R5: 1614 Road at Snow Creek – Funding approval to storm proof drainage culverts and reshape ditches.

R6: 1526 Road at Pole Creek – Funding approval to storm proof drainage culverts, reshape ditches, and install armored drainage dip east side of culvert to direct and disperse energy and increase flows.

R7: 1024 Road – Funding approval to install armor drainage dips along the road for approximately 2 miles.

Trail stabilization

R8: Trail System Emergency Drainage and Tread Stabilization – Funding approval to replace and rebuild drainage features along trails, redefine tread width, and reinforce stream crossings along two miles of trail.

Soil Types within the Pole Creek fire

Soils within the Pole Creek Fire are influenced by materials deposited as a result of volcanic eruptions, including volcanic ash, pumice, and cinders. In some areas of the fire these materials fell upon previously developed soils that were formed from the older geologic materials, which included glacial till and glacial outwash. Site productivities and vegetation types in these soil types are strongly influenced by elevation and climate (Larsen, 1976). Mean annual precipitation (MAP) ranges from over 70 inches at the upper elevations of the fire down to 16 inches at the lower elevations. Soil temperature regimes include the colder cryic soil temperature regime at higher elevations and the slightly warmer frigid soil temperature regime at lower elevations. Site productivity is limited at higher elevations by cold temperatures and short growing seasons and limited at lower elevations by lower amounts of soil moisture. Site productivity is highest at mid elevations in the fire where MAP ranges from 30 to 50 inches and temperatures are still somewhat mild.

Figure 2 displays the Deschutes National Forest Soil Resource Inventory (SRI) soil mapping units for the Pole Creek fire area (Larsen, 1976). Soil types in the upper elevations of the fire consist of mapping unit complexes MC, MD, WB, and GB which include soil mapping units 12, 16, 17, 19, and 20. These landtypes occur on uneven glaciated uplands and gently sloping glaciated uplands with slopes commonly ranging from 0 to 40 percent. Soils on these landscapes formed in well drained moderately thick layers of pumice and volcanic ash over glacial till. Surface soil textures include pumiceous loamy sands and sands and buried soils are cobbly or stony sandy loams. Compact glacial till is generally encountered at a depth of 30 to 45 inches. Soil infiltration rates are high and the soil permeability is very rapid in surface soils and non-permeable in the glacial till. Mean annual precipitation in these areas ranges from 40 to over 70 inches. These higher precipitation zones are important sources of surface water in the watershed because water infiltrates rapidly into the soil profile, perches on the glacial till, and then moves down slope through the soil profile to drainages below.

Soil types at the mid elevations of the fire are predominately SRI soil type 28. These landtypes are described as uneven glaciated uplands with slopes commonly in the range of 10 to 40 percent. Soils formed in well drained moderately thick layers of volcanic ash over glacial till. Surface soil textures are loamy sands, and subsoils are cobbly to boulder sandy loams with a compact zone of glacial till often encountered at a depth of 40 to 60 inches. Soil infiltration rates are high and soil permeability is rapid to very rapid in the surface soil and moderate to slow in the subsoil. Mean annual precipitation ranges from 35 to 45 inches and like the higher elevation soils, these soils are important source of ground water to nearby drainages. These soils are also some of the more productive soils in the watershed with a ponderosa pine Site Index of 80 to

100.

Soil types in the lower elevations of the fire are predominately SRI soil type 32. Similar to the mid elevations these landtypes occur on uneven glaciated uplands with slopes generally less than 30 percent. Soil textures, depths, and depths to glacial till are similar to that described for mid elevation soils. Mean annual precipitation on these soil types, however, drops to around 18 to 30 inches. This results in less soil water movement within the soil profile and lower site productivity. Ponderosa pine Site Index for these soils is in the range of 60 to 80.

Figure 2: Soil types within the Pole Creek fire
(Larsen, D.M. 1976. Soil Resource Inventory – Deschutes National Forest).

Fire Effects on the Soil Resource

Fire effects on soil erosion and sediment delivery to streams

Effects of the fire on soil erosion and sediment delivery to streams are determined largely by the severity of the fire and the immediate post fire precipitation regime (Brooks et al., 2003). Fire behavior within the Pole Creek and Rooster Rock fires varied from rapidly spreading crown fires to slower moving underburns resulting in a range of post-fire stand mortality and soil conditions (Pole Creek fire BAER Report 2013). Post fire ground cover conditions resulting from a moderate and high fire burn severity directly affects the interception of rain and snow through the removal of vegetation structure and soil litter layers. Water infiltration rates can also be affected by this reduction in vegetation cover as well as through the formation of hydrophobic soil conditions (DeBano, 2000). These conditions can have a direct effect on hillslope soil erosion and sediment delivery to streams through the increase in the amounts of overland flow (Robichaud et al., 1999; Neary et al., 2005).

The recent Pole Creek fire has reduced effective ground cover in the short-term. In addition, post-fire observations of changes in soil infiltration rates due to hydrophobic soil conditions indicate a 5 percent decrease in water infiltration in areas of stand replacement burns (Reinwald, 2012). This short term change in vegetation cover and reduced soil infiltration is expected to both increase overland flow and elevate erosion and sediment yield in the short term.

Hill slope soil erosion modeling using Disturbed WEPP was used to estimate potential erosion and sedimentation yield within the Pole Creek fire (Elliot and Hall, 2010). Table 2 shows the expected hill slope erosion rates on different burn severity classes and various slopes. Model outputs for the Pole Creek burn indicate that hill slope erosion is not occurring under thinned and unburned forest conditions. Soils having a low fire severity show a small amount of sediment yield while a soils with a high severity burn show an order of magnitude higher erosion rate and sediment delivery. Modeling results also indicate that slopes of 30 percent increase hill slope erosion by an order of magnitude over slopes of 10 percent and slopes of 60 percent result in an order of magnitude increase over slopes of 30 percent.

Table 2: Hill slope erosion modeling results the first year following the Pole Creek fire, modeling results generated from Disturbed WEPP (Elliot and Hall, 2010).

Disturbance Type	Storm Return Period (years)			
	1	2	5	10
Undisturbed	Hill Slope Erosion (tons/acre)			
Slope 10%	0	0	0	0
Slope 30%	0	0	0	0
Slope 60%	0	0	0	0.01
Low Severity Fire	Hill Slope Erosion (tons/acre)			
Slope 10%	0	0	0	0.01
Slope 30%	0	0	0.01	0.18
Slope 60%	0	0.01	0.24	0.40
High Severity Fire	Hill Slope Erosion (tons/acre)			
Slope 10%	0	0	0.09	0.15
Slope 30%	0	0.23	0.67	0.80
Slope 60%	0	0.51	1.41	2.85

Studies have shown that erosive losses of surface soil from overland flow following a fire can range from less than 0.5 tons per acre to greater than 40 tons per acre (Baird et al, 1999). Thus, while modeling results for the Pole Creek fire indicate erosion rates as high as 2.85 tons on steeper slopes with high burn severity these soil erosion rates are low in comparison to empirically-derived erosion rates and sediment yields. Short-term losses of effective cover are expected to reverse toward pre-fire levels within the next two years through the regrowth of herbaceous vegetation and significant needle fall (Sussmann and Craigg 2006), thereby further mitigating hill slope erosion in the fire area in the future.

Fire effects on soil productivity

In the absence of major disturbance such as wildfire forest accumulate standing biomass and surface organic matter. In western forest standing biomass often exceeds 300 tons/acre of which roughly half is organic carbon. Nitrogen concentrations in the forest floor commonly are much higher than in the mineral soil (Cole and Gessel, 1992). A moderate to high severity wildfire oxidizes or volatilizes much of the above ground C and N in the forest floor and surface layers of mineral soil (Dyrness et al. 1989). The greatest effect on soil fertility resulting from moderate to high fire severity is the loss of this forest litter and duff layer; the largest reservoir of aboveground N and other nutrients in the forest ecosystem (DeLuca and Zouhar, 2000).
Tree boles remaining after a fire are an important source of coarse woody debris (CWD) (Brown, 2003). Due to the historical frequent fire occurrence within these ecological types, there most likely were not large amounts of CWD historically. Observations in past burned areas indicate that wildfires commonly burn up much of the CWD on the ground while recruiting new materials through the killing of trees that eventually fall, thus maintaining adequate levels of CWD over time.

Fire can alter chemical and biological components of the soil resource to varying degrees as a result of the direct combustion of organics and heat generated during the burn. Heat duration and depth of soil heating both contribute to the degree of soil burn severity. The degree of burn severity is also dependent upon fuel characteristics, weather conditions at the time of the fire, and fire behavior (Neary et al. 1999). Areas with soil heating high enough to detrimentally limit or alter soil productivity are generally associated with complete consumption of down wood or stumps where mineral soil changes color and below ground char are readily apparent. These conditions are limited to areas where long durations of elevated temperatures occurred at the soil surface or within the top 10 cm of mineral soil and often meet the detrimental soil burn definitions outlined in Regional Soil Quality Standard Guidelines (FSM 2520, R6 Supplement No. 2500-98-1). In the Pole Creek fire this high burn severity was limited to less than one percent of the fire (Pole Creek fire BAER Report 2013) and is not expected to significantly affect the overall long term soil productivity in the fire area.

Potential Effects of Post Fire Salvage Logging on Soils and Hydrology

Soil disturbances resulting from salvage logging

Over the last century a number of timber harvest activities have occurred in areas within the Pole Creek Fire boundary. The primary sources of soil disturbances are associated with the transportation system and existing logging facilities that were used for timber harvest and yarding activities. Temporary roads, log landings, and primary skid trails were constructed and used to access individual harvest units of past timber harvests. Most project-related impacts to soils occurred on and adjacent to these heavy use areas where mechanical disturbances removed vegetative cover, displaced organic surface layers, or compacted soil surface layers.

One of the more commonly cited physical soil disturbances resulting from ground-based salvage logging is soil compaction. When soils become compacted there is an alteration of basic soil properties such as soil density, total pore volume, pore size distribution, macro pore continuity and soil strength (Greacen and Sands, 1980). Soils vary in their susceptibility to soil compaction (Seybold et al., 1999). Once a soil becomes compacted the condition can persist for decades (Froehlich et al., 1985).

The degree, extent, distribution and duration of soil disturbance resulting from salvage logging can vary with the size and type of equipment used for forest vegetation removal, volume and type of material being removed, frequency of stand entries, the soil type, and the soil conditions when the activity takes place (Froehlich 1976; Adams and Froehlich 1981; Page-Dumroese 1993). Soil monitoring on local landtypes and similar soils have shown that soil disturbance typically occurs on 15 to 20 percent of an activity area disturbed by ground-based salvage operations (Deschutes Soil Monitoring Reports).

Changes in effective ground cover resulting from salvage logging

The effect of the Pole Creek fire on the hydrologic response of the soil resource is directly related to changes in effective ground cover. Effective ground cover is defined as including all living or dead herbaceous or woody materials and rock fragments greater than three-fourths inch in diameter in contact with the ground surface. This includes tree or shrub seedlings, grass, forbs, litter, woody biomass, and chips (US Forest Service LRMP, 1990). The fire has reduced effective ground cover in the short-term. However, short-term losses of effective cover are expected to reverse toward pre-fire levels within the next two years through the regrowth of herbaceous vegetation and significant needle fall (Sussmann and Craigg 2004).

The direct effects of salvage logging on effective ground cover would be the crushing or uprooting of vegetative or organic components in areas where equipment travels. Vegetation on skid trails and landings would be crushed or uprooted from multiple machine passes and the yarding of material behind grapple skidders. Skid trails and landings are estimated to cover less than 15% of a salvage activity area over which this would occur. This would leave approximately 85% of the activity area having little or no disturbance of effective ground cover.

Indirect effects of disturbance from salvage logging include potential short-term increases in soil erosion rates in areas where mineral soil was disturbed or exposed by salvage activities. Disturbed WEPP hill slope soil erosion modeling was again used to estimate potential increases in soil erosion that could result from salvage operations within the Pole Creek fire (Table 5).

Results indicate there would be the potential for short term increases in hill slope erosion as a result of salvage logging. The amount and length of change to water erosion rates within an activity area depends primarily on the spatial extent of disturbance incurred by machine traffic, storm intensities and durations occurring the first few years following disturbances, and the recovery rate of herbaceous vegetation. These risks would be mitigated in the project design through the instillation of water bars where appropriate and the use of other suitable measures to stabilize and restore skid trails after use (Project Design Criteria and Best Management Practices, 2013).

Table 5: Hill slope erosion modeling results the first year following the Pole Creek fire, modeling results generated from Disturbed WEPP (Elliot and Hall, 2010).

Disturbance Type	Storm Return Period (years)			
	1	2	5	10
Skid trail above Low Severity Fire	Hill Slope Erosion (tons/acre)			
Slope 10%	0	0.07	0.20	0.24
Slope 30%	0	0.43	1.10	1.13
Skid trail above Mod/High Severity Fire	Hill Slope Erosion (tons/acre)			
Slope 10%	0	0.07	0.36	0.42
Slope 30%	0	0.58	1.58	1.75

Effects of salvage logging on levels of coarse woody debris

The effects of management activities such as fire salvage on soil productivity and other desired soil functions is dependent upon the amounts of coarse woody debris (CWD) and surface organic matter retained following a salvage operation. A balance between fuel management objectives and ensuring adequate amounts of CWD are left on site is an important goal for maintaining long term soil productivity. Using mycorrhizal fungi as a bio-indicator of productive forest soils, research studies have been used to develop conservative recommendations for leaving sufficient CWD following management activities (Graham et al., 1994; Brown et al. 2003). Based on these studies, a minimum of 5 to 10 tons per acre of CWD (greater than 3 inches in diameter) should be retained on dry, ponderosa pine sites and 10 to 15 tons of CWD per acre on mixed conifer sites. A sufficient number of standing dead snags and or live trees should also be retained for future recruitment of these materials.

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Resource Report
HYDROLOGY

HYDROLOGY

This report updates the hydrology sections of the 1998 Whychus Watershed Analysis and the 2009 Whychus Watershed Analysis Update. Since the 2009 update, the 2010 Rooster Rock fire burned 6,119 acres on private and Forest Service land, and the 2012 Pole Creek Fire burned 26,795 acres within both the Whychus and Deep Canyon watersheds on the Sisters Ranger District. This report discusses watershed changes from the Pole Creek Fire and Rooster Rock fires. A discussion of restoration projects completed since 2009 and those that are planned or in process is also included.

Whychus Watershed Analysis Area

The Whychus watershed analysis area includes 12 subwatersheds (SWS) within two watersheds; Deep Canyon and Whychus Creek. Since the 2009 Whychus Watershed Analysis Update, there have been several subtle SWS boundary and acreage changes which are shown in Table 1. Two SWS names have also changed since 2009; Snow Creek Ditch was formerly Triangle Hill, and Deep Canyon Dam-Deep Canyon was formerly Deep Canyon.

Table 1: Watersheds and subwatersheds included in the Whychus Watershed Analysis project area.

Watershed	Subwatershed Name	Number	2009 Acres	2013 Acres
Deep Canyon	Three Creek	170703010601	18,760	18,790
	Snow Creek Ditch	170703010602	14,598	14,636
	Deep Canyon Dam-Deep Canyon	170703010604	30,545	31,928
Whychus Creek	Headwaters Whychus Creek	170703010701	22,790	22,764
	Upper Whychus Creek	170703010702	18,290	18,305
	Upper Trout Creek	170703010703	12,105	12,100
	Fourmile Butte	170703010704	17,543	19,201
	Upper Indian Ford	170703010705	12,103	10,448
	Lower Trout Creek	170703010706	20,015	20,056
	Lower Indian Ford	170703010707	23,660	26,854
	Middle Whychus Creek	170703010708	14,980	14,834
	Lower Whychus Creek	170703010709	20,238	20,238

Watersheds are located within the Upper Deschutes Subbasin 17070301, Deschutes Basin 170703, Columbia Basin 1707, Pacific Northwest Region 17.

303(d) Listings and TMDL Development

The entire lengths of Indian Ford Creek and Whychus Creek are on the 2010 303(d) list for temperatures exceeding the state standard of 18°C for salmon and trout rearing and migration (ODEQ, 2010). The Whychus Watershed Analysis (USDA Forest Service, 1998) and the Whychus Watershed Analysis Update (Press, 2009) describe how state beneficial uses of the Deschutes Basin apply to waterbodies in the Whychus analysis area. Oregon DEQ has performed temperature modeling to guide development of a Total Maximum Daily Load (TMDL) and subsequent Water Quality Management Plan (WQMP). Once complete, these documents will specify the total load of pollutant (in this case temperature) a waterbody can carry and still meet beneficial uses, and outline the process through which beneficial uses can be met through the identification of sources of pollutants, and actions that lead to improved water quality. To assist and provide local expertise to TMDL development, DEQ convened the Upper Deschutes and Little Deschutes Technical Advisory Committee in early 2012, a group composed of state and federal agencies, the Confederated Tribes of the Warm Springs Reservation, city and county government, irrigation districts, the Upper Deschutes Watershed Council, Deschutes River Conservancy and agricultural and fisheries organizations. TMDL development is currently on hold pending final court judgment on a lawsuit challenging EPA's approval of Oregon's temperature standard. (ODEQ, 2012)

Watershed Changes from Recent Fires

Background

The 2010 Rooster Rock and 2012 Pole Creek Fires burned a portion of the Whychus Watershed Analysis area. The Rooster Rock Fire burned primarily on private land with very little high intensity fire on Forest Service land. The Pole Creek fire burned entirely on the Sisters RD and potential effects from this fire are the primary focus of this analysis. A detailed discussion of effects of the Rooster Rock Fire is not included in this report; most of the burn was on private land, occurred on relatively flat ground, and burned less than 80 acres in riparian reserves associated with Three Creek. The majority of the Three Creek stream channel through the Rooster Rock burn is intermittent.

This report uses both burn severity and burn intensity to describe potential watershed changes from recent fires. Burn severity describes the effects of fires on soil structure, infiltration capacity and biotic components. It is used to indicate runoff and soil erosion potential from fire. Burn severity maps were produced and field-verified as part of the Burned Area Emergency Response (BAER) process for both fires. Burn severity is defined through differences in surface organics, duff cover, and characteristics of mineral soils (Debano et al, 1998):

- Low severity – low soil heating, litter scorch or consumption with duff largely intact, mineral soil is not changed.
- Moderate severity – litter consumption with moderately charred or consumed duff, no visible alteration of mineral soil surface.
- High severity – complete consumption of duff and mineral soil surface visibly reddish or orange color.

Table 2 shows SWS acres by burn severity in the Pole Creek and Rooster Rock fires. At the SWS scale, a low percentage of acreage was burned by high and moderate severity fire across affected SWSs. The highest percentage of burned area was in the Upper Whychus SWS were 22% of total land area was burned at high and moderate severity.

Burn intensity describes fire effects to vegetative characteristics including tree mortality and consumption of understory vegetation and down wood (Debano, 1998).

- Underburn— <25% tree mortality, live green tree crowns predominate.
- Mixed mortality— 25-75% tree mortality, tree crowns are generally not consumed.
- Stand replacement— >75% tree mortality, tree crowns are generally consumed.

In this report, burn severity is used as a measure to predict potential erosion effects. Burn intensity is used as a measure to predict potential increases in peak flows and reduction in riparian canopy cover.

Table 2: SWS acres burned by severity in the Pole Creek and Rooster Rock Fire areas.

Pole Creek Fire	Subwatershed	High severity (acres)	Moderate severity (acres)	Low severity (acres)	Underburned or unburned (acres)	Total burned high and moderate severity (acres)	% SWS burned by high and moderate severity fire
	Headwaters Whychus Creek	265	4062	2924	2299	4327	10
	Lower Trout Creek	3	220	161	66	223	1
	Three Creek	41	1415	1547	1042	1456	8
	Upper Trout Creek	0	184	1220	920	184	2
	Upper Whychus Creek	98	4016	3521	2179	4114	22
Rooster Rock Fire	Deep Canyon Dam-Deep Canyon	132 (pvt)	1965 (pvt)	544 (pvt)	8 (pvt)	2513	8
		1 (FS)	415 (FS)	589 (FS)	86(FS)		
	Middle Whychus Creek	2 (pvt)	245 (pvt)	31 (pvt)	7 (pvt)	267	2
		0 (FS)	20 (FS)	1 (FS)	0 (FS)		
	Snow Creek Ditch	42 (pvt)	202 (pvt)	54 (pvt)	1 (pvt)	244	2
		0 (FS)	0 (FS)	0 (FS)	0 (FS)		
	Three Creek	54 (pvt)	1294 (pvt)	144 (pvt)	28 (pvt)	1592	8
		16 (FS)	228 (FS)	13 (FS)	0 (FS)		
	Upper Whychus Creek	0 (pvt)	2 (pvt)	1 (pvt)	0 (pvt)	8	.04
		0 (FS)	6 (FS)	1 (FS)	2 (FS)		

Hydrologic Processes and Flow Regime

Table 3 shows miles of streams in each subwatershed by flow regime. Drainage densities in the Whychus watershed are low due to highly permeable soils and underlying geology. Soils in the analysis area are primarily volcanic ash and have rapid infiltration rates. In a significant portion of the analysis area, these soils overlie highly permeable fractured rock, cinders, and ash (Larsen 1976). These coarse materials allow water to move quickly through the soil and rock profile into the groundwater. In some areas, volcanic ash overlies less permeable glacial outwash and till. As water moves through the soil profile in these areas, it may become perched and move laterally across the outwash and till and emerge as springs (Press, 2012).

Table 3: SWS miles of stream by flow regime. Streams in **bold** are within the Pole Creek Fire area.

Subwatershed	Perennial Miles	Intermittent Miles	Named Streams	Flow Regime
Deep Canyon Dam-Deep Canyon	0	25.0	Intermittent streams	Snow-melt
Fourmile Butte	0	0	No surface flow	No surface flow
Headwaters Whychus Creek	54.7	9.2	**Whychus Creek**	Snow-melt
			NF Whychus Creek	Snow-melt
			SF Whychus Creek	Snow-melt
			Soap Creek	Snow-melt
			Snow Creek	Spring-fed/Snow-melt
			Park Creek	Snow-melt
Lower Indian Ford	9.9	4.5	Indian Ford Creek	Spring-fed
Lower Trout Creek	2.6	4.6	**Trout Creek**	Spring-fed/Snow-melt
Lower Whychus Creek	14.6	37.7	Whychus Creek	Snow-melt
Middle Whychus Creek	7.6	1.2	Whychus Creek	Snow-melt
Snow Creek Ditch	0	24.4	Intermittent streams	Snow-melt
Three Creek	6.6	9.4	***Three Creek**	Snow-melt/lake controlled
			Melvin Creek	Spring-fed
			Intermittent streams	Snow-melt
Upper Indian Ford	6.2	0.7	Indian Ford Creek	Spring-fed
			Captain Jack Creek	Spring-fed
Upper Trout Creek	8.3	4.1	**Alder Creek**	Spring-fed/Snow-melt
			Trout Creek	Spring-fed/Snow-melt
Upper Whychus Creek	23.4	4.8	**Whychus Creek**	Snow-melt
			Pole Creek	Spring-fed
			Intermittent tributary	Spring-fed/Snow-melt

*Three Creek is the only stream within the Rooster Rock Fire area

Description of Streams in the Pole Creek Fire Area

The primary streams within the Pole Creek fire area include Whychus Creek, Pole Creek, Snow Creek, Trout Creek, Three Creek, Alder Creek, Soap Creek, Park Creek and their headwater tributaries in the Three Sisters Wilderness. Effects from the Pole Creek fire have the potential to be greatest in Whychus Creek, Pole Creek, Snow Creek. These waterbodies experienced the highest burn severities, with channels burning to the water's edge with little or no vegetation unburned along Pole Creek and Snow Creek (Riehle, 2012). Table 4 shows miles of stream flowing through the burned area and burn severity. Figure 1 shows the primary streams in the Pole Creek Fire and burn severity. Burn intensity along streams in the Pole Creek fire is discussed in the Temperature section of this report.

Table 4: Length of stream flowing through the Pole Creek burned area by burn severity.

Stream	**Stream length through high severity burn**	**Stream length through moderate severity burn**	**Stream length through low severity burn**	**Stream length through underburn or unburned**
Whychus Creek and South and North Forks	0.2	3.5	5.4	5.9
Snow Creek	0.1	3.8	1.2	1.3
Pole Creek (including North Pole Creek)	0.1	3.1	2.9	2.3
Trout Creek	0	0	0.2	0.5
Alder Creek	0	0.1	1.1	1.0
Three Creek	0	0	0	0
Park Creek (and forks)	0	0.3	0.7	0.1
Soap Creek	0	0.4	1.2	0.2

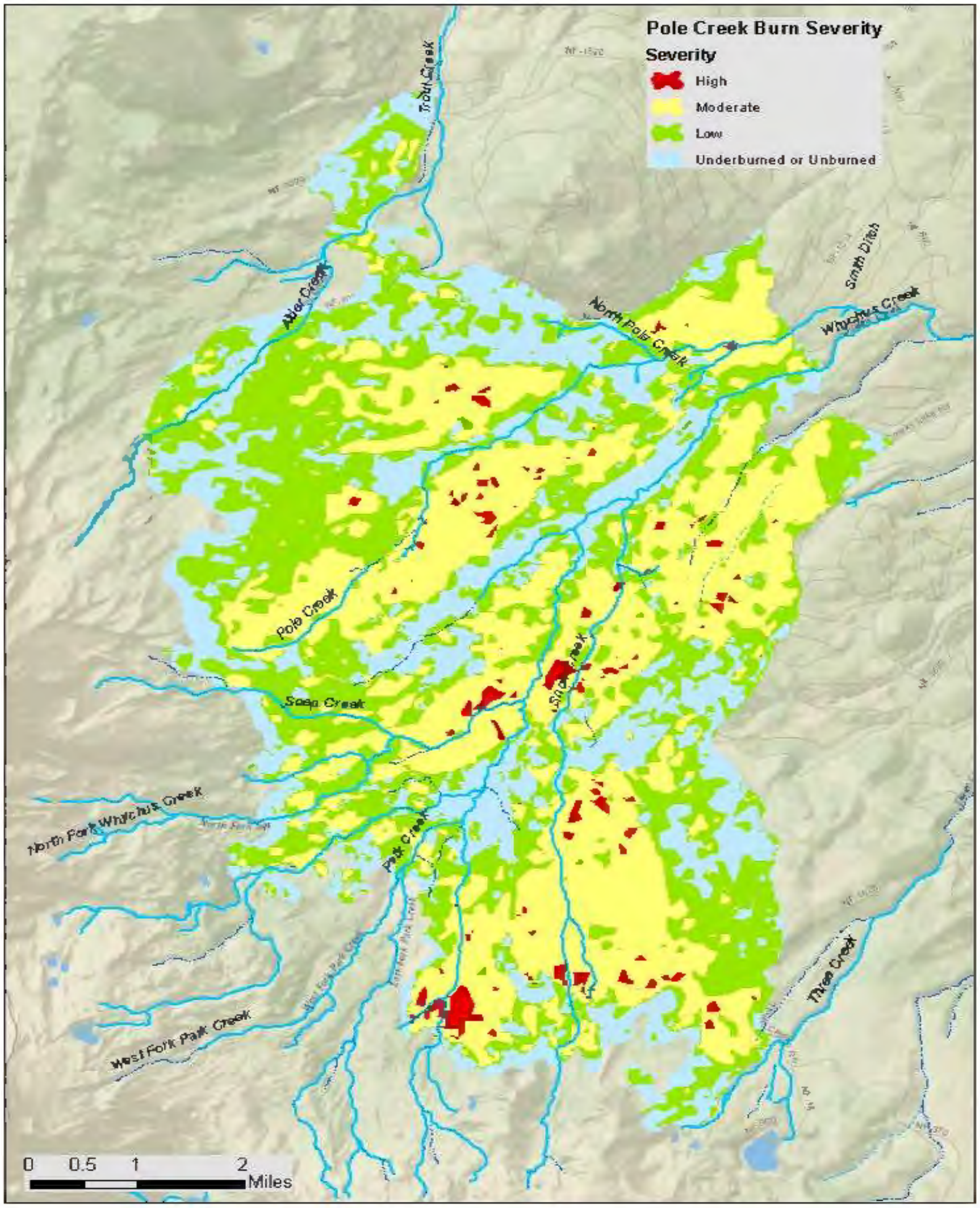

Figure 1: Streams in the Pole Creek Fire and burn severity

Whychus Creek and its Forks

Whychus Creek is the largest stream in the fire area in terms of watershed area and surface water flow. It is a predominately a snow-melt and glacial-fed, high bedload system that efficiently transports sediment. Whychus Creek is believed to be the largest gravel contributor to the Upper Deschutes River (US Forest Service, 2007). Fifteen miles of Whychus Creek and its primary forks and tributaries flow through the Pole Creek burned area. Although only 0.2 miles burned at high severity, 3.5 miles burned at moderate severity and ground and canopy cover is reduced from pre-fire levels.

<u>Snow Creek</u>

Snow Creek is a north-flowing perennial tributary to Whychus Creek that drains the western flank of Tam McArthur Rim. It has a fairly stable spring-fed flow regime with wetlands and springs along most of its length. The Snow Creek gage #14074900, operated by the Oregon Water Resources Department (OWRD) is located adjacent to the Three Sisters Wilderness boundary and has been in operation since 1970. This gage was burned in the Pole Creek Fire and replaced on March 14, 2013. The drainage area at the gage is 2 mi^2. Average peak flows are approximately 30 cfs and baseflows are approximately 4 cfs. Most of Snow Creek is within the Pole Creek Fire area; approximately 3.8 miles was burned by moderate severity fire.

<u>Pole Creek</u>

Pole Creek is a predominately spring-fed system with a fairly constant flow regime. Pole Creek is a tributary to Whychus Creek that is currently diverted into the Pole Creek ditch prior to reaching Whychus Creek to serve as irrigation for agriculture and the Sisters public water supply. The city does not currently use water from Pole Creek, but reserves the right to use the water when necessary (Tanner and Gritzner, 2012). The entire length of the main stem of Pole Creek is within the Pole Creek Fire area, with approximately 3.1 miles burned by moderate severity fire.

<u>Trout Creek</u>

Trout Creek is an intermittent stream with isolated segments of perennial flow that originates from springs in the mid to upper elevations in the watershed. Trout Creek is a tributary to Indian Ford Creek that only connects during high runoff events. A relatively small portion of the Upper and Lower Trout Creek subwatersheds burned in the Pole Creek Fire, with no high or moderate severity burning adjacent to the Creeks. However, 3.8 miles of Trout Creek (20% of total length) was burned in the 2006 Black Crater Fire. Since the Black Crater Fire, Trout Creek has flowed at least once in the winter almost every year past Highway 20 and often past Camp Polk Road. This is an event that rarely occurred prior to the fire.

<u>Alder Creek</u>

Alder Creek is primarily spring-fed intermittent tributary to Trout Creek. 2.2 miles of Alder Creek burned in the Pole Creek fire; however, most burned at low severity and mortality.

<u>Three Creek</u>

Three Creek has a snow-melt flow regime, but is less flashy than other nearby streams because it is controlled by Three Creek Lake and Little Three Creek Lake in its headwaters. Three Creek is a highly regulated system with numerous diversion ditches and water rights. Three Creek is a tributary of the Deschutes River, but flows do not currently make it to the River. LiDAR imagery indicates that Three Creek flowed historically past Highway 20, but most likely intermittently (Press, 2012). Only 8% of the Three Creek subwatershed was burned in the Pole Creek fire, and no land directly adjacent to Three Creek was burned. In addition, the abandoned Snow Creek Ditch that once carried water from Snow Creek to Three Creek Lake was decommissioned during the Pole Creek Fire.

Soap Creek
Soap Creek is a snow-melt dominated tributary to Whychus Creek, located primarily in the Three Sisters Wilderness. Approximately 2.8 miles of Soap Creek burned in the Pole Creek fire; however only 0.3 miles were burned at moderate severity, with no high severity burning.

Park Creek
Park Creek is a snow-melt dominated tributary to Whychus Creek located primarily in the Three Sisters Wilderness. One mile of Park Creek burned in the Pole Creek fire; however only 0.3 miles burned at moderate severity, with no high severity burning.

Flows in Whychus Creek

The hydrology of the Whychus system is flashy (short lag time between precipitation and high flows) in response to summer convective storms and rain on snow events in winter and spring. The typical hydrograph for Whychus Creek is bi-modal with lower-magnitude consistent spring snowmelt flows, and higher, flashier rain on snow events in the winter months. The Whychus Creek flow regime is altered by several diversions near the town of Sisters. The primary diversion is located 3 miles upstream from Sisters and is used for irrigation by the Three Sisters Irrigation District (TSID). This diversion diverts up to 150 cfs or 90% of flows from April to Oct and has significantly affected the natural hydrograph in lower Whychus Creek. As recently as 1998, all summer flows of Whychus Creek were diverted for irrigation. Since then, water conservation efforts have been implemented including improvement of diversion efficiency, and transfer and leasing of water rights. Median low flow of Whychus Creek from 2009-2012 averaged 27 cfs in Sisters. Base summer flows below the TSID diversion are warm and shallow because width to depth ratios are high and no low-flow channel has developed given the armored bed (UDWC and USFS, 2013).

Flow data on Whychus Creek was recently compiled in the 2013 Whychus Canyon Restoration Plan using data from the gages shown in Table 5. The flow regime above the TSID diversion was determined based on the stream gage record dating back to 1906 at gage 14075000. Streamflow downstream of the diversion from 1906 to 2000 was estimated by subtracting the daily flow diverted during irrigation season using data from the 14076000 gage. From 2000 to 2012 flows were verified using data from the 14076050 gage which only has a 12-year period of record.
Table 5: OWRD gages on or near Whychus Creek used to calculate discharge in this analysis.

Gage	Years of record	Location	Run by
14075000	1906-present	1.5 miles upstream from TSID diversion	USGS/OWRD
14076000	1924-present	Within TSID diversion	OWRD
14076050	2000-present	Sisters	OWRD

There are several potential sources of error within this flow record: 1)few high flows have been measured, so there are few data points used to make a rating curve (a graph and formula that relates stage measurements to flow), 2)The 14075000 gage was moved from its original location in the 2000s to a location with a more stable cross-section, and 3)the flows downstream of the TSID diversion are estimated based on the subtraction of mean daily flow values from the TSID diversion (gage 14076000). Improvement in rating curves for the Whychus Creek gages is expected in the near future; OWRD has acquired new equipment for measuring high flows. Flow data will be updated using the improved rating curve as additional data becomes available.

Figure 2 shows yearly instantaneous peak discharge of Whychus Creek in Sisters, Oregon for the 96-year period of record (there are data gaps for 7 years in the period of record). The trendline through these data points indicates that peak flows have increased in Whychus Creek over the period of record. Bankfull flows, which are considered to be the channel maintenance flows and are associated with the spring-melt season peak, appear to be occurring more frequently. Bankfull flow downstream of the TSID diversion was estimated to be approximately 300 cfs at a 1.5 year recurrence interval using the entire period of record (Flynn et al. 2006). In the last 20 years, flows around 300 cfs are occurring almost yearly and are now associated with a 1.15 recurrence interval, while flows associated with the 1.5 recurrence interval have increased to approximately 500 cfs. It appears that rain-on-snow events, resulting in high streamflows, are becoming more frequent in the Whychus Creek watershed. This corresponds to the period when a large swath of lodgepole pine was killed by mountain pine beetle which could have reduced interception and increased snow pack.

Figure 2: Yearly instantaneous peak discharge for Whychus Creek in Sisters, Oregon. Data points denoted with an X are estimates.

Potential Fire Effects on Peak Flows in Whychus Creek and its Tributaries

Climate is the primary determinant of flow regime and magnitude of large flood events (Dunne and Leopold, 1978); however, land use practices and fire can also increase peak flows through increases in overland flow and subsequent delivery of increased runoff (Helvey, 1980, Kunze and Stednick, 2006). Peak flows are important for sediment transport, redistribution, and channel formation, and can cause significant changes in the hydrologic function of the stream system (Rosgen, 1996, Neary et al., 2005). Watersheds exhibit great natural variability in flow and can accommodate some increases in peak flows without damage to stream channels and aquatic organisms.

Overland flow in the Whychus Watershed is rare because soils are highly permeable. Permeability rates for the majority of soils in the analysis area near streams exceed the 2 yr, 30 minute rainstorm intensities for the same area (permeability for most soils in project area = 20 in/hr; 2 yr, 30 min rain = 0.7 in) (Soil code = 17, 19, 28, 32, WB). A study of soils on the Sisters Ranger District showed that infiltration rates generally exceeded typical rainstorm rates by an order of magnitude (Litton 2006). In the Whychus Watershed analysis area, the mechanisms with the potential to increase overland flow include reduction in canopy cover and attendant reduction in evapotranspiration and canopy interception of rain and snowfall. These mechanisms can increase the amount of precipitation available for runoff as streamflow. Within the analysis area, overland flow does not generally occur from a reduction in evapotranspiration when trees are harvested or killed by fire or insects and disease because infiltration and permeability rates often still exceed precipitation rates (Craigg 2009). However, overland flow can occur in areas where infiltration rates are reduced, such as rain-on-snow zones and road surfaces.
Studies have shown that snow water equivalent and snow melt rates are higher in open areas than in forested areas (McCaughey and Farnes, 2001, Skidmore et al. 1994). The seasonally impermeable areas created by a snow or ice layer could accumulate more snow as a result of decreased interception from trees and associated evaporation, leading to more overland flow during a rain-on-snow (ROS) event.

Table 6 shows acres of SWSs in the ROS zone and the percentage of each SWS burned with stand replacing fire in the Pole Creek Fire as well as acres of mountain pine beetle mortality (from 2012 aerial photography). The Rooster Rock fire did not burn in the ROS zone. Figure 3 shows areas of stand replacing fire and areas with high mountain pine beetle mortality in the ROS zone.

Runoff during ROS events is expected to be highest in SWSs with the greatest reduction in canopy cover. Across the Whychus Watershed analysis area, mountain pine beetle mortality in lodgepole stands is extensive in the ROS zone, and is greatest in the Fourmile Butte, Headwaters Whychus Creek, Snow Creek Ditch, Three Creek, Upper Trout Creek, and Upper Whychus Creek SWS. Stand replacing fire conditions from the Pole Creek Fire are greatest in the Headwaters of Whychus Creek and Upper Whychus Creek. The Headwaters Whychus SWS is particularly at risk for increased runoff given that 97% of the ROS zone has been either burned by a stand replacing fire or killed by mountain pine beetle. Sixty-one percent of the area in the Whychus watershed in the ROS zone that directly contributes surface flow to Whychus Creek (Headwaters, Upper, Middle, and Lower Whychus SWSs) has been burned by a stand replacement fire or affected by beetle kill. Peak flows in Whychus Creek due to ROS events are likely to increase and the spring-melt peak is also likely to increase and occur earlier in the year.

Table 6: Acres of SWSs in ROS zone of 3500 to 5000ft and percent of ROS zone burned by stand replacing fire in the Pole Creek Fire and high mountain pine beetle mortality.

Subwatershed	**Subwatershed Acres in ROS zone (3,500-5,000 ft)**	**% Watershed in ROS zone**	**Acres of ROS zone killed by mountain pine beetle that are not within the stand replacement burn area**	**Acres of ROS zone burned by a stand replacing fire in the Pole Creek Fire**	**% of ROS zone burned by a stand replacing fire and/or with high mountain pine beetle mortality**
Deep Canyon Dam-Deep Canyon	7197	23	648	0	9
Fourmile Butte	9746	51	1977	0	20
Headwaters Whychus Creek	2305	10	1070	1178	97
Lower Indian Ford	7159	26	508	0	7
Lower Trout Creek	10621	53	492	223	7
Lower Whychus Creek	0	0	0	0	0
Middle Whychus Creek	1854	13	11	0	.6
Snow Creek Ditch	7136	49	1461	0	20
Three Creek	9923	53	1974	167	21
Upper Indian Ford	4959	47	303	0	6
Upper Trout Creek	2911	24	1807	82	65
Upper Whychus Creek	9607	52	2177	3927	63

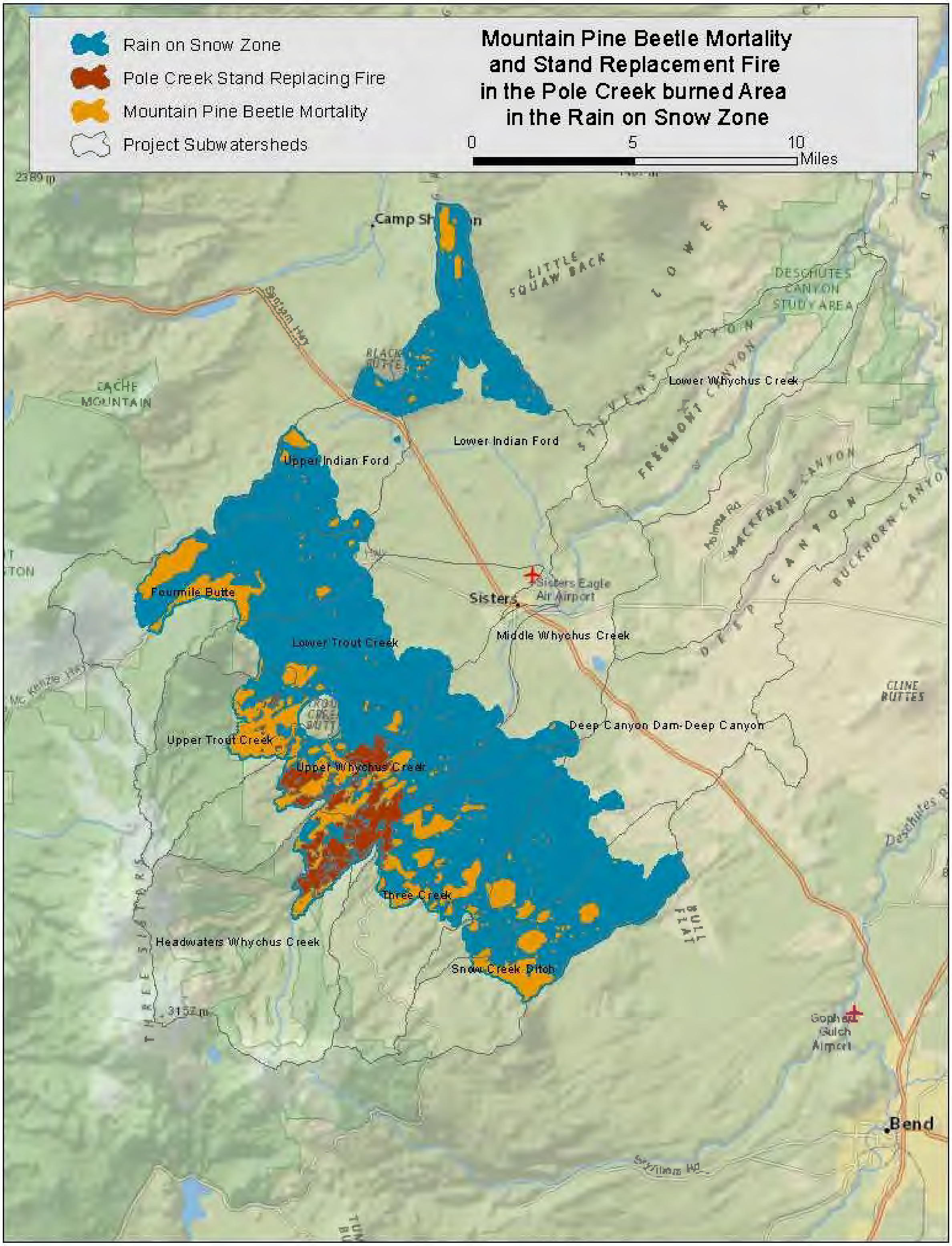

Figure 3: Mountain pine beetle mortality and Pole Creek stand replacement fire in the ROS zone.

Potential Effects of Fire and Climate Change on Snow

The effects of fire on snowpack and the timing of snowmelt are dependent on complex interactions between precipitation timing and type, elevation, temperature, canopy cover, and disturbance. Measurements of April snow water equivalent (SWE) dating back to 1950 show that the Pacific Northwest has experienced the largest decline in snowpack in the western United States (Mote et al, 2005) and has experienced a 9-11 day earlier snowmelt runoff (Stewart et al, 2004 and 2005). These changes are primarily attributed to increases in winter temperatures (Mote, 2003, Mote et al, 2005, Nolin and Daly, 2006). Snow in maritime climates falls at temperatures close to 0°C, making accumulation of snow versus rainfall highly sensitive to temperature increases (Sproles et al, 2012). Nolin and Daly (2006) mapped areas at risk of transitioning from a snow-dominated to a rain-dominated winter precipitation regime ("at risk snow") with a minor increase in winter temperatures (2°C). Mapping indicates that the ROS zone in the Whychus WA area is at risk of transitioning from a winter snow to rain precipitation regime (Nolin and Daly, 2006).

Recent research in the nearby McKenzie basin indicates that wildfire-derived black carbon sloughing from burned trees onto snowpack increases absorption of solar energy (albedo) and results in loss of snowpack up to 23 days earlier than in unburned forest (Nolin et al., 2012, Nolin, 2013).

Stream Temperature

Potential impacts to temperature are expected to be greatest in Pole Creek, Snow Creek, and the main stem of Whychus Creek because these streams experienced the highest fire impacts in riparian reserves and stand replacement fire conditions through their lengths (Tables 7 and 8). Reduction in shade from riparian vegetation increases the exposure of the channel to solar radiation. Decreases in riparian vegetation can also exacerbate channel erosion and widening, leading to warmer stream temperatures from increased surface area.

Pole Creek is a spring-fed system with water temperatures well below the Oregon state temperature standard for salmonids spawning and rearing of 18°C. A 2001 survey (Dachtler) of temperature at headwater springs found temperatures of 3 °C. Continuous summer water temperature data was collected at the 1514 road crossing using electronic thermographs in 1995 and 1997 where daily maximums were in the range of 12 °C (Dachtler, 2013). With 3.2 miles of Pole Creek flowing through stand replacing fire, temperatures in Pole Creek could increase. These effects may be tempered by cold-water spring that feed the channel.

Table 7: Length of stream flowing through the Pole Creek burned area by burn intensity.

Stream	Total stream length	Stream length through stand replacing fire	Stream length through mixed mortality fire	Stream length through underburn or unburned land	Stream length in stand replacement and mixed mortality fire	% of total stream length in stand replacement and mixed mortality fire
Snow Creek	7.9	3.9	1.2	1.3	5.1	64
Pole Creek (including North Pole Creek)	9.0	3.2	2.9	2.3	6.1	68
Trout Creek	10.8	0	0.2	0.5	0.2	2
Alder Creek	4.1	0.1	1.1	1.0	1.2	29
Three Creek	9.1	0	0	0	0	0
Park Creek (and forks)	8.9	0.3	0.7	0.1	1.0	11
Soap Creek	3.2	0.4	1.2	0.2	1.6	50
Whychus Creek and South and North Forks	50.5	3.7	5.4	5.9	9.1	18

Snow Creek has a fairly stable spring-fed flow regime. Water temperatures in Snow Creek during a 2007 stream inventory ranged from 5 to 13°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. Temperatures at the 1514 crossing reached a maximum temperature of 12.3 °C in August and a maximum of 10 °C in September (Dachtler, 2013). Snow Creek also has wetlands and springs along its length, making the system less susceptible to large temperature fluctuation. Temperatures in Snow Creek could increase given nearly 4 miles of Snow Creek and adjacent wetlands were burned by stand replacing fire in the Pole Creek Fire.

Whychus Creek is on the state 303(d) list for temperature, however temperatures in the upstream reaches where the Pole Creek fire burned are well below the state water temperature standard of 18°C. Temperatures within Whychus Creek are consistently above the standard below the 16 road and progressively get warmer as water moves downstream. Insufficient in-stream flows are the primary cause of high water temperatures. Recent flow, channel, and floodplain restoration in the lower reaches of Whychus Creek have resulted in a recent cooling trend in Whychus Creek. Whychus temperatures were lower on the hottest water day in 2011 than in 2010, and lower in 2010 than in 2009 (Mork, 2011).

Additional information on temperature in Whychus Creek can be found in Mork, 2011.
A more detailed discussion of existing temperature data and potential impacts from the Pole

Creek Fire can be found in the fisheries report of this Watershed Analysis Update (Dachtler, 2013). The hydrology report for the 2009 Whychus Watershed Update also includes additional information on stream temperatures across the analysis area.

Table 8: Acres of riparian reserves (RR) of streams, wetlands and lakes burned by intensity.

SWS	Type	Stand replacement	Mixed mortality	Underburned or unburned	Total RR with stand replacement conditions
Headwaters Whychus Creek	Riparian Reserve	658	501	451	997
	Lakes	0	0	0	
	Wetlands	339	269	221	
Lower Trout Creek	Riparian Reserve	2	3	2	2
	Lakes	0	0	0	
	Wetlands	0	0	0	
Three Creek	Riparian Reserve	1	24	11	1
	Lakes	0	2	0	
	Wetlands	0	4	18	
Upper Trout Creek	Riparian Reserve	3	69	90	3
	Lakes	0	0	0	
	Wetlands	0	12	18	
Upper Whychus Creek	Riparian Reserve	206	253	219	274
	Lakes	0	0	0	
	Wetlands	68	74	118	

Erosion

Hillslope Erosion

Burned areas are vulnerable to accelerated soil erosion which can increased post-fire sediment yield (Neary, et al., 2005). Increases in surface erosion following wildfire have been well documented (Helvey, 1980, Robichaud et al, 2000; Wondzell et al., 2003; and Neary et al., 2005); however effects are spatially variable based on soil condition, burn severity, and timing and magnitude of precipitation (Robichaud and Hungerford, 2000). Accurately predicting erosion is difficult and subject to large errors from various sources because of highly complex processes including spatial variation in slope, soil, and vegetative conditions, and uncertainty in precipitation (Walling, 1988). Therefore, applying hillslope estimates across landscapes and watersheds generalizes actual rates of erosion that may occur.

Post-fire observations in the Pole Creek fire area indicate that soil infiltration rates are expected to decrease by 5% from absence of ground cover and duff. Although soil infiltration rate change is minor, and soil condition is not uniform across the burned area, this is enough of an increase in overland flow to elevate erosion and sediment yield for several seasons (Reinwald, 2012).

Modeling using Disturbed WEPP is one way to conceptualize hillslope erosion. Disturbed WEPP was used for the Pole Creek burned area to estimate potential erosion and sedimentation yield to compare between different management scenarios, ground cover, and slope. WEPP is a physically-based soil erosion model that provides estimates of soil erosion and sediment yield considering the specific soil, climate, ground cover, and topographic conditions. It was developed by an interagency group of scientists including the U.S. Department of Agriculture's Agricultural Research Service (ARS), Forest Service, and Natural Resources Conservation Service; and the U.S. Department of Interior's Bureau of Land Management and Geological Survey (Elliot et al., 2010).

Modeled erosion and sediment rates are recognized as highly variable. Neary et al. (2005) suggest "A rule of thumb in interpreting erosion observations or predictions is that the true 'average' value is likely to be plus or minus 50% of the observed value". The soils report for this watershed analysis contains additional information on WEPP modeling and assumptions (Craigg, 2013).

Model outputs for the Pole Creek burned area indicate that thinned, unburned forest has near-zero sediment yield, land with low fire severity shows a small amount of sediment yield and a high severity burn has an order of magnitude higher sediment delivery. Sediment delivery on slopes of 30% is almost an order of magnitude greater than slopes of 10% with sediment delivery on slopes of 60% almost and order of magnitude greater than slopes of 30% (Craigg, 2013). The 2013 Whychus Watershed Analysis Soils Report includes additional descriptions of model simulations using a number of different disturbances and slope classes (Craigg, 2013).

Modeled sediment yields for the Pole Creek burned area are significantly lower than empirically-derived sediment yields from several studies using plot sampling methods where rainfall regimes are similar to those in the Pole Creek area. Sediment yield from these studies averaged 5.9 tons/acre (Moody and Martin, 2009). The highest modeled sediment yield from the Pole Creek Fire is 2.6 tons/acre on a skid trail above high severity fire on 60% slopes. A total of 2 acres within the burned area represent these burned conditions (high severity burn on >60% slope). The discrepancy between empirical and modeled sediment yields is likely based on both the difficulty in modeling sediment yield, and differences in runoff potential of soils for each study area. Runoff potential of sandy loam soils used in the WEPP modeling process (soil erodibility (K factor) of 0.05-0.2) reflect the highly permeable soil conditions in the Whychus WA area. Background erosion rates (K-factor) in the three fire study areas synthesized by Moody and Martin (2009) were 0.90 (Robichaud and Brown, 1999), 0.39 and 0.69 (Radek, 1996).

Monitoring of hillslope erosion on steep high burn severity slopes in the Eyerly Fire area was extremely low (0.04 tons/acre/year) but showed a significant difference in erosion rate between unburned control slopes and high burn severity slopes in only the first year following the fire (McCown and Wasniewski, 2005). Sediment yield was likely low because storm events were minor in the first few years following the fire.

Table 9 shows acres burned in each SWS affected in the Pole Creek Fire by burn severity and slope class. Based on these metrics, a small percentage of the burned area is at risk for increased erosion in the Lower and Upper Trout Creek (2%), and Three Creek (12%). The Headwaters Whychus Creek and Upper Whychus Creek SWSs both have a moderate percentage of burned area at increased risk for slope erosion with 26% and 21% of the high to moderately burned area on slopes over 15% respectively. Only 41 acres across the Pole Creek fire area burned at high or moderate severity on slopes greater than 60%.

The burned area emergency response (BAER) team identified approximately 200 acres along Whychus, Snow and Pole Creeks for aerial application of mulch. Sites were chosen based on adjacency and potential hydrologic connectivity, burn severity, and slopes (>15%). Mulching implementation is planned for spring 2013 (Craigg personal communication, 3/22/2013). These treatments should help reduce sediment yield transported to Whychus Creek (Tanner and Gritzner, 2012). Robichaud and others (2012) showed that erosion reduction from wood shred mulch treatments ranged from 50-96% with greater effectiveness correlated with wood shred cover of 50-60%.

Table 9: Soil severity acres by slope class by SWS for the Pole Creek Fire. Shaded cells are areas of concern for slope erosion.

SWS	Soil burn severity	0-5%	5-15%	15-30%	30-60%	>60%	Total acres moderate and high burn on slopes >15%	% burned area at risk for slope erosion
Headwaters Whychus Creek	High	21	104	106	32	2	2001	26%
	Moderate	350	1850	1269	556	36		
	Low	281	1182	937	462	54		
	Underburned or Unburned	176	745	832	460	55		
Lower Trout Creek	High	1	2	0	0	0	10	2%
	Moderate	123	86	10	0	0		
	Low	58	63	35	4	0		
	Underburned or Unburned	11	23	27	2	0		
Three Creek	High	0	23	16	0	0	427	12%
	Moderate	107	897	357	54	0		
	Low	217	979	294	53	0		
	Underburned or Unburned	104	656	242	30	0		
Upper Trout Creek	High	0	0	0	0	0	36	2%
	Moderate	33	114	32	4	0		
	Low	192	697	296	25	3		
	Underburned or Unburned	145	597	158	9	1		
Upper Whychus Creek	High	13	38	39	8	0	1733	21%
	Moderate	515	1816	1400	283	3		
	Low	494	1891	917	209	8		
	Underburned or Unburned	462	1024	542	132	8		

Model results also indicate that following shrub recovery which is expected to occur 1-2 years post- fire, erosion rates return to baseline or near-baseline. Erosion increases are generally highest in the first few years following a wildfire and rapidly decline as revegetation occurs (DeByle and Packer, 1972; Robichaud and Brown, 1999). A 2006 soil photo point monitoring report on Lower Jack Unit 85, a salvage unit in the B&B Complex fire on the Sisters RD indicates that vegetation recovery was visually substantial with ceanothus present on approximately 75% of the unit area providing up to 80% aerial cover two years post disturbance (Craigg, 2006). Vegetative recovery on previously compacted or disturbed ground (skid trail) was more variable; germinants were smaller than those observed on undisturbed areas.

Monitoring results indicate that vegetative recovery post-fire on areas with no compaction will occur 2 years post-fire (Craigg, 2006). This is supported by vegetation monitoring in the Eyerly Fire area which showed that vegetative ground cover was 80% two years after the fire (Suna, 2004).

Stream Channel Erosion

A synthesis of studies of sediment yields following wildland fire found that 25% of sediment comes from hillslopes, and 75% of sediment yield comes from stream channels (Moody and Martin, 2009). Given that approximately 92% of Whychus Creek is currently functioning as a transport reach due to its natural confinement in a canyon or artificial confinement in berms in alluvial fan and meadow reaches, increases in peak flows will likely cause increased channel erosion. Sediment yield is also expected to increase from ephemeral channels.

Two storms moved over the Pole Creek Fire area closely following the burn. The first produced approximately 1 inch of rain over several hours, with flows peaking at an estimated 600cfs in Sisters on 10/16/2012 (estimated based on gage interpretation and field observations). A second storm on 10/28/2012 peaked at around 300 cfs at the Sisters gage (OWRD). Runoff from these storms damaged a number of roads and stream crossings. Field observations following these storms indicate that ephemeral drainages across the burned area with no evidence of recent scour conveyed water and moved substantial amounts of sediment in the October storms (Riehle, personal communication, 1/29/2013).

To understand the scale and potential effects of post-fire flows on ephemeral draws, previously unmapped features were mapped using LiDAR data and a raster accumulation technique. While the ephemeral draw network mapped through this process likely overestimates drainage network increase, it provides locations of channels with increased potential for sediment delivery and channelized stormflow. Results of this analysis will be used in project design to mitigate effects of projects in the burn area. This spatial dataset will be refined as ephemeral draw existence and condition are field-verified. Flows and erosion in ephemeral draws will likely occur with less frequency as vegetation and ground cover re-establish across the burned area.

Field observations of Whychus Creek in the winter of 2013 indicate higher levels of stored sediment within the channel and floodplain than observed following other recent fires (Riehle, personal communication, 2/12/2013). A fall 2012 monitoring report for the TSID channel restoration project notes that flows from the October storms deposited several inches of ash laden silt and fines on flood channels in the project area. These nutrient-rich fines covered up planted grasses and forbs, but provide soil for recruitment of additional riparian vegetation (Jensen, 2012).

Robichaud and Brown (1990) found that erosion rates were highest in the first year post-fire, with most erosion occurring during spring runoff. Erosion rates were one to two orders of magnitude less due to vegetative regrowth two years post-fire in their study on the Wallowa Whitman National Forest. The longer-term effects of potential increases in sediment delivered to Whychus Creek and its tributaries will require time and field observation to understand and quantify. Restoration projects throughout the watershed will continue to improve resiliency of stream channels to erosional and depositional processes. As discussed previously in this report, Whychus Creek is high bedload system capable of efficient sediment transport during high flows. As the watershed recovers from fire effects, sediment contributions to Whychus Creek are expected to decrease. The temporary increase in erosion from both hillslopes and stream channels from the Pole Creek fire are not expected to affect the long-term integrity of the Whychus system.

Roads

Effects of fire on peak flows and erosion can be exacerbated by roads, skid trails, and firelines (DeByle and Packer, 1972). Roads increase the volume of flow during large storm events through overland flow generated by the interception of precipitation on compacted road surfaces with low infiltration capacity. Roads can also intercept subsurface flow and convert it to rapid surface runoff, extending channel networks and increasing watershed efficiency (Wemple, 1996). Roads also reduce vegetative cover in streamside areas and accelerate erosion and sedimentation into streams (Megahan, 1983). Slope position of roads is a critical factor in the interaction between roads and streams. Ridge-top roads can influence watershed hydrology by channeling flow into small headwater swales, accelerating channel development. Mid-slope roads can intercept subsurface flow, extend channel networks, and accelerate erosion (Gucinski et al., 2001). Roads adjacent to and crossing streams, or hydrologically connected to streams have the greatest influence on streamflow, streamside shade, accelerated erosion. Hydrologically connected roads increase flow routing efficiency and can increase peak flows and sedimentation and are of greatest concern from effects of fire and other management activities (Wemple, 1996).

Field verification is required to effectively determine road/stream connectivity. Stream connectivity data is not available for most roads in the Whychus WA area; therefore, road mileage and density in riparian areas and number of stream crossings are used as a surrogate in this report to understand potential effects from interaction between roads, streams, and fire. Additional field verified data on location and condition of hydrologically connected road segments is needed for project level planning within the Whychus WA area.

Table 10 shows road density, riparian road mileage and density, and number of road crossings by SWS. The Document "Determining Risk of Cumulative Watershed Effects Resulting from Multiple Activities (USDA Forest Service, 1993) considers road density above 4.6 in relatively low-relief to be high risk. Road density in Lower Indian Ford, Lower Trout Creek, Middle Whychus Creek, Three Creek, Upper Indian Ford Creek, and Upper Whychus Creek SWSs are considered to be high. Riparian road densities are highest in the Deep Canyon Dam-Deep Canyon, Lower Trout Creek, and Snow Creek Ditch SWSs. Lower Trout Creek, Middle Whychus Creek, Three Creek, and Upper Whychus Creek also have a high number of road stream crossings.

Of the SWSs burned, the Headwaters of Whychus Creek and Upper Whychus Creek SWSs are expected to have the highest risk for road issues following the Pole Creek Fire based on high road densities within riparian reserves, and high road mileage and stream crossings within the Pole Creek burned area (Tables 11 and 12).

Table 10: Total road density, riparian road density, and # of crossings by SWS.

SWS	Total road length (mi)	SWS area (mi^2)	Road density (mi/mi^2)	Riparian road length (mi)	Riparian area (mi^2)	Riparian road density (mi/mi^2)	# of road crossings
Deep Canyon Dam-Deep Canyon	165.3	49.9	3.3	2.6	0.5	5.2	30
Fourmile Butte	100.3	30.0	3.3	0.4	0.2	1.9	0
Headwaters Whychus Creek	33.3	35.6	0.9	10.1	8.5	1.2	9
Lower Indian Ford	239.8	42.0	5.7	5.1	1.8	2.8	12
Lower Trout Creek	205.0	31.3	6.5	6.4	0.8	8.2	57
Lower Whychus Creek	57.5	31.6	1.8	5.5	3.0	1.8	37
Middle Whychus Creek	113.0	23.2	4.9	4.3	1.0	4.2	19
Snow Creek Ditch	83.1	22.9	3.6	4.3	0.8	5.2	42
Three Creek	143.0	29.4	4.9	5.2	1.5	3.5	32
Upper Indian Ford	101.4	16.3	6.2	5.9	2.0	3.0	4
Upper Trout Creek	30.8	18.9	1.6	3.2	1.1	2.8	7
Upper Whychus Creek	134.5	28.6	4.7	11.9	3.0	4.0	28

All road calculations include Forest Service and non-Forest Service open and closed roads. Unclassified roads were not included in calculations.

Table 11: Riparian road mileage within the Pole Creek burned area by severity

SWS	Road length in high severity burn (mi)	Road length in moderate severity burn (mi)	Road length in low severity burn (mi)	Road length unburned or underburned	Total
Headwaters Whychus Creek	0.1	3.3	3.3	3.4	10.1
Lower Trout Creek	0	0	0.1	0	0.1
Three Creek	0	0	0.1	0	0.1
Upper Trout Creek	0	0	0.6	0.5	1.1
Upper Whychus Creek	0.1	2.3	1.8	0.7	4.9

Table 12: Crossings within the Pole Creek burned area by severity

SWS	# of crossings in high severity burn	# of crossings in moderate severity burn	#crossings in low severity burn	#of crossings in underburn or unburned	Total
Headwaters Whychus Creek	0	3	1	5	9
Lower Trout Creek	0	0	0	0	0
Three Creek	0	0	2	0	2
Upper Trout Creek	0	0	2	2	4
Upper Whychus Creek	0	8	8	4	20

Several roads and culverts were identified through the BAER process to be at risk from storm runoff and increased peak flows. The culverts and roads shown in Table 13 were either recommended for treatment or were determined to be at risk from potential fire effects. The two October storms that closely followed the fire produced significant damage to several roads and crossings; these roads are also shown in Table 13. Work submitted for 2013 BAER funding is also shown in Table 13. Additional information on roads and crossings can be found in the Pole Creek BAER hydrology and roads reports (Tanner and Gritzner, 2012, Walker, 2012, and Walker, 2013), and the Roads report for the Whychus Watershed Analysis Update (Walker, 2013).

Table 13: Roads and crossings at risk from effects of the Pole Creek Fire.

Road or Crossing	Damage from post-fire storms	Maintenance following October 2012 storms	Work submitted for 2013 BAER funding
1018 crossing at Trout Creek	None	None	None
1018000	None	None	None
1024000	Erosion on upgrade portion of road	None	None
1500000	Debris in road, clogged ditch relief culverts	Constructed armored drain dips and partially cleaned ditch.	Ditch improvement, reinforcement of 2 drain dips, installation of culvert at 1 drain dip
1500200 crossing at Pole Creek	None	None	None
1500600	Areas of erosion	Constructed water bars	None
1500700	Washout of parking lot at Pole Creek Trailhead	None	Installation of 2 armored drain dips
1514000 at Snow Creek	None	Installed natural dip, armored road shoulder	None
1514000 crossing at Pole Creek	Plugged and overtopped	Culverts cleared	None
1514000	Multiple plugged culverts and area of erosion	Road bladed, sediment and debris from Pole Creek crossing	Installation of gates to close road due to hazard trees
1514600	Plugged culverts	Clean culverts and ditches. Shaped road to drain. Relocated trailhead to intersection of 1514640.	None
1514610	Areas of erosion	Construction of armored drain dip	None
1514640	Areas of erosion	Construction of armored drain dip	None
1514680	Gullying delivered sediment onto 1514600 road	None	None
1514880	Areas of erosion	Reconstruct drain dips and lead-out ditches. Road bladed.	None

1516000	Areas of erosion	Clean culverts	Improve ditch capacity
1516500	Areas of erosion	Remove sediment and debris from culvert, spot-cleaned ditch line. Constructed 1 drain dip	Improve ditch capacity
1526000	Areas of gullying	Cleaned culverts and ditch. Constructed vented ford at the Pole Creek crossing.	Improve road drainage capacity, replace 15" culvert with 22" culvert
1526000 crossing at Pole Creek	Pugged and overtopped	Culvert cleared	None
1526200	Culverts washed out at Pole Creek Trailhead	None	Construct armor ford crossing at Pole Creek Trailhead
1600000	Sediment deposited onto paved road	Cleaned culverts and ditch. Removed debris from paved road.	Installation of new culvert to supplement ditch drainage
1600700	Road washed out onto the 1600000	Road reconstruction	Remove sediment and debris from culverts. Install drain dips

Roads Projects

There has been an effort to close and decommission roads throughout the watershed, including the Whychus Creek Riparian Protection project completed in 2007. The Whychus Portal project closed 0.17 miles of road, and decommissioned 5 miles of road. Road decommissioning, closures, and improvements will continue throughout the watershed. A number of roads were recommended for closure and decommissioning in the Popper and Sky Roads Analyses. These roads are discussed in the 2013 Whychus Watershed Analysis Update Roads Report.

Recommended Project Design Features

To protect areas within the Pole Creek burn that may be susceptible to increased erosion, future projects will be designed to mitigate hydrologic concerns. Potential design features include:

- Expansion of riparian buffers to include sensitive areas upslope of riparian reserves if they are determined to have potential hydrologic connectivity to the stream system.
- Previously unmapped ephemeral draws may be buffered or excluded from ground-based activities.
- Log haul on hydrologically connected road segments may be limited to dry season, frozen ground, or log over snow.
- Avoid treatments in areas that were mulched through the BAER process.

Watershed Restoration

Numerous restoration projects have occurred in the Whychus Creek watershed in recent years that address multiple limiting factors to aquatic health. Watershed-scale projects include stream restoration, fish passage improvement, road decommissioning, recreation management, and fuels management. Recent stream restoration projects include:

- Three Sisters Irrigation District (TSID) Fish Passage and Channel Restoration (Completed 2010)
- Whychus Creek Restoration at Camp Polk Meadow Preserve (Completed 2012)
- Road decommissioning and closures through the Whychus Portal project (Completed 2010)
- Whychus Creek Restoration and Management Plan for lands in the City of Sisters (Completed 2011)
- Sokol Apron Fish Passage project (Completed 2010)
- Restoration of instream flows above 20 cfs to Whychus Creek below the TSID diversion (Ongoing, beginning in 2009)
- Fish passage restoration projects at Pelton and Round Butte Dams restored access for steelhead, sockeye salmon, and chinook salmon to the Upper Deschutes River, including Whychus Creek.
- Road decommissioning through the Whychus Creek Riparian Protection Project

The 2009 Watershed Analysis Update includes descriptions of some of the projects listed above and additional restoration projects that were completed at the time of the update (USDA Forest Service, 2009).

Extensive restoration work continues in the Whychus WA area. Projects include:

- Leithauser Dam Removal (Implementation expected 2013)
- Whychus Canyon Stream Restoration (Implementation expected 2015)
- Whychus Floodplain Stream Restoration (Implementation expected 2014)
- Screening of diversion pipes along Whychus Creek (on-going)

Indian Ford Projects

Indian Ford Creek is also a high priority for restoration. Indian Ford Creek is a 12-mile long, spring-fed, channel that flows through a checkerboard of private and public lands, to its confluence with Whychus Creek. Sixty percent of Indian Ford Creek is privately owned and has experienced extensive hydrologic and vegetative manipulations. Due to irrigation diversions, primarily the 7 cfs diversion for Black Butte Ranch at the headwater springs, Indian Ford Creek usually goes dry before its confluence. Historically, Indian Ford was a series of densely vegetated wetlands with multiple, small channels over 80% of its length, similar to the wetland immediately upstream and downstream of Pine Street on USFS lands. Now, due to extensive grazing, farming, and irrigation withdrawals, only 32% is composed of wetland complexes, and the majority of the rest is single thread and lacking abundant and diverse riparian vegetation. As a result of both irrigation withdrawals and lack of shade, Indian Ford Creek is consistently at or above the State water temperature standard and listed on the Oregon 2010 303(d) list (Press 2007b).

In the last few years, Indian Ford Creek has had perennial flow past the Camp Polk Road which is approximately 2.5 miles further downstream than it has in the past. This is likely a result of beaver damming and water storage upstream of Pine Street and the recent instream water right transfer of 1.045 – 2.09 cfs (depending on month) to instream in 2005.

Potential projects in Indian Ford include:

- Wetland enhancement and riparian thinning in meadow habitat through the Glaze Riparian Thinning project and the Indian Ford Allotment Enhancement.
- Fence 10 acres of riparian area on the Indian Ford Allotment to protect riparian vegetation from cattle near a headcut.
- Indian Ford Creek Calliope Crossing aquatic habitat enhancement project to remove roadbed from wetland.
- Partnership with Black Butte Ranch and other land owners to increase instream flows through conservation of irrigation water and purchase and lease of water rights
- Partnership with Black Butte Ranch to reduce nutrient pollutants from sewage system effluent, and raw sewage spills.
- Partnership with landowners along Indian Ford Creek to reconnect stream to floodplain, create wetlands, and manage use in the riparian areas.
- Glaze Meadow wetland restoration projects include; filling of old ponds and ditches (dependent on acquisition of additional instream water rights from Black Butte Ranch), and stabilization and improvement of horse trails through meadow.
- Sisters community trail project, including construction of a paved trail from Sisters to Black Butte Ranch with a bridge over Indian Ford Creek and bog bridging through wetland areas. The project also includes several potential road closures on FS land.

Three Creeks Projects

Three Creeks is a highly regulated system; flows were historically diverted from Three Creek Lake and Little Three Creek Lake for irrigation as early as 1886. In 1936 Snow Creek Irrigation District built small earth dams on both lakes to store water for irrigating lands in the Plainview area; however, neither dam has stored water since approximately 1990 (Giffin 2011). A ditch currently diverts most of the water out of the Little Three Creek Lake outflow stream and carries it to Three Creek Lake. Meadows downstream of Little Three Creek Lake may have been detrimentally impacted from the ditch that removed water from these wetlands and carried it to Three Creek.

Until 2004, Three Creek only flowed to the 1612 road approximately 8 miles downstream of the lakes. In 2004, the owners of the Three Creeks irrigation rights cancelled all but 48.4 acres of their water rights. This transfer created mitigation credits and a new instream water right for 0.757 cfs in Three Creek. Since this transfer, Three Creek flows to the Mainline Road (USFS 4606 road), over the McAllister Ditch and down the Plainview ditch, both of which divert water from Whychus Creek. LiDAR imagery shows that Three Creek once flowed to the Deschutes River, although likely intermittently.

The breach of the dams and the transfer to instream water right has changed the flow regime of Three Creek so it mimics more of the natural/historical flow regime prior to manipulation. There are numerous infrastructure concerns with increased flows in Three Creeks. Development in the Three Creek floodplain that occurred under the previously reduced flow regime has prevented water from flowing to the natural channel below the Harrington Loop Road. There are no culverts at the Harrington Loop Road or Highway 20 to accommodate increased flows in the historic channel (Press, 2012 and Giffin, 2011). There are also several developments in the floodplain of Three Creek that flood during higher flows. ODWR has alleviated flooding of these developments by diverting water into the Plainview Ditch, which floods developed land adjacent to the ditch. Potential projects in Three Creek address infrastructure concerns with increased flows include:

- Decommissioning of ditch from Little Three Creek Lake to Three Creek Lake and the Snow Creek Ditch.
- Remove dams on Little Three Creek Lake and Three Creek Lake.
- Potential partnership opportunity between ODOT, Deschutes County, OWRD, USFS, Plainview Ditch owners, and private landowners to alleviate flooding of existing developments and determine additional infrastructure conflicts with flow restoration downstream of the Plainview Ditch Crossing.

The Watershed Condition Framework Process

As part of the 2010 Watershed Condition Framework (WCF) process, the Upper Whychus Creek SWS was identified as a National Priority SWS. The Upper Whychus Creek Watershed Action Plan outlines nine essential projects that when completed will improve watershed condition from "Functioning at risk" to "Functioning properly". Essential projects include:

- Continue work to increase flow below water diversions to meet ODEQ temperature standards.
- Restoration of fish passage at 6 irrigation diversions
- Installation of fish screens at 7 irrigation diversions
- Replace the 1514 culvert at Snow Creek for fish passage improvement
- Closure of 5 miles of road and decommission 6 miles of road in the Whychus Wild and Scenic Corridor through the Whychus Portal project
- Road closure monitoring and maintenance at sites along Whychus Creek
- Trail maintenance in riparian areas of Whychus Creek
- Change in management of brook trout and brown trout in Whychus Creek, including changes in lake stocking schedules, harvest regulations, and angler education

The WCF was updated for the Whychus WA area to evaluate changes in conditions resulting from the Pole Creek Fire. Additional information on the WCF process and changes in watershed condition from 2010-2013 can be found in the WCF section of the 2013 Whychus WA Update.

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Resource Report
VEGETATION

VEGETATION

Introduction

For the 1998 watershed assessment, the 2009 update 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.

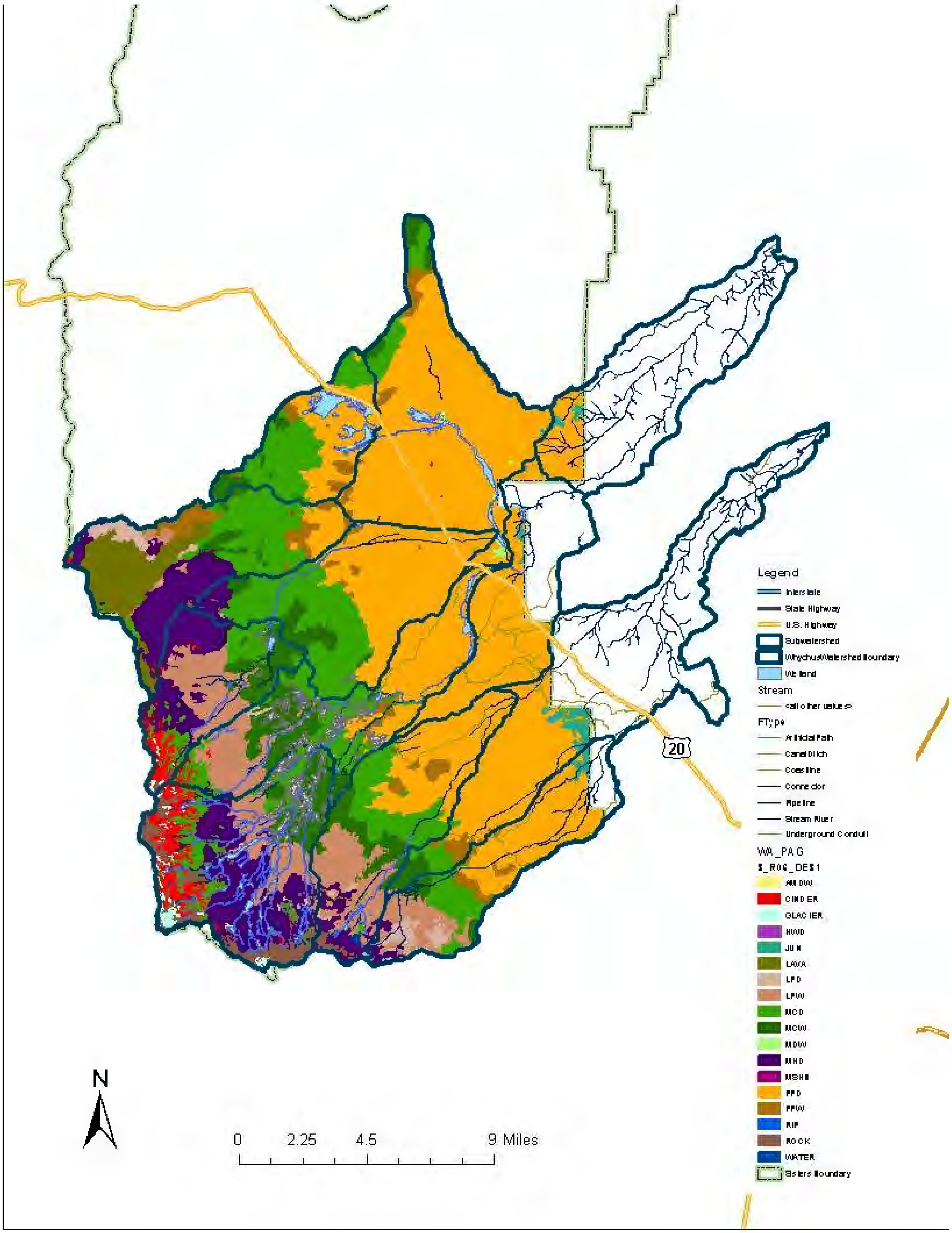
Plant Associations and Plant Association Groups

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	77,031	**Ponderosa Pine**	83,000	45%
Ponderosa Pine Wet	PPW	5,969			
Mixed Conifer Dry	MCD	32,517	**Mixed Conifer Dry**	32,517	18%
Lodgepole Pine Dry	LPD	2,191	**Lodgepole Pine**	17,922	10%
Lodgepole Pine Wet	LPW	15,731			
Mountain Hemlock Dry	MHD	16,525	**High Elevation Mt. Hemlock**	16,525	9%
Mixed Conifer Wet	MCW	15,854	**Mixed Conifer Wet**	15,854	8%
Cinder	CINDER	3,666	**Special (Non-Forest)**	12,739	7%
Glacier	GLACIE	711			
Lava	LAVA	4,919			
Rock	ROCK	3,443			
Riparian	RIP	1,318	**Riparian**	2,395	1%
Mesic Shrub	MSHB	886			
Hardwood	HWD	191			
Juniper Woodlands	JUN	1,407	**Juniper Woodlands**	1,407	1%
Alpine Meadow	AMDW	56	**Meadow (Non-Forest)**	1,362	1%
Meadow	MDW	1,306			
Water	WATER	231	**Aquatic (Non-Forest)**	231	<1%
GRAND TOTALS		183,952		183,952	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 and the update that was completed in 2009 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.
Since the 2009 update there has been continued treatment within vegetation management projects.

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	439
Sisters Area Fuels Reduction Project	31,329	17,573	9,419

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 effect 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. Stands within these project areas have experienced reduced densities and a slight change in species composition and stand structure.

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. All of the Pole Creek Fire wood cutting area and a portion of the Three Creeks Fire wood cutting area were burned in the Pole Creek Fire, reducing the area available to the public for personal use fire wood cutting.

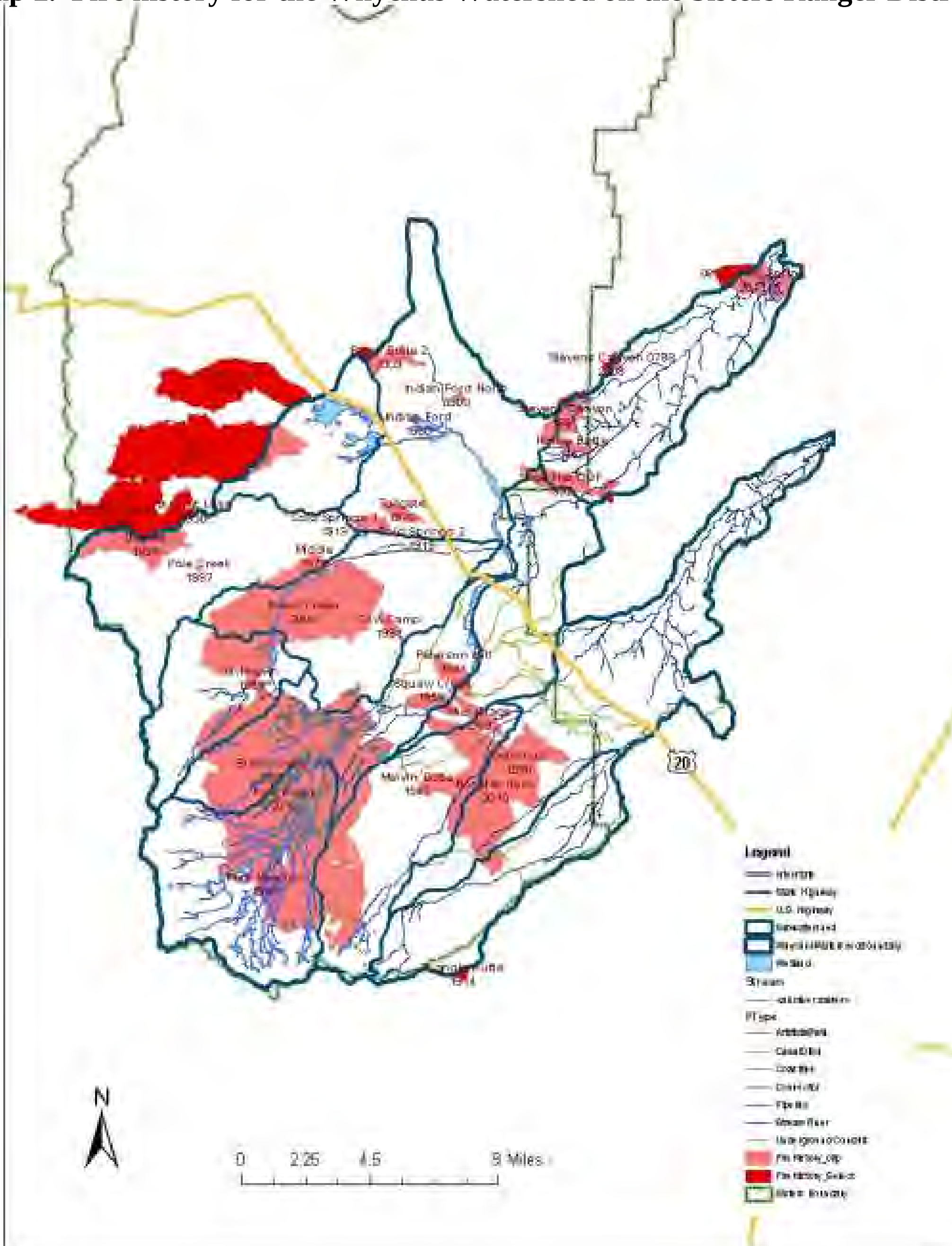
Wildfire

Since the original Whychus watershed assessment there have been eight wildfires greater than 10 acres within the project area as displayed in Table 3. Three of these fires have occurred since the 2009 update.

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	43
Black Crater	2006	9,411	9,396
Lake George	2006	5,537	1,857
GW	2007	7,349	954
Steven Canyon	2008	173	76
Black Butte II	2009	578	559
Rooster Rock	2010	6,119	6,119
Alder Springs	2011	1,449	1,052
Pole Creek	2012	26,119	26,119
Total		61,093	46,175

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



The Black Crater, Rooster Rock and Pole Creek fires burned entirely within the project boundary. However, the Cache Mountain, Lake George, GW, Steven Canyon and Black Butte II 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	10,846	6%
Moderate	14,499	8%
High	19,974	11%
Total	45,319	25%

*The Black Crater, GW, Rooster Rock and Pole Creek Fires were the largest fires, making up the majority of the burned acres within the watershed.
*Severity maps were not created for fires that did not have BAER, and severity is raster based rather than polygon based so there is a slight difference in total fire acres between the Fire severity table (Table 4) and the large fires table (Table 3).

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. Since the 2009 update there has been little change in the amount of mortality in lodgepole pine from mountain pine beetle as it was at the end of its cycle at the time of the 2009 update.

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 has reached 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 small pockets of 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, GW in 2007, Steven Canyon in 2008, Black Butte II in 2009, Rooster Rock in 2010, and Pole Creek in 2012), and the mountain pine beetle outbreak. Within the areas burned by wildfire there was a mix of severities, each of which has 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 11% 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 8% 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 6% of the watershed.

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 effect 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 effect 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 and LiDAR data from 2012. 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	1-3	0	17-18
Mixed Conifer Dry	22	8-33	6-18	0-4	10-19
Mixed Conifer Wet	30	10-18	5-10	0-3	21-26
Lodgepole Pine	83	0-1	0-1	90-100	0-8
High Elevation Mt. Hemlock	29	0-1	0-1	50-100	0-14
TOTAL	29	18-55	12-33	28-40	12-25

*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. Since the 2009 update and the Mountain Pine Beetle outbreak occurred there have been a couple of large fires, mainly the Pole Creek Fire in 2012 which have burned a number of these areas. The Pole Creek Fire burned 9,060 acres of the lodgepole pine PAG at varying intensities. Of the acres burned within the lodgpole pine PAG 3,070 were stand replacing, 4,276 were mixed severity and 1,714 were underburned. The Pole Creek Fire also burned 2,372 acres of the High Elevation Mountain Hemlock PAG, 609 acres of the Ponderosa Pine PAG, 5,113 acres of the Mixed Conifer Dry PAG and 8,038 acres of the Mixed Conifer Wet PAG.

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 shift 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 areas 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 19,974 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 (approximately 14,499 acres) 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 effect 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 19,974 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 (approximately 10,846 acres), 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) **45% 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 2009:

- There has been a slight shift in species composition or stand structure due to wildfire within this PAG in the watershed because there has been some 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 watershed. 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 **10% 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 2009:

- There has been a shift in species composition and stand structure due to wildfire within this PAG in the watershed due to the fires that have occurred within the watershed. Most of the change in species composition and stand structure occurred prior to the fires due to the MPB outbreak and then were burned up in the fires. Areas within the fire that were in the smaller size classes and had not been affected by the MPB outbreak were now burned in the fire.

- 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 **18% 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 2009:

- There has been a 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 due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The small classes have decreased due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The pole classes have decreased due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The seedling/sapling/pole class has decreased due to high severity fire, but has increased greatly within the lodgepole pine dominated stands due to the MPB outbreak.
- There has been a 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 **8% 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 2009:

- There has been a 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 due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The small classes have decreased due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The pole classes have decreased due to high severity, stand replacement fire, as well as decreased where lodgepole pine was the dominated species due to the MPB outbreak.
- The seedling/sapling/pole class has decreased 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 2009:

- There has been a slight effect on species composition or stand structure due to wildfire within this PAG in the watershed since the fires burned a small portion of this area. The biggest change is in the stands that experienced moderate to high severity fire, which will result in an increase in the grass/forb/shrub size class and a decrease in all the other size classes.
- There has been a slight change to the species composition, stand structure and density since the 2009 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, and a little potential old growth that experienced moderate and/or high severity wildfire.

RIPARIAN LPAG — 1% 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 2009*:**

- 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, as well as wildfires.

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 (10% 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 (8% 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 has 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.

2009/2013 (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.

Recent Fire Activity Related to Fire Regimes and Historic Fires

Some questions have been raised regarding the size and intensity of the recent wildfires in relation to historic fire regimes. Specifically,, was the size and intensity of the Pole Creek Fire within the historical range of variability for where it burned? The Pole Creek Fire burned primarily within 4 fire regimes: 1(low severity), 3(mixed severity), 4(high severity/stand replacement) and 5(high severity/stand replacement). 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 Whychus Watershed Analysis 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 what would be expected. The size of the stand replacement event may or may not be within the historic range of variability. In Langille and others (1903) numerous large fires are apparent on their maps and 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 desginations. 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 area 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 addition acres outside of wilderness. Simon also identified 13 other large (i.e., >50 acres) fires and of those, 4 were larger than 1,000 acres, and 9 were less than 1,000.

In conclusion, regarding fire regimes 4 and 5, fire intensity was within the historic range of variability, however, the size of the stand replacing event is likely outside 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 and 5. In the 1998 watershed analysis, most of the ponderosa pine and mixed conifer associations were found to be dominated by medium/large size early seral species 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 Langille and others (1903) below about 4,500' 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 wildfires, especially the Pole Creek Fire are outside the historic range of variability, in both size and intensity, for the ponderosa pine and mixed conifer.

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 11 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 19,974 acres were involved in stand replacement wildfire and 14,499 acres were involved in mixed severity wildfire, which may be available for salvage harvest. Within in Pole Creek Fire of 2012 10,304 acres were involved in stand replacement wildfire and 9,374 acres were involved in mixed severity wildfire, which would have the highest economic value for salvage, if harvested within the next couple of years. The other acres which were burned in fires prior to the Pole Creek Fire in 2012 are unlikely to be economically viable due to the amount of time that has passed since the fire occurred. These areas could be salvaged to provide firewood to local communities and proved economic value to local communities. 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 15+ 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.

SAFR Project unit which had thinning and prescribed fire on Rd 16/Rd 1514 junction before (top) and after (bottom) the Pole Creek Fire

Findings

- 25% (45,319 acres) of the watershed area has been involved in wildfire since 1998.
- 11% (19,974 acres) of the watershed area has experienced stand replacement fire in which virtually all vegetation canopy was consumed/removed.
- 8% (14,499 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.

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Resource Report
FIRE/FUELS

Pole Creek Fire in the Whychus Watershed, September 2012.
Photo taken from Broken Top by Katie Ryan.

FIRE/FUELS

Fire as an Ecological Process

Wildfires are a natural and desirable characteristic of forested landscapes, especially on the east slope of the Cascade Range (Agee 1993, Aplet 2003). However, in much of the Whychus Fireshed the current condition, as it relates to fuels and fire, are markedly different from historical conditions. Decades of fire exclusion, insect and disease activity, and previous forest management activities, have all contributed to increased vertical and horizontal forest fuel loadings, which has contributed to recent large fires across the Sisters Ranger District. These large wildfires have burned near and sometime into communities, threatening public safety, and damaging private and public property and infrastructure as well as natural resources. The 2012 Pole Creek Fire, for example, resulted in notice to community evacuations, burned structures, and destroyed 18 northern spotted owl nest areas before it was declared controlled.

Typically, wildfires have started within wilderness high country and moved east, driven by the prevailing wind patterns toward communities in the Greater Sisters area. Several recent large fires exhibit this burn pattern: 2003 - B&B, 2006 - Black Crater, 2006 - Lake George, 2007 - GW, 2011 - Shadow Lake, 2012 - Pole Creek.

Current forest fuel loadings are for the most part continuous and plant associations are variable, ranging from high elevation dry mountain hemlock and lodgepole pine to dense multistoried mixed conifer and ponderosa pine stands with a considerable shrub or small diameter understory tree component (Figure *). This spectrum of plant associations is associated with a similar array of historic fire regimes, fire history, fuel arrangements, and consequently fire behavior.

Evolving Fire Science

This section includes an overview of recently published science covering fire ecology topics such as fire history, and effects of thinning and burning on fire behavior and fuels. Everett et al.(2000) report on mean fire free intervals of 6.6 to 7 years in dry forest types during the pre-settlement period (1700/1750-1860**)** and lengthened intervals of 38 to 3 years during the fire suppression period (1910-1996). They found a clear shift to a less frequent, but greater severity fire regime, associated with longer recovery intervals (Everett et al. 2000)

Wright and Agee (2004) report mean fire free intervals of 7 to 43 years (1562 to 1995) in dry mesic forests of eastern Washington State. Sampling with Dry forests suggested that historical fires were of low intensity, leaving over story structure intact. The composition and structure of the historical forest was characterized by a preponderance of very large (>100 centimeters or 39.4 inches dbh) ponderosa pine. Mesic forests exhibit a wider range of fire severities, with moderate and occasional high severity fires or crown fires. Fire frequency and size decline dramatically about 1900, coincidentally with increased timber harvesting and fire suppression (Wright and Agee 2004).

The effects of thinning and burning on fire behavior and fuels have been well studied in the past decade. Evaluating fuel treatments from across the west, the reduction in fire behavior parameters and fuel loading is maximized by the combination of mechanical thinning plus burning (schwilk et al. 2009). Thinning alone by traditional commercial harvest methods leads to increases in small diameter (<1 inch dbh) surface fuels immediately after treatments (Agee and Lolley 2006), but these fuels decrease to pre-treatment levels within 5 years (Youngblood et al. 2008). Amounts of larger fuels (>1 inch dbh) post-thinning can significantly increase and may not decrease for a long period without the use of prescribed burning. Pre-commercial thinning using mastication equipment can increase total fuel loading and fuel bed depths by as much as two inches, but the magnitude varies by fuels size class (Harrod et al. 2008a). Thinning followed by burning significantly decreases surface fuel loading (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Youngblood et al. 2008, Harrod et al. 2008a) regardless of thinning method.

Canopy closure, canopy bulk density, canopy base height, and surface fuel loading influence torching and crowning fire behavior. Thinning generally reduces canopy closure and canopy bulk density, and increases canopy base height (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Harrod et al. 2007a, Harrod et al. 2007b, Harrod et al. 2008a, Harrod et al. 2009). Burning alone is less effective at altering these characteristics in mature stands (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Harrod et al. 2007b, Harrod et al. 2009, Schwilk et al. 2009), but can reduce surface fuels loading (youngblood et al. 2008), thereby decreasing surface fire behavior and the potential for fire to move into the canopy. However, burning alone can be effective alone in young coniferous forests for thinning stands from below, reducing surface fuels, and raising canopy base height (Peterson et al. 2007). Crown fire severity is generally mitigated by fuel treatment (prescribed fire only, thinning only, or combination), as compared to stands with no treatment (Pollet and Omi 2002, Finney et al. 2005).

National & Local Directives

National Fire Plan (2000)

The National Fire Plan is a series of documents with an accompanying budget request that guides fire and fuels management as to how best to respond to recent fire events, reduce the impacts of wildland fires on rural communities, and ensure sufficient firefighting resources in the future. The National Fire Plan is also where direction on reducing immediate hazards to the Wildland Urban Interface (WUI) began.

- Hazardous Fuels Reduction- Assign highest priority for fuels reduction to communities at risk, readily accessible municipal watersheds, threatened and endangered species habitat, and other important local features where conditions favor uncharacteristically intense fires

- Restoration- Restore healthy, diverse, and resilient ecological systems to minimize uncharacteristically intense fire on a priority watershed basis. Methods will include removal of excess vegetation and dead fuels through thinning, prescribed fire, and other treatments.

A National Cohesive Strategy

Fuels and fire management are also guided by A National Cohesive Wildland Fire Management Strategy (2011). This new strategy differs from the 2006 strategy in that it is national in scope, including the state and local government levels, whereas the 2006 strategy was only federal.

The National Cohesive Wildland Fire Management Strategy (Cohesive Strategy) builds on the success of the National Fire Plan, including the 10-Year Comprehensive Strategy and Implementation Plan, and other foundational documents: Quadrennial Fire Review 2009; A Call to Action; Wildland Fire Protection and Response in the United States; the Responsibilities, Authorities and Roles of Federal , State, and Local Tribal Government (Missions Report); and Mutual Expectations for Preparedness and Suppression in the Interface. It has developed in three phases, allowing stakeholders to systematically engage in a dynamic approach to planning for, responding to, and recovering from wildland fire. The three phases include:

Phase I: National Cohesive Wildland Fire Management Strategy (completed)
Phase II: Development of Regional Strategies and Assessments (in progress)
Phase III: National Trade-Off Analysis and Execution (2012)

The Cohesive Strategy seeks to provide clear guidance on roles and responsibilities for all wildland fire management entities and emphasizes how effective public-private partnerships and the sharing of responsibility among stakeholders are essential to achieving the identified three national goals. The goals of the Cohesive Strategy are:

1. **Restoring and maintaining resilient landscapes** – Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.
2. **Creating fire-adapted communities** – Human populations and infrastructure can withstand a wildfire without loss of life and property.
3. **Responding to wildfires** – All jurisdictions participate in making and implementing safe, effective, efficient risk based wildfire management decisions.

Sisters Country Community Wildfire Protection Plan

In 2004, the City of Sisters, local fire protection districts, Deschutes and Jefferson Counties, Oregon Department of Forestry, U.S. Forest Service, and the Bureau of Land Management formed a committee to develop a community wildfire protection plan (CWPP) under the direction established by the 2003 Healthy Forest Restoration Act (Project Wildfire 2009). The purpose of the Greater Sisters CWPP is to:

- Protect lives and property from wildland fires;
- Instill a sense of personal responsibility and provide steps for taking preventive actions regarding wildland fire;
- Increase public understanding of living in a fire-adapted ecosystem;
- Increase the community’s ability to prepare for, respond to and recover from wildland fires;

- Restore fire-adapted ecosystems; and
- Improve the fire resilience of the landscape while protecting other social, economic and ecological values.

The plan outlines a strategy, identifies priorities for action, and suggests immediate steps that can be taken to protect the communities from wildland fire while simultaneously protecting other important social and ecological values. The plan was revised in May 2006 to include considerations of community growth, seasonal recreation areas, and ingress and egress corridors that were not identified in the initial plan or in the Federal Register (Vol. 66 No 3.) and again in December 2009 to outline updated priorities and action plans for fuels reduction treatments, structural vulnerabilities, and defensible space in the Greater Sisters Country wildland urban interface (WUI). As a result of these revisions, the committee outlined the following goals:

- Reduce hazardous fuels on public lands;
- Reduce hazardous fuels on private lands (both vacant and occupied);
- Reduce structural vulnerability;
- Increase education and awareness of wildfire threat; and
- Identify, improve and protect critical transportation routes

And prioritized the following treatments on public lands:

- All areas where Crown Fire Potential is rated Extreme by the federal agencies within the designated WUI boundary (Figure 1) (*with priority given first to the areas within ¼ mile of communities at risk);*
- Within 300 feet of any evacuation route from each Community at Risk;
- For mixed conifer and lodgepole stands which have missed typical fire cycles and still pose threats of potential crown fires to communities, specific fuels treatments shall be accomplished on federal and state lands to reduce and maintain fuel loads to that which can produce flame lengths of less than four feet to provide for effective initial attack and minimize the resistance to control; and
- Although the treatments should focus on areas rated Extreme for Crown Fire Potential, maintenance of previously treated lands is also a top priority where treatment is critical to maintain this status within the CWPP area. Treatment and maintenance of previously treated lands before treatment begins again in other places is an important component of keeping communities safe.

Additionally, the committee determined that the overall WUI boundary would include communities as well as key transportation corridors and seasonal recreation areas with infrastructure.

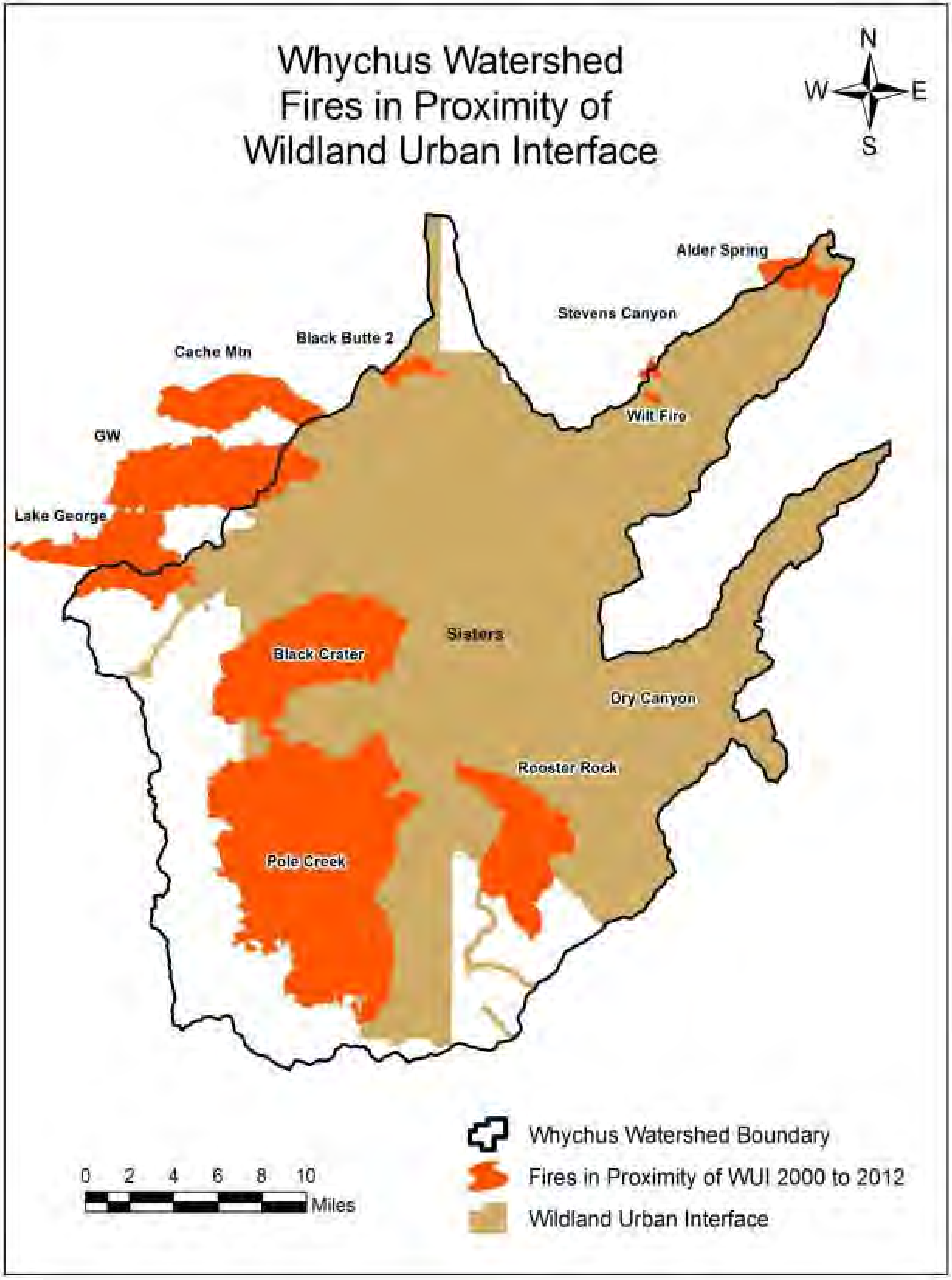

Figure * CWPP WUI + Significant fires within and adjacent to watershed

(Table*) 9 Significant fires in and adjacent to Whychus Watershed since 2000

Fire Name	Year	Cause	Fire Acres	Analysis Area Acres
Cache Mountain	2002	Lightning	4,358	43
Black Crater	2006	Lightning	9,411	9,396
Lake George	2006	Lightning	5,537	1,857
GW	2007	Lightning	7,349	954
Steven Canyon	2008	Lightning	173	76
Black Butte II	2009	Lightning	578	559
Rooster Rock	2010	Unknown	6,119	6,119
Alder Springs	2011	Human	1,449	1,052
Pole Creek	2012	Lightning	26,578	26,578
TOTAL			61,552	46,634

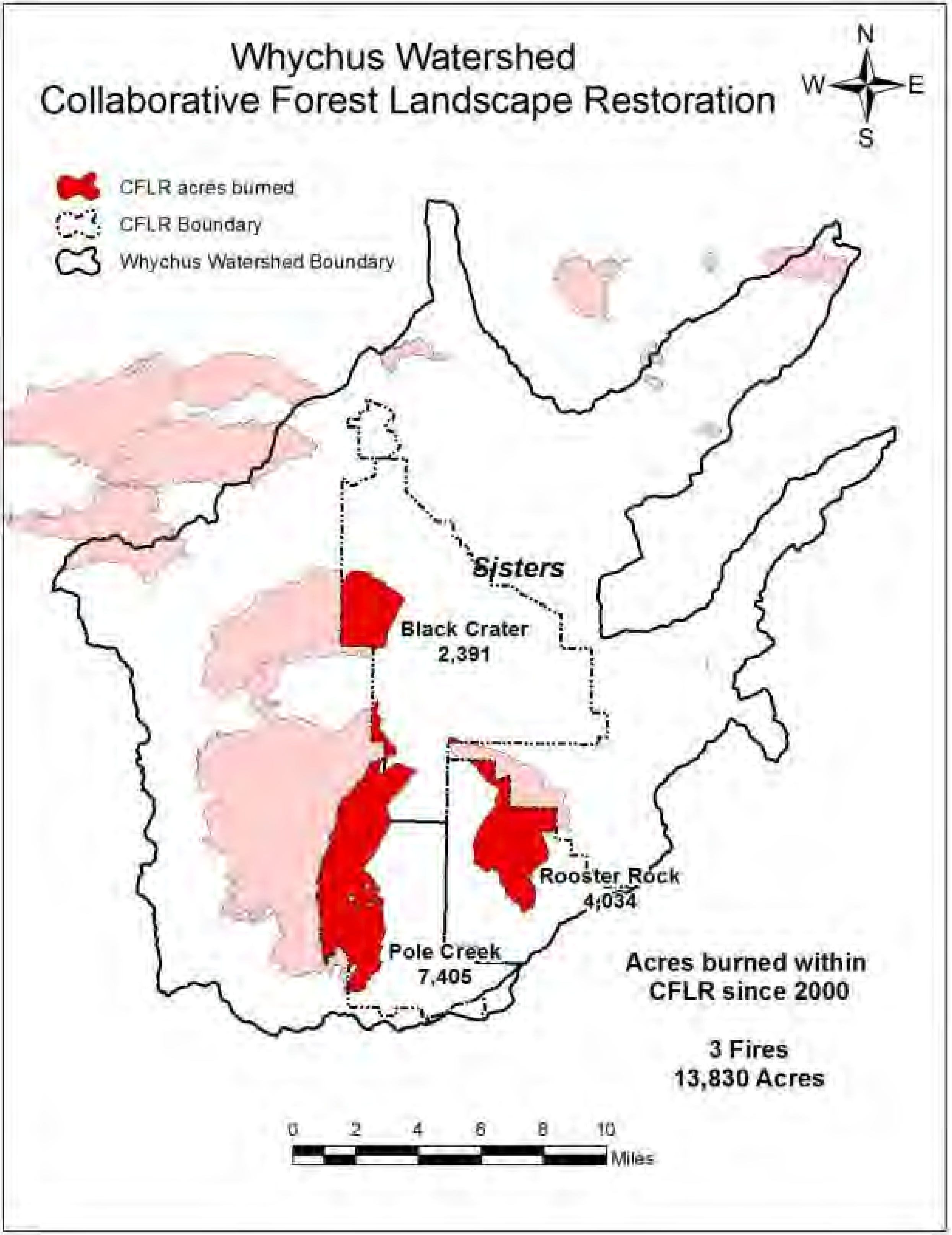

Figure 2- Whychus Collaborative Forest Landscape Restoration with Large Fires since 2000

Collaborative Forest Landscape Restoration Act

The Deschutes Landscape Strategy is an evolving process that recognizes and addresses the social and technical barriers to restoring forests is and fire resiliency on federal, state and private landscapes. Restoring forests and fire resiliency is needed across the intermountain west due to the altered forest and fuel composition found today as a result of a variety of activities including a century of fire exclusion. Studies of fire history and dendrochronological reconstruction combined with historical records and early survey information tell a compelling story of changing forests due to management changes. These stresses may be potentially exacerbated by climate change. Comprehensive landscape assessment processes, while limited across the intermountain west, are necessary to not only provide a science-based process for setting desired conditions and prioritizing management plans but to incorporate the social needs of a multi-stakeholder collaborative. Landscape level assessment should occur at scales large enough to encompass the largest typical natural disturbances, and include current forest condition, historic forest condition and the desired ecological, social and economic conditions across ownership boundaries.

Existing Conditions

Stands that were once open and park-like are now more densely stocked with small trees, they are more multi-storied, and have far fewer large fire resistant trees in the overstory than in the past. The Whychus Watershed Analysis (US Forest Service 1998) found that historically and even as recently as 1953, 97% of forest acres in ponderosa pine forests in the watershed were dominated by trees over 21" diameter. By 1998 only 9% of forest acres were dominated by large pine. This is because large trees were removed by timber harvest practices and many more small trees have grown in with the exclusion of fire and now dominate forest areas. Since 2009, management treatments within the Sisters Area Fuels Reduction (SAFR) project have occurred along with 4 significant wildfires within the Whychus Watershed.

The condition of forested land has a direct impact to safety and protection. The dense and multiple forest fuels layers which can be found in the untreated portions of the watershed increase the probability of high to extreme wildfire behavior, increase the risk of a wildfire spreading faster, increase the difficulty and danger in controlling a wildfire, and increase the danger to the public and firefighters. Not only is there a risk of a fire starting within the watershed area, there is also a risk of a fire starting on private lands and moving onto adjacent public lands.

Plant association groups found in the Whychus Watershed area can be further interpreted into historical fire regimes (Figure 3 & Tables 2-5). A fire regime is 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. Coarse scale definitions for four natural (historical) fire regimes were developed by Doug Havlina (2003), Schmidt et al. (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). These five natural (historical) fire regimes are classified based on average number of years between fires (fire frequency) combined with the severity (amount of mortality) of the fire on the dominant over story vegetation. Definitions of the five coarse scale categories are as follows:

Management Treatments

In addition to the large fires since 2009 approximately 24,000 acres within the analysis area have received some form of fuels or stand modifying treatment on federal public lands. These treatments consist of commercial harvest, precommercial thinning, pile burning, and underburning. This measure does not incorporate activities on private lands many of which have ongoing range and forest management activities accomplished.

Forest fuels treatments will thin concentrations of small and medium diameter trees to decrease the connection from the younger trees crown base height to the older trees crown base height. This space between tree crowns will decrease torching and crowning as well as increase growing space for the larger diameter trees. Low canopy base heights are the primary contributors to torching and crown fire initiation.

Mowing shrub concentrations around the base of desirable trees where needed will decrease the forest floor fuel connection to the crowns by reducing small trees and brush (fine ladder fuels). By reducing ladder fuels, mowing facilitates the reintroduction of prescribed fire and mitigates the effects of smoke on air quality during prescribed fires. By reducing shrubs mowing will also temporarily reduce wildlife hiding cover and browse quality; however, regenerating shrubs will be more vigorous and palatable. Mowing leaves behind ground organic mulch and generally produces little visual impacts.

Thinning in meadows and riparian areas, including aspen groves will promote regeneration of fire dependent species such as aspen and willows and reduce the potential for damage from higher intensity wildfire.

Prescribed burning would remove primarily fine fuels (< 3 inches in diameter) and with varied prescription conditions will create a mosaic of effects. This reintroduction of fire would reduce competition for nutrients and water by killing some undergrowth and will increase short term nutrient cycling. Prescribed fire will result in a charred appearance of lower tree boles and shrub skeletons for 1 to 3 years post burning. Scorch heights will result in a red or brown color to the lower limbs and needles of remaining trees, these effects will gradually disappear within a 1 to 3 year period. If prescribed fire is designed to thin or kill small trees, the area would have pockets of dead residual trees. Prescribed burning would allow bare soils to promote the regeneration of some species that have evolved in a fire-dependent ecosystem.

Post thinning and slash biomass removal and prescribed underburning will further reduce fuels to decrease rate of spread, flame length and duff mound build up and reduce high intensity fire behavior to lower intensities.

Fire Regime Descriptions

I. 0-35 years, low severity

Typical climax plant communities include ponderosa pine, eastside/dry Douglas-fir, pine-oak woodlands, Jeffery pine on serpentine soils, oak woodlands, and very dry white fir. Large stand-replacing fire can occur under certain weather conditions, but are rare events (i.e., every 200+ years).

III. 35-100+ years, mixed severity

This regime usually results in heterogeneous landscapes. Large, stand-replacing fires may occur but are usually rare events. Such stand-replacing fires may "reset" large areas (10,000-100,000 acres) but subsequent mixed intensity fires are important for creating the landscape heterogeneity. Within these landscapes a mix of stand ages and size classes are important characteristics; generally the landscape is not dominated by one or two age classes.

III+ IV. 100 -200 years; primarily moderately long – to long interval mixed severity and stand replacement fires.

Geographic areas: Pacific Northwest, Columbia Plateau, Great Basin. Potential Natural Vegetation Group (PNVG): Juniper Steppe-Infrequent. This PNVG is common on mountain slopes, high plateaus, scablands, and rim rock sites. Soils are shallow, stony, and low in organics. The climate is the most xeric for and tree occurring in the western U.S. Associates may include big sagebrush spp., curlleaf mountain mahogany, bitterbrush, rabbitbrush spp., and a variety of arid land bunchgrasses. Stand development patterns range from savannahs to old-growth individuals on rocky sites.

IV. 35-100+ years, stand-replacing

Seral communities that arise from or are maintained by stand-replacement fires, such as lodgepole pine, aspen, western larch, and western white pine, often are important components in this fire regime. Dry sagebrush communities also fall within this fire regime.

V. >200 years, stand-replacing or any severity

This fire regime occurs at the environmental extremes where natural ignitions are very rare or virtually non-existent or environmental conditions rarely result in large fires. Sites tend to be very cold, very hot, very wet, very dry or some combination of these conditions.

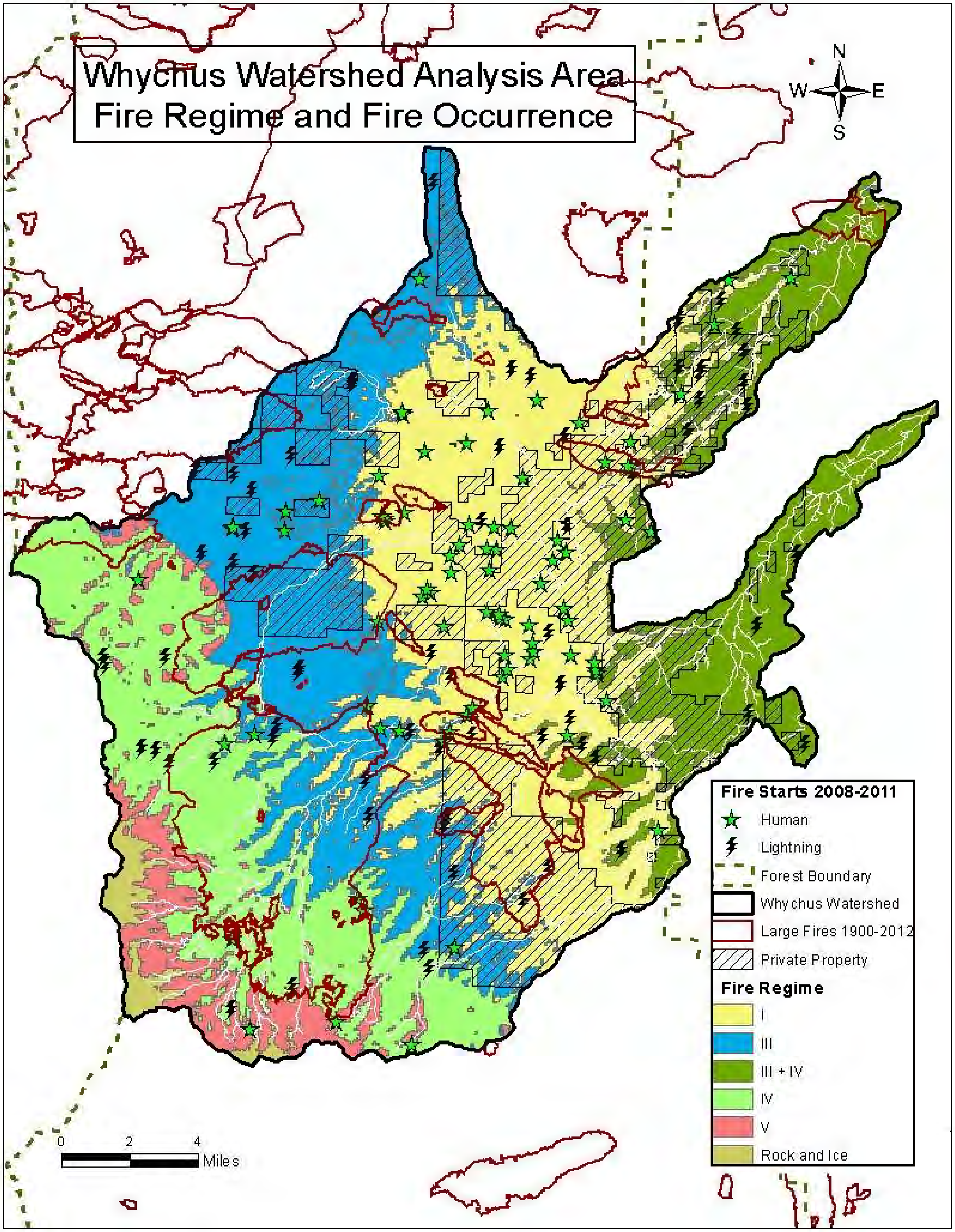

Figure 3 Watershed map with Fire Regime, Fire Occurrence, and Large Fires

Table 2 Fire Regimes within the Whychus Watershed boundary

FIRE REGIME	ACRES	WATERSHED
Fire Regime I	79,577	35%
Fire Regime III	55,460	24%
Fire Regime III + IV	34,881	15%
Fire Regime IV	43,990	19%
Fire Regime V	12,692	6%
Rock and Ice	3,555	1%

Table 3 1900-2012 large fire acres by Fire regime within the Whychus Watershed boundary

FIRE REGIME	LARGE FIRE ACRES
Fire Regime I	14,444
Fire Regime III	17,710
Fire Regime III + IV	1,726
Fire Regime IV	19,280
Fire Regime V	1,764
Total	**54,924 or 24%**

Table 4 2008-2011, point fire history within the W. Watershed boundary

FIRE REGIME	OCCURRENCE
Fire Regime I	87
Fire Regime III	30
Fire Regime III + IV	15
Fire Regime IV	16
Fire Regime V	4
Rock and Ice	1
Total	**153**

Table 5 1900 - 2011, point fire history on record within the W. Watershed boundary

FIRE REGIME	OCCURRENCE
Fire Regime I	360
Fire Regime III	69
Fire Regime III + IV	37
Fire Regime IV	33
Fire Regime V	13
Rock and Ice	4
Total	**516**

Vegetative conditions in the mountain hemlock plant dominated areas can generally be classified as Fire Regime V. 6% of the watershed falls into this fire regime. The whitebark pine/lodgepole pine dominated areas of the watershed analysis area are best described by Fire Regime IV where historically, a 35 - 100 + year fire return interval with high severity could be expected. Approximately 19% of the project area falls within this fire regime. Wet mixed conifer stands can generally be classified into Fire Regime III where mixed (i.e., low and high) severity fire at a 35 – 100 + year fire return interval was expected under historical conditions, 24% of the watershed analysis area falls into this category. 15%, comprised primarily of the juniper shrublands of the eastern portion of the analysis area, can be classified as Fire Regime III + IV. The highest percentage, 35%, of the analysis area can be classified into Fire Regime I, where frequent low severity fire at a 0 – 35 year interval could be expected under historical conditions (Table 2).

Fire has been an important disturbance process for millennia in forested wild lands east of the Cascade crest (Agee, 1993). Unlike today, fires of the past did not occur as isolated events, but rather, they occurred regularly and greatly influenced the development of forest habitats. As evidenced by the mapped fire regimes across the analysis area, historically fires have been a major influence in shaping the ecological components of the landscape. However, in recent times, fire suppression efforts have reduced the influence of fire across the analysis area. Although it is not possible to determine the number of ignitions suppressed prior to 1980 or how much area each one of these ignitions would have burned if they were not suppressed, it is evident that the majority of the analysis area has missed at least one typical fire cycle and is altered from that which would have occurred historically.

Large fires of record have burned acres 24% (54,924) of burnable acres in the analysis area since 1900 (Figure*). Of significance is that 62% (33,849 acres) of the acres consumed have occurred since 2009. This recent increase of large fire over the past few years is likely the result of the current vegetation condition across the landscape that is increasingly dominated by shrub and small tree ladder fuels, closed canopies, perhaps the increased fuel loading associated with the spruce budworm and mountain pine beetle outbreaks of the 1980s and 1990s, and/or an increasingly warmer and drier climate across the inland Pacific Northwest (McKenzie 2008, Davis et al. 2011). The 26,578 acre 2012 Pole Creek fire remains a significant example of what many dub as uncharacteristic wildfire, with approximately 31% of the burned area classified as Fire Regime III and 62% of the burned area classified as Fire Regime IV (lodgepole pine and dry& mixed conifer). Upwards of 75% of this acreage burned under high or moderate severity killing or stressing most all living over story. There is evidence that suggests large stand replacement events occurred in these plant associations historically (Heyerdahl 2012, Langille and others (1903), Simon (1991), Agee (1993)) however, the scale of fire size in Fire Regime IV may be uncharacteristic due to the homogeneous vertical and horizontal forest fuel loadings.

The change in conditions resulting from fire suppression and past management activities are most noticeable in Fire Regime types I, III+V, IV where increases in vegetation growth in the absence of fire and consequently increased fire hazard and fire size are apparent. The risk of losing key ecosystem components in these systems is still high in portions of the Whychus Watershed since the patch size of combined large fires since 2009 is so high.

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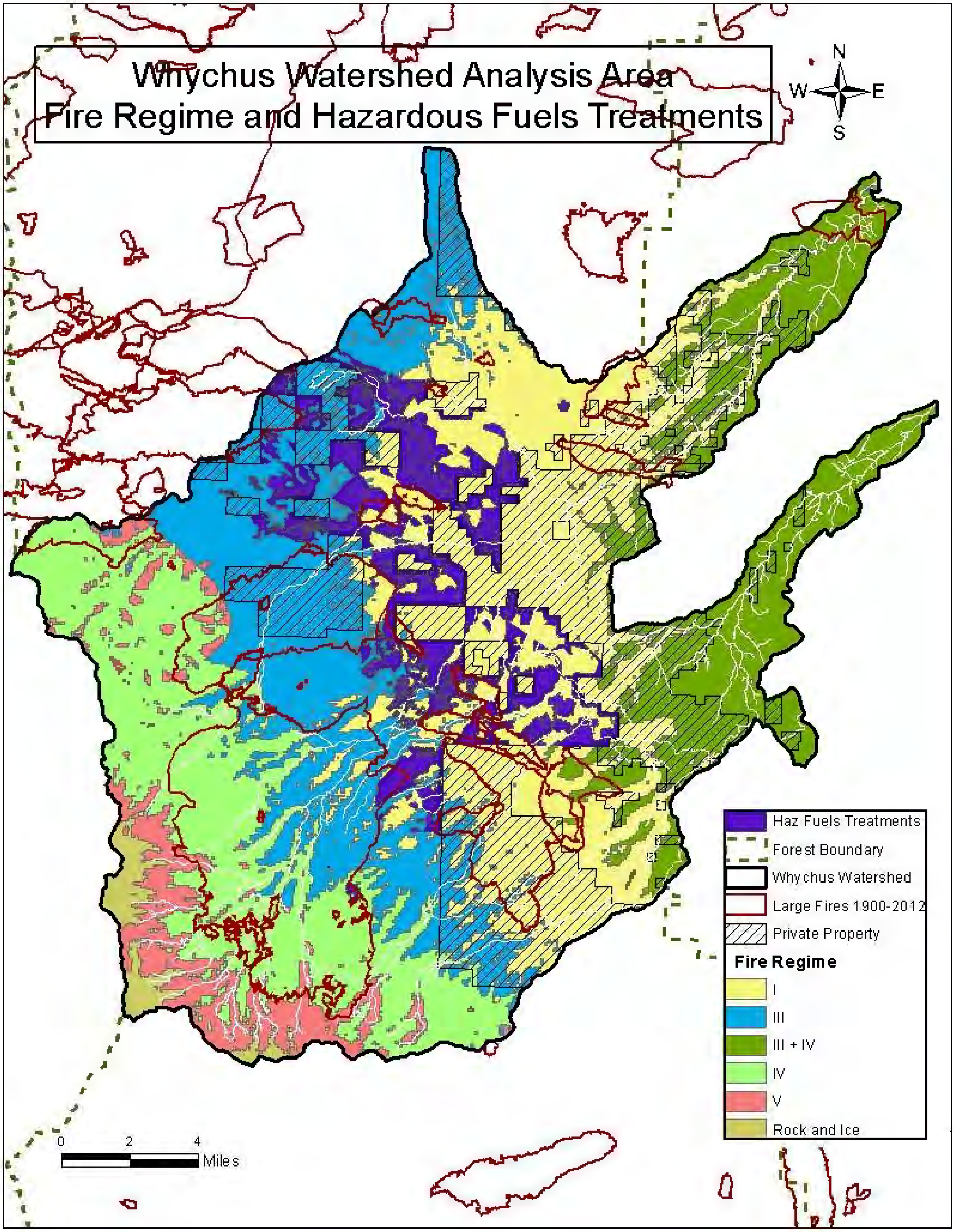

Figure 4 Watershed map with FR, hazardous fuels treatment, and large fires.

Trends common to all fire regimes

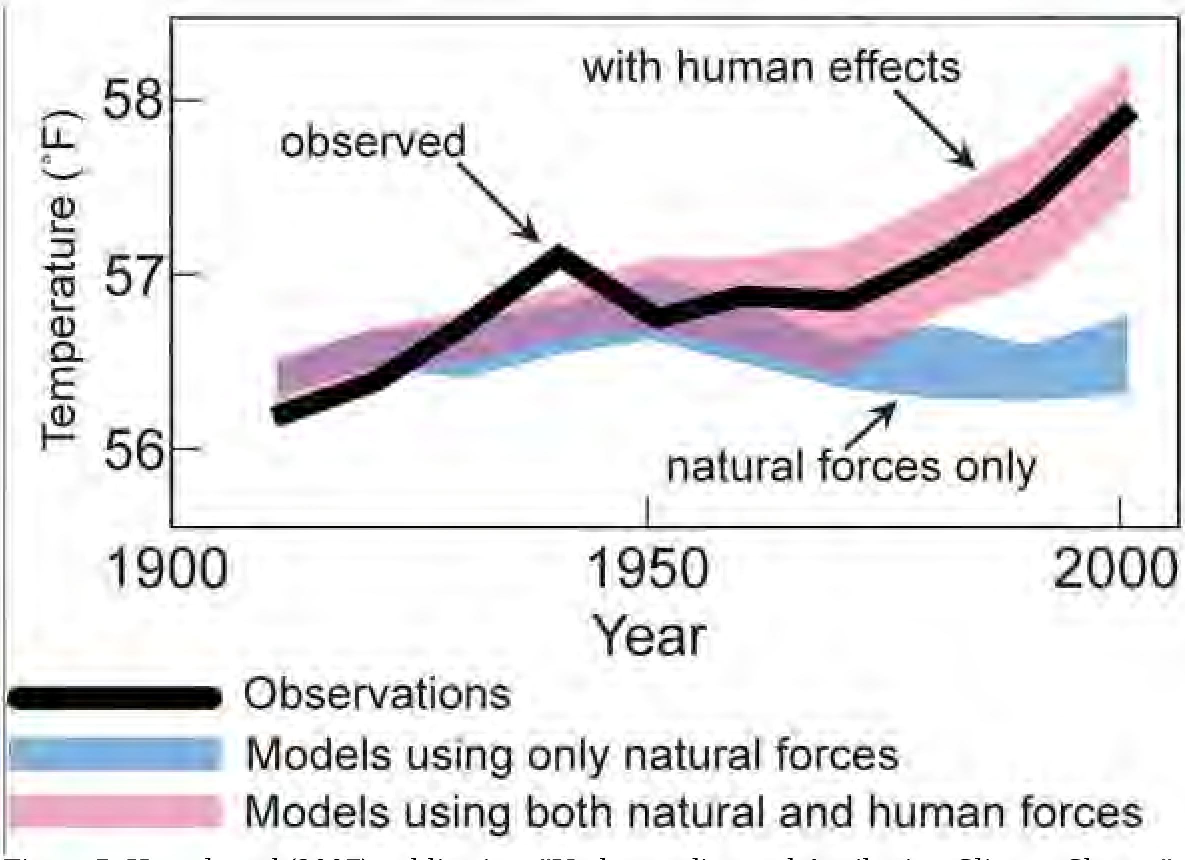

Figure 5 Hegerl *et al* (2007) publication, "Understanding and Attributing Climate Change", *The Physical Science Basis.*

Weather: Weather patterns attributed to the Pacific Decadal Oscillation (PDO) resulted in warmer drier weather between the early 1900's and mid 1940's. After 1945 the weather became cooler once again and continued moist until the early 1970's. By the mid 1970's the cool trends reversed and turned. Some research indicates this warmer dryer trend could last 70 years as illustrated above in Figure 5.

Condition class: The condition class within each fire regime will continue to evolve and deviate from the historic range of variability (HRV) with suppression of fire. This will expose each plant association to more intense fire behavior, greater resistance to control and potential loss of habitat (or creation of different habitat). Learn more about condition class in the vegetation report of the Whychus Watershed Analysis.

Fire suppression: Aggressive fire suppression will continue across the watershed to protect life, property and habitat.

Fuels Management: There is recognition that the conditions of the vegetation in the watershed represent a hazard that puts the habitat and public at risk. New treatment analysis is on the horizon for upland resources including Popper and West Trout Environmental Impact Statements located adjacent to the Three Sisters Wilderness along with a possible Environmental Assessment for Garrison in the low land northeastern portion of the Whychus Watershed.

Fire Regime: Some questions have been raised regarding the size and intensity of the recent wildfires in relation to historic fire regimes. Specifically, was the size and intensity of the Pole Creek Fire within the historical range of variability for where it burned? The Pole Creek Fire burned primarily within 4 Fire Regimes: I(low severity), III(mixed severity), IV(high severity/stand replacement) and V(high severity/stand replacement). 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 MetoliusWatershed Analysis regarding the historic distribution of forest size/structure, species composition and density.

Within Fire Regimes IV and V, which are primarily found within the wilderness areas, the intensity of the fire was well within the historic range and what would be expected. The size of the stand replacement event may or may not be within the historic range of variability. In Langille and others (1903) numerous large fires are apparent on their maps and 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 area 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 addition acres outside of wilderness. Simon also identified 13 other large (i.e., >50 acres) fires and of those, 4 were larger than 1,000 acres, and 9 were less than 1,000.

In conclusion, regarding Fire Regimes IV and V, fire intensity was within the historic range of variability, however, the size of the stand replacing event is likely outside the historic range of variability.

Management treatments such as thinning, mowing, and prescribed fire have occurred on 55 acres or 0% of Fire Regime IV within the watershed. Management emphasis has been focused in low land fire regimes. Although the Popper EIS was scheduled to be completed and signed in the fall of 2012, however the Pole Creek Fire burned through a significant portion of the proposed project area which has put the project on hold to analyze the affect environment post fire.

Large Fire Effects in Fire Regime IV & V

The 26,578 acre 2012 Pole Creek fire remains a significant example of what many dub as uncharacteristic wildfire, with approximately 62% (16,359 acres) of the burned area classified as Fire Regime IV (lodgepole pine and dry & mixed conifer). Upwards of 75% of this acreage burned under high or moderate severity killing or stressing most all living over story. There is evidence that suggests large stand replacement events occurred in these plant associations historically (Heyerdahl 2012, Langille and others (1903), Simon (1991), Agee (1993)) however, the scale of fire size may be uncharacteristic. The existing and potential fuel loading within Fire Regime IV will range from light to heavy based on burn severity within this area. Portions of the fire that burned at high and moderate severity can be expected to have fuel loading in excess of 70 tons per acre within the next five to twelve years.

Unburned & Underburned (low intensity)

The high elevation forests, (Fire Regimes IV and V) are recognized as being near the "natural" end of their fire cycles and stand replacement events is probable. The natural disturbances caused by insects, disease and fire are typical mechanisms that resulted in landscape changes within these fire regimes. During 1990's large portions of the landscape within and adjacent to the Three Sisters Wilderness area were affected by mountain pine beetle and spruce budworm infestation. By the late 1990's many of these patches of timber had died and snags had begun to fall resulting in elevated fuel loading across much of the area. **All unburned portions of Fire Regime IV and V are still at risk of stand replacement fire events.**

Burned areas

Areas that burned at high intensities resulted in stand replacement or mixed mortality conditions. FVS-FFE modeling of stands predicted dead trees will fall faster; logs will decay and result in a buildup of ground fuels that will likely exceed 70 tons per acre. Fire hazard associated to fuel loading is predicted last up to 60 years. Fire Risk could be minimized with high annual precipitation and snow pack and/or management treatments such as post fire salvage in strategic locations.

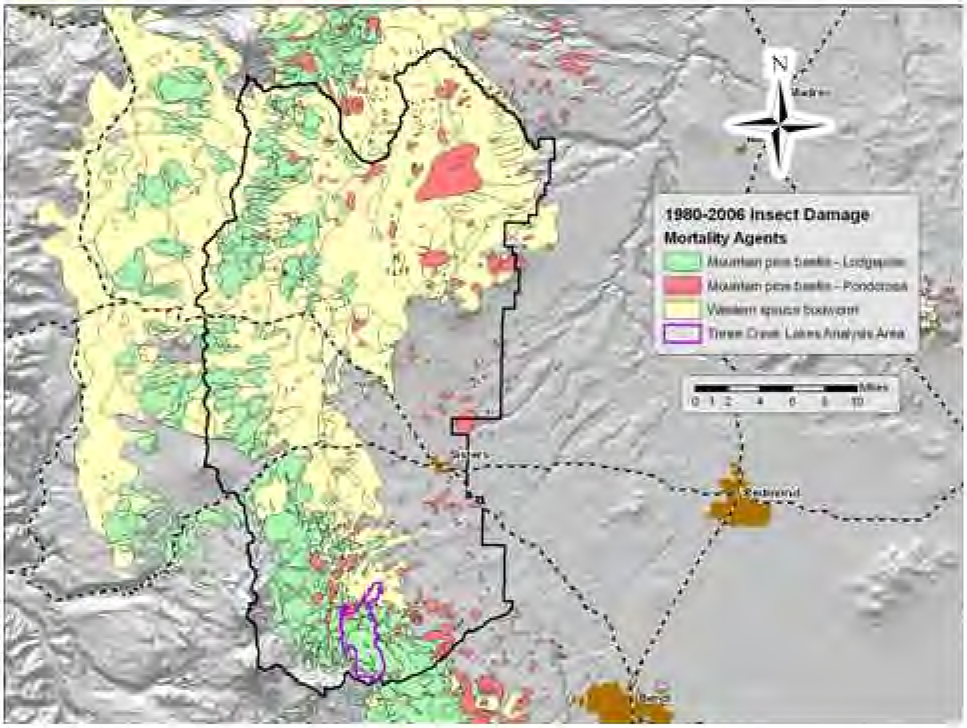

Figure 6 Map of insect mortality within and adjacent to the Sisters Ranger District

Trends specific to Fire Regime III +IV (15%)

Management treatments such as thinning, mowing, and prescribed fire have occurred on 210 acres or 0% of this Fire Regime within the watershed. The various combinations of the slope, aspects, and elevation within this fire regime create a landscape that could burn with a mixture of high, mixed, and low severity effects to vegetation.

Trends specific to Fire Regime III (24%)

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 I. A portion of the mixed conifer plant associations, especially the wetter/higher site mixed conifer associations, likely burned under Fire Regime III.

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 IV and V. In the 1998 watershed analysis, most of the ponderosa pine and mixed conifer associations were found to be dominated by medium/large size early seral species 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 Langille and others (1903) below about 4,500' elevation are in line with what might be expected in Fire Regime III. Fire Regime III 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 wildfires, especially the Pole Creek Fire are outside the historic range of variability, in both size and intensity, for the ponderosa pine and mixed conifer plant association groups.

Trends specific to Fire Regime I (35%)

Management emphasis has occurred in the watershed through the following lowland project analysis: Hwy 20, Sisters Area Fuels Reduction (SAFR), and Glaze. Since 2009, these projects have resulted in mechanical treatments such as thinning, mowing, and prescribed fire on approximately 17,752 acres or 20% of this fire regime within the watershed.

Large Fire Effects in Fire Regime I

The 2010 Rooster Rock Fire was a human caused fires initiated in the lowlands. This was an August, high fire danger indices fire that burned at moderate to high intensities on 4,632 acres or 75% of total fire size, in a high frequency low intensity Fire Regime I. Approximately 75% of the fire burned onto previously treated private lands within the watershed.

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Resource Report
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Introduction

The Whychus WA (Watershed Analysis) Update covers the portions of Whychus Watershed and the Three Creeks Subwatershed. All or portions of the following subwatersheds are included in this analysis; Upper Indian Ford, Lower Indian Ford, Fourmile Butte, Upper Trout Ck, Lower Trout Ck, Headwaters of Whychus Creek, Upper Whychus Creek, Middle Whychus Creek, Lower Whychus Creek, Three Creek, Deep Canyon, and Triangle Hill.

This document is intended to update conditions and recommendations since the (USDA) 1998 and Whychus WA (Watershed Analysis) and 2009 Whychus WA update was completed. Subwatershed boundaries and names have been updated since the 1998 Whychus WA. Some small streams have been mapped and added to the stream layer with some changes to stream routes to improve accuracy. The entire area will be discussed but data analysis and surveys are focused on National Forest lands. Within the analysis boundary the primary perennial stream channels are: Trout Creek, Alder Creek, Pole Creek, Whychus Creek, Snow Creek, Indian Ford Creek and Three Creek. Major tributaries to Whychus Creek include Soap Creek, Park Creek, E.F. Park Creek, W.F. Park Creek, N.F. Whychus Creek, and S.F. Whychus Creek. Some small unnamed perennial and several intermittent/ephemeral streams also exist.

Significant landscape changes have occurred since the 2009 WA update from the Rooster Rock Fire in 2010 and the Pole Creek fire in 2012.

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. Middle Columbia River summer steelhead are federally listed as threatened but above Pelton Round Butte dams they are considered an experimental population so the listing does not apply at this time. Steelhead were first reintroduced to Whychus Creek in 2007 below the analysis area but could access the project area once passage is provided around irrigation dams. Spring chinook reintroduction in Lower Whychus Creek was started in the spring of 2009. Spring Chinook habiat is located in Whychus Creek.

Alder Creek is a tributary to Trout Creek and 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. Recently with the installation of a headgate at the diversion point, more water from Pole Creek is being allowed to flow into its original channel and into Whychus Creek. Previous to this all of the water in Pole Creek was diverted into the ditch. Indian Ford Creek begins as series of springs at Black Butte Ranch. It is heavily used for irrigation and has historically gone 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 historically diverted for irrigation.

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 an approximate 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 along their entire length.

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 (USDA and USDI 1994b), INFISH (USDA 1995), 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, scenic resources, cultural prehistory resources, and cultural traditional use. These values need to be 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 WA, 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 have been 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.

Whychus Watershed Analysis (USDA 1998) for Riparian Reserves

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.

- ♦ If vegetation manipulation is needed, only treat a portion of the reserve in each entry so that untreated refugia is 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

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

Restore Forest Habitats through Vegetation Management

- 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

- 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 and Sensitive Aquatic Species

Within the WA area habitat exists for summer steelhead and spring chinook (EFH). Steelhead were reintroduced to Whychus Creek in 2007 and spring chinook were first reintroduced in 2009 through fry plants, which are ongoing. Reintroduced summer steelhead have been recently classified as an experimental population above the Pelton Round Butte dams. Columbia River bull trout are federally listed as threatened and it is unknown if bull trout were present on FS lands in upper Whychus Creek. Bull trout are present several miles downstream below near Alder Springs which is located a few miles above the mouth of Whychus Creek.

Redband trout are a USFS Region 6 sensitive species that are present within all streams that originally had native fish populations. In 2011 the Indian Ford Juga *Juga hemphilli ssp.* and A caddisfly *Rhyacophila chandleri* were added to the USFS Region 6 list of sensitive species that are either suspected or documented in the WA area. The Indian Ford Juga was documented in Indian Ford Creek near Indian Ford Campground (Frest & Johannes 1995). The A caddisfly has not been documented but is suspected in the area and typically inhabits cold headwater spring fed streams. These types of habitats are present in the analysis area.

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 analysis area. A map of fish distribution within the Whychus WA area is shown in Figure 1.

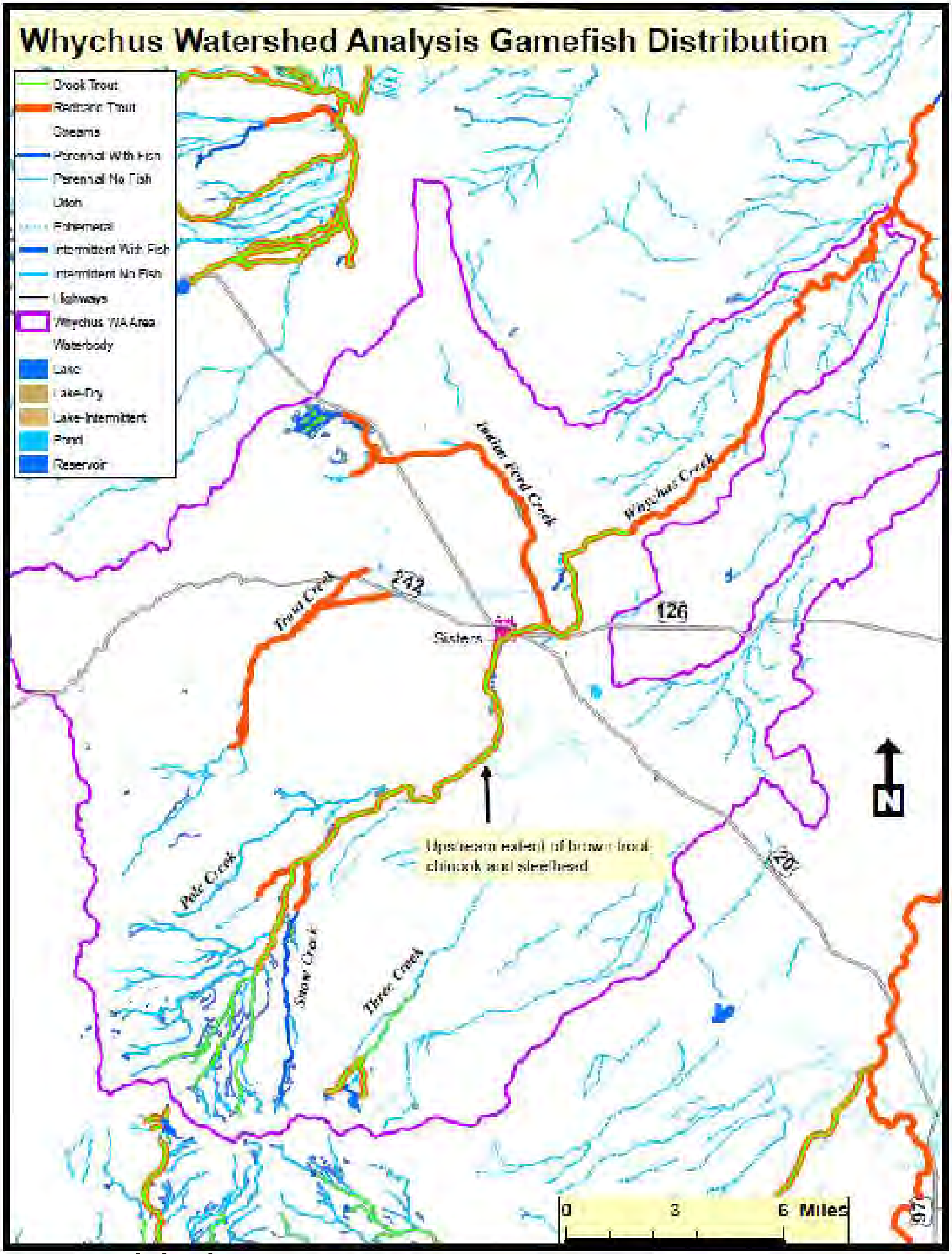

Figure 1. Fish distribution map

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 Trout Creek 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 has more frequently regained this connection after the Black Crater Fire.

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. Even with 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 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 in the lower portions of the stream are low to none in the 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 was used by the City of Sisters and now by one ranch that owns the water rights. The City of Sisters recently switched their water source to wells and does not use the water right at this time. Recently a hydrologic connection between Pole Creek and Whychus Creek was restored and some water now runs in the old channel. Pole Creek Swamp currently drains into Pole Creek and then Whychus Creek with a six to eight foot waterfall with boulder cascades present at the confluence. 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 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 flow has exceeded the capacity of the ditch during the winter time and caused water to run through the forest and down roads. This can create resource damage when Off Highway Vehicles use these wet areas. This should no longer be a problem because a headgate was recently installed and excess flow is diverted into the original channel with only the allocated water going into ditch.

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.

Much of Pole Creek Riparian Reserve and its subwatershed were burned during the Pole Creek fire. An above average rain event following the fire caused flooding and damage to roads and culverts associated with Pole Creek.

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. The stream goes subsurface before reaching Pole Creek.

Whychus Creek

The portion of Whychus Creek that flows within the project area is a Wild and Scenic River, with a ¼ mile corridor or greater 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 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 up to 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.

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 have been reintroduced starting in the 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 the loss of anadromous species as forage.

Whychus Creek, primarily above the 1514 road and its headwater tributaries were impacted by the Pole Creek fire. This already flashy stream will likely have more frequent and larger peak flows for several years to come until vegetation becomes reestablished.

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 seven foot falls exists that limits 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 at river mile 1.6.

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 historically was 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 Lake dam is determined to be stable water storage in the spring would enhance fish production and recreational activities at the lake. Another alternative is dam removal and this would allow greater fish movement between the lake and the stream.

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, the shoreline and the ditch from Little Three Creeks Lake. Brook trout have been observed spawning in Three Creek below the Lake and in the ditch that comes over from Little Three Creek Lake. Catchable rainbow trout are 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. The brook trout population is greatest 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 headwaters on private land 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 crew 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. The location and duration of dewatering changes yearly depending on water use, snow pack and other factors. Indian Ford Juga, a USFS Region Six sensitive species was documented near Hwy 20 in 1995 by Frest and Johannes, but little is known about this population.

Wilderness Tributaries to Whychus Creek

Within the Three Sisters Wilderness perennial streams that flow into Whychus Creek are N. F. Whychus Creek, S. F. Whychus Creek, Park Creek, E.F. Park Creek, W.F. Park Creek and Soap Creek. Of these Streams N.F. Whychus, S. F. Whychus Creek and Soap Creek are more influenced by glacial runoff with the others dependent on snow melt and high elevation springs.

N.F. Whychus had a small moraine lake fail in the early 1970's that sent a flood of water and debris down to Whychus Creek and evidence of this event can still be seen at the mouth from trees that were buried and a large delta of substrate. The effects of this event caused some bank erosion and bed scour that can still be seen along the stream. The S.F. of Whychus has not had such an event but has high amounts of boulders and bedrock substrate present. Other streams in the area are generally higher gradient (> 4%) and contain a lot of boulder and bedrock substrate that is located in Rosgen (1996) A and B type channels. However some short low gradient sections of Rosgen (1996) C type channels exist in Park Meadow and Red Meadow. Many of these wildness streams contain self-sustaining populations of brook trout that were introduced from the stocking of high lakes. The Park Meadow fire in 1996 was the last large fire in the area until the Pole Creek Fire in 2012. A stream habitat survey was completed two years after the Park Meadow fire and noted that wood recruitment and streambank erosion was increasing.

Disturbance and Change in Aquatic Systems

Resilient and functioning aquatic habitats are maintained through time with natural disturbance processes. Scientists studying aquatic disturbance events have characterized them into three categories: *pulse*, *press*, and *ramp*, depending on the duration, intensity, and spatial pattern of impacts, (Lake 2000, Reeves et al. 1995). This discussion focuses on pulse and press events because these are most relevant to the Whychus WA aquatic environment. Pulse events are intense and short term; press events reach a constant level that is maintained over time. An example of a pulse event would be a flood or fire that occurs over a relatively short time period. If the watershed where this event occurs is in a natural condition, the disturbance can be absorbed and, in fact, will help maintain the aquatic function through time. A press disturbance could be a change of land use that, over time, interrupts and maintains altered ecological processes. An extensive road network is a classic example of a press disturbance. Road networks can interrupt and alter flow regimes, change wood delivery, and contribute excessive amounts of fine sediment to the stream network. This is considered a press effect because it maintains degraded aquatic conditions over time. Human land use patterns have created increasing anthropogenic press disturbances affecting both the terrestrial and aquatic environments in the western United States, especially in lower elevation dry forests (Rieman et al. 2000).

Road Systems and Aquatics

Aquatic communities in the western United States have evolved in response to a variety of disturbance regimes, including glaciation, volcanism, and fire. Natural disturbances organize and maintain aquatic systems in western landscapes (Reeves et al. 1995) and shape species' resilience and persistence (Yount and Niemi 1990). Furthermore, disturbances have a dominant role in structuring aquatic communities (Yount and Niemi 1990).

Forest restoration treatments will require a transportation network for access and for removal of, trees and forest products. However, roads can have negative impacts on aquatic systems. Road networks affect aquatic environments by blocking fish passage, simplifying stream function, altering sediment delivery mechanisms and increasing fine sediment yields (Trombulak and Frissell 2000). According to Rieman and Clayton (1997), road construction causes the most severe disturbance to soils on slopes, far overshadowing fire and logging as a cause of accelerated erosion. Numerous studies have identified adverse effects of roads on the aquatic environment (Quigley and Arbelbide 1997, Gresswell 1999, Gucinski et al. 2001). Generally, as the density of roads in a watershed increases, aquatic habitat quality decreases. In a scientific literature review considering the effects of roads, Trombulak and Frissell (2000) stated, "Our review underscores the importance to conservation of avoiding construction of new roads in roadless or sparsely roaded areas and of removal or restoration of existing problematic roads to benefit both terrestrial and aquatic biota."

Today, roads are recognized as one of the primary issues affecting the aquatic environment (Gresswell 1999, Trombulak and Frissell 2000, Gucinski et al. 2001, Grace and Clinton 2007). Road management is currently complex for many reasons. One reason is that many historical roads still in use today were built in locations that would not be currently acceptable (Swift and Burns 1999, Grace and Clinton 2007). Roads built decades ago are often located in valley bottoms next to streams and are difficult to relocate (Swift and Burns 1999). Today's recreation use (duration and intensity) on many forest roads currently surpasses the original road design capability and has resulted in dramatic increases in sediment delivery to the stream network (Grace and Clinton 2007). A lack of sufficient maintenance, as well as increased use above original design specifications, increases sediment delivery to water bodies (Grace and Clinton 2007, Luce et al. 2001). Environmental solutions to road issues often call for reconstruction, relocation, or restoration (Swift and Burns 1999, Gresswell 1999, Trombulak and Frissell 2000, Grace and Clinton 2007).

Existing roads are often considered essential for effective fire suppression and fuels reduction projects. Brown et al. (2004) states that roads have negative interactions with some ecological processes and may increase human ignitions, decrease response time to wildfire, act as holding lines, and make prescribed fire easier to apply. They suggest that building new roads to implement thinning and prescribed fire may be inappropriate in roadless areas. Further, their findings along with others (Lee et al. 1997, Rieman et al. 2000) recognize that active management to improve forest sustainability will likely improve aquatic function. As related to fuels reduction, Brown et al. (2004) recommend focusing thinning in areas with existing road systems, and using minimal impact harvest techniques.

Grace and Clinton (2007) suggest the most acceptable approach to minimizing the harmful effect of the road system on the aquatic environment is to first focus on critical roads and relocate and/or reconstruct them. Luce et al. (2001) propose a hierarchical set of questions to identify road treatments that are the most ecologically effective and have the least fiscal and social cost: (1) where are the highest priorities ecologically; (2) within those, where are the most damaging roads; and (3) within those, which ones can we effectively decommission or mitigate.

Although some work has been done to close user roads and some system roads in the Whychus WA area, there are still higher than desired road densities outside of the wilderness (See Hydrology and Transportation sections). Many of these road miles are located in riparian reserves and are affecting aquatic systems, to varying degrees. These effects include altering stream channel patterns at road crossings, runoff with sediments from roads during the wet season, interception of overland flow and resulting road failure following the Pole Creek fire and degradation of riparian habitats and stream channels from dispersed recreation activities.

Riparian Habitat and Fire Interactions

Rieman et al. (2000) suggest that restoration of low elevation mixed fire severity
ponderosa pine forests has short- and long-term effects on aquatic ecosystems. In the short term, efforts to restore forests along riparian corridors could increase sediment loads and increase the risk of landslides and debris flows from steep facing drainages (Rieman et al. 2000). Current

habitat has been degraded in many of these forest types, and treatments (such as road decommission and relocation, culvert replacement, and thinning to restore old forest structure) could create more suitable habitat in the long term. Land managers need to consider a variety of spatial and temporal scales, improve **s**cientific understanding, and emphasize experimental design to understand the effects of restoration treatments on aquatic ecosystems (Rieman et al. 2000, Luce and Rieman 2005).

The relative continuity of fire behavior between riparian areas and adjacent uplands is influenced by a variety of factors, contributing to high spatial variation in fire effects to riparian areas. Fire typically occurs less frequently in riparian areas (Russell and McBride 2001, Everett et al. 2003). Riparian areas can act as a buffer against fire and therefore as a refuge for fire-sensitive species. However, under severe fire weather conditions and high fuel accumulation, they may become corridors for fire movement (Pettit and Naiman 2007). Fire effects occurring upstream will likely influence downstream conditions (Wipfli et al. 2007), as well as future fire behavior (Pettit and Naiman, 2007). In the eastern Cascade Range, ecological conditions vary dramatically from the Cascade crest east to the arid conditions adjacent to the Columbia River (Wissmar et al. 1994). Depending on geologic and topographic features, riparian conditions and response to fire also vary (Halofsky and Hibbs, 2008). Biophysical processes within a riparian area, such as climate regime, vegetation composition, and fuel accumulation are often distinct from upland conditions (Dwire and Kaufmann, 2003). This can be especially true for understory conditions (Halofsky and Hibbs, 2008). Considering these varied conditions that occur from the stream edge to upslope and from river mouth to mountaintop, riparian response to fire is complex and heterogeneous.

Landform features, including broad valley bottoms and headwalls, appear to act as fire refugia (Camp et al. 1996, Everett et al. 2003). Halofsky and Hibbs (2008) suggested a general rule from their study: the wider the stream, the lower the fire severity. Both of these studies correlated fire severity to vegetation type to varying degrees. These studies, combined with local knowledge, can help identify portions of riparian reserve/riparian habitat conservation area (RHCA) in which to minimize or avoid reintroduction of fire.

Fire events investigated by Everett et al. (2003) indicated significant continuity often occurred between riparian forests and adjacent side-slopes in steep, narrow valleys, troughs and ravines. Because these up-slopes and riparian forests have qualitatively similar fire effects, treatments guided by these findings are likely to restore ecological function of fire regimes at the landscape level (Finney et al. 2007).

Fire Effects on Fish Populations and Instream Habitat

A study by Rhoades et al. (2011) found that basins burned at high severity on 45% of their area had twice the stream water nitrate and four times the turbidity as basins burned to a lower extent; these analytes remained elevated through 5 years post-fire. Summer stream water temperatures were 4.0°C higher in burned streams on average compared with unburned streams (Rhoades et al. 2011). Dunham et al. (2007) indicated that summer maximum water temperatures can remain significantly elevated for at least a decade following wildfire, particularly in streams with severe channel reorganization. However the same study by Dunham et al. (2007) suggests that wildfire may be less of a threat to native species than human influences that alter the capacity of stream-living vertebrates to persist in the face of natural disturbance.

Instream fine sediments have been shown to increase immediately following a wildfire (Dachtler 2004, Jordan et al., 2004). Instream fine sediments can degrade salmonid spawning gravel quality and can reduce egg to fry survival in the redd. Amounts of sediment of five times the normal have been measured the first year following a large fire (Ryan and Dwire 2012). Generally in large fire areas these fine sediment increases from overland flow on burned hillslopes tend to decrease as vegetation recovers (McCowan and Wasniewski 2005, Robichaud and Brown 2002). Vegetative recovery can occur fairly quickly (2-5 years) depending on the forest type and elevation. However, fine sediments can become elevated above normal levels when channel process from bank erosion and increases in large wood occur after the fire and these effects can be longer lasting. Ryan and Dwire (2012) found that fine sediment levels were doubled eight years post fire and this was attributed to bank erosion and increases in large wood. However another stream study in British Columbia following a large wildfire and compared to an unburnt reference stream nearby found similar amounts of fine sediment suggesting that the burnt areas have remained relatively stable and that the sediment supply has not been dramatically altered (Eaton et al. 2009). In contrast, this study found that stream channel widening had occurred by over 100% of the original width in some places and was transforming from a laterally stable plane-bed morphology to a laterally active riffle-pool morphology. Following the Eyerly Fire unstable stream banks increased from 11.9 % to 22.4 % (Dachtler 2004). Along with fine sediments, fire and subsequent bank erosion contribute wood and coarse sediments that help create and maintain productive aquatic habitats (Reeves et al. 1995).

Fires may result in increased aquatic productivity by stimulating primary and secondary production (Minshall 2003; Spencer et al. 2003), which may ameliorate otherwise stressful conditions for fish (e.g., high temperatures) (Reeves et al. 2006). However these conditions may allow for populations of non-native fish and aquatic species to increase in size or distribution (Crowl et al. 2008).

Within and downstream of the recent fires on Whychus Creek, Snow Creek and Pole Creek increases in peak flows, nutrients, runoff, fine sediments, water temperatures, and large woody debris are expected to occur. Peak snow melt off timing may occur earlier in the year as was observed by Eaton et al. (2009). The magnitude, timing and duration of these effects will be determined by yearly snowpack and precipitation events. Exactly how these changes will translate to effect redband trout and steelhead fish populations is unknown but can be generalized. The productivity of Whychus Creek may actually increase above what it is currently upstream of Sisters from increases in sunlight and nutrients that in turn will increase periphyton and macroinvertebrate communities. Before the fire water temperatures were cold in this section, with healthy but not abundant macroinvertebrate populations (Lovtang and Riehle 2000). However these same effects may further raise temperatures downstream of Sisters causing increased stress to fish and possibly decreased survival. Downstream of Sisters is where water temperatures start to become elevated above the ODEQ temperature criteria of 18 °C due to loss of instream flow from irrigation withdrawals. Upper Whychus Creek although altered by the fire may become a cold water refugia for fish populations in the future. Habitat quality and adequate fish passage will be critical for allowing populations of redband and steelhead to flourish. It is also possible these same water quality changes may increase the distribution and abundance of non-native brook trout and brown trout. After the Eyerly Fire brown trout and three spine stickleback colonized Street Creek and made up 9.1 % of the fish population and they were not present previous to the fire (Dachtler 2003).

Within the WA area the Pole Creek Fire has had the greatest effect on the Whychus Creek watershed. The Rooster rock fire and Black Crater fires were smaller and did not burn much of the riparian areas on FS lands. Increased overland flow following the fire is expected to occur the most on subwatersheds located in the headwater streams of the Whychus Watershed based on high amounts of these subwatershed burned at high and moderate severity (Table 2). The Pole Creek and Snow Creek catchments were significantly affected by the fire (Riehle 2012) and these areas experienced rill erosion and road damage from an intense rainstorm that occurred shortly after the fire. Future sediment delivery was modeled using the WEPP model and it showed orders of magnitude greater sediment delivery from areas burned at high and moderate severity than those burned at low severity (see Soils Report). However this should become much less as vegetation recovers.

Although other fires on the district such as the B and B fire and Eyerly fire have revegetated rapidly, recovery in the high elevation areas of the wilderness may not recover as rapidly. Very slow vegetative recovery was noted in the Park Meadow fire area sixteen years after it had burned (Brian Tandy 2013 Personal communication).

Table 2. Subwatersheds burned at high moderate and low soil severities and the percent burned at high and moderate soil severity.

Subwatershed	High	Moderate	Low	Total subwatershed acres	Subwatershed burned at high and moderate severity
Headwaters Whychus Creek	265	4,062	2,924	22,764	19 %
Upper Whychus Creek	98	4,016	3,521	18,305	23 %
Upper Trout Creek	0	184	1,220	12,100	2 %
Three Creek	41	1,415	1,547	18,790	8 %
Lower Trout Creek	3	220	161	20,056	1 %

Channel changes and fines sediments will continue to enter streams and occur the most where riparian areas burned at high and moderate severity (Tables 3 and 4). Most of this will occur in low to moderate gradient reaches where banks are not armored with boulder and bedrock. These processes could add additional fine sediments, coarse sediments and wood to streams channels for up to a decade or longer.

Table 3. Miles of class 1-4 streams burned at different severity levels during the Pole Creek fire in 2012.

Subwatershed	Stream (mi) burned at high severity	Stream (mi) burned at moderate severity	Stream (mi) burned at low severity	Stream (mi) unburned	Total Stream (mi)
Headwaters Whychus Creek	0.4	11.2	11.2	9.5	64.2
Upper Whychus Creek	0.1	6.4	5.1	4.7	30.4
Upper Trout Creek	0.0	0.1	1.8	1.6	12.8
Three Creek	0.0	1.2	0.5	0.3	20.0

Table 4. Percent of class 1-4 streams burned during the Pole Creek Fire in 2012.

Subwatershed	% of streams burned at high and moderate severity	% of Streams Burned at Low severity	% of streams burned at all severities	% streams unburned
Headwaters Whychus Creek	18.1	17.4	35.5	64.5
Upper Whychus Creek	21.6	16.9	38.4	61.6
Upper Trout Creek	0.6	13.7	14.3	85.7
Three Creek	6.2	2.7	8.9	91.1

Climate Change Effects on Aquatics

Climate projections for eastern Oregon suggest that winter snow packs may decline, and the duration and severity of the summer dry period may increase (Bachelet et al. 2001, Mote et al. 2003 and McKenzie et al. 2004). East-side forests are particularly dependent on winter snowpack, the timing and quantity of which are expected to substantially change. Climate change is expected to have significant direct and indirect effects on forest ecology on the east side of the cascades (Mote et al. 2003, Keeton et al. 2007), including:

- Changes in the physiology and ecology of organisms, including trees and forest pests, due to increased temperatures and summer moisture deficits.
- Elevational and latitudinal shifts in the distribution of species and forest communities.
- In some cases, increased moisture stress will increase tree species vulnerability to insects and diseases, especially on the driest sites in densely forested stands.

- Increase in the severity and frequency of summer droughts may lengthen fire seasons and result in larger and more severe wildfires. A statistical relationship between climatic warming, lengthened snow-free seasons, and the frequency and size of wildfires has already been established for some parts of western North America (Westerling et al. 2006).

Climate change is likely to increase the challenges for sustainable forest management, including issues associated with wildfire and forest insects and pathogens (Franklin et al. 2008). Fortunately, logical management responses to climate change – such as reducing stand densities and fuels, treating landscapes, and restoring drought-tolerant and fire resistant species and tree size classes are consistent with management responses to other important issues, including forest health, wildfires, old and large tree structures, and protection of wildlife habitat (Franklin et al. 2008).

Climate change is also expected to increasingly alter hydrologic regimes of streams and rivers, based on studies that have considered the effects of climate change for the Columbia River basin. A review of scientific information completed by the Independent Scientific Advisory Board (ISAB 2007) identified numerous impacts of climate change. Bisson (2008) summarized expected changes from the ISAB report as follows:

- Warmer air temperatures will result in precipitation falling more often as rain rather than snow.
- Snowpack will diminish and streamflow timing will be altered.
- Streamflow magnitude will likely increase, with a shift in the timing of peak flow occurrence earlier in the water year.
- Water temperatures will continue to rise in streams and lakes.

Increases in large flood events, wildfires, and forest pathogen and insect outbreaks may reconnect floodplains and increase large wood accumulations. In combination, these effects may increase stream channel complexity (Bisson 2008). Depending on landscape position and stream habitat, dependent species such as trout and salmon may experience negative consequences resulting from climate change. A higher frequency of severe floods could scour streambeds and reduce spawning success for fall spawning fish (Bisson 2008). Smaller snowpack and earlier spring runoff would affect migration patterns for salmon and could therefore affect their survival in the ocean (Mote et al. 2003, Pearcy 1997). Summer base flows are expected to be lower and last longer, which would shrink available habitat, forcing fish into smaller and less diverse habitat (Battin et al. 2007, Bisson 2008). Summer temperatures in some stream locations that currently support salmon and trout could rise to a point where they become lethal (Crozier et al. 2008). Higher stream temperatures will likely favor non-salmonid species that are better adapted to warm water, including potential predators and competitors (Reeves et al. 1987, Sanderson et al. 2009).

How streams will be affected by Climate Change in the WA area will likely be similar to effects described above. Climate change effects will likely be exacerbated by the effects of the recent wildfires and more frequent large wildfires caused by outbreaks of forest insects and diseases are often seen as a result of climate change. Large fires will create more disturbance and sediment delivery to streams (Goode et al. 2011). Local climate change research suggest that much of the Upper Deschutes Subbasin may shift from a snow-dominated regime to a rain-dominated regime by the middle of this century (Graves 2008). However, large portions of the Deschutes subbasin overlay porous volcanic rock, which is an important storage mechanism for water, and a year-round source of cool groundwater inputs into surface streams. Spring fed streams will experience a lower rise in water temperatures because groundwater provides a year-round storage and delivery mechanism for cool water, even when snowpack is lost (Graves 2008). Isaak et al. (2011) estimates that stream temperatures will rise 0.3-0.45 °C per decade and this coupled with decreases in summer instream flows could create bottlenecks for fish survival and rearing capacity during the summer months. A long term dataset over 20 years on juvenile brown trout and Atlantic salmon indicates higher water temperatures and lower base flows, as a result of climate change has significantly reduced these populations (Clews et al. 2010). Bilby et al. (2007) estimates salmon habitat loss across the Pacific Northwest from temperature increase and summertime flow loss would be most severe in Oregon and Idaho with potential losses exceeding 40% by 2090.

Aquatic Invasive Species

Primary known aquatic invasive threats to streams include ditymo, New Zealand Mudsnails, whirling disease, and chytrid fungus. These species can be spread through wading gear. There are established methods to disinfect gear and education of the public on where these species exist and how to prevent their spread is important. In lakes the known treats include zebra mussels, quaga mussels, Eurasian milfoil and other aquatic plants. Education and cleaning of watercraft are the primary methods of prevention with these species. Introductions of other non- natives species such as crayfish, snails or goldfish is also a concern. New threats of aquatic invasive species not listed above could also become a concern in the future.

Another form of invasive species includes game fish introductions and the illegal movement of other native species found in the Northwest. In the WA area these include brook trout, brown trout and hatchery rainbow trout. Stocking of non-native game fish by ODFW outside of wilderness lakes without connection to stream systems with native fish populations is no longer occurring. But self-established populations of these species exist in many areas. Other species of concern not native to Central Oregon include three spine stickleback, tui chub, goldfish, brown bullhead, bass, catfish and sunfish, which are all known to be established in the Upper Deschutes Subbasin.

In the WA area known populations of invasive species include a population of Chinese mystery snails in Indian Ford Creek at Black Butte Ranch. Populations of brook trout exist in Whychus Creek, Three Creek, wilderness lakes and wilderness tributaries. Brown trout are found in Whychus Creek up to the TSID diversion and have expanded upstream in the last 5-10 years. Hatchery stock rainbow trout are found in Three Creek that find their way out of Three Creek Lake.

Riparian Vegetation 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 areas that were not recently burned are similar to what is described in the Whychus WA (USDA 1998) and Whychus WA update (USDA 2009). Encroachment of white fir and lodgepole pine may be affecting some small stands of aspen and cottonwoods in specific areas. Areas of aspen and/or cottonwood that burned at moderate to low severity may actually benefit from the fire in the long term by creating openings for more light and killing competing vegetation.

Areas that have seen change since the 1998 WA include the Riparian Reserves of lower Trout Creek that got burned during the Black Crater Fire reducing shade and creating some streambank instability. The Pole Creek fire in 2013 burned through riparian areas in Upper Whychus Creek, Pole Creek, upper Trout Creek and Snow Creek. The Rooster Rock Fire originated in in the riparian area of Whychus Creek but burned very little of the riparian area, it did however burn parts of Three Creek that are on private land. Whychus Creek summertime flows below the TSID diversion have improved from purchasing water rights and conservation through piping. Close to 25 cfs of flow has been restored to Whychus Creek since 1999 (Deschutes River Conservancy 2013). The increased flows have created more favorable growing conditions for riparian vegetations and aquatic species. Above Sisters roads and campsites along Whychus Creek have been closed or defined 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 some areas in upper Trout Creek were burned at low to moderate severity during the Pole Creek fire in 2012. 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 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 future wood recruitment to upper Pole Creek where a large die off of lodgepole pine has occurred. The perennial portion of Pole Creek above the 1514 road was noticeable affected by the Pole Creek Fire.

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. 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 mountain alders and Engelmann spruce is located 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 stands dominate the lower part of the stream and transition to more white fir and mountain hemlock at higher elevations. Lodgepole and ponderosa pine are scattered in pockets along the stream, with high densities of white fir in some locations. 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. This has likely caused these wetlands to shrink in size from the drying effect and the encroachment of conifers. 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 Indian Ford Swamp then through aspen/ponderosa pine plant associations. Riparian vegetation occurs in the floodplain and consists of aspen woodlands in the upper reaches and willow/sedge plant associations in the lower reaches. Glaze meadow also has an intermittent stream that feeds into Indian Ford Creek. Glaze meadow has been impacted by historical ditching to dry out the meadow to make it better for grazing. 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 USFS grazing permit and allotment management plan was recently approved for the Indian Ford Allotment which is located Southeast of the 2058 road crossing. Active beaver ponds and dams are present in several locations along the creek and are probably the primary natural disturbance factor for this stream system.

East Fork Park Creek

East fork Park Creek was surveyed for fish and habitat in 1998. A portion of the stream had been burned two years earlier by the Park Meadow Fire. Riparian vegetation consisted of a thin strip of grasses and ground cover with mountain hemlock and lodgepole pine. Willows and native grasses were present in Park Meadow and some other areas.

In-Channel Fish Habitat Conditions

The following sections present the most current data for riparian vegetation and in-channel habitat conditions. The majority of this data was collected using the USFS Region 6 stream inventory protocol (USDA FS 2013). All of this data was collected prior to the large fires in the WA analysis area except for the East Fork Park Creek data which was collected after the Park Meadow Fire. Stream inventory reaches within the Whychus WA area are displayed in Figure 2. Water temperature data was collected by various agencies and organizations including the USFS, UDWC and ODEQ.

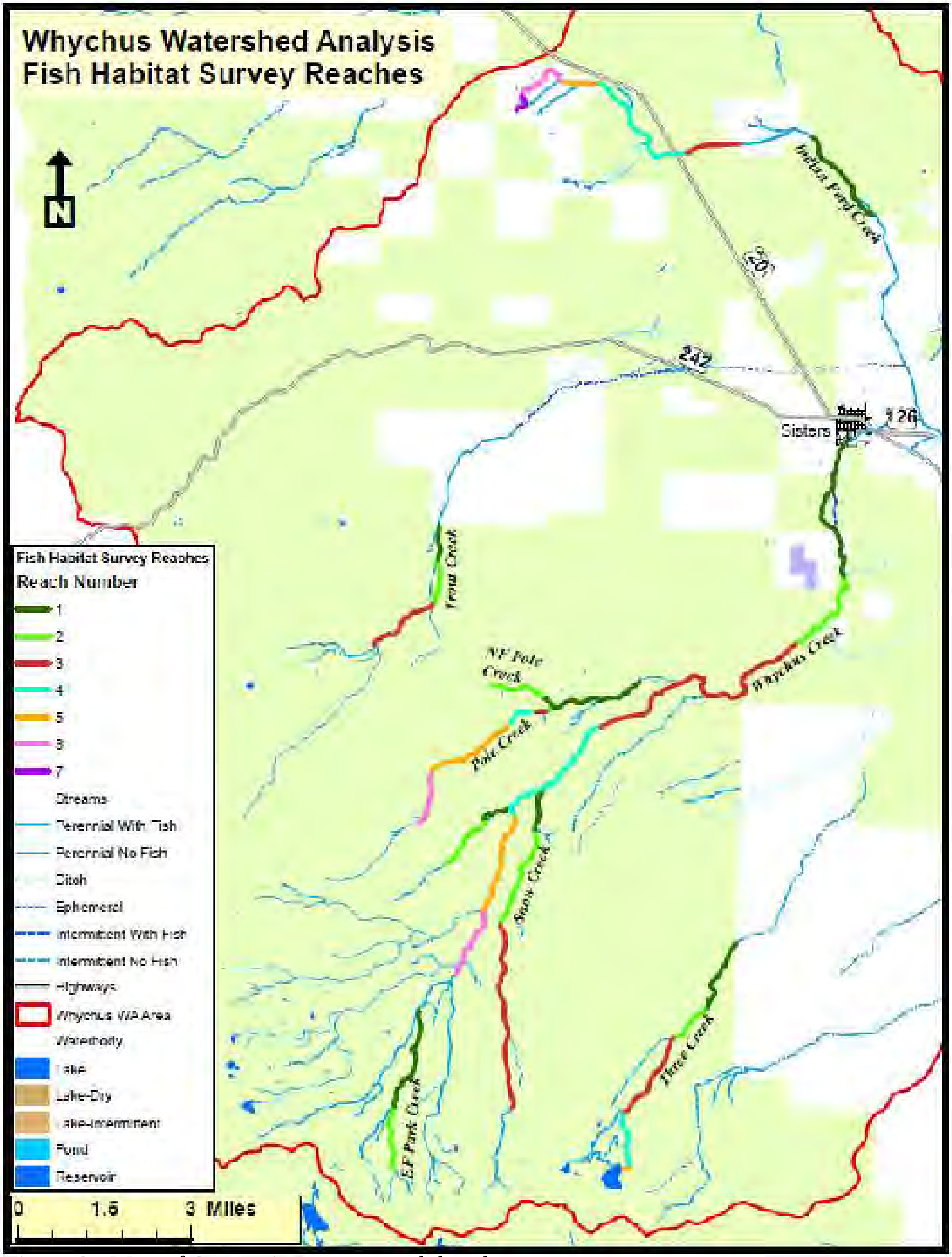

Figure 2. Map of Stream inventory reach breaks map.

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 at Whispering Pines Campground during 1996, 2000 and 2001. Temperature data was also collected above the 1018 road crossing in 2001. Daily maximums collected with the electronic thermograph at Whispering Pines Campground did not exceed 14 °C. Monthly maximum thermograph temperatures during July and August of 2001 at the Whispering Pines Campground 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. Daily maximums collected with electronic thermographs in 1995 and 1997 were around 12 °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. At the 4606 Road below TSID and Sokol diversions, 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 shows it exceeded the ODEQ temperature criteria at this location as well.

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.

The highest water temperature in E.F. Park Creek measured during the July 1998 habitat survey was 56 °F with warmer water noted coming from the tributary flowing out of Golden Lake.

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. 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 road, likely a reflection of high water temperatures.

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. Snow Creek was not measured for embeddedness during the 2007 stream inventory but pebble counts 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.

A stream habitat inventory for Indian Ford Creek was first performed in 1992 and data from this survey is included in the 1998 WA. The 1992 survey found that the majority of gravel and cobble substrate was embedded more than 35 % in each habitat unit (Mullong 1992). In 2010 a stream habitat inventory was completed on Indian Ford Creek from the USFS allotment below the Pine Street crossing to the headwaters at Black Butte Ranch. Substrate particle measurements in the lower stream reaches showed substrate was 100% fine sediments until above the Highway 20 crossing. This is likely because it is low gradient, has several historical beaver dams and has a wide floodplain that is in many areas is a wetland. The influence that historical livestock grazing may had on this in the past is unknown. Upstream of Highway 20 pebble counts amounts of fine sediments (<2mm) were still very high (over 40 %) except for one pebble count which had 23% fine sediments. It is likely past grazing, ditching, pond building and development have affected the stream which is entirely spring fed and does not receive high flushing flows to move fine sediments. Parts of the stream have wetlands and beaver ponds which have had naturally high amounts of fine sediments before they were altered.

E.F. Park Creek was not measured for embeddedness in 1998 but pebble counts ranged from 14 % to 38 % fine sediments (<2mm). It is unlikely that this creek has embedded substrate.

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). Wood recruitment in Snow Creek, Upper Whychus Creek and Pole Creek will likely increase due to tree mortality after the Pole Creek fire.

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 5). 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 5. 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 6). 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 young ponderosa pine plantations have replaced the mixed conifer stands in certain areas along the stream.

Table 6. 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

N.F. 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 N.F. 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 1997 stream 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 7).

Riparian Reserves 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.

Table 7. 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

Pieces of medium and large sized woody debris per mile in Snow Creek were high except in reach 3 (Table 8). 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 8. 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 fir in reach 4 (Table 9). Reaches 2 and 3 were dominated by lodgepole pine and white fir. Lodgepole pine seldom grow to larger size classes that meet the USFS Region 6 definition of large wood. 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 smaller lodgepole pine 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 9. 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 been surveyed twice, once in 1990 and more recently in 2010. Medium and large wood sized wood ranged from 0 to 27.8 pieces per mile (Table 10). Reaches with no large wood and low amounts of wood were located in wide wetland areas with no sizable trees present. Also in reaches 6 and 7 large wood or surrounding large trees may have been removed in the past on private land. Indian Ford Creek is not large enough to move even small sized pieces of wood.

Table 10. Indian Ford Creek large wood attributes from the 2010 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
Indian Ford Creek	1	19.7	57.0	1.894	0.654
	3	6.8	63.6	1.625	0.174
	4	27.8	85.2	1.628	0.531
	5	0.0	1.6	0.004	0.000
	6	0.0	1.1	0.020	0.000
	7	0.0	20.5	0.060	0.000

E.F. Park Creek located in the wilderness had from 15.4 pieces of large and medium sized wood in reach 2 but a portion of this reach was located in meadow where tree there is no tree recruitment (Table 11). The stream can probably move small sized wood in reach 1 during high flow event but movement of larger size classes is not likely.

Table 11. E.F. Park Creek large wood attributes from the 1998 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
E.F. Park Creek	1	12.3	35.4	0.078	0.226
	2	15.4	24.0	0.032	0.051

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 greater than 3 ft deep 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 12). 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 12. 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 13). 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 13. 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.

On Whychus Creek periodic high flows 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 high flows can leave the main channel and access the floodplain and some of its overflow channels (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 WA 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 altered flow regimes, the stream may have reduced its potential to form stable deep pools. Pools are primarily formed by bedrock and boulders 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 14) 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.

Table 14. 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

The 2007 stream inventory data for Snow Creek found a similar number of pools per mile in the first two reaches with much fewer pools in reach 3. This is most likely due to the higher gradient in reach 3 (Table 15). The majority of pools for the survey were formed by woody debris with an increase in pools formed by boulders in reach 3.

Table 15. 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 16). 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 16. 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 Indian Ford Creek.

The 2010 Indian Ford survey found low numbers of pools in all reaches except for reach 5 (Table 17). Slow water pool like habitat exists in reaches 1, 3, 4 and 6 with marshy characteristics. These habitat units do not fit the typical pool definitions with undefinable breaks or pool tail crests and were mostly called marshy areas in the survey if no definable channel could be found or in some cases were called non turbulent riffles.

Table 17. Inventoried pools, average residual pool depth, and number of pools with large wood in stream reaches of Whychus Creek within the project area.

STREAM	REACH	Average residual pool depth ft	Pools / mile	Pool >3ft deep/mi	Pools Frequency
Indian Ford Creek	1	6.5	0.5	0.5	0.017
	3	3.5	1.1	1.1	0.029
	4	1.4	8.5	1.9	0.035
	5	1.7	17.2	9.4	0.026
	6	3.0	7.6	7.6	0.142
	7	1.4	2.3	0.5	0.017

In E.F. Park Creek pools over 3 feet deep were only found in reach 1 and riffles made up the majority of the habitat in both reaches (Table 18). Pools were more frequent in the short Park Meadow area but this was not broken out into its own reach.

Table 18. E.F. Park Creek pool habitat attributes from the 1998 stream inventory.

STREAM	REACH	% Pool	Pool Residual Depth (feet)	# Pools >3ft Deep/mi	# of Pools Frequency	Pools Per Mile
E.F. Park Creek	1	7.1	1.5	1.8	0.045	13.2
	2	2.4	1.5	0.0	0.020	9.6

Off-Channel Habitat

Backwaters and side channels provide important habitat for fry and juvenile 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 during low flows 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 non existent 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 4,000 ft^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 floods into 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 short spring fed stream that enters 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 during the 1990 survey had 0.6 % of the habitat as side channels. However other forms of off channel habit exist in marshy wetland areas and beaver ponds, and manmade ponds. During the 2010 survey numbers of side channels were low and ranged from 0-7 per reach. Side channels made up less than 1% of the habitat except for in reaches 5 and 7 where side channels accounted for 19 % and 7 % of the available habitat.

In E.F. Park Creek refugia is limited with only one percent of the habitat in reach 1 comprised of side channels. Some refugia may be available in the tributary that comes in from Golden Lake (Dachtler 1998).

Spawning Gravel Quality

Aquatic habitat is developed and persists around different varieties 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 effect 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 N.F. 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 very little 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 high stream bank instability in some areas.

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 non existent 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 where you enter Black Butte swamp. There are also areas of spawning gravels on Black Butte Ranch near the headwater springs. Both the 1990 and 2010 survey found sand and silt to be dominant substrate in reaches 1, 3, 4 and 6 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.

In E.F. Park Creek Amounts of fine sediments ranged from 14 % to 38% Suitable spawning gravels were present in both reaches with reach 1 having from 35% to 41% gravel and reach 2 having from 33% to 53% gravel. These condition likely help maintain the natural reproduction of brook trout.

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 amphibians and aquatic insects can also be impaired by 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 would 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 prohibits 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 may 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 until recently caused a disconnect with the original stream channel and its connection to Whychus Creek.

N.F. 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 a 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. Some bridges restrict floodplains and straighten channel meanders that cause increased stream bank erosion and channel widening downstream of these bridges. 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 and Leithauser diversion dam. Recent fish passage improvement projects have occurred at the TSID diversion dam, Leithauser diversion dam and another concrete structure located on private land just upstream of Sisters. The restoration of fish passage and fish screens was recently completed in 2011 for the new and old TSID diversion dams. A small falls upstream of the USGS gauge (Road 16-390) is a fish barrier but this may change as the falls was created by a wood jam on large boulders that has trapped bedload behind it. Chush falls is located just inside the Three Sisters Wilderness is a natural fish barrier and the upstream extent of redband trout.

On Snow Creek the 1514 road culvert 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 is perched on the downstream end. It unknown to what extent this culvert may be prohibiting upstream fish movement but it is scheduled to be replaced with an open arch culvert in 2013. 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 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 during some summers fish passage is not the primary issue. Another culvert on the old mainline road (205 road) is also a fish passage barrier and it is scheduled to be removed in 2013. Several beaver dams along the creek may also create temporary or seasonal fish passage barriers. Also a small irrigation diversion dam in reach 4 creates a small drop onto boulders which likely makes upstream fish passage difficult especially during low flows.

On E.F. park creek a 150 ft high falls near the bottom or reach 1 prohibits upstream fish migration. In reach 2 a 40 ft fall is located at the upper end and no fish are present above this (Dachtler 1998).

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 or have side channels.

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 N.F. Pole Creek refugia is currently not an issue because no fish populations are present and a 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. Complete access to the upper reaches is currently not possible due to an impassable diversion dam. 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 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. This is expected to increase from the effects of the Pole Creek fire in the Upper Watershed.

In Three Creek the main area of refugia is in reach 5 up near the dam which usually has water flowing all year. A self sustaining brook trout population is located in this reach. 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 currently 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 but it is fishless.

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.

Width to depth ratios ranged from 16 to 22 in Whychus Creek and may reflect instability and past channel alterations in some locations (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 and channel entrenchment. 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 the diversions had 6.4 % bank instability indicating that portions of Whychus Creek may have naturally elevated 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 in some locations.

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 and since Black Butte Ranch became a resort and not a working ranch. During the 2010 survey bank instability was found to be very low in all reaches and ranged from 0 % to 0.9% except for reach 5 which had 2.2 % unstable stream banks.

However, grazing still occurs in Indian Ford Creek riparian areas on the USFS allotment below the 2058 road, at Black Butte Ranch and on private lands. 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 and have had riparian vegetation removed. 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 or ditching practices.

On E.F. Park Creek two years after the Park Meadow Fire reach 1 that had burned had 7 % unstable banks while the unburned reach 2 only had 1.7% Some bank instability was noted in from dispersed camping and horse packers in Park Meadow.

Changes in Aquatic Habitat since 1998

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 is entering stream reaches that have lodgepole pine and to a lesser extent white fir due to insect mortality. It is also likely that reaches with second growth pine are slowly losing large pieces of large 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 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.

The most notable change to Whychus Creek has been the reintroduction of steelhead in 2007 and spring chinook in 2009. Reintroductions are being done with fry releases on a yearly basis. 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. Projects to provide passage and fish screens around four of these dams were implemented from 2010 to 2012. Once passage is achieved around the Sokol dam 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. The 900 road which runs along an intermittent stream to Whychus Creek was decommissioned in 2011. 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. Currently almost 25 cfs is secured for instream benefits below the TSID diversion. 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 to pipe canals from the TSID and Uncle John diversions have helped with restoring instream flows. A large scale restoration project was completed in 2011 in Camp Polk Meadow where the stream was previously straightened and since had become entrenched. Another project above the 4606 road footbridge is being planned to improve habitat and reconnect side channels and floodplains that had been cut off by berms placed after the 1964 flood.

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.

Portions of the riparian zone on Trout Creek got burned during the Black Crater Fire and the Pole Creek Fire. Portions of Whychus, Snow Creek and Pole Creek got burned during the Pole Creek 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 tree 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. However there are still several roads that are located in Riparian Reserves or near sensitive wetlands that should be considered for future closure. Increases in peak flows, large wood, fine sediment, stream temperature and nutrients are expected in areas affected by the Pole Creek Fire. Especially in areas that burned at high and moderate severity.

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. Within the water challenges priorities completing fish passage and habitat restoration within Whychus Creek should be a priority to improve conditions for reintroduced steelhead and chinook salmon. Continued instream flow restoration should also be a priority. Almost 25 cfs of instream flow has been added to Whychus Creek meeting the ODFW instream flow goal (Deschutes River Conservancy 2013). This is a vast improvement from when the stream used to go dry but a study by Jones (2011) indicates that 67 cfs would be need to meet the ODEQ water quality criteria of 18 °C and this would increase habitat capacity and the survival of reintroduced steelhead.

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Resource Report
WILDLIFE

WILDLIFE

Introduction

The Whychus Watershed Analysis Update is needed to analyze changes from two fires that occurred since 2009. The 6,113 acre Rooster Rock occurred in 2010 in the Deep Canyon watershed, primarily in the ponderosa pine dry plant association group. Of these acres, 1,363 were stand-replacement (high severity), 4,628 acres were mixed mortality, and 122 acres were underburned or unburned. Approximately 80% of this fire occurred on private lands and 20% on Federal lands. The private lands in this fire were salvage logged in 2011. The federal lands were not salvaged.

The Pole Creek Fire occurred in 2012 and burned approximately 26,272 acres in five subwatersheds in the Whychus watershed: Headwaters Whychus Creek, Three Creek, Upper Whychus Creek, Upper Trout Creek, and Lower Trout Creek. Of the acres burned, 406 acres were high-severity (stand-replacement), 9,987 acres were moderate or mixed-severity burns, and 15,879 acres underwent low-severity or underburns. The Pole Creek fire occurred in mixed conifer wet and dry, and lodgepole pine wet plant association groups.

The entire watershed analysis area encompasses 230,155 acres. Nine subwatersheds in the Whychus watershed (HUC 10) are included in this analysis: Upper Indian Ford, Lower Indian Ford, Fourmile Butte, Upper Trout Creek, Lower Trout Creek, Headwaters of Whychus Creek, Upper Whychus Creek, Middle Whychus Creek, and Lower Whychus Creek. Three subwatersheds in the Deep Canyon watershed (HUC 10) are also included: Deep Canyon Dam-Deep Canyon, Snow Creek Ditch, and Three Creek.

Appendix 1 lists the threatened, endangered, and proposed species under the Endangered Species Act, Regional Forester Sensitive Species, and Deschutes National Forest Land and Resources Management Plan Management Indicator Species, and whether they have habitat in the Whychus watershed analysis area.

Threatened, Endangered, and Proposed Species under the Endangered Species Act

Gray wolf - Endangered

The gray wolf was added to the list of species required for analysis for the Deschutes National Forest (Forest) in 2010 (USDA FS 2010). Gray wolves occur in a wide variety of habitats. They prefer forested habitats with some open areas such as river valleys and meadows for hunting prey including pronghorn, deer and elk, and smaller mammals. Wolf packs (usually 5-10 animals) can have very large territories up to 400 square miles or larger. Key wolf habitat components identified in the 1987 Wolf Recovery Plan (USDI FWS 1987) are: 1) a sufficient, year-round prey base of ungulates and alternative prey, 2) suitable and somewhat secluded denning and rendezvous sites, and 3) sufficient space with minimal exposure to humans. Den sites are excavated areas in the soil but wolves also use hollow logs, beaver lodges, the base of hollow trees, pit excavations, and rock caves, usually near water. Rendezvous sites are the activity sites used by wolves after the denning period and prior to the nomadic hunting period in fall and winter. These sites are often in open grassy areas near water or at forest edges.

In Oregon, the gray wolf is listed as federally endangered in areas west of Highways 395, 78 and 95 which includes the Forest. In 2011, a single male gray wolf was documented dispersing through the Deschutes National Forest and subsequently traveled south into California. In 2012, it was documented moving back and forth across the California/Oregon southern border. There is a low probability that a gray wolf could use the Whychus watershed for dispersal. The watershed analysis area does not likely contain habitat for denning or rendezvous sites. Currently there are no Section 7 consultation requirements under the Endangered Species Act for the gray wolf on the Deschutes National Forest. Neither the Pole Creek Fire or Rooster Rock fires affected gray wolf dispersal habitat in the Whychus watershed.

TREND: The gray wolf has increased in Oregon from 14 individuals at the end of 2009 to a minimum of 46 at the end of 2012 (Oregon Department of Fish and Wildlife 2013).

Northern Spotted Owl - Threatened

Recovery Plan and Critical Habitat

The spotted owl final recovery plan was revised on June 30, 2011. It listed the most important range-wide threats as competition with barred owls, ongoing loss of habitat as a result of timber harvest, habitat loss or degradation from stand-replacing wildfire and other disturbances, and loss of amount and distribution of habitat as a result of past activities and disturbances. To address these threats, the recovery plan includes four steps: (1) completion of a rangewide habitat modeling tool; (2) habitat conservation and active forest restoration; (3) barred owl management; and (4) research and monitoring. Efforts to promote forest resiliency in the context of climate change was also emphasized. The previous recommended network of Managed Owl Conservation Areas identified in the 2008 Recovery Plan was eliminated.

Critical habitat for the spotted owl was revised on November 21, 2012. The final designation changed the boundaries of the previous 2008 designation and increased the number of acres on the Forest. Under the 2012 critical habitat rule, 27,837 acres are designated in the watershed analysis area in the East Cascades North unit (subunit 8), which is a 59% increase from the number of acres listed under the 2008 critical habitat designation. The 2012 designation was finalized prior to the 2012 Pole Creek fire.

Spotted Owls in the Watershed

The western half of the watershed occurs within the range of the northern spotted owl under the Northwest Forest Plan boundary. Approximately 2,280 acres of Nesting, roosting, and foraging (NRF) habitat are no longer functional in the watershed due to the Pole Creek fire. Currently there are 7,414 acres of NRF habitat in the watershed. Of these, 4,032 acres are in the

Congressionally reserved allocation (4,013 acres in wilderness and 19 acres in wild and scenic river), 3,299 acres are in late-successional reserves, and 83 acres in the matrix allocation.

There are four known spotted owl activity centers in the watershed: Bluegrass Butte, Black Crater, Trout Creek, and Snow Creek. Table 1 lists the number of acres of NRF habitat in each activity center. The Pole Creek fire resulted in a mix of fire severities. Stand-replacement (>75% mortality) and mixed mortality (25-75% mortality) fires resulted in the loss of 33 acres of NRF habitat in the Trout Creek activity center and 367 acres of NRF habitat in the Snow Creek activity center. The Snow Creek home range is no longer considered viable due to the large number of NRF habitat lost from the Pole Creek fire. For home ranges to considered viable post-fire, there need 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. The Trout Creek activity center is considered viable but inactive.

Habitat in the Black Crater and Bluegrass Butte activity centers were not affected by the Pole Creek fire. Both of these activity centers are considered viable but inactive. The 2011 Rooster Rock occurred outside of the range of the spotted owl and did not affect any NRF habitat or owl activity center.

Table 1. Habitat Conditions for the Four Owl Activity Centers in the Whychus watershed.

Spotted Owl Activity Center Name	NRF Acres within 1.2 Mile Radius of Activity Center Prior to 2012 Pole Creek Fire	Existing NRF Acres After the 2012 Pole Creek Fire	Existing Percent (%) NRF acres within 1.2 Mile Radius of Activity Center
Black Crater	277	277	10%
Bluegrass Butte	314	314	11%
Trout Creek	588	553	19%
Snow Creek	404	37	1%

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.

The Pole Creek fire affected dispersal habitat and connectivity through the watershed. Dispersal habitat in stand-replacement and mixed severity burns will no longer function as dispersal habitat. Areas that underwent low severity or underburns may still function as dispersal habitat. These areas would need to be ground-truthed to determine if they still function as dispersal habitat. Prior to the Pole Creek fire, dispersal habitat was degraded due to previous harvest, insects and disease, and large-scale unplanned fires. Connectivity between the LSRs and activity centers on the Sisters Ranger District and the Bend-Ft. Rock Ranger District has been further reduced due to the fire.

Effects of Fire on Spotted Owl Habitat

The following information is from the 2011 revised recovery plan for the spotted owl and summarizes currently known effects to spotted owl habitat from fire (USFWS 2011).

While spotted owls have been observed roosting in forests experiencing the full range of fire severity, most roosting owls were associated with low or moderate severity burns (Clark 2007, Bond et al. 2009). Specifically, Bond et al. (2009) found that California spotted owls selecting low severity burns for roosting and avoiding high severity burns. In addition, roost sites from which stand measurements were taken had high levels of canopy closure (i.e., greater than 60 percent) and a large tree component, regardless of burn severity (Clark 2007, Bond et al. 2009)… Clark (2007) found that spotted owls did not use large patches of high severity burns, and Bevis et al. (1997) found spotted owls shifting their use away from areas burned at a higher severity to those burned at a lower severity; however, the results in both studies may be confounded due to post-fire logging that occurred in the burn areas. Bond et al. (2009) found owls selecting burned areas, including high-severity burns, over unburned areas for foraging when those areas were within 0.9 miles of a nest or roost site. Bond et al. (2009) postulated that selecting burned patches over unburned patches for foraging may be due to increased presence of prey, such as the dusky-footed woodrat, a species associated with open stands and increased shrub and herbaceous cover… It is unknown whether spotted owl selection of high-severity burns for foraging would prevail where dusky-footed woodrats are not available (eastern Washington Cascades and most of eastern Oregon Cascades). In these areas, northern flying squirrels are the principle prey species (Forsman *et al.* 2001, 2004, Sztukowski and Courtney 2004) and are more closely tied to closed canopy forest (Lehmkuhl *et al.* 2006a, b). Northern flying squirrels are the principle prey species for owls in the Whychus watershed.

TREND: Range-wide spotted owls are declining due to habitat fragmentation and loss from harvest, insects and disease, competition with the barred owl, increased stand densities and loss of large trees from overstocking (white fir), and large-scale fires. The number of activity centers on the Sisters Ranger District have further decreased due to the loss of the Snow Creek activity center in the watershed. Barred owls have not been detected in the watershed; however, the number of detections of barred owls have increased on the Sisters Ranger District since 2009.

North American wolverine

The wolverine is a federal Candidate species, a Regional Forester Sensitive Species, and a Deschutes LRMP Management Indicator Species. On February 4, 2013, the U.S. Fish and Wildlife Service (USFWS) proposed it for listing as a threatened species under the ESA primarily due to shrinking mountain spring snowpack as a result of climate change (Federal Register Vol. 78, No. 23; USFWS 2013*a*). Final listing is anticipated for 2014.

The wolverine was thought to have been extirpated in Oregon by 1936 (Hiller 2011). At least one report of a wolverine was documented for each decade from the 1960s to the 1990s in Linn, Harney, Wheeler, and Grant counties, respectively (Hiller 2011). In 2011, a monitoring project detected three individual wolverines in the Wallow-Whitman National Forest in northeastern Oregon, an area with no prior documentation of wolverines (Magoun et al. 2013). During 2008, a wolverine (probably of Rocky Mountain origin) was confirmed in northern California, the first evidence in almost 90 years (Moriarty et al. 2009).

A draft habitat assessment for the wolverine on the Forest was completed in 2012. Of the 1,656 acres of wolverine denning habitat modeled for the Forest prior to the Pole Creek fire, approximately 863 acres are in the Whychus watershed which is 52% of the habitat forestwide. All of these denning habitat acres are within designated wilderness areas, primarily in the Three Creek wilderness area, with small patches in the Mount Jefferson wilderness area. Of the 863 acres in Whychus watershed, 756 acres are within one subwatershed: the Headwaters Whychus Creek. High-severity and moderate severity burns occurred in the watershed analysis area during the Pole Creek fire; however the majority of denning habitat was not affected.

During the winter of 2012/2013, a research monitoring project using motion-detection at bait stations (similar to photo at left) and a hair snag system to collect samples for genetic analysis began on the Deschutes and Williamette National Forests. Target forest carnivores include the wolverine, the American marten, and a montane subspecies of red fox (*Vulpes vulpes* sp.). The Sierra Nevada red fox (*V. v. necator*) is presumed to be the montane red fox subspecies present on the Deschutes. This subspecies is currently under review for potential protection under the ESA (USFWS 2013*b*). The project will continue during the winter of 2013/2014.

Wolverine feasting on carcass at camera bait station in the Eagle Cap Wilderness in Oregon. Photo by Mark Penninger, Wallowa-Whitman National Forest.

TREND: Detections of wolverine increased in northeastern Oregon since 2009. Occurrence on the Forest is unknown.

Regional Forester Sensitive Species

Species No Longer Listed as Sensitive

Two species were removed from the Regional Forester Sensitive Species list in 2010: the pygmy rabbit and greater sage grouse. Neither species has habitat in the watershed analysis area.

Avian Sensitive Species With Habitat in the Watershed Analysis Area

American peregrine falcon

The peregrine falcon is a sensitive species and a Forest Land and Resources Managemetn Plan (LRMP) Management Indicator Species. They nest on ledges or holes on the face of rocky cliffs or crags in a variety of forested and open areas, overlooking or within several miles of a large body of water, river, riparian area, marsh, sandy shore, or tidal area. There are 17,590 acres of potential habitat mapped across the forest based on a 2012 forestwide habitat assessment for the Deschutes. Of these acres, 2,464 occur in the watershed analysis area. There are no known peregrine falcon nests in the watershed analysis area. The Rooster Rock and Pole Creek fires did not affect nesting habitat for this species.

TREND: Populations in Oregon are stable or increasing. Few known nests occur on the Forest.

Bald eagle

The bald eagle is a Sensitive Species and a Deschutes LRMP Management Indicator Species. Breeding habitat is typically associated with water, but actual distance to water varies within and among populations (Buehler 2000). Nests are usually built in live trees or snags, consist of bulky stick platforms built in the super-canopy of live trees, but are also rarely built on cliff faces or on the ground in treeless areas (Buehler 2000).

Potential nesting habitat modeled across the Forest for the bald eagle in 2012 resulted in 155,171 acres forestwide, with 98,026 acres (63% of the total acres) meeting the LRMP size criteria of green trees ≥20 inches dbh. Of these 98,026 acres, none are modeled for the Whychus watershed analysis area. One known nest occurs in the watershed analysis area. Neither the Rooster Rock nor the Pole Creek fire impacted nesting habitat for this nest site.

TREND: Populations in Oregon are increasing. Surveys conducted from 1971 to 2009 on the Forest showed an increase in nesting pairs from 12 to 49, which exceeds the upper baseline management objective of 45 in the LRMP. The two recovery zones that occur on the Forest have also exceeded their recovery population goals. Bald eagle nesting pairs on the Sisters Ranger District are stable.

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. The Pole Creek fire likely had both positive and negative impacts to bufflehead habitat by both removing and creating snag cavities for nesting.

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. Not known to occur on the Forest.

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. Not known to occur on the Forest.

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.

TREND: Unknown. Not known to occur on the Sisters Ranger District.

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 in Oregon are primarily in the Rogue Valley (Jackson County) and Klamath Basin. They are uncommon to rare in fall and winter in Crook and Deschutes County. They breed in hardstem bulrush, cattail, nettles, willows and blackberries. They are not known to 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 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 but likely declining. Not known to occur on the Forest.

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.

TREND: Unknown.

Tule Greater White-Fronted Goose

The Tule greater white-fronted goose was added to the Regional Forester Sensitive Species list in 2010. Nesting habitat includes marshy ponds in Canada and Alaska. Wintering populations occur in Central California and Texas. Non-breeding residents occur in Western and Eastern Oregon. This species may migrate through the Forest between wintering and nesting grounds. It has not been documented on the Forest. A low potential for occurrence exists in the watershed analysis area. Habitat was likely not affected by the Pole Creek or Rooster Rock fires.

TREND: Unknown. Not known to occur on the Forest.

Sensitive Woodpeckers: White-headed and Lewis's woodpecker

Female White-headed woodpecker (left) and adult Lewis' woodpecker (right) at Cabin Lake Viewing Blind on the Deschutes National Forest. Photos by Dave Herr.

Both the white-headed and Lewis' woodpeckers are Regional Forester Sensitive Species and Deschutes LRMP Management Indicator Species. Draft habitat assessments for these species on the Deschutes National Forest were completed in 2012 prior to the Pole Creek fire. These habitat assessments also provide snag and down wood levels preferred by these species.

White-headed woodpecker

Dixon (1994) found that white-headed woodpecker densities positively increased with large ponderosa pine in Central Oregon. However, in south-central Oregon, white-headeds were found using primarily managed ponderosa pine dominated mixed conifer stands where 85% of the stands were <50 or 50-75 year old trees (Lindstrand III and Humes 2009). Kozma (2011) found that white-headed woodpeckers in Washington nested in ponderosa pine stands with low densities of large diameter (>20 inches dbh) trees. The mean diameter of all ponderosa pine trees was 12.9 inches dbh while the mean snag diameter in nest stands was 10 inches dbh (Kozma 2011).

White-headed woodpeckers may require dynamic landscapes with both burned and unburned habitat for the long-term persistence of populations (Hollenbeck et al. 2010). Wightman et al. (2010) found existing open-canopied ponderosa pine forests before a fire and a mosaic of burn severities within 0.6 miles of nests for nest sites on the Fremont-Winema National Forest. They found the presence of larger, more decayed snags and fewer live trees near a snag (within 2.5 acres) after fire were important factors for nest selection; however this did not influence nest survival. Open-canopied pine forests with mature, cone-producing trees within proximity of burns were also important as long as most of the landscape was not subjected to stand replacement burns (Wightman et al. 2010). A mosaic of burn severities across the landscape may improve white-headed woodpecker habitat by opening forest canopies in higher severity burned areas while retaining decayed snags created before wildfire and live cone-producing trees in unburned or low severity burned areas (Wightman et al. 2010).

Snags created by fire have lower retention rates than trees killed more slowly by insects or disease and fire-killed snags may not reach levels of decay favored by white-headeds until 2-3 years post-fire (Wightman et al. 2010). Therefore, snags existing before fire, if retained, or those with more advanced decay seem to be critical components in post-fire landscapes, especially in the first few years after fire (Wightman et al. 2010). Post-fire areas provide high density snag patches and areas not salvaged provide temporal snag habitat especially when adjacent to green suitable habitat (USDA FS 2012).

The golden-mantled ground squirrel and yellow pine chipmunk are known nest predators. Golden-mantled ground squirrels are positively associated with down wood volume and yellow pine chipmunks are positively associated with shrub cover (Wightman et al. 2010). Down wood and shrub cover are reduced in post-fire environments; thus nest placement in high severity burned areas may be a viable strategy to reduce nest predation as long as unburned or low severity burned areas are available within the landscape for foraging (Wightman et al. 2010). Nests in unburned forests may be more vulnerable than those in burned forests as these may also experience lower ambient temperatures which affect incubation behavior and reproductive effort (Hollenbeck et al. 2010).

Studies show that cavity-nesting birds require higher snag densities in post-fire conditions versus green stands for nesting and productivity. This is likely due to cavity nesting birds requiring more snags for foraging, cover, and protection from predators in post-fire environments.

Prior to the Pole Creek fire, approximately 198,330 acres of potential nesting habitat was modeled across the forest (USDA FS 2012d). Approximately 25,000 of these acres occurred in the Whychus watershed analysis area. The Pole Creek Fire burned approximately 26,282 acres. Of these, the stand-replacement (406 acres) and mixed severity fires (9,987 acres) most impacted white-headed woodpecker nesting habitat both positively and negatively.

TREND: NatureServe (2010) lists the white-headed woodpecker as apparently secure at both the global and national scales but imperiled for the state of Oregon. This species is also listed as focal species for the Partners in Flight *Conservation Strategy for Landbirds on the Eastslope of the Cascades Mountains in Oregon and Washington*, and is a priority species on the USFWS Birds of Conservation Concern. The reasons for inclusion on these lists include primarily population declines, loss of large ponderosa pine trees and snags, and habitat degradation due to fire suppression.

Other population trend data from the North American Breeding Bird Surveys indicate an increasing population trend in Oregon and in the Great Basin Bird Conservation Region. In contrast, the Partners in Flight species assessment database indicates this is a Regional Species of Concern, a Species of Continental Concern, as well as a Continental Stewardship Species due to small and declining populations, limited distributions, and high threats throughout their range. The broad-scale source habitat analysis conducted by Wisdom et al. (2000) indicated that there have been basin-wide declines of source habitat for the white-headed woodpecker in the interior

Columbia Basin. They show source habitat roughly covers the same geographic extent but habitat is now more disjunct. Strong declines (>65%) in source habitat have occurred in both Ecological Reporting Units (ERUs) that cover the Deschutes National Forest due to timber harvest, fire suppression, and snag loss.

An Historical Range of Variability (HRV) analysis for the Forest shows the amount of nesting habitat for the white-headed woodpecker and the percent of the landscape with snags >20 inches dbh roughly fall within historical estimates (USDA FS 2012*d*). Based on population trends, large-scale habitat assessments, risk factors, and snag analysis, white-headed woodpecker populations are highly distributed and dispersed across the forest with low abundances.

Lewis' woodpecker

Lewis' woodpeckers feed on flying insects and are not strong cavity excavators. As such, they require large snags in an advanced state of decay that are easy to excavate, or use old cavities created by other woodpeckers, primarily northern flickers and hairy woodpeckers (Wisdom et al. 2000, Marshall et al. 2003, NatureServe 2010). Linder and Anderson (1998) estimate that optimal canopy closure for Lewis' Woodpeckers is less than 30%. This species is identified as a focal species for ponderosa pine with patches of burned old forests for the East Cascades Landbird Strategy (Altman 2000). Lewis' woodpeckers utilize post fire habitats over the longest period of time for nesting habitat. They will use old fires and large snags for nesting, using post fire habitat 10 years and greater. Lewis' woodpeckers also prefer open habitat where they select large snags for nesting that are in very open environments.

The Lewis' woodpecker is abundant in recent (2-4 years) and older burns (10-30 years post-fire) (Saab and Dudley 1998, Saab et al. 2007). It is positively associated with large diameter and higher snag densities in ponderosa pine patches in more open or salvage logged areas (Saab et al. 2002, Saab et al. 2009). Most research shows the Lewis' woodpecker is most abundant in stands with low snag abundance (0-30 snags/acre) and does not occur or nest in areas with high snag densities (91-198 snags/acre) (Haggard and Gaines 2001). Haggard and Gaines (2001) found that 80% and Hejl and McFadzen (2000) found that 75% of the snags used for nesting by Lewis' woodpeckers had broken tops.

Prior to the Pole Creek fire, approximately 84,978 acres of nesting habitat on the Forest were modeled. Of these, there were 3,117 acres in the Whychus watershed and 1,404 acres in the three subwatersheds in the Deep Canyon 5th field for a total of 4,521 acres of nesting habitat in the watershed analysis area. The Pole Creek Fire burned approximately 26,282 acres. Of these, the stand-replacement (406 acres) and mixed severity fires (9,987) most affected Lewis' woodpecker nesting habitat.

TREND: NatureServe (2012) states that the Lewis' woodpecker is apparently secure at both the global and national scales but imperiled for the state of Oregon (NatureServe 2010). This species is listed as focal species for the Partners in Flight *Conservation Strategy for Landbirds on the Eastslope of the Cascades Mountains in Oregon and Washington* and is a priority species on the USFWS Birds of Conservation Concern list. Population data from the North American Breeding Bird Surveys shows a decreasing trend in both the Great Basin and Oregon. The

Partners in Flight species assessment database indicates this is a Regional Species of Concern.

There have been basin-wide decreases in source habitat for the Lewis' woodpecker in the interior Columbia Basin (Wisdom et al. 2000), with decreases in both Ecological Reporting Units (ERUs) that cover the Deschutes National Forest due to habitat alteration of old forest, single-story ponderosa pine to mid-seral structural stages and declines in snags basinwide. Lewis' woodpecker populations are not highly distributed across the forest but concentrated in large fire events. Minimal habitat is scattered in small patches across the rest of the forest.

Sensitive Butterflies: Johnson's hairstreak and Silver-bordered fritillary

Silver-bordered fritillary. Photo by Darius Baužys, Wikimedia Commons.

Johnson hairstreak adult butterfly on the Mt. Hood National Forest. Photo by Alan Dyck.

Johnson's hairstreak

This hairstreak butterfly is dependent on dwarf mistletoes (genus *Arceuthobium*) and other mistletoes as host plants in coniferous forests. It may be a primary herbivore of dwarf mistletoe plants. Peak conditions exist in old-growth and late-successional second growth forests although younger forests with dwarf mistletoe may also support populations. This species typically spends much of its time in the top of the forest canopy which may contribute to the rarity of sightings. Previous detections of the Johnson's hairstreak are at Black Butte and Suttle Lake to the north of the watershed. Potential habitat likely exists in the watershed due to the abundance of mistletoe in mixed conifer PAGs; however occurrence is not known.

TREND: Declining in Region. In the watershed analysis area, habitat with mistletoe was reduced due to the Pole Creek fire in high and mixed severity burn areas.

Silver-bordered fritillary

The silver-bordered fritillary inhabits wet meadows, bogs, and marshes as well as forest openings in mountainous areas, and spring-fed meadows in dry prairies. Sunny wet habitats encourage adult flight. Adults lay eggs on or near violets, usually marsh violet (*Viola palustris*) and bog violet (*V. nephrophylla*) (Pyle 200). Butterfly adults feed on nectar of various composites including mints and *Verbena*. Habitats known to contain these butterflies should be managed to maintain hydrology and monitoring willow succession (Scheuering 2006). Vegetation treatments to reduce conifer encroachment may be needed at some sites.

In Oregon, these butterflies have been found in Big Summit Prairie, Crook County, the Strawberry Mountains, Grant County, and in the Southern Wallow Range north of Halfway, and Baker Co. (Pyle 2002). Occurrences of these butterflies have been documented in the Prineville District BLM and in the Malheur and Wallowa Whitman National Forests. They have not been detected on the Deschutes National Forest.

The Rooster Rock and Pole Creek fires may have improved habitat conditions in fritillary habitat by reducing conifer encroachment into meadows.

TREND: NatureServe (2009) ranks this species as globally and nationally secure but imperiled in the State of Oregon. Populations have recently been put under stress due to drying and vegetation succession (meadow encroachment). Recreational impacts in the Three Creek subwatershed and lodgeopole encroachment in wet meadows continues.

Western Bumblebee

Western bumblebee populations have declined dramatically (70-100%) since the late 1990s in western and central California, western Oregon, western Washington, and British Columbia (NatureServe 2012). Recent observations in Oregon were documented in Wallowa County in 2008 and near Mt. Hood in 2009 (NatureServe 2012). Bumblebees are pollinators of many crops and wildflowers. As generalist foragers, they do not depend on any one flower type. Threats to bumblebees include: spread of pests and diseases by the commercial bumble bee industry, other pests and diseases, habitat destruction or alteration, pesticides, invasive species, natural pest or predator population cycles, and climate change. Destruction of nest sites and hibernation sites for overwintering queens, such as abandoned rodent burrows and bird nests, may adversely affect these bees. In the absence of fire, native conifers encroach upon meadow habitat. This species is expected to occur on the Forest; however, sightings have not been documented.

TREND: Recent significant population declines in the western U.S. including Oregon. Unknown trend on the Forest.

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. 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. Tightcoils have very thin, fragile shells, and are easily damaged from fire, timber harvest, and trampling due to recreational use including hiking, fishing, camping and firewood gathering. The tightcoil occurs in the watershed based on surveys conducted in 2000-2002. Most individuals were found within 10 feet of the streambank. High-severity or mixed severity fires in riparian areas would have likely have removed habitat for this species at least on a short term basis.

The tightcoil is also a Survey and Manage species under the Northwest Forest Plan. The Forest Service is currently implementing the January 2001 Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as modified by the 2011 Settlement Agreement in Litigation over the Survey and Manage Mitigation Measure in *Conservation Northwest et al. v. Sherman et al.*, Case No. 08-1067-JCC (W.D. Wash.). The 2011 Settlement:

1. sets aside the 2007 Records of Decision and reinstates the January 2001 ROD,
2. revises the January 2001 species list maintaining most of the category changes and species removals made during the 2001, 2002 and 2003 Annual Species Reviews,
3. adds exemptions for pre-disturbance surveys for the following activities:
    a. non-motorized recreation projects,
    b. fish/wildlife habitat restoration projects,
    c. noxious/invasive weed treatments,
    d. Sudden Oak Death treatments,
    e. hazardous fuel reductions in portions of Wildland Urban Interface,
    f. legacy tree culturing,
    g. dry forest restoration projects, and
    h. bridge replacement, and
4. adds flexibility in known site management for sites within projects meeting the above exemption categories.

TREND: Declining regionwide. 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. The trend on the Forest is unknown.

Evening Fieldslug

The evening fieldslug was added to the Regional Forester Sensitive Species list in 2010. The following species' summary is based on the Conservation Assessment for *Deroceras hesperium*, Evening fieldslug (Duncan 2005). This species is associated with perennially wet meadows in forested habitats; microsites include a variety of low vegetation, litter and debris and rocks may also be used as refugia. It appears to have high moisture requirements and is almost always found in or near herbaceous vegetation at the interface between soil and water, or under litter and other cover in wet situations where the soil and vegetation remain constantly saturated. Because of the apparent need for stable environments that remain wet throughout the year, suitable habitat may be limited to moist surface vegetation and cover objects within 30 meters (98 feet) of perennial wetlands, springs, seeps and riparian areas. Down wood may provide refugia sites for the species that remain more stable during drier periods of the year than the general habitat. The Crater Lake tightcoil is an associated species in some sites. Many of the habitats where this species is found are wetlands less than one acre in size.

Surveys have not been conducted for this species on the Forest and it is not known if they occur. Similar to the tightcoil, high-severity or mixed severity fires in riparian areas may be removed habitat for this species at least on a short term basis.

TREND: Declining regionwide. Unkown on the Forest.

Pacific Fisher

Fisher populations are considered to be extremely low in Oregon, Washington, and parts of the Rocky Mountains. There are only two known populations of fisher in Oregon—one on the Rogue River National Forest and the other in southwestern Oregon along the Oregon-California border. They occur in landscapes dominated by late-successional and mature forests. Suitable spotted owl habitat (NRF) serves as suitable habitat for fishers. Fishers have been found to use riparian areas disproportionately to what exists. They tend to prefer areas with high canopy closure and late-successional forests with relatively low snow accumulations. Critical features of fisher habitat include physical structure of the forest and prey associated with forest structure. Structure includes vertical and horizontal complexity created by a diversity of tree sizes and shapes, light gaps, down woody material, and layers of overhead cover. Major prey species include small to medium sized mammals, birds, and carrion. Porcupines are the best known prey species but fisher will also prey on snowshoe hare, squirrels, mice and shrews (Powell and Zielinski 1994).

Trailmaster baited camera set-ups located along the wilderness boundary were conducted across the Sisters Ranger District in the winters of 1997/1998 (December through March) and 1999 (February through April) according to the protocol outlined in Ruggiero et al. (1994). There were no fishers located during the surveys. A similar baited camera station monitoring project is underway in wilderness areas on the Deschutes and Williamette National Forests during 2013 and 2014 to detect forest carnivores.

Impacts to spotted owl nesting, roosting, and foraging habitat is a rough approximation of loss of fisher habitat in the watershed analysis area.

TREND: Regionwide decline. Reduction of habitat in the watershed analysis area due to the Pole Creek fire.

Great gray owl

The great gray owl is no longer a Regional Forester Sensitive Species but is a Survey and Manage species and a Deschutes LRMP Management Indicator Species. The great gray owl was determined to be closely associated with lodgepole pine forests adjacent to meadows, but was also found in other coniferous forest types. Modeling in 2012 resulted in 197,929 acres of potential great gray owl nesting habitat across the Forest (prior to the Pole Creek fire). Of the 197,929 acres of potential nesting habitat, 45,533 acres are within the Whychus watershed analysis area, which accounts for 23% of the potential habitat forestwide.

TREND: Globally there are no evident population declines in the vast majority of the range. It is apparently stable; however, actual population data are lacking for many areas (NatureServe 2011). The Partners in Flight assessment databases for the Great Basin BCR scores the great gray owl population trend as uncertain. The percent change in population over 30 years is highly variable and unknown in Oregon. For relative density, great grays owls are 1-10 percent of their maximum density. They breed in low average abundance relative to the maximum density within the Great Basin. The assessment scores concluded the great gray owl is a regional concern species, recommending "Management Attention" conservation action for improving or maintain the current population.

The main concentration of great gray owl nesting habitat on the Forest is on the Sisters Ranger District with 96,029 acres (49 percent of nesting habitat forestwide), and where 4 nests are located. There are large patches of contiguous great gray owl nesting habitat on the Sisters Ranger District. Between the Sisters and Bend-Fort Rock district there are few barriers for connectivity of nesting habitat. The Rooster Rock and Pole Creek fires did not affect any known great gray owl nest sites.

Bat Species

Habitat for 11 species of bats occurs in the Whychus watershed analysis area. The Northwest Forest Plan calls for retaining snags, decadent trees, and green tree recruitment for roosting bats in matrix and Adaptive Management Areas as well as surveys for and protection for roosts identified in caves, mines, buildings, and abandoned wooden bridges. As an interim measure, timber harvest is prohibited within 250 feet of sites containing bats. Snag densities are poorly known for most species of bats but some research indicates that snag density requirements may be higher than those needed for woodpeckers.

Little is known about the roosting ecology of bats in burned forests. In general, low intensity wildfires and prescribed fire create relatively few snags (Horton and Mannan 1988) and many are small diameter, which are of less use for roosting bats that usually prefer large-diameter roost trees (Barclay and Kurta 2006). A higher number of snags and potential roosts may be created under mixed and high-severity fires. For species that avoid foraging in dense forests, bat activity may increase post-fire due to an increased insect productivity and more open foraging conditions at least for the first year after the fire (Buchalski et al. 2013).

White-nose syndrome (WNS) is a newly described invasive fungal disease that has killed almost 6,000,000 hibernating bats in the midwestern and eastern U.S. and Canada since 2006. It is caused by a cold-obligate fungus (*Geomyces destructans*) that thrives in cave temperatures similar to the ones that occur on the Deschutes National Forest (35-50 deg. F.). Researchers have confirmed that the fungus was transported by humans to North American from Europe. This fungal disease has now been detected in 22 states and 5 provinces in Canada. The disease or the fungus have not been detected west of Oklahoma. Transmission is spread primarily through bat to bat contact; however, there is evidence that fungal spores can attach to human clothing, boots, and gear. There is growing concern that humans could transport this fungus and spread WNS to the western U.S. including Oregon.

Six species have been affected by WNS with detection of the fungus (but not the WNS disease) in another three species. To date, the Virginia big-eared bat in the eastern U.S., a closely related species to the Townsend's big-eared bat, has not been affected by the fungus or the disease, even while inhabiting caves where other species have been affected. Bats on the Forest that appear to be most susceptible to the fungus if it were to occur in Central Oregon include seven species of myotis, the big brown bat, and the canyon bat.

A popular recreational cave, Skylight Cave, exists just north of the watershed. Townsend's big-eared bat and other bat species roost in this cave for winter hibernation and roosting during the summer and fall. A regional draft analysis and process was completed in 2011 that ranks the watersheds on the Forest at a regional scale in terms of their risk of the spread of WNS. The Upper Metolius River ranks as a high risk watershed due to the location of Skylight Cave. The Whychus watershed ranks as a medium risk watershed for WNS.

The 2009 Whychus Watershed Update recommended consideration of a trail in the watershed leading to Skylight Cave. In light of WNS concerns, a trail is not recommended at this time. Improved educational signage and law enforcement of regulations and the winter seasonal closure are recommended.

Regional Forester Sensitive Bat Species

Townsend's big-eared bat

The Townsend's big-eared bat is a Regional Forester Sensitive Species and a Deschutes LRMP MIS. This species inhabits caves year-round and forages in early seral stage vegetation in ponderosa pine and mixed conifer habitat. No known caves with Townsend's big-eared bat occupancy occur in the watershed. Lepidoptera, their primary insect prey, appears to be vulnerable to high-severity fire

Townsend's big-eared bat, Ashley National Forest, Utah. Photo by Diane Probasco.

effects; however, low severity fires may enhance their habitat.

TREND: Declining across the western U.S. This species is stable or slightly decreasing on the Forest.

Fringed myotis

The fringed myotis was added to the Regional Forester Sensitive Species list in 2010. This small bat is distributed patchily throughout the west and occurs at 3,900 to 6,900 feet. It is most common in drier woodlands (oak, pinyon-juniper, ponderosa pine) but is also found in desert scrub, mesic coniferous forest, grassland, and sage-grass steppe. It roosts in large decadent trees and snags, crevices in buildings, underground mines and caves, rocks, cliff faces, and bridges. It is likely that structural characteristics (e.g. height, decay stage) rather than tree species play a greater role in selection of a snag or tree as a roost.

Fringed myotis, Tonto National Forest, AZ. Photo by Duke Klein.

Threats include loss or modification of roosting snag habitat, closure or renewed activity at abandoned mines, recreational caving and mine exploration, replacement of buildings and bridges with non- bat friendly structures, loss of clean, open water, and loss of prey species due to pesticides/chemicals.

No winter records in caves on the Forest (including the Sisters Ranger District) have been documented. One record during summer surveys with the use of mist-nets was documented at the south end of the Bend-Ft. Rock Ranger District in 1992. Summer surveys have not occurred on the Sisters Ranger District. This species potentially occurs in ponderosa pine habitat and rock outcrops in the watershed analysis area. Both the Rooster Rock and Pole Creek fires may have both removed some roosting habitat while enhancing some snag habitat and opening up dense forest patches for foraging at least short-term.

TREND: NatureServe 2010 considers this species to be widespread in western North America with low abundances. The trend is poorly known but declines are probable, possibly due to roost loss and modification, habitat alteration, and toxic chemicals. It is considered imperiled in the State of Oregon (NatureServe 2010). There is one known occurrence of this species on the Bend-Ft. Rock Ranger District but likely occurs in other areas on the Forest.

Pallid Bat and Spotted Bat

Both pallid bats and spotted bats are mostly found in desert habitats but may also occur in oak and pine forested areas and open farmland. They roost in a variety of places and can be found roosting in caves, mines, cliffs, rock crevices, hollow trees, buildings, and bridges. Spotted bats often roost in cracks in tall vertical cliffs. Roosts are usually near a source of water, but this does not appear to be a main requirement for roosting locations. Winter hibernation sites are poorly known. Habitat on the Forest primarily exists in eastern arid habitats. The pallid bat has not been documented on the Forest. The spotted bat has been documented at Lake Billy Chinook and in Dry River Canyon near Highway 20 north of the Forest.

The Rooster Rock and Pole Creek fires would likely have had little impacts to pallid or spotted bat habitat on a landscape scale.

TREND: Pallid Bat: Large range in western North America; fairly common and likely relatively stable in many areas of the arid southwestern United States; regional population trends are poorly known. NatureServe (2012) considers the spotted bat to be widespread in western North America with sparse, but more common than formerly believed. Abundance, population trend, and threats are essentially unknown. The trend on the Forest for both species is unknown.

Management Indicator Species

Draft forestwide habitat assessments were completed for each Management Indicator Species in 2012. These were completed prior to the 2012 Pole Creek Fire. The assessments provide information on the conservation status, biology, threats, and acres of potential reproductive habitat modeled across the Forest and by watersheds.

Snags, Logs, and Down Wood Associated Species: American marten and Woodpeckers

Many wildlife species depend on snags and logs for denning, nesting, roosting, and foraging. Most of these species are associated with late-successional habitats in various plant association groups. The American marten is associated with mixed conifer and high elevation hemlock and lodgepole pine late-successional habitats and is a focal species for climatic climax habitats. Marten habitat is generally greater than 40% canopy cover with significant amounts of large down logs. Suitable spotted owl habitat (NRF) serves as suitable habitat for martens. However, vertical and horizontal structure complexity may not occur to the level preferred by martens.

Primary cavity excavators include the following woodpeckers: white-headed, Lewis', black-backed, three-toed, pileated, Williamson's sapsucker, northern flicker, hairy woodpecker, downy, red-naped sapsucker, and red-breasted sapsucker. The white-headed woodpecker is a primary cavity excavator of softer snags in large open ponderosa pine snags with low shrub levels. Lewis' woodpeckers prefer low snag densities in forests with burned or insect and diseased trees. Black-backed and three-toed woodpeckers are associated with burned and insect and diseased trees in lodgepole pine. Pileated woodpeckers and Williamson's sapsuckers prefer mature and late-successional habitats in mixed conifer plant associations while northern flickers and hairy woodpeckers are found in a mix of habitats, especially those associated with edges. The downy woodpecker, red-naped sapsucker, and red-breasted sapsucker are associated with riparian habitat (especially aspen) but can also be found in a mix of habitats.

Both the Rooster Rock and Pole Creek fires consumed down wood and large green trees in the stand-replacement (1,769 acres) and mixed severity burns (14,615 acres), reducing potential denning and nesting habitat. Snags created as a result of the fire benefitted some species (Lewis', black-backed, and three-toed woodpeckers) at least short-term. Table 2 lists the population trends and the changes in habitat in the watershed since 2009.

Table 2. Snags, Logs, and Down Wood Associated Species.

Species	Habitat	Impacts to habitat in watershed since 2009
American marten	Mixed conifer forests/late-successional habitats with high canopy cover and down wood	Decrease of potential denning habitat due to Rooster Rock and Pole Creek fires
White-headed woodpecker	Open ponderosa pine stands with large snags and low shrub cover	Decrease of potential nesting habitat in high-severity burns from Rooster Rock and Pole Creek fires. Hhigh density snag patches may provide temporal snag habitat especially when adjacent to green suitable habitat
Lewis' woodpecker	Open ponderosa pine and burned areas with large snags and low snag densities	Increase of potential nesting habitat decreased due to Rooster Rock and Pole Creek fires at least short-term
Black-backed woodpecker	Large lodgepole pine snags in burned areas or insect and diseased stands	Increase of potential nesting habitat, at least short-term, due to Rooster Rock and Pole Creek fires
Three-toed woodpecker	Lodgepole pine snags in burned areas or insect and diseased stands	Increase of potential nesting habitat, at least short-term, due to Rooster Rock and Pole Creek fires
Pileated woodpecker	Large snags in mixed forests with high canopy cover	Decrease of potential nesting habitat due to Rooster Rock and Pole Creek fires
Williamsons' sapsucker	Large snags in mixed forests	Decrease of potential nesting habitat due to Rooster Rock and Pole Creek fires
Hairy woodpecker	Large snags in mixed forests	Decrease of potential nesting habitat due to Rooster Rock and Pole Creek fires
Northern flicker	Large snags in mixed forests	Decrease of potential nesting habitat due to Rooster Rock and Pole Creek fires
Downy, woodpecker, Red-naped sapsucker, Red-breasted sapsucker	Riparian hardwoods in mixed forests	Rooster Rock and Pole Creek fires minimally impacted nesting habitat

Accipiters: Northern goshawk, Cooper's hawk, sharp-shinned hawk

All three of these accipiters have habitat in the watershed analysis area. Draft forestwide habitat assessments for these species on the Deschutes National Forest were completed in 2012. Table 3 lists the number of acres forestwide and in the watershed analysis area for these species based on modeling. This modeling occurred prior to the 2012 Pole Creek fire.

Table 3. Forestwide and Watershed Acres for Accipiters.

Species	Habitat Acres Modeled Forestwide	Habitat Acres Modeled in Watershed Analysis Area	Percent (%) of Watershed Analysis Area Acres in Forest
Northern goshawk	446,402	51,370	12%
Cooper's hawk	275,340	30,459	11%
Sharp-shinned hawk	426,138	52,278	12%

Nine known goshawk nesting territories are in the watershed analysis area. None were impacted by the Rooster Rock Fire. Three were impacted by the Pole Creek fire. One was complete lost due to stand-replacement fire and a second one likely no longer functional. Only a small area burned in a third territory which did not likely affect its function.

One known Cooper's hawk nest is known in the watershed. Neither fire impacted this nest.

Red-tailed Hawk

The red-tailed hawk preferred habitats are open to semi-open coniferous, deciduous and mixed forests, forest edges, grasslands, parklands, rangelands, river bottomlands, and agricultural fields with scattered trees (Marshall et al. 2003, NatureServe 2011). Forest clearings, alpine meadows, estuaries, marshes, agricultural lands, clear cuts, sagebrush plains, and high elevation environments are also used, though less commonly (Marshall et al. 2003, NatureServe 2011). Limiting factors in preferred habitat selection are suitable perches and hunting grounds open enough to locate and catch ground prey (NatureServe 2011). Nesting occurs in large mature trees, usually at a forest edge or near an opening in canopy (Timossi and Barrett 1995).

Potential nesting habitat was modeled across the Forest in 2012 which resulted in 192,492 acres. Of these acres, 49,446 acres were on the Sisters Ranger District with 13,666 acres in the Whychus watershed analysis area. Both the Rooster Rock and Pole Creek fires likely removed some potential nest trees, while creating more open conditions favorable for the red-tailed in other areas.

TREND: NatureServe (2011) lists the red-tailed hawk as *Secure* at the global level (G5), *Secure* at the national level (N5) and *Secure* for the state of Oregon (S5) (Table 5). Nature Serve does show a reduced amount of historic habitat (unquantified) throughout the state and on the Forest. Breeding Bird Survey data from 1999-2009 indicates no major threats to their population or habitat. The BBS population trend for the red-tailed hawk is increasing in both Oregon and the Great Basin BCR. The existing habitat is of sufficient quality to support a population (or populations) of nesting red-tailed hawk that are able to interact with each other and reproduce on the Forest. The trend on the Forest is not known.

Golden eagle

Currently there are approximately 49,233 acres of potential nesting habitat on the Forest. The forest types included open habitats and had a structure class >6 (>20" dbh average diameters). Cliff and rock associated with these habitats was also included.

There are an estimated 21 breeding areas on the Deschutes National Forest. These are concentrated on the eastern side of the Forest as well as the lower parts of the Metolius River. The 1983-2010 database shows that for the Forest, 7-16 nests were active in any given year. In 2011 there were 112 active breeding areas within the four counties that overlap the Deschutes National Forest (e.g. Lake, Klamath, Deschutes, and Jefferson).

Only 3 acres of potential nesting habitat exists for the golden eagle occurs in the Whychus watershed analysis area with all of these acres in the Snow Creek ditch subwatershed.

TREND: There have been significant declines regionwide in many of the important source habitats for golden eagles from the historic levels to the current. Both nesting and prey base habitats have been diminished and contributed to the documented downward trend in golden eagle population. There was no change in habitat in the watershed due to the Rooster Rock or Pole Creek fires.

Great blue heron

During the breeding season, herons forage in wetlands, water bodies and water courses of all shapes and sizes, but can also be found occasionally in upland areas as well. Great blue herons will nest in trees, bushes, on the ground and on artificial structures, usually near water. It prefers to nest in vegetation on islands or in swamps, probably to avoid ground predators. In Oregon, nest locations were determined primarily by proximity and availability of food, however nest-site fidelity is weak (Marshall et al 2003). The LRMP emphasized providing large, mature, and over-mature ponderosa pine within the general vicinity of existing rookeries.

Potential habitat exists in the watershed. There are no known nests or rookeries in the watershed. Nesting habitat across the Forest and by watersheds was modeled in 2012 and defined as forested areas within ½ mile of all water sources and ¼ mile from disturbance (e.g. recreation sites). Stand replacement burns in the Pole Creek and Rooster Rock fires may have removed potential nest trees.

TREND: Great blue herons are secure across their range and apparently secure in Oregon. According to the Oregon Conservation Strategy, nesting colonies in the Willamette Valley are of the greater concern and otherwise the great blue heron populations are apparently secure.Great blue heron populations are limited on the Deschutes National Forest largely due to the availability of nest sites. There are 9 to 10 known rookery sites across the Forest and at least 1 to 3 of these sites has been active in the last 30 years.

Osprey

The osprey is specialized for catching fish and nesting occurs primarily along rivers, lakes, reservoirs, and seacoasts. They build large bulky stick nests, which are often reused in subsequent years. Preferred nest sites are usually snags or dead topped trees near or surrounded by water, presumably to deter mammalian predation (Ewins 1997).

Potential habitat occurs in the watershed. There are no known nests. The high-severity and mixed-severity fires Pole Creek fire may have reduced potential nest trees.

TREND: NatureServe lists the osprey as *Secure* at the global scale (G5), *Secure* for breeding (N5B) and *Apparently Secure* for nonbreeding (N4N) at the national scale, and *Apparently Secure* for breeding for the state of Oregon (S4). Nature Serve does show a reduced amount of historic habitat (unquantified) throughout the state and on the Forest. Breeding Bird Survey data from 1999-2009 indicates a 5.5% population increase at the Great Basin scale and a 5.7% population increase in Oregon. The Partners in Flight database lists the population trend as stable, possibly increasing, or moderately increasing with a slight to moderate decline in the future suitability of breeding conditions for Bird Conservation Region 9. The trend is unknown on the Forest.

Mule Deer and Elk

Both thermal cover and hiding cover for deer and elk were reduced on private and Federal lands (all Deer Habitat) in the 6,100 acre Rooster Rock fire in 2011. All of the Pole Creek fire occurred within deer summer range and reduced both thermal and hiding cover across the 26,000 acre fire area. There are no Key Elk Areas in the watershed analysis area.

Approximately 49% of all 12th field subwatersheds on the Forest meet Forest Plan objectives for open road densities in summer range (2.25 miles per square mile). Table 4 lists the open road densities in the subwatersheds in the Whychus analysis area.

Table 4. Open road densities in the subwatersheds in the Whychus watershed analysis area.

Open Road Density in the Subwatersheds			
	Sub-watershed (HUC 12)	Miles of Open Roads	Open Road Density (miles per square mile)
Watershed (HUC 10)	Fourmile Butte	67.63	2.17
	Headwaters Squaw Creek	32.62	0.88
	Lower Indian Ford	97.68	4.40
	Lower Squaw Creek	3.43	.43
	Lower Trout Creek	248.94	5.45
	Middle Squaw Creek	54.44	4.83
	Upper Indian Ford	48.46	3.32
	Upper Squaw Creek	110.16	4.17
	Upper Trout Creek	30.21	0.69
Deep Canyon	Deep Canyon Dam-Deep Canyon	4.53	5.07
	Snow Creek Ditch	10.46	1.24
	Three Creek	83.85	3.83

TREND: The overall trend for mule deer populations for the state of Oregon and the Deschutes National Forest has been declining, and is currently below Management Objectives (MOs). As a direct response, there has also been a decline in allowable harvest for both antlered and antlerless portions of the population in the Paulina and Metolius units. In the Upper Deschutes Wildlife Management Unit, buck to doe ratios continue to meet MOs and therefore allowable harvest has not changed from 2,200 available tags. However in all three hunt units, due to drastic decline in the population and low fawn recruitment, very minimal antlerless harvest occurs. The Metolius Unit has seen an increase in population over the last 4 years, but due to the buck to doe ratio continuing to be below MO, allowable harvest has declined drastically since 1990.

Migratory Birds and Landbirds

The Forest addresses impacts to migratory birds and landbirds 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 U.S. Fish and Wildlife Birds of Conservation Concern list (USDI FWS 2008b). Impacts to migratory birds from the Pole Creek and Rooster Rock fires include loss of late-successional habitat including large green trees and down wood and the creation of short-term snag habitat for some species.

Tables 5 and 6 lists the short or long-term habitat increase or decrease for focal landbirds and Birds of Conservation Concern in the watershed analysis area.

Table 5. Priority Habitat Features and Associated Focal Landbird Species.

Habitat	Habitat Feature	Species	Habitat in the Watershed Analysis Area?	Short or long-term habitat increase or decrease trend in watershed?
Ponderosa pine	Large patches of old forest with large snags	White-headed woodpecker	Yes	Long-term decrease in habitat
	Large trees	Pygmy nuthatch	Yes	Long-term decrease in habitat
	Open understory with regenerating pines	Chipping sparrow	Yes	Long-term decrease in habitat
	Patches of burned old forest	Lewis' woodpecker	Yes	Long-term increase in habitat
Mixed conifer (late successional)	Large trees	Brown creeper	Yes	Long-term decrease in habitat
	Large snags	Williamson's sapsucker	Yes	Long-term decrease in habitat
	Interspersion grassy openings and dense thickets	Flammulated owl	Yes	Long-term decrease in habitat.
	Multi-layered/dense canopy	Hermit thrush	Yes	Long-term decrease in habitat
	Edges/openings created by wildfire	Olive-sided flycatcher	Yes	Long-term increase in habitat
Lodgepole Pine	Old-growth	Black-backed woodpecker	Yes	Long-term decrease in old-growth nesting habitat. Short-term increase in foraging habitat.
Meadows	Wet and dry	Sandhill Crane	No habitat	Long-term decrease in habitat due to encroachment
Aspen	Large trees with regeneration	Red-naped sapsucker	No habitat	Long-term decrease in habitat
Subalpine fire	Patchy presence	Blue grouse	Yes	Neutral

Table 6. Birds of Conservation Concern BCR 9 (Great Basin) 2008.

Bird Species	Preferred Habitat	Habitat in the Watershed Analysis Area?	Short or long-term habitat increase or decrease trend in watershed?
Greater Sage Grouse (Columbia Basin DPS)	Sagebrush dominated Rangelands	No	Not Applicable (NA)
Eared Grebe (non-breeding)	Open water intermixed with emergent vegetation	Yes	NA
Bald Eagle	Lakeside with large trees	Yes	
Ferruginous Hawk	Elevated Nest Sites in Open Country	No	NA
Golden Eagle	Elevated Nest Sites in Open Country	Yes	NA
Peregrine Falcon	Cliffs	Yes	NA
Yellow Rail	Dense Marsh Habitat	No	NA
Snowy Plover	Dry Sandy Beaches	No	NA
Long-billed Curlew	Meadow/Marsh	No	NA
Marbled Godwit	Marsh/Wet Meadows	No	NA
Yellow-billed Cuckoo	Dense riparian/cottonwoods	No	NA
Flammulated Owl	Interspersed grassy openings in ponderosa pine forests	Yes	Long-term decreasing trend
Black Swift	Cliffs associated with waterfalls	No	NA
Calliope Hummingbird	Open mountain meadows, open forests, meadow edges, and riparian areas	Yes	Short-term increasing trend
Lewis's Woodpecker	Ponderosa pine forests, burned forest	Yes	Short-term increasing trend
White-headed Woodpecker	Large snags in open ponderosa pine forests	Yes	Long-term decreasing trend
Loggerhead Shrike	Open country with scattered trees or shrubs	No	NA
Pinyon Jay	Juniper, juniper-ponderosa pine transition, and ponderosa pine edges	No	NA
Sage Thrasher	Sagebrush	No	NA
Virginia's Warbler	Scrubby vegetation within arid montane woodlands	No	NA
Green-tailed Towhee	Open ponderosa pine with dense brush	Yes	Long-term decreasing trend
Brewer's Sparrow	Sagebrush clearings in coniferous forests/bitterbrush	No	NA
Black-chinned Sparrow	Ceanothus and oak covered hillsides	No	NA
Sage Sparrow	Unfragmented patches of sagebrush	No	NA
Tricolored Blackbird	Cattails or Tules	No	NA
Black Rosy Finch	Rock outcroppings and snowfields	No	NA

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Appendix 1. Federally Listed and Proposed, Regional Forester Sensitive Species, and LRMP Management Indicator Species Occurring on the Deschutes National Forest.

Federally Listed and Proposed Species under the Endangered Species Act			
Species	**Status**	**Habitat**	**Habitat and Presence in Watershed Analysis Area**
Gray wolf (*Canis lupus*)	Federal Endangered	Any Forest PAG	Existing dispesal habitat
Northern spotted owl (*Strix occidentalis caurina*)	Federal Threatened, MIS	Old growth mixed conifer forests	Suitable NRF and dispersal habitat; presence known
North American wolverine (*Gulo gulo luscus*)	Federal Proposed, Sensitive, MIS	Mixed forests, High Elevation	Potential Habitat
Regional Forester Sensitive Species			
BIRDS			
American Peregrine Falcon (*Falco peregrinus anatum*)	Sensitive, MIS	Riparian, Cliffs	Potential habitat
Bald eagle (*Haliaeetus leucocephalus*)	Sensitive, MIS	Lakes, snags	Existing habitat
Bufflehead (*Bucephala albeola*)	Sensitive	Lakes, snags	No habitat
Northern waterthrush (*Seiurus noveboracensis)*	Sensitive	Riparian streambanks with dense willows	No habitat
Harlequin duck (*Histrionicus histrionicus*)	Sensitive	Rapid streams, Large trees	No habitat
Horned grebe (*Podiceps auritus*)	Sensitive	Lake	No habitat
Red-necked grebe (*Podiceps gisegena*)	Sensitive	Lake	No habitat
Tricolored blackbird (*Agelaius tricolor*)	Sensitive	Lakeside, bulrush (cattails)	No habitat
Yellow Rail (*Coturnicops noveboracensis*)	Sensitive	Marsh	No habitat
Tule greater white-fronted goose (*Anser albifrons*)	Sensitive	Nests on marshy ponds in the tundra; winters in open country	No habitat

Lewis woodpecker (*Melanerpes lewis*)	Sensitive, MIS	Open ponderosa pine snags, burned areas	Existing habitat
White-headed woodpecker (*Picoides albolarvatus*)	Sensitive, MIS	Large-diameter ponderosa pine snags	Existing habitat
Great gray owl	MIS, Survey and Manage		Existing habitat
INVERTEBRATES			
Johnson's hairstreak (*Callophrys johnsoni*)	Sensitive	Mixed forests with dwarf mistletoe	Potential habitat
Silver-bordered fritillary (*Bolaria selene*)	Sensitive	Bogs and wet meadows	Potential habitat
Western bumblebee (*Bombus occidentalis*)	Sensitive	Forest edges, gardens, near houses and urban areas	Potential habitat
Crater Lake tightcoil (*Pristiloma articum crateris*)	Sensitive, Survey and Manage	Perennial riparian areas	Potential habitat
Evening field slug (*Deroceras hesperium*)	Sensitive	Perennial wet meadows	Potential habitat
AMPHIBIANS			
Oregon spotted frog (*Rana pretiosa*)	Federal Candidate, Sensitive	Shallow lakes, ponds	No habitat
Columbia spotted frog (*Rana luteiventris*)	Federal Candidate, Sensitive	Shallow lakes, ponds	No habitat
MAMMALS			
Townsend's big-eared bat (*Corynorhinus townsendii*)	Sensitive, MIS	Mixed forests, desert, caves, buildings, bridges, mines	Existing habitat
Pallid bat (*Antrozous pallidus*)	Sensitive	Caves, cliffs, rock outcrops	No habitat
Spotted bat (*Euderma maculatum*)	Sensitive	Cliffs, caves, rock outcrops	Potential habitat
Fringed myotis (*Myotis thysanodes*)	Sensitive	Cliffs, caves rock outcrops, trees/snags	Potential habitat
Pacific fisher (*Martes pennanti*)	Federal Candidate, Sensitive, MIS	Mixed forests, High Elevation	Potential Habitat
LRMP Management Indicator Species and Habitats			
Species	**Status**	**Habitat**	**Habitat and Presence in**

			Watershed Analysis Area
Cooper's Hawk (*Accipiter cooperi*)	MIS	Mature forests with high canopy closure/tree density	Existing habitat. Presence known.
Great Gray Owl (*Strix nebulosa*)	MIS, Survey and Manage	Mature and old growth forests associated with openings and meadows	No habitat
Golden Eagle (*Aquila chrysaetos*)		Open ponderosa pine or mixed conifer	Existing habitat
Northern Goshawk (*Accipiter gentiles*)	MIS	Mature and old-growth forests; especially high canopy closure and large trees	Existing habitat
Great blue heron (*Ardea herodias*)	MIS	Lakeshores, marshes	Potential habitat
Osprey (*Pandion haliaetus*)	MIS	Large snags associated with fish-bearing water bodies	Potential habitat
Red-tailed Hawk (*Buteo jamaicensis*)	MIS	Large snags, open country interspersed with forests	Potential habitat
Sharp-shinned Hawk (*Accipiter striatus*)	MIS	Mature forests with high canopy closure and young, dense, even-aged stands	Existing habitat.
Waterfowl	MIS	Lakes, ponds, streams	Existing habitat
Woodpeckers*	MIS, White-headed and Lewis are Sensitive	Snags, burned areas, riparian hardwoods	Existing habitat
MAMMALS			
American marten (*Martes americana*)	MIS	Mixed Conifer or High Elevation late successional forests with abundant down woody material	Existing habitat

Elk (*Cervus elephas*)	MIS	Mixed forest habitats	Existing habitat
Mule Deer (*Odocoileus hemionus*)	MIS	Mixed forest and edge habitats	Existing habitat
Townsend's Big-eared Bat (*Corynorhinus townsendii*)	MIS, Sensitive	Caves, mines, ponderosa pine	Existing habitat
HABITATS			
Species Associated with Snags, Down Wood and Logs			
Species Associated with Special or Unique Habitats: Springs, seeps, cliffs, and talus slopes			

*****Woodpeckers: Lewis's Woodpecker, White-headed Woodpecker, Williamson's Sapsucker, Downy Woodpecker, Hairy Woodpecker, Three-toed Woodpecker, Black-backed Woodpecker, Northern Flicker, Red-naped Sapsucker, Red-breasted sapsucker

Resource Report

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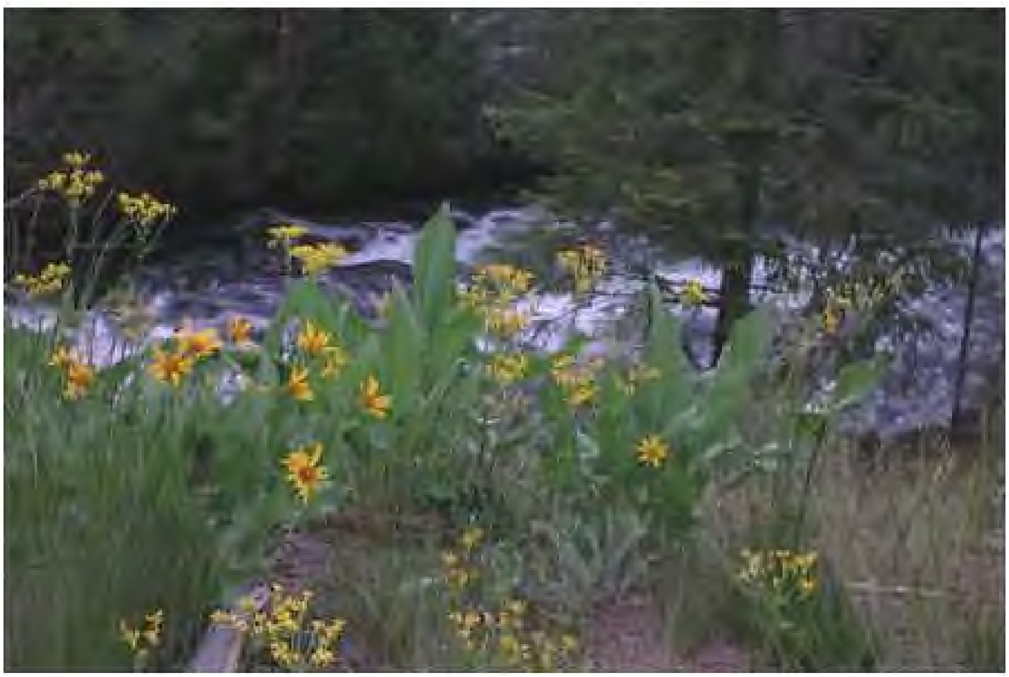

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Introduction

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 2009 Sisters/Whychus Watershed Analysis. Since 2009 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 Appendix 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 watershed analysis area.

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 (USFS 2011) 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*)
Capitate sedge (*Carex capitata*)
Crater Lake grapefern (*Botrychium pumicola*)
Whitebark pine (*Pinus albicaulis*)

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 has "sensitive" status on the Regional Foresters Sensitive/Strategic 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 12 known sites within the Whychus watershed assessment area.

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: Three of the twelve sites of Newberry's gentian occurring within the Whychus watershed assessment area were included within the perimeter of the Pole Creek Fire. 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. Thirty-one populations (approximately 34% of the global population) are documented within the Whychus watershed assessment area. One site is found within the perimeter of the Pole Creek Fire but it did not burn.

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:

Two of the 31 sites of Peck's penstemon occurring within the Whychus watershed assessment area were either fully or partially included within the perimeter of the Pole Creek Fire. 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 (Pajutee 2009).

Salvage of fire killed timber has occurred in Peck's penstemon habitat area under the guidelines of the Conservation Strategy. Besides heavy ground disturbance which can uproot plants, the most serious risks of salvage 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. Many portions of the B&B Fire Recovery salvage were logged over snow and this greatly reduced ground disturbance and protected 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 (Pajutee 2009). 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. The newly established plants survived for 2 years, doubled in number, and flowered 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.

Invasive plants are spreading into forest areas along major roads and are introduced by vehicles and equipment. 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. Some populations within the watershed 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 fire line, safety zones, or equipment in population areas.

2) Timber Harvest and Fire Salvage

- 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.
- Do not burn concentrations of slash on top of population.
- Utilize prescribed fire whenever possible for its benefits to the plant.
- Consider thinning and prescribed fire in population areas to increase flowering.
- 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 (*Helvella crassitunicata*)

This mycorrhizal fungi species is associated with Abies spp found in coniferous forests over a broad elevational range in OR and WA.

Status: This rare fungus has "sensitive" status on the Regional Forester's Sensitive/Strategic Plant List. It is also a Category B "survey and manage" species, a status which requires management of known sites and equivalent effort pre-disturbance surveys in old growth habitats. It is an endemic species of Oregon and Washington. Within Northwest Forest Plan lands there are only 10-50 known sites. The one known site within the Whychus watershed assessment area is on the west shore of Three Creeks Lake.

Habitat: Within OR and WA, this fungus species is known primarily from mountain hemlock and Pacific silver fir forest types, but is also known from parklands and Douglas fir, subalpine fir-Engelmann fir and white fir-grand fir forest types and elevations of 1533-9673 feet. It fruits from August to October.

Changes to Habitat/Threats: As with mycorrhizal fungi in general, current literature suggests that threats to local occurrences of this species include events and/or activities that negatively impact either the fungal mycelium or the mycorrhizal hosts. Such impacts can be caused by moderate to severe fire, removal of a large percentage of host plants (and the attendant reduction in canopy cover and reduction in moisture content of upper soil layers), removal of large woody debris, and soil compaction. Such impacts can reduce both fungal biomass and species diversity within communities of ectomycorrhizal fungi for periods ranging from several years to multiple decades. The one documented site of this fungus within the Whychus watershed assessment area was not within the perimeter of the Pole Creek Fire.

Potential Management Conflicts and Recommendations:

Forest thinning with the intent of reducing wildfire-related risks and increasing general forest health/resiliency is likely to pose conflict with the goals of maintaining or improving habitat for rare ectomycorrhizal fungi and promoting the persistence of extant rare fungal populations. Forest thinning will likely result in the direct loss of ectomycorrhizal fungal hosts. Collective reduction in woody plant (tree and shrub) cover is likely to promote evaporative loss of soil moisture upon which fungal mycelia depend. Post-thinning prescribed fire is likely to reduce coarse woody debris and the litter and duff layers that support mycelial existence. Prescribed fire may also directly damage or kill mycelia due to heat. Heavy equipment use may contribute to soil compaction which is generally detrimental to mycelial function.

To provide a reasonable assurance of the continued persistence of occupied sites consider revisiting known localities to confirm persistence and determine extent of populations. Conduct surveys to locate new populations. Consider buffering known sites from adjacent vegetation management activities. When conducting vegetation management activities in areas with good habitat potential, consider leaving scattered and clumped host trees and ample coarse woody debris, while minimizing soil compaction and burn severity of activity-related fires.

4) Tomentypnum moss (*Tomentypnum nitens*)

This moss species is associated with montane fens and wet meadows.

Status: This moss has "sensitive" status on the Regional Forester's Sensitive/Strategic Plant List. It is circumboreal. There are 9 known sites for this species within the Whychus watershed assessment area including Trout creek Swamp, upper Trout Creek fen, Alder Creek fen, Twin Meadows, 1526 and 1526-north fens, 1514-780 fen, 1516 fen complex, and Heidi's fen below Three Creeks Lake.

Habitat: Tomentypnum moss is found in montane fens, typically dominated by mosses and sedges often with lodgepole or Engelmann spruce, bog blueberry, resin birch, and willows. Fens, such as those supporting this moss, are typically small (often no more than a few acres) and sparsely occurring across the mountains of OR and WA.

Changes to Habitat/Threats:

Threats to tomentypnum moss include hydrologic impacts, including degradation of water quality, impairment of delivery rates from the providing aquifer(s), reduction in water residence time by ditching or formation of stock trails, soil damage (e.g., compaction, pedestal formation) and damage to plants due to the persistent impact of hooves, and invasive species. The climate change currently being documented, globally and regionally, may influence the aquifers wetting the local fens occupied by this moss. Hydrological restoration efforts completed at Trout Creek Swamp in 2005 notably improved habitat for this moss and several other resident, fen-loving plant species (Dewey 2008). With the exception of Trout Creek Swamp, recent forest management activities within the Whychus watershed assessment area have largely been excluded from the fen habitats occupied by this moss. Five of the nine sites of tomentypnum moss documented within the Whychus watershed assessment area were included within the perimeter of the Pole Creek Fire. Preliminary reports by BAER botanists (Powers et al., 2012) indicate that this fire did not burn within the fens occupied by this moss. Currently, the introduction or spread of wetland invasive plant species (reed canarygrass, Canada thistle) may be the most significant threat to this species within the Whychus watershed assessment area.

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.

2) Invasive Plants

- Monitor habitats and control invasive plants

5) Lesser bladderwort (*Utricularia minor*)

This aquatic plant species is associated with montane fens.

Status: This small aquatic insectivorous plant has "sensitive" status on the Regional Forester's Sensitive/Strategic Plant List. It is known from 2 sites in the Whychus watershed assessment area: Trout Creek Swamp and the 1526 fen.

Habitat: The lesser bladderwort is found in montane fens, typically dominated by mosses and sedges, often with lodgepole or Engelmann spruce, bog blueberry, resin birch, and willows.

Changes to Habitat/Threats:
Threats to the lesser bladderwort include hydrologic impacts, including degradation of water quality impairment of delivery rates from the providing aquifer(s), reduction in water residence time by ditching or formation of stock trails, soil damage (e.g., compaction, pedestal formation) and damage to plants due to the persistent impact of hooves, and invasive species. The climate change currently being documented, globally and regionally, may influence the aquifers wetting the local fens occupied by this insectivorous plant. Hydrological restoration efforts completed at Trout Creek Swamp in 2005 notably improved habitat for this moss and several other resident, fen-loving plant species (Dewey 2008). With the exception of Trout Creek Swamp, recent forest management activities within the Whychus watershed assessment area have largely been excluded from the fen habitats occupied by this plant. One of the two sites of lesser bladderwort documented within the Whychus watershed assessment area was included within the perimeter of the Pole Creek Fire. Preliminary reports by BAER botanists (Powers et al., 2012) indicate that this fire did not burn within either of the fens occupied by the lesser bladderwort. Currently, the introduction or spread of wetland invasive plant species (reed canarygrass, Canada thistle) may be the most significant threat to this species within the Whychus watershed assessment area.

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 fire line, safety zones, or equipment in fens and wet meadows.
- Avoid actions which would lower the water table.
- Do not allow equipment to stage in meadows during fire suppression.

2) Invasive Plants

- Monitor habitats and control invasive plants

6) Capitate sedge (*Carex capitata*)

On the Deschutes and Fremont/Winema National Forests, this sedge occurs along the edges of, or within less wet interior portions of fens/wet meadows.

Status: This sedge has “sensitive” status on the Regional Forester’s Sensitive/Strategic Plant List. It is known from 4 sites within the Whychus watershed assessment area: Three Creeks Lake vicinity (2) and the 1514-780 and 1526 fens. Three of the four sites of capitate sedge occurring within the Whychus watershed assessment area were included within the perimeter of the Pole Creek Fire. Fire effects at two of these three sites are currently not known. The other two did not burn.

Habitat: On the Deschutes National Forest, this sedge is found in association with fens and other sites persistently wetted by groundwater. It typically occupies less wet edges of these wetlands, or less wet inclusions within the interior of the wetland, within plant communities dominated by other herbaceous plant species. Small lodgepole pine or Engelmann spruce may be a minor component of the vegetation along with shrubs such as bog blueberry, resin birch and certain willow species.

Changes to Habitat/Threats:
Even though this species seems to be principally a groundwater wetland “edge” species, remarks made under this section heading for tomentypnum moss and lesser bladderwort largely apply to this species. Hence wetland aquifer alterations, wetland drainage actions, livestock impacts and invasive plant species are notable threats to habitat quality and site occupation for this species.

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.

2) Invasive Plants

- Monitor habitats and control invasive plants

7) Crater Lake grapefern (*Botrychium pumicola)*

This species typically occupies exposed sites at higher elevations.

Status: This fern has “sensitive” status on the Regional Forester’s Sensitive/Strategic Plant List. The one site within the Whychus watershed assessment area is located along a ridgetop extending between Broken Top and South Sister.

Habitat: The Crater Lake grapefern occurs on alpine and subalpine ridges, slopes, meadows, openings in montane lodgepole forest, and open forest in basins containing frost pockets or pumice flats.

Changes to Habitat/Threats:

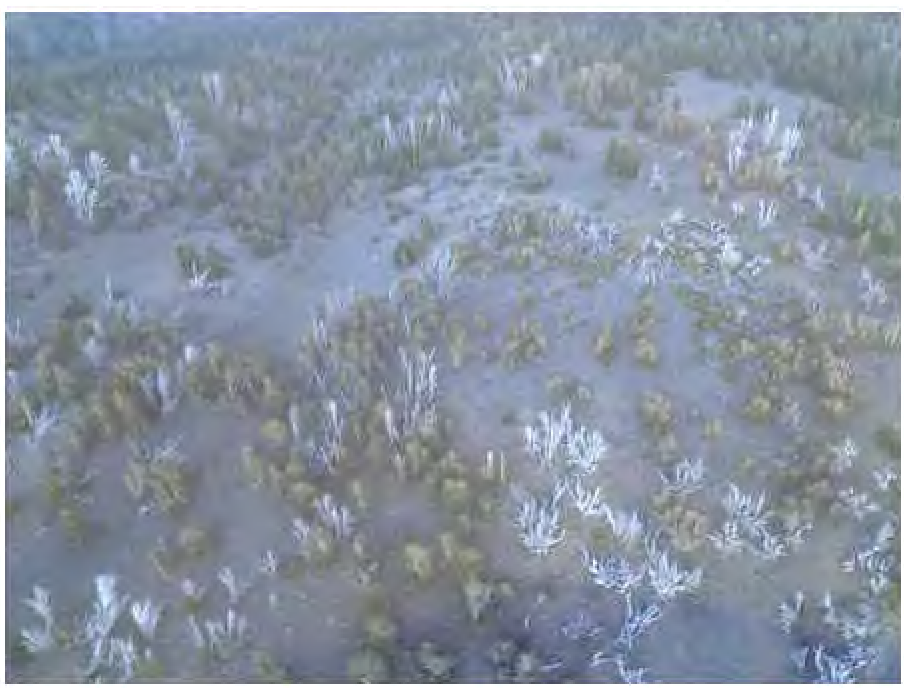
Threats to this species include absence of natural fire and consequent increases in canopy cover (shading), heavy fuel accumulations, litter buildup and competition with other plant species (Powers, 2006). Additional threats include soil disturbance associated with activities such as machine salvage harvesting, slash piling, and construction of landings, skid trails and temporary roads. Recreational uses such as hiking, mountain biking and OHV travel can also cause soil disturbance or direct damage to plants. Invasive plants also pose a potential threat. The greatest threat to persistence of Crater Lake grapefern at this documented site may be regional climate change. An observed and projected warming trend in the region is expected to pose a special risk for subalpine forests and alpine ecosystems, which may undergo nearly complete replacement by other vegetation types by the 2080s (Rogers et al., 2011). The one known site of this species included within the watershed assessment area was not included within the perimeter of the Pole Creek Fire.

Potential Management Conflicts and Recommendations:

Notably, the single documented site of Crater Lake grapefern within the watershed analysis area is deep with the Three Sisters Wilderness Area on a ridgeline at an elevation of just over 7,700 feet. This location essentially precludes all the management-related threats listed above. The nearest hiking trail (Green Lakes) is about one half mile west and 1,100 feet below the known site. There are no documented invasive plant sites in the area.

8) Whitebark pine (*Pinus albicaulis*)

This is a high elevation/high latitude species, found principally in subalpine parkland communities and down into the upper portions of the mountain hemlock forest zone.



Dead Whitebark pine (white) in the Three Creeks Wilderness

Status: This tree has "sensitive" status on the Regional Forester's Sensitive/Strategic Plant List.

It is known from 132 sites within the Whychus watershed assessment area, 18 of which are within the perimeter of the Pole Creek Fire. In 2011, USF&WS (USF&WS 2011) determined that whitebark pine warrants protection under the Endangered Species Act, and added it to the candidate species list with a priority of 2 (threats are of high magnitude and are imminent). It was noted, however, that a decision to list as Endangered or Threatened would be precluded for some time due to a backlog of listing assessments with a higher priority. The species is regarded as an ecological "keystone" species due to its multiple importance ecosystem services such as erosion reduction (though slowing the progress of snowmelt and rapid re-establishment following fires) and providing nutrient-rich food source (pine seeds) to mammals and birds including grizzly bears and the Clark's nutcracker. The species is endemic to western North America.

Changes to Habitat/Threats: Threats to whitebark pine noted by USF&W include habitat loss and mortality due to white pine blister rust, mountain pine beetles, catastrophic fire and fire suppression, and inadequacy of existing regulatory mechanisms. Increasing impacts by disease, insects and changing fire patterns appear to be largely underlain by gradual warming at the historically colder altitudes/latitudes occupied by the pine. USF&W anticipates that whitebark pine forests may be extirpated in as few as two to three generations (120-180 years).

Potential Management Conflicts and Recommendations:

As noted in the 2012 Pole Creek Fire Ecology/Botany BAER report (Powers et al., 2012), there currently is no way to stop the exotic white pine blister rust or the mountain pine beetle from infecting trees. However, progress has been made toward developing more disease resistant stands, partly through selection of disease resistant trees, breeding programs, and reforestation.

Over 100 Select trees have been designated on the Deschutes National Forest; seven of these trees appear to be within the perimeter of the fire and an additional seven more may be impacted depending on fire in the wilderness. All of these Select trees have had cones collected from them and are under blister rust screening at Dorena Genetic Resource Center. In addition to the Select trees, 75 permanent monitoring plots have been installed throughout whitebark pine stands in the central Cascades, of which at least one appears to have been affected by the burn. Seven more plots could be impacted as the fire creeps westward into higher elevation whitebark pine habitat. These monitoring plots are instrumental in assessing the overall health of the population.

Survey and Manage Species

In 1994, the Bureau of Land Management and Forest Service adopted standards and guidelines for the management of habitat for late-successional and old-growth forest-related species within the range of the northern spotted owl, commonly known as the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994). Additional direction was provided in 2001 for management of known sites and conducting surveys for these species (USFS and USDI 2001).

There are 5 categories of Survey and Manage Species with different requirements for inventory and management. These are described below:

Survey and Manage Category:

A-Pre-disturbance surveys and management of all known sites are required
B- Equivalent effort surveys required if old growth habitat disturbed and manage all known sites
C-Pre-disturbance surveys and management of high priority sites are required
D-Pre-disturbance surveys are not required, but required to manage high priority sites
E-Pre-disturbance surveys are not required, but required to manage all known sites

This analysis applies the Survey and Manage species list in the 2001 ROD (USFS and USDI 2001, Table 1-1, Standards and Guidelines, pages 41-51) and thus meets the provisions of the 2001 *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines.*

The following Survey and Manage species occur in the Watershed:

Lichens:

Calicium abietinum (pin lichen)
Chaenotheca chrysophela (pine lichen)
Chaenotheca furfuracea (pin lichen)
Cladonia norvegica (squamulose lichen)

Moss:

Buxbaumia viridis (green bug moss)

Fungi:

Clavariadelphus ligula (club fungus)
Elaphomyces subviscidus (deer truffle)
Gastroboletus turbinatus (gastroid bolete)
Gautieria magnicellaris (false truffle)
Gyromitra californica (false morel)
Helvella crassitunicata (elfin saddle)
Hydnotry inordinata (wood truffle)
Nivatogastrium nubigenum (gastroid pholiota)
Phaeocollybia attenuata (gilled mushroom)
Ramaria rubrievanescens (coral fungus)
Rhizopogon evadens var. subalpinus (truffle)

Survey and Manage Lichen Species

1) Least powderhorn lichen (*Cladonia norvegica*)

Status: *Cladonia norvegica* is a Category B species. About 30 Pacific Northwest populations are known and can be queried at the Oregon Biodiversity Information Center, http://orbic.pdx.edu/. It is known from 1 site near Whychus Creek.

Habitat: This species is found on rotten wood and tree bases in humid forests. Its 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).

2) Pin lichen (*Calicium albietinum*)

Status: Survey and manage Category B; strategic surveys complete – equivalent effort surveys not required; manage known sites. The one known site of this species included within the watershed assessment area was not within the perimeter of the Pole Creek Fire.

Habitat: Semi-open mixed conifer forest including *Abies* sp., *Pinus ponderosa, Pinus contorta, Pseudotsuga menziesii* and *Salix* sp. at 4800 feet elevation.

3) Pin lichen (*Chaenotheca chrysocephala*)

Status: Survey and manage Category B; strategic surveys complete – equivalent effort surveys not required; manage known sites.

Habitat: In semi-open coniferous forest variously including *Pinus ponderosa, Pinus contorta, Pinus monticola, Pseudotsuga menziesii, Picea engelmannii, Abies concolor, Abies amabilis, Abies lasiocarpa, Tsuga mertensiana, Populus* sp. and *Alnus* sp.

General Discussion of Changes to Habitat/Threats for Lichens

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. 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. It's reasonable to anticipate that fire (natural or prescribed) is detrimental to local occurrences of this species as well as its habitat. Intense heat will likely kill the lichen. Incineration of coarse woody debris destroys an important current or future (whether rotten or freshly fallen) substrate for this species. Fire, in general is likely to open the forest canopy and understory, reducing local capacities for moisture retention and concurrently, ambient humidity. Mapping of soil-based severity effects of the Pole Creek Fire indicates that the single documented site of this species within the watershed assessment area was "underburned or unburned", but mapped "high" severity conditions exist as close as 25-35 meters.

Potential Management Conflicts and Recommendations:

1) Revisit known site to assess post-fire condition of populations within the fire boundary.

2) Forest management in riparian forests

- Retain patches of unthinned and unburned forest in riparian areas in the population area.

Survey and Manage Bryophyte Species

Green Bug Moss (*Buxbaumia viridis*)

Status: Survey and manage Category D; manage high priority sites.

Habitat: *Buxbaumia viridis* occurs on rotten stumps and logs and on mineral or organic soil in cool, shaded, humid locations at middle elevations. Floodplains and stream terraces are favorable habitats because of the large amount of decayed wood available in old growth, but the species can be found on almost any landform as long as microclimatic conditions are favorable. A number of specimens have been found growing on shaded cutbanks of trails and roads. Elevations of known sites range from 1165 to 1525 m (3500 to 5000 feet).

Changes to Habitat/Threats and Recommendations for *Buxbaumia viridis*:

Buxbaumia viridis is sensitive to changes in microclimate and light level caused by canopy removal or thinning and requires adequate amounts of coarse woody debris in appropriate decay classes. The species may also be affected by recreational impacts caused by trails and foot traffic.

A closed canopy provides the needed microclimate for this species and maintains moist decaying wood and duff for long term viability. Known sites should be managed as prescribed (USFS and USDI 1994, pg. C-27). Maintain decay class 3, 4, 5 logs, leaving windfalls in place to provide structurally diverse habitat and maintain a dense overstory to maintain humidity.

Survey and Manage Fungi Species

The following survey and manage fungi species are known to occur in the watershed assessment area. 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.

1) Club fungus (*Clavariadelphus ligula*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There is one known site in the watershed assessment area south of Lava Camp Lake. This site was not within the perimeter of the Pole Creek Fire.

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.

2) Sequestrate fungus (*Elaphomyces subviscidus*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. Within the watershed assessment area, there is one site shortly south of Three Creeks Lake. This site was not included within the perimeter of the Pole Creek Fire.

Habitat: *Elaphomyces subviscidus* is associated with the roots of *Pinus contort*a and *Tsuga mertensiana*. It fruits in summer. It is found in a portion of the Northwest Forest Plan area in Oregon where it is known from fewer than 10 sites.

3) Sequestrate fungus (*Gastroboletus turbinatus*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There is one known site in the watershed assessment area near Lava Camp Lake. This site was not included within the perimeter of the Pole Creek Fire.

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

4) Sequestrate fungus *(Gautieria magnicellaris)*

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There is one known site in the watershed assessment area near Lava Camp Lake. This site was not included within the perimeter of the Pole Creek Fire.

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 Northwest Forest Plan area in Oregon.

5) False morel (*Gyromitra californica*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites.

Habitat: *Gyromitra californica* occus on or adjacent to well-rotted stumps or logs of coniferous trees, on litter or soil rich in brown rotted wood. Primarily with *Abies amabilis, A. conolor, A. magnifica, Pinus contorta, P. lambertiana, P. ponderosa, Pseudotsuga menziesii, Picea engelmannii, Tsuga mertensiana* and *Populus tremuloides*. The one known site of this species within the watershed assessment area is just outside and east of the Pole Creek Fire perimeter in the Deep Canyon 12^{th} field hydrologic unit.

6) Wood truffle (*Hydnotrya inordinata*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. The one known site within the watershed analysis area, in the Lava Camp Lake area, was not within the perimeter of the Pole Creek Fire.

Habitat: *Hydnotrya inordinata* is associated with roots of *Abies amabilis, Pinus contorta, Pseudotsuga menziesii,* and *Tsuga heterophylla* from 3500-6500 ft. elevation.

7) Mushroom (*Nivatogastrium nubigenum*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There are 2 known sites are outside the Pole Creek Fire boundary.

Habitat: On rotten *Abies* logs at elevations above 4200 ft.

8) Mushroom (*Phaeocollybia attenuata*)

Status: Survey and manage Category D; manage high priority sites. There is one site in the watershed assessment area shortly west of McKenzie Pass (actually mapping as 90 meters onto Willamette National Forest). This site is not included within the perimeter of the Pole Creek Fire.

Habitat: *Phaeocollybia attenuata* is found scattered in litter, humus or soil under mixed coniferous forests or forests associated with *Pseudotsuga*, *Tsuga*, *Picea*, *Abies*, *Pinus* and *Sequoia*. It fruits in September-December. It occurs within the Northwest Forest Plan area in Washington, Oregon and California, where it is known at 150-200 sites.

9) Coral fungus (*Ramaria rubrievanescens*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There is one known site within the watershed assessment area near Lava Camp Lake. This site is not within the perimeter of the Pole Creek Fire.

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.

10) Sequestrate fungus/truffle (*Rhizopogon evadens var. subalpinus*)

Status: Survey and manage Category B; conduct equivalent effort surveys in old growth habitats; manage known sites. There is one known site within the watershed assessment area in the Three Sisters Wilderness Area between Soap Creek and Whychus Creek, within the perimeter of the Pole Creek Fire.

Habitat: *Rhizopogon evadens* var. *subalpinus* is associated with *Tsuga mertensiana* or *Abies* species. It fruits in August-October. It occurs within the Northwest Forest Plan area in Washington, Oregon and California where it is known at 10-50 sites.

General Discussion of Changes to Habitat/Threats for Fungi:

The discussion in this section references a treatment effects white paper (Dewey, 2012) as well as two draft treatment effects white papers (Emerson, 2013; Lippert, 2013) that are currently under review.

Two important components of local forest ecosystems, that promote both and abundance and diversity of mycelial networks representing ectomycorrhizal fungi, are live woody plants (shrubs, and especially, trees) and coarse woody debris . The former serve as ectomycorrhizal fungal hosts while providing shade and wind-calming structure that promotes retention of moisture in both the soil and air. Coarse woody debris also promotes local moisture retention while providing habitat/substrate for a subset of local ectomycorrhizal fungi. Thinning, fire (both prescribed and natural), and salvage harvests can all be reasonably expected to reduce that capacity of live woody plants and coarse woody debris to support an abundance and diversity of ectomycorrhizal fungi. Thinning and fire will reduce the number of ectomycorrhizal fungal hosts available in a local forest ecosystem while concurrently reducing the capacity of live woody plants to moderate local microclimate. Entry of heavy equipment associated with thinning or salvage logging is likely to cause soil compaction which is known to impede the formation of feeder rootlets where mycorrhizae form. Fire will reduce the volume of coarse woody debris and, along with salvage logging, reduce the opportunity for recruitment of coarse woody debris in the future. Additionally, fire, in a direct relationship with intensity, can be lethal to the mycelial networks of a subset of the local ectomycorrhizal fungal species.

Recommendations for Survey and Manage Species related to Vegetation Management including Timber Harvest and Fire Salvage

A potential for management conflict exists when attempting to manage for both early and late seral species on the same acres of land. Managing for more open forest conditions typical to Fire Regimes 1 and 3, or for fire adapted species at a particular locality, may reduce viability and habitat quality for reputedly old-growth dependent species such as the survey and manage bryophytes, lichens or fungi that are occupying habitats within or adjacent to that same locality.

To provide a reasonable assurance of the continued persistence of occupied sites consider incorporation of patch retention areas (USFS and USDI 1994, as described in Standards and Guidelines, 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)

More specific recommendations can be found at the Interagency Special Status / Sensitive Species Program (ISSSSP) conservation planning tools webpage at http://www.fs.fed.us/r6/sfpnw/issssp/planning-tools/

Invasive Plants

Noxious weeds are now generally 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. Invasive plant 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 Plants within the Watershed Analysis Area

There are 11 species of invasive plants documented within the watershed analysis area over 1,684 acres. In most of these areas the invasive plant populations are very light and scattered. Active control is done by the Sisters Ranger District Invasive Plant program each year to remove seed sources by hand where effective and feasible. Herbicide treatments have begun on the District in 2013 as approved by the Deschutes and Ochoco National Forests Crooked River National Grasslands Invasive Plant Treatments Environmental Impact Statement. Herbicide treatments in the watershed analysis area this year were limited to Rd 4606, Highway 20, and Indian Ford Road.

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 little enforcement actions done on infested private lands.

The yellow shrubs are leafy spurge an Oregon State Weed List Class B plant found on private land at Sisters Airport- this population was treated with herbicides by the County in 2012, but needs to be re-monitored

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).
- Back road into Tollgate off Hwy 242 (Private land).
- Sisters Middle and High School

Partnerships with the City of Sisters, Sisters Schools, and Deschutes County have begun to raise awareness and address some invasive weed areas inside City limits. More work and enforcement actions are needed.

Invasive Plants within the Pole Creek and Rooster Rock Fire areas

The Pole Creek Fire Burned Area Emergency Response Botany Report (Powers et.al 2012) identified 7 invasive plant sites in or adjacent to the Pole Creek Fire area, including scattered infestations of diffuse and spotted knapweed along access routes to the fire on Rd 16 and Hwy 242. A large infestation of reed canary grass is found adjacent to the fire in Trout Creek Swamp and Canadian Thistle near Twin Meadows. One year post fire follow-up monitoring of routes, fire lines, and known sites is currently being conducted.

The Rooster Rock Fire Burned Area Emergency Response Botany Monitoring Report (Allen and Trahern 2011) identified 4 invasive plant sites in the Rooster Rock area on Rd 16 and Rd 4606. Sites were small and controlled by handpulling. Other sites along Rd 4606 have been sprayed this year (see above).

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.

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. Data from the Deschutes NF Invasives Species Inventory GIS layer, of documented weed sites within the Whychus Watershed Assessment area, is summarized in Appendix 1.

Pole Creek Fire Weed Wash Station

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Appendix 1-Invasive Plants by Species by Subwatershed			
HU_12_NAME	**ACCEPTED_SCIENTIFIC_NAME**	**COMMON_NAME**	**INFESTED_ACRES**
Deep Canyon Dam-Deep Canyon	*Centaurea diffusa*	diffuse knapweed	25.2658
Deep Canyon Dam-Deep Canyon	*Centaurea stoebe ssp. micranthos*	spotted knapweed	0.758
Headwaters Whychus Creek	*Centaurea*	knapweed	0.1003
Upper Whychus Creek	*Centaurea diffusa*	diffuse knapweed	53.8744
Upper Whychus Creek	*Centaurea*	knapweed	11.3658
Upper Whychus Creek	*Centaurea stoebe ssp. micranthos*	spotted knapweed	132.2436
Upper Whychus Creek	*Cirsium arvense*	Canada thistle	0.1234
Upper Whychus Creek	*Cirsium vulgare*	bull thistle	0.9071
Upper Whychus Creek	*Senecio jacobaea*	stinking willie	31.5143
Upper Trout Creek	*Cirsium vulgare*	bull thistle	0
Upper Trout Creek	*Hypericum perforatum*	common St. Johnswort	0
Upper Trout Creek	*Phalaris arundinacea*	reed canarygrass	4.9294
Upper Trout Creek	*Senecio jacobaea*	stinking willie	0.5545
Fourmile Butte	*Centaurea diffusa*	diffuse knapweed	249.4131
Fourmile Butte	*Centaurea stoebe ssp. micranthos*	spotted knapweed	250.7486
Upper Indian Ford	*Centaurea diffusa*	diffuse knapweed	56.2476
Upper Indian Ford	*Centaurea stoebe ssp. micranthos*	spotted knapweed	56.3063
Upper Indian Ford	*Cirsium vulgare*	bull thistle	2.0786
Upper Indian Ford	*Cytisus scoparius*	Scotch broom	0.1018
Upper Indian Ford	*Hypericum perforatum*	common St. Johnswort	0.5618
Upper Indian Ford	*Linaria dalmatica*	Dalmatian toadflax	0.0078
Upper Indian Ford	*Senecio jacobaea*	stinking willie	0.0774
Upper Indian Ford	*Taeniatherum caput-medusae*	medusahead	0.6039
Lower Trout Creek	*Centaurea diffusa*	diffuse knapweed	216.449
Lower Trout Creek	*Centaurea stoebe ssp. micranthos*	spotted knapweed	195.9608
Lower Trout Creek	*Cirsium vulgare*	bull thistle	0
Lower Trout Creek	*Hypericum perforatum*	common St.	0.3344

		Johnswort	
Lower Trout Creek	*Linaria dalmatica*	Dalmatian toadflax	1.9362
Lower Trout Creek	*Salsola kali*	Russian thistle	2.0228
Lower Indian Ford	*Centaurea diffusa*	diffuse knapweed	353.3257
Lower Indian Ford	*Centaurea*	knapweed	3.6322
Lower Indian Ford	*Centaurea stoebe ssp. micranthos*	spotted knapweed	234.4437
Lower Indian Ford	*Cytisus scoparius*	Scotch broom	115.3978
Lower Indian Ford	*Hypericum perforatum*	common St. Johnswort	1.0846
Lower Indian Ford	*Linaria dalmatica*	Dalmatian toadflax	1.2686
Lower Indian Ford	*Verbascum thapsus*	common mullein	4.4939
Middle Whychus Creek	*Centaurea diffusa*	diffuse knapweed	85.7975
Middle Whychus Creek	*Centaurea*	knapweed	2.1566
Middle Whychus Creek	*Centaurea stoebe ssp. micranthos*	spotted knapweed	54.1487
Middle Whychus Creek	*Linaria dalmatica*	Dalmatian toadflax	1.3324

Total Infested Invasive Plant Polygon = 1,684 acres

Appendix A- WHYCHUS WATERSHED ANALYSIS UPDATE

TRENDS

TREND	**CAUSE**	PROCESSES AFFECTED **(ECOLOGICAL and SOCIAL)**	**RESOURCES AT RISK**	**Measure(s)**
Reduced stream flows during summer months **Trend 1** **UPDATE- Improved flows, however more stream flow restoration is still needed**	Dewatering through stream diversions 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 Loss of connectivity to off channel habitats	Fish and Wildlife habitat and populations Riparian vegetation Streambank stability Treaty rights for fishing	Amount of restored instream flows (cfs) to support robust fish and wildlife populations. Trends in Streamflow from gage data Water temperature

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measure(s)
Reduction in riparian vegetation along streams Decrease in riparian habitat effectiveness **Trend 2** **UPDATE- Improved flows and restoration projects 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 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 and deciduous leaf input into streams supporting invertebrates	Fish and instream habitat Riparian species habitat/ populations Water quality Cultural plants protected by treaty rights	Amount of stable vegetated streambank and restored stream access to vegetated floodplain areas Acres burned in riparian reserves by stream type and intensity
Decrease in cottonwood galleries and aspen and localized increase in structure and shrubs in some riparian areas **Trend 3** **UPDATE- Starting to improve but still needs more restoration of aspen and cottonwood species**	Channelization and drainage Loss of beaver Fire exclusion Dewatering Timber harvest Fire exclusion	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)	Aspen and cottonwood stands where conifers have been removed (acres) Newly planted cottonwood or aspen stands (acres) Amount of off channel and floodplain habitat restored (acres)

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measure(s)
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 Channel constriction caused by road crossings	Loss of sinuosity resulting in increased energy and increased bank erosion and down cutting of stream Channel formation	Instream habitat and flood plain habitat for fish Floodplain habitat Peck's penstemon habitat	Amount of stream access to floodplains restored Miles of additional habitat created or restored outside of the main channel (ie side channels and flood channels)
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	Same measures as Trend 3 and 4
Decrease in size and quality of wetlands and wet meadows **Trend 6** **UPDATE- Meadow restorations are improving conditions but more is needed.**	Grazing Ditching Water diversion Fire exclusion	Hydrology (water filtration and storage) Reproductive success Species composition	Fish, wildlife and amphibian habitats Late summer flows Aquatic connectivity	Acres of Meadow restoration (plugging ditches, restoring flows or conifer removal

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measure(s)
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 irrigation dams Public water supply and demand Historic channel cleaning for flood protection	Pool development Flooding pattern Habitat development for survey and manage species, wildlife species, and aquatic species Habitat and food sources for macroinvertebrates	Fish habitats and populations Survey and manage plant and wildlife habitat and populations Riparian soils and function	Amount of instream wood recruitment from natural sources and restoration projects. Number of debris jam Large woody debris loading potential from fires
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 Road development	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	Soil compaction and displacement

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
Increased run-off due to roads Decreased road maintenance **Trend 9- Increased in some areas due to the fire but decreased in other areas due to road closures and decommissioning**	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 Heritage Resources	Miles of road maintenance completed, miles of road closed or decommissioned particularly where hydrologically connected Miles of hydrologically connected road—and channel network extension % Storm patrols following the fire
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. **Trend 10** **UPDATE- Same, with increased risk in high mortality areas under extreme conditions**	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 Spotted owl Dispersal habitat Forest/urban interface homes Big game forage, esp. winter range Firefighter/public safety	Fuel loading Fire risk models

TREND	**CAUSE**	PROCESSES AFFECTED **(ECOLOGICAL and SOCIAL)**	**RESOURCES AT RISK**	**Measures(s)**
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 Spotted Owl Dispersal habitat Big game forage, esp. winter range Forest/urban interface homes Private forest lands Firefighter/public safety Urban interface areas Fragile Archaeological resources	Fire start data
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	Acres of fuels treatment

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
~~Increased need for additional fire camp sites~~ **Trend 13** **UPDATE-This trend has been deleted** **Large fire camps for Incident management teams now need electricity and access to data, best served by developed sites.**	Three fire camp sites serve this area: 1) Sisters Middle School, 2) Sisters High School, and 3) Sisters Rodeo Grounds. Sisters Middle School is also a possibility			
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	Number of blowdown trees

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 and Fire**	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	Number of large trees Gradient Nearest Neighbor (GNN) data Fire Intensity mapping
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	Acres of forest type/stand stage Gradient Nearest Neighbor (GNN) data Fire Intensity mapping

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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 except in Fire areas where trend has reversed**	Fire exclusion Wildfire 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	Current Overstory Species Potential Vegetation Canopy Closure Trees/acre Gradient Nearest Neighbor (GNN) data Fire Intensity mapping

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
Increase in old growth in Lodgepole and High Elevation PAGs. Decreased stand age diversity. **Trend 18** **UPDATE-Trend has reversed due to high mortality and Pole creek fire. Now a decrease in old growth and beginning of an increase in stand age diversity.**	Fire Insect outbreak	Fire behavior Natural succession 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	Gradient Nearest Neighbor (GNN) data Fire Intensity mapping Insect mortality data
Decrease in connectivity for spotted owl dispersal habitat **Trend 19** **UPDATE- Increased due to loss of habitat in Pole Creek and other fires**	Timber harvest Roads Fire	Natural succession Reproductive success Fire behavior Predation Gene flow Microclimate	Spotted owl dispersal habitat Interior forest species habitat	Fragmentation modeling Gradient Nearest Neighbor (GNN) data Fire Intensity mapping

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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.	Snag data Fuel loading data
Decrease in Late successional wildlife and plant species and increase in early and mid seral species **Trend 21** **UPDATE-Decrease has intensified due to wildfires**	Timber harvest Fire exclusion Wildfire	Reproductive success Predation	Proposed, endangered, threatened, sensitive, and survey and manage species	Changes in habitat types Species surveys
Degradation/encroachment of meadows and other special habitats such as caves **Trend 22** **UPDATE-Same**	Irrigation diversions Channelization Ditching Fire exclusion Timber harvest Recreation	Fire behavior Microclimate Stream flow Water quality	Great gray owl nest sites Bats – cave vandalism Aquatic species - habitat loss	Invasive plant data Habitat checks

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
Decrease or extirpation of native fish species **Trend 23** **UPDATE-Slightly improved trend with reintroduction of anadromous fish, but few adult returns known for Whychus Creek.**	Dams Irrigation Diversions Dewatering Ditching Channelization Fish stocking – disease and genetic concerns Overfishing	Gene flow Food chains Aquatic connectivity Migration	Eagle,osprey and other wildlife foraging Aquatic species habitats and populations – unnatural predators Biodiversity Treaty rights Fishing	Numbers of spawning adult salmon or steelhead Successful natural reproduction
Increase in exotic and non-native wildlife and fish species **Trend 24** **UPDATE Brook trout moving in from wilderness lakes has decreased or stabilized but brown trout are increasing in distribution and abundance. Data is lacking for other aquatic species**	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	Miles of habitat occupied by invasive aquatic fish or macro-invertebrate species

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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	Acres of known invasive plant species
Increased contact with Tribes **Trend 26** **UPDATE-Same**	Joint projects	Management sensitivity to Federal Trust obligations	Cultural resources Treaty rights	Feedback at coordination meetings
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	Population numbers Economic indicators

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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	Building permits Land use permits Economic data
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	Acres of public land

TREND	**CAUSE**	PROCESSES AFFECTED **(ECOLOGICAL and SOCIAL)**	**RESOURCES AT RISK**	**Measures(s)**
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	Acres of public land
Decrease in grazing Lack of funding to monitor grazing **Trend 31** **UPDATE- Same**	Economics Environmental concerns Decline in large ranches Increase in small specialty operations raising exotics – llamas, etc.	Erosion Compaction Hydrologic process Habitat quality (introduction of invasive plants) Natural succession Migration (fences)	Aquatic species and habitats Special habitat and associated species Grass dependent species	Grazing use (AUM's) Range budget
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 Risk of movement of non-native aquatic species	Eagle and osprey foraging Aquatic species and habitats	Number and Miles of irrigation ditches in use Number of ponds

TREND	**CAUSE**	PROCESSES AFFECTED **(ECOLOGICAL and SOCIAL)**	**RESOURCES AT RISK**	**Measures(s)**
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	Building permits Land use permits Law enforcement incidents Filed Ranger Reports
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	Firewood permits sold Special Forest Products permits sold and buyer data Mineral pit use data Geothermal permits

TREND	CAUSE	PROCESSES AFFECTED **(ECOLOGICAL and SOCIAL)**	**RESOURCES AT RISK**	**Measures(s)**
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	Special use permits Environmental analysis for line installations
Increase in road densities – trend has peaked Some unmaintained are closing themselves but need hydrological fix, some roads have been closed and decommissioned **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	Road densities (mi/sq mi)

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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	Road Use data
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	ODOT Road Use data
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	Campground use Parking lot use from counters where present Field Ranger reports Concessionaire information

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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 wildlife and plant species and habitats	Law enforcement reports Field Ranger reports Amount of devegetation at dispersed sites
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	Use data from permits Field Ranger reports
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	Law enforcement reports Field Ranger reports

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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	Public feedback
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	Scenic integrity assessments
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	Law enforcement reports Field Ranger reports Cultural resource surveys

TREND	CAUSE	PROCESSES AFFECTED (ECOLOGICAL and SOCIAL)	RESOURCES AT RISK	Measures(s)
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	Recreation budget Facilities inspections
Increased volcanic activity on South Sister- has slowed **Trend 47- SAME**	Geological processes	Earthquakes Lake stability	Public safety Watershed resources (soil, water, habitat)	Geologists reports
Increased number and intensity of winter floods, and timing of peak flows **Trend 48- This trend will likely increase due to the fire effects and climate change**	More rain on snow events Climate change?- earlier snowmelt, more precipitation falling as rain, lower snow water equivalent	Streambank stability Sediment transfer Streamside housing developments	Streambank integrity Houses constructed in floodplains Fish spawning habitat and reproductive success Infrastructure	Change in flows in past 20 years. General discussion on climate trends for the PNW in the past century and projected future changes
Fish Passage at man-made barriers **Trend 48- NEW**	Irrigation Diversion Dams Culverts	Connectivity access to refugia access to spawning areas genetic exchange	Fish populations Reintroduction success	Number of barriers where fish passage has been obtained Miles of stream opened above barriers