White River Watershed Assessment

Prepared by
Wasco County Soil and Water Conservation District

For
White River Watershed Council

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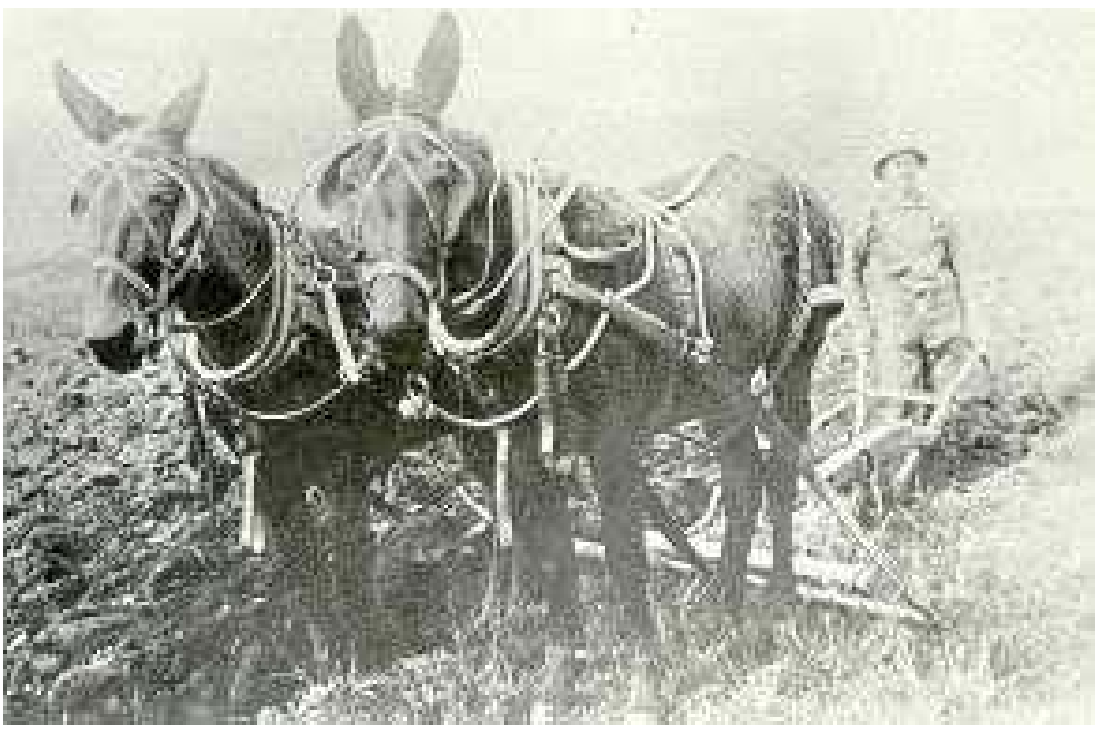

Walkin'plow near Pine Grove
from *Chaff in the Wind*, published by Friends of Maupin Library

Copies of the White River Watershed Assessment are available in electronic or paper format from jen-clark@or.nacdnet.org, or by contacting Wasco County SWCD at 2325 River Road, Suite 3, The Dalles OR 97058 or (541) 296-6178 x119.

Introduction

This Assessment has been undertaken by the White River Watershed Council, in partnership with the Wasco County Soil and Water Conservation District. The purpose of the Assessment is to provide a description of conditions and trends in the White River Watershed relevant to conservation of its natural resources. The objective is to discover where natural resources or processes are working, and where they need to be restored, particularly in regards to fish habitat and water quality.

The term "watershed" describes an area of land that drains downslope to the lowest point. A watershed consists of a network of drainage pathways that can be underground, or on the surface. These pathways converge into a stream and river system as the water moves downstream. The White River Watershed includes all of the waters that drain into the White River, between its headwaters on the flanks of Mt. Hood, to its mouth where it joins the Deschutes River. Because of the connectivity between groundwater, wetlands, streams and rivers within a watershed, any activity that affects the water quality, quantity, or rate of movement at one location may influence characteristics of the watershed at locations downstream. Everyone who lives, works, or plays within the watershed is part of this system.

The format used in this Assessment follows the Oregon Watershed Assessment Manual, developed for the Governor's Watershed Enhancement Board (July 1999). The assessment examines the history of the watershed, describes its features, evaluates its resources, and identifies issues within the watershed. Characteristics and processes of the watershed as a whole are analyzed, as well as conditions specific to individual streams.

Humans have used the resources of the White River Watershed from as early as 10,000BC. Fish, wild game, and plant foods supported inhabitants for thousands of years. Many people lived and fished along salmon-bearing rivers and streams in the region, including the lower White River.

In the mid 1800s the Barlow Road was established along the Oregon Trail through the White River basin. This overland route was the only alternative for emigrants to finishing the cross-continent journey via rafts down the Columbia river from present-day The Dalles. Thousands of people and their animals and belongings passed over this toll road. Today the Barlow Road is designated as a National Historic District.

In 1855, the US Government signed a treaty with the tribes of Middle Oregon. As a condition of this treaty, the Tenino and Wasco Indians ceded most of their traditional lands to the United States of America, and moved to the Warm Springs Indian Reservation. The Tribes reserved exclusive right to fish within reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.

Following this treaty, American pioneer families began to move into the White River Watershed. With the Donation Land Act of 1850 and the Homestead Act of 1863 Euro-Americans settled and built towns in the valleys, bringing livestock, and establishing logging operations in the upland forests. Forest Reserves were established by the federal government in 1891, leading to the establishment of the Oregon National Forest in 1908, renamed as the Mt Hood National Forest in 1924. In 1988 the White River was designated by Congress as a National Wild and Scenic River.

Today lands in the watershed are predominantly used for agriculture, timber, and recreation, with a local economy developed around irrigated agriculture. Agriculture in the basin is centered on production of livestock, hay, and dryland and irrigated grains. Irrigation provides important pasture and winter feed for livestock, with most of the water coming from tributaries of the White River. Public lands represent over half of the acreage of the Watershed, and include the Mt. Hood National Forest and Badger Creek Wilderness Area, the Barlow Trail National Historic District, and the state owned White River Wildlife Management Area. Visitors from the surrounding region make increasing use of public lands for recreational assets and scenic beauty.

It is the intent of this Assessment to provide a reference point from which the stakeholders in the White River Watershed, those who live and work here, can continue to plan for the health of its lands and waters into the future.

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Acknowledgments:
Data and information was provided by the following individuals and organizations:

- Friends of the Maupin Library.
- Juniper Flat District Improvement Co., Pine Grove, OR.
- Rock Creek Improvement District, Wamic, OR.
- Gary Asbridge, US Forest Service, Mount Hood Ranger District
- Sally Bird, Confederated Tribes of the Warm Springs Reservation
- Dan Boldt, Wasco County Department of Public Works
- Rod French, Oregon Department of Fish and Wildlife
- Rebecca Hogenkamp, Maupin City Library
- Ray Johnson, Oregon Department of Fish and Wildlife
- Merle Keys, Wasco County Weedmaster
- Chris Rossel, US Forest Service, Barlow District
- Steve Pribyl, Oregon Department of Fish and Wildlife
- Oregon Department of Environmental Quality, Bend OR.
- Oregon Department of Fish and Wildlife, The Dalles OR.
- Oregon Department of Forestry, The Dalles OR.
- Oregon Water Resources Department, The Dalles OR.
- USDA Forest Service, Dufur OR.
- USDA Natural Resources Conservation Service, The Dalles OR.
- USDI Fish and Wildlife Service.
- Wasco County Historical Society, The Dalles OR.
- Wasco County Planning Department, The Dalles OR.
- Wasco County Public Works, The Dalles OR.
- Wasco County Soil and Water Conservation District, The Dalles OR.
- Wasco County Weed and Pest Management Office, The Dalles OR.
- Wasco County Water Master, Larry Toll, The Dalles OR.

In addition, we would like to thank the residents of the White River Watershed, and members of the White River Watershed Council for their suggestions and patience in reviewing several drafts of the Assessment in progress.

1) Watershed Description

1.1) Physical Characteristics

The White River Watershed is located on the east slope and in the eastern foothills of the Cascade Range. The area considered by this report includes the White River Watershed proper, including its principal tributaries, Tygh Creek, Badger Creek, Threemile Creek, and Jordan Creek, as well as Wapinitia Creek watershed, Nena Creek watershed, and other areas draining to the Deschutes River from the west. The total drainage area is 350,199 acres, or approximately 547 square miles. White River originates within the Mount Hood National Forest on the southeastern slope of Mount Hood (highest point in Watershed, 11,291 feet). White River flows southeast, then curves to the northeast before entering the Deschutes River. White River enters the Deschutes River just upstream from Sherar's Falls, at River Mile (RM) 47.5. The elevation at the mouth of White River is 789 feet.

Throughout this document, Whiter River Watershed is also referred to as "the Watershed". White River Watershed proper is divided into five subwatersheds: Upper, Middle and Lower White River, Badger Creek, Threemile Creek and Tygh Creek. The division between the Middle and Upper White River subwatersheds occurs downstream of the confluence with Boulder Creek. The division between the Lower and Middle White River subwatersheds occurs at the confluence with Tygh Creek.

The divisions between Upper, Middle and Lower White River subwatersheds are based on topography. A north-south running ridgeline divides the Upper and Middle subwatersheds. White River is the only river or stream to cut through this ridge. To the west of the ridge in the upper subwatershed, all streams drain into the White River. The flood plain is relatively broad, and has been repeatedly flooded by glacial melt. To the east of the ridge, the river drops into a canyon which runs the length of the middle section of the Watershed. Tygh, Badger and Threemile subwatersheds originate on the east slopes of this ridge.

Leaving the canyon the White River enters Tygh Valley. The area from Tygh Valley to the mouth of the White River at its confluence with the Deschutes is considered the Lower White River subwatershed for the purposes of this study. Lower White River subwatershed has no significant tributaries.

Middle White River subwatershed has several notable tributaries which include North and South forks of Rock Creek, Wildcat Creek, North and South forks of Gate Creek, and North and South forks of Hazel Hollow.

Upper White River subwatershed includes Boulder Creek and its tributaries Lost and Forest creeks, Clear Creek and its tributaries Camas and Frog creeks, and in the uppermost reaches, Barlow and Iron creeks.

Tygh Creek originates on the south side of Tygh Ridge and the east side of Lookout Mountain at an elevation of 5,920 feet). Tygh Creek enters the White River 5.25 miles above the mouth of White River. The Tygh Creek subwatershed includes Butler Creek, Jordan Creek, and its tributaries Gurley and Pen Creeks.

Badger Creek originates in the Badger Wilderness Area, on the east slopes of Lookout Mountain at an elevation of 6,000 feet. Badger Creek flows into Tygh Creek 3.8 miles above the mouth of Tygh Creek. The Badger Creek subwatershed includes Little Badger Creek and a number of smaller creeks.

Threemile Creek originates on Grasshopper Butte, at an elevation of 5,320 feet. Threemile Creek flows into White River 7.7 miles above the mouth of White River. Threemile Creek subwatershed includes Pine Hollow and Dry Creek.

Wapinitia Creek, Nena Creek, Oak Springs and Winter Water Creek all drain into the Deschutes River and therefore are not technically part of the White River Watershed. They are included in this Assessment because it would not have been practical to conduct an assessment for them separately. Wapinitia and Nena creeks differ biologically from the White River in that they have no passage barriers that would prevent use by anadromous fish, while the White River is non-anadromous above White River Falls.

Wapinitia Creek originates at the head of McCubbins Gulch at an elevation of 3,559 feet. Wapinitia Creek flows into the Deschutes River at RM 55.8. Rice Creek is a seasonal tributary of Wapinitia Creek.

Nena Creek originates on the north side of the Mutton Mountains at an elevation of 3,600 feet. Nena Creek flows into the Deschutes River at RM 58.9. Nena Creek has only seasonal tributaries.

Nearly 70% of the land within the Nena Creek subwatershed is owned by the Confederated Tribes of the Warm Springs Reservation (CTWSRO). Tribal lands are managed according to an Integrated Resource Management Plan (IRMP). This plan includes natural resource monitoring and adaptive management. At the Tribes request, the watershed assessment does not include natural resource data collected by CTWSRO or make any recommendations relating to management of tribal lands. Most of the lower portion of Nena Creek is owned by private, nontribal landowners. Therefore, Nena Creek was included in the watershed assessment to reflect the needs of these lands and resources.

Oak Springs originate on Juniper Flat at an elevation of approximately 1,780 feet and includes the area between the White River and Wapinitia Creek subwatersheds. The City of Maupin and the Oak Springs Fish Hatchery are located in the Oak Springs drainage. Upper Oak Springs on Juniper Flat is seasonal (personal observation, 10/02), while the lower springs continue to seep from cliffs above Oak Springs Fish Hatchery.

Winter Water Creek, as shown on the USGS topographic map, originates on the south side of Tygh Ridge at an elevation of 3,343 feet. Several springs on the slopes below Tygh Ridge feed this stream. Winter Water Creek crosses and parallels Highway 216 approximately 2.25 miles upstream from the Deschutes River and Sherars Bridge. It is observed to be perennial where it crosses the highway and upstream of the crossing for approximately a quarter mile (personal observation, 10/2), but may be seasonal farther upslope.

The geology of the White River area is dominated by multiple basalt lava flows laid down between 15 and 17 million years ago. These lava flows are believed to be more than 3000 feet thick, and are generally tilted toward the north. The oldest flows are exposed near Nena Creek, while the uppermost flows are visible in the bluffs south of The Dalles. The general northward tilt is interrupted by Tygh Ridge, where the layers warp upward in what is known as an anticline (Kinzey, 1986).

Typically, these lava flows display a hexagonal, columnar jointing that is a fracture system formed when the molten lavas cooled. Many of them display spheroidal “pillows” at their base, where the lava spilled into water or mud as it cooled. Some lavas were charged with air, and thus form frothy, vesicular flow. The top of each flow often weathered into reddish, baked clays while it was on the surface, before being covered by another lava flow. These layers also typically contain fossilized wood and organic matter (Kinzey, 1986).

Gay Jervey, a geologist in Northern Wasco County, reports that the vesicular flows and pillow lavas are typically the sites of the most productive aquifers (Jervey, 1995).

The older lava flows near Nena Creek have been mined to produce perlite and fossilized bones from the same era as Picture Gorge, 100 miles east (Kinzey, 1986).

Non-volcanic boulders were deposited in the area by the Bretz Floods, which roared down the Columbia from Montana during the last 100,000 years (Kinzey, 1986).

Climate varies across the Watershed because of its wide range of elevations and transitional location between weather dominated by wet marine airflow from the west and the dry continental climate of eastern Oregon. The average annual rainfall varies from 100+ inches at the headwaters of White River, down to 11 inches or less near the mouth (Figure 1-2). Areas of climate and landscape similarity called ecoregions have been defined as a common framework for ecosystem management in the U.S. (Pater et al. 1998). The headwaters of the White River are located in the Cascade Alpine and Cascade Crest Montane Forest ecoregions. The headwaters of Tygh, Threemile and Badger creeks are located in the Grand Fir Mixed Forest ecoregion. Middle elevations are located in the Ponderosa Pine/White Oak ecoregion. The eastern part of the watershed is located in the Umatilla Plateau ecoregion, characterized by bunchgrass prairie with mixed hardwood trees in the riparian zones.

The headwaters of Wapinitia Creek originate in the Ponderosa Pine/Bitterbrush ecoregion. From there, it flows into the Umatilla ecoregion.

The headwaters of Nena Creek are considered part of the John Day/Clarno Uplands ecoregion. From there, it flows down into the Deschutes Canyon ecoregion. Both of these ecoregions are characterized by juniper and bunchgrasses in the uplands and small hardwoods in the riparian areas.

This system of ecoregions is used by the Oregon Watershed Assessment Manual as defined by the Oregon Natural Heritage Foundation (http://www.gis.state.or.us/data/alphalist.html).

Figure 1-1. Location of White River Watershed in the state of Oregon. Locations of major streams.

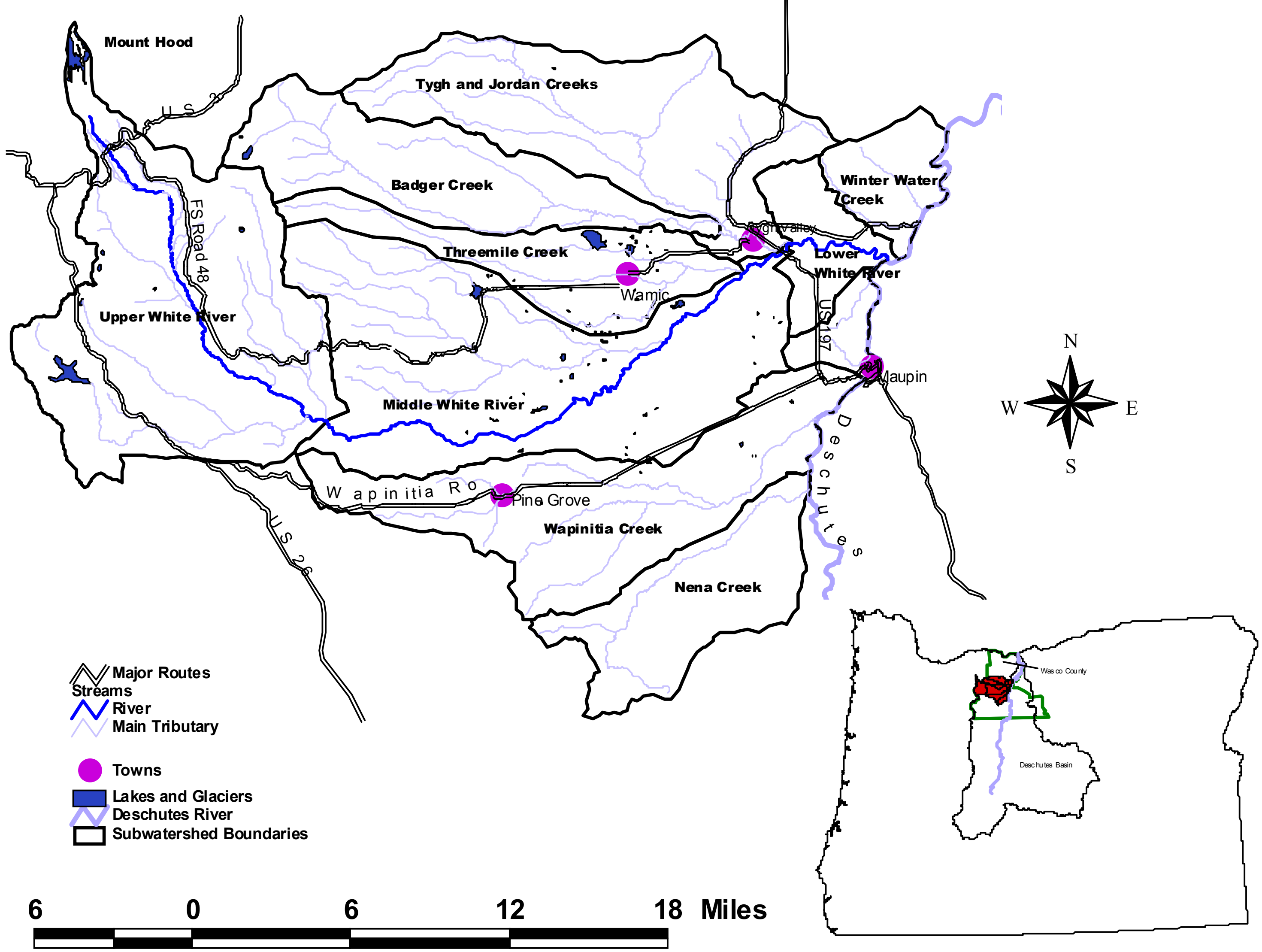
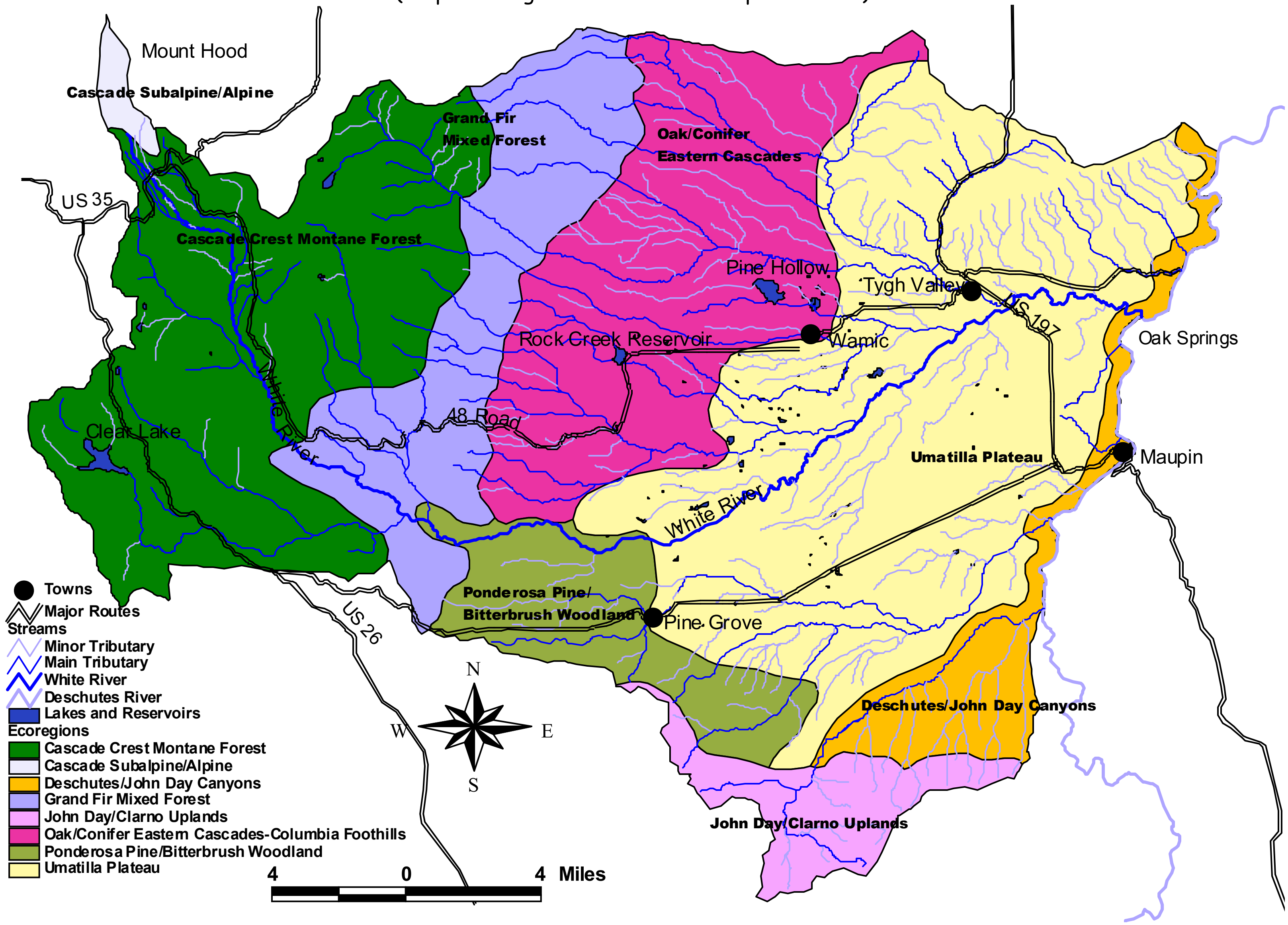


Figure 1-2. Ecoregions. Source: Oregon Natural Heritage Foundation (http://www.gis.state.or.us/data/alphalist.html).



1.2) Social and Economic Background

Population

Wasco County had a population of 23,791 in Year 2000, a rise of 2,108 from 1990. Of the total county population, less than half - 11,635 - lived outside the City of The Dalles. According to Census 2000, the City of Maupin had a population of 411. Tygh Valley had a population of 224. Pine Hollow was listed with a population of 424, and Pine Grove with a population of 162. The average population density in Wasco County is 10 people per square mile (CGEDA website 2001: http://www.cgeda.com/).

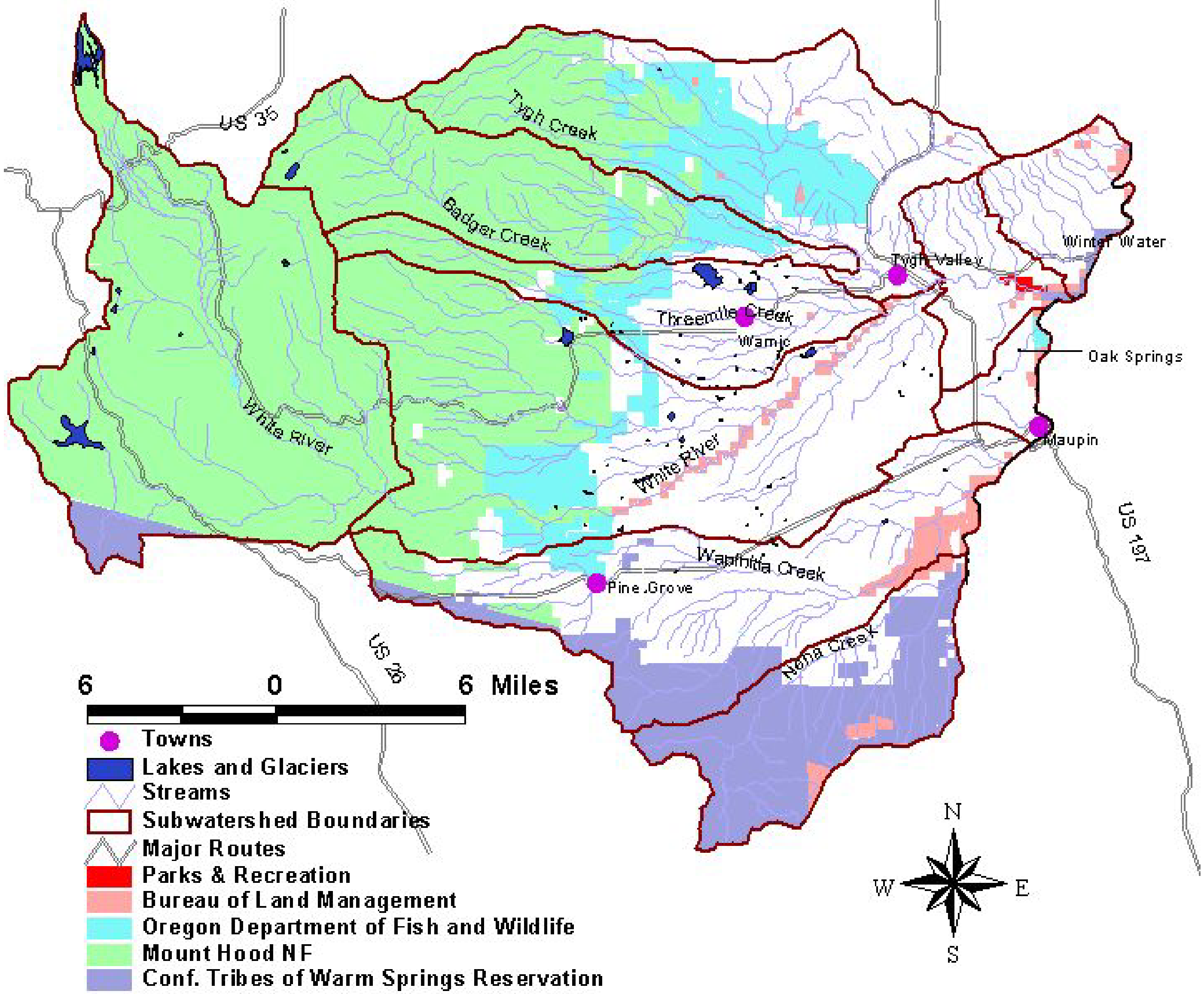
Land Ownership and Treaty Rights

Over half the acreage of the Watershed is owned by the public (Table 1-1). The largest landowner is the United States Forest Service (USFS). Most of the high elevation land in the western half of the Watershed is part of the Mount Hood National Forest, including the headwaters of White River, Badger Creek, Threemile Creek, Tygh Creek and Jordan Creek (Figure 1-2). The White River Wildlife Area, owned by Oregon Department of Fish and Wildlife (ODFW), covers a narrow band just outside of the National Forest. The Confederated Tribes of the Warm Springs Reservation own most of the land within the reservation boundaries, as well as several thousand acres of the Nena Creek Subwatershed. The Bureau of Land Management (BLM) owns 7,275 acres, mostly along the White River, the Deschutes River and Wapinitia Creek.

Table 1-1. Land Ownership (Source: Wasco County Assessor's Office, 2003, Natural Resources Conservation Service, 2003)

OWNERSHIP	ACRES
Private Ownership	129,180
U.S. Forest Service	150,880
OR Department of Fish and Wildlife	29,235
Wasco County	266
Parks and Recreation	297
BLM, Prineville District	7,275
Tribal: CTWSRO	32,645
TOTAL ACRES:	**349,778**

Figure 1-3. Public Land Ownership. Source: Wasco County Assessor's Data via GIS Coordinator.



2) Settlement and Development

2.1) Native American Inhabitants and Land Use

Archaeological evidence shows that the earliest occupation of Wasco County dates to approximately 10,000 years before present (BP) (Thomas 1986). Historically, Tenino people occupied the project area with populations numbering approximately 1,200 (Thomas 1986). The Tenino are a group of western Columbia Plateau Sahaptin speaking people. Generally, they associate themselves with village communities located on the Columbia River or its tributaries in the area just above The Dalles to above Alder Creek in Washington (Hunn and French 1998). Descendants are usually enrolled as Warm Springs, Yakama, and Umatilla tribal members (Hunn and French 1998).

The Tenino, like the Wasco and Wishram, had villages along the Columbia River and its tributaries. The Tenino proper (tinaynułáma) summered in a village known as *tináynu* four miles east of The Dalles on the Columbia River and wintered inland along Fifteenmile Creek. A group of the Tenino known as wyam of the Lower Deschutes occupied the summer village of *wayám* located at Celilo Falls and wintered at a village known as *wanwa'wi* located on the left bank of the Deschutes River just above its confluence with the Columbia River. The John Day people, or takšpašłáma, occupied several villages on the south side of the Columbia River, with a principal summer village noted as being located at the mouth of Blalock Canyon or Philippi Canyon (Toepel et al. 1980; Connolly 2002), while the small bands of Tygh or Upper Deschutes people wintered in Tygh Valley and the surrounding area, including Sherar's Falls (Toepel et al. 1980; Thomas 1986).

While winter villages and major summer and fall fisheries were located along the major rivers, the Sahaptin speaking peoples obtained approximately 60 percent of their food by gathering plants from areas further inland from the Columbia River, rather than from the preservation and trade of fish. Plant foods included roots such as camas, bitterroot, biscuitroot, balsamroot, and other various lomatiums (Thomas 1986), many were sun-dried whole or as cakes for later consumption. Also included are berries (many gathered near Mt. Hood in the fall) (Hunn and French 1998; Winegar 1986), several species of "Indian celeries", seeds and nuts, and tree lichen (baked underground to create a confection). Like the Wasco and Wishram, Tenino ceremonies included the First Fruits Rite, held in both early April and in July. (Toepel et al. 1980). These cultural foods are still gathered today for consumption and ceremonial purposes.

Salmon, particularly Chinook, was an important food source (Thomas 1986), but it is reported that fishing came secondary, with the Tenino people using five species of Pacific salmon, suckers, lamprey, and trout. However, Toepel et al. (1980) disputes the use of fishing as a secondary resource, stating that fish was the most important staple in the diet. Whitefish, northern pike minnow, chiselmouth, peamouth, and red-sided shiner were caught during the winter. While white sturgeon and bull trout (Dolly Varden) have been reported to be avoided, however, tribal elders from the bands of the Warm Springs and Wasco Tribes recall eating both, sturgeon and bull trout, in historical times (Hunn and French 1998; Sally Bird, personal communication, July 22, 2002). Salmon were generally dried for later consumption or trade. By pounding dried salmon flesh the Indians were able to make dehydrated salmon flour, which was stored in bags made of cattail leaves lined with salmon skin. Mule deer, white-tailed deer, bighorn sheep, pronghorn antelope, black bear and smaller mammals were hunted for meat and furs. Grouse and waterfowl were also hunted. Painted turtle and several species of freshwater mussels were collected as winter famine food (Hunn and French 1998).

Seasonal rounds were observed as early as 1826 when Peter Skene Ogden reported that approximately 20 families were catching and drying salmon at the summer village, to be joined in July by the portion of the group which had traveled to hunt and gather. After July it was reported that half of the group then traveled into the Cascades to gather berries and nuts and hunt until September at which time they traveled up the Deschutes River. The women would gather late-ripening roots and berries and smoke meat brought in by the men. Another group was reported to be gathering tule reed for mat-making in October. Summer structures were then dismantled and the group would travel back to the winter village site (Thomas 1986).

The Tenino had four major social groups, including the nuclear family, the hearth group, the winter lodge household, and the village. The nuclear family shared a common hearth and sleeping area within the winter lodge and traveled together on seasonal rounds, while the hearth group consisted of pairs of closely related nuclear families, often those of "brothers". The extended family unit occupied the winter lodge and was under the leadership of a household head; however, hearth group memberships varied from year to year. The village consisted of one or more lodges that were established in close proximity to one another. Usually one or more of the outstanding men in each village were considered "chiefs" (Hunn and French 1998). During historical times, the power of chiefs was increased to facilitate interaction with United States Government officials (Thomas 1986).

Winter dwellings included A-frame tule mat-covered lodges, longhouses, or circular semi-subterranean houses (Hunn and French 1998). Generally, these dwellings were placed in areas that were protected from the elements and in which water and fuel was readily available (Thomas 1986). These were dismantled in spring so the mats could be transported to use with tepee poles that had been stored at various campsites. During the summer circular mat-covered tepees or rectangular open-walled ramadas were used, both as habitations and as fish-drying shelters (Hunn and French 1998; Thomas 1986). Dome-shaped sweat lodges were also common (Hunn and French 1998).

Like the Wasco and Wishram peoples, the technology of the Tenino had a dual purpose of everyday use and decoration. Stone was worked for tool making, such as mortars, pestles, and bowls, and wood was used for fuel, net and lodge poles, net hoops, cross-braces, mortars, bows, bowls, spoons, digging stick shafts, sweat lodge frames, basket traps, binding and whips. Arrow shafts, needles, straws, whistles, and drum frames were also constructed. Indian hemp was used for binding and twined weaving for nets, root-collecting bags, and women's hats. These weavings were usually decorated using beargrass leaves. Tule stalks were formed into mats to cover lodges and tepees, as well as to create flooring within these structures, tablemats, food-drying platforms, and burial shrouds. Alder and Oregon grape bark, wolf lichen, Indian paint fungus, and sand dock rhizomes were used as decorative dyes. A variety of animal products were used, including hides for clothing, river otter and weasel skins for hair decorations, sinew for bowstrings, rawhide binding strips, elk antler for stone working or hooks, and deer bone for fish spear points, hooks, and gorges. Bighorn sheep horn was used to make spoons and bowls. Deer hooves were used for dance rattles and porcupine quills, bird feathers, and shells were used for ornamentation and decoration (Hunn and French 1998; Thomas 1986).

On June 25, 1855, the Tenino and neighboring Wasco signed a treaty with the U.S. Government in which they ceded most of their lands to the United States and agreed to relocate to the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). By 1857 Tenino peoples had relocated to the CTWSRO in the area known as Simnasho. Northern Paiute were relocated to CTWSRO at a later date (Thomas 1986)

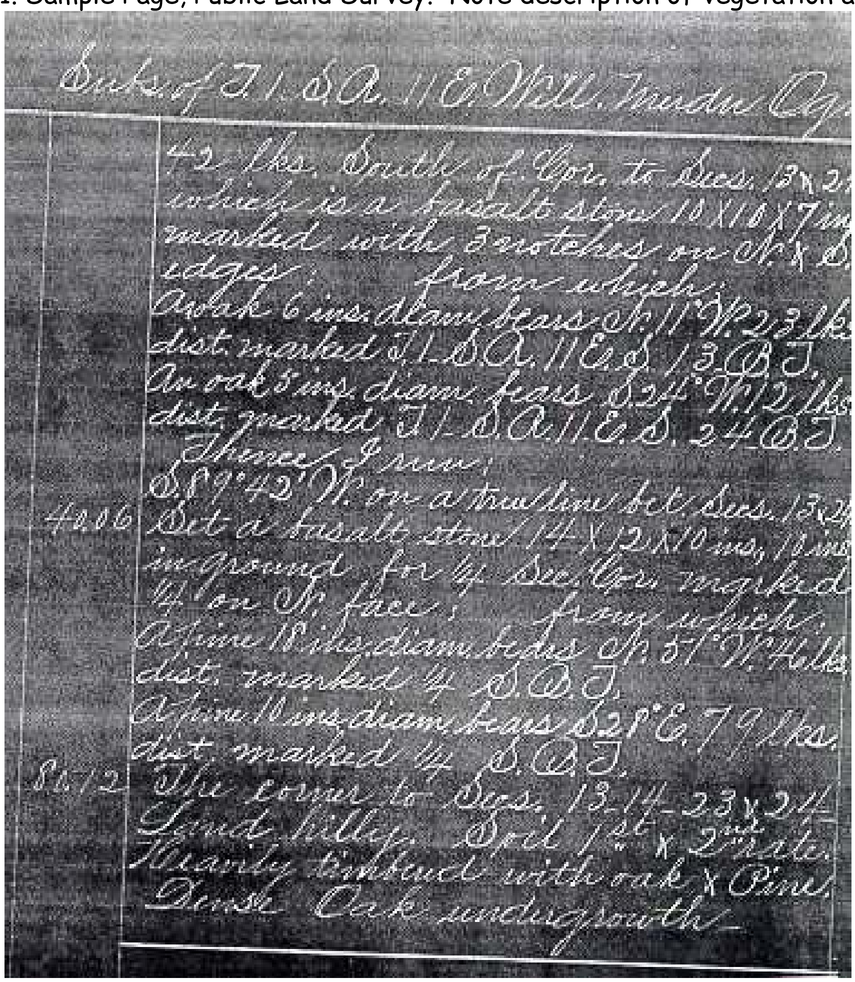
CTWSRO holds federally reserved rights in lands ceded to the United States, to include those within the project area. These rights include the exclusive right to fish within CTWSRO boundaries and the right to fish in common with citizens of the United States at all other usual and accustomed places, including ceded lands. Ceremonial, commercial and subsistence fishing remains an essential part of CTWSRO culture and economy; however treaty fishing opportunities have become limited because of low abundance and the necessity to protect weak or threatened fish stocks. Tribal and non-tribal fishing is regulated or co-managed by CTWSRO and the Oregon Department of Fish and Wildlife (ODFW). The tribal co-management authority is derived from the 1855 Treaty and subsequent court rulings. As co-managers of surrounding watersheds the CTWSRO is actively involved in habitat protection, restoration, fisheries enforcement, enhancement, and research activities (Thomas 1986).

2.2) Historic Land Cover Types

In 1855, the US Government signed a treaty with the tribes of Middle Oregon. As a condition of this treaty, the Tenino and Wasco Indians ceded most of their traditional lands to the United States of America, and moved to the Warm Springs Indian Reservation. The Tribes reserved exclusive right to fish within indian reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.

Following this treaty, American pioneer families began to move into the White River Watershed. The Butler and Shamrock families were the first to move into Tygh Valley in 1856 (Table 2-1). In response to this, Wasco County commissioned a series of public land surveys, which continued through the 1880's before they finished. Surveyors crossed the landscape, establishing township and section lines and noting timber, undergrowth, grass, soil types and land formations (Figure 2-1). These notes provide a basis for mapping the vegetation at the time of American settlement (Figure 2-2).

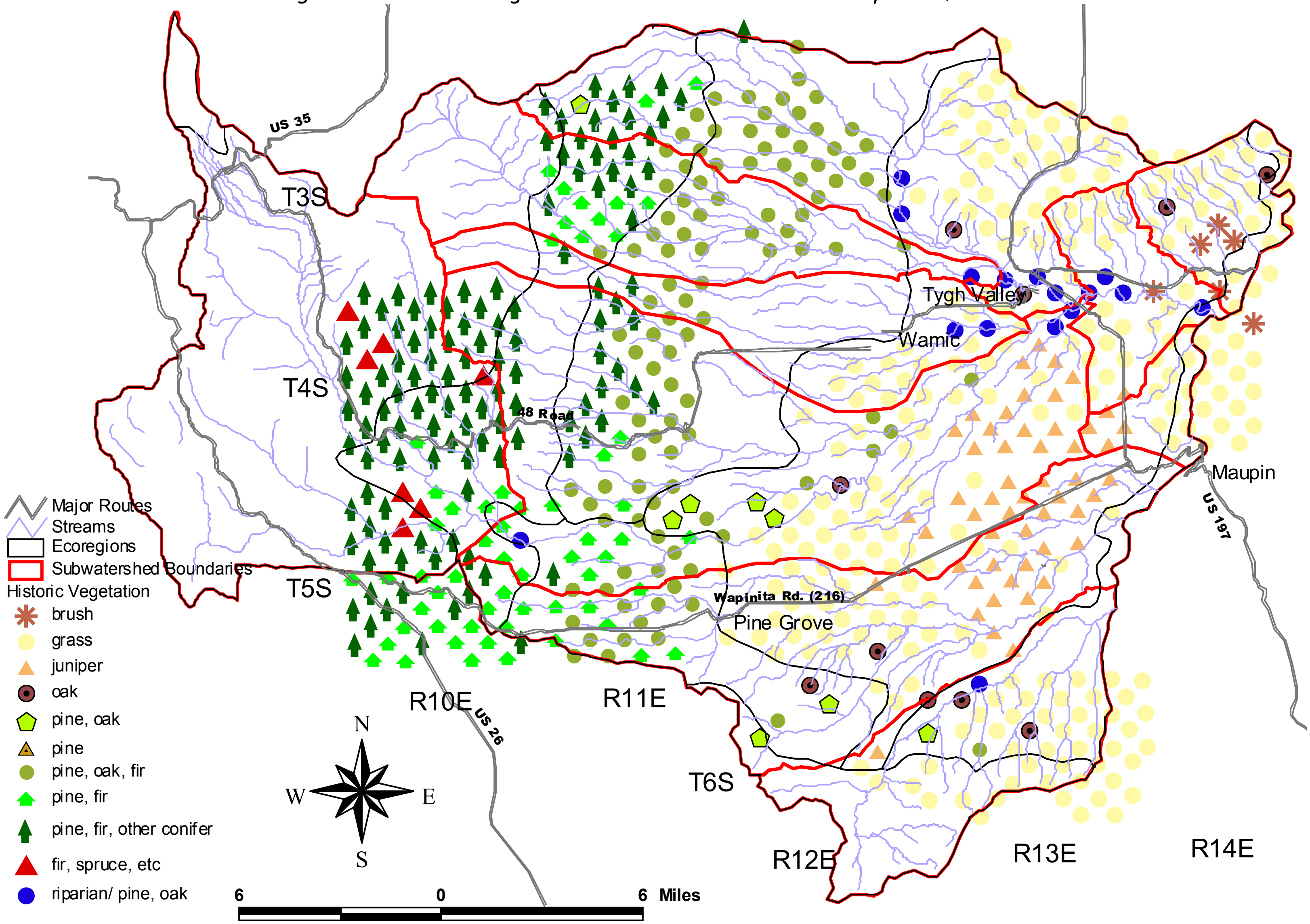
Figure 2-1. Sample Page, Public Land Survey. Note description of vegetation at bottom.



Subs. of T.1 S.R. 11 E. Will. Merid. Or.

42 lks. South of Cor. to Secs. 13 & 24
which is a basalt stone 10 X 10 X 7 ins.
marked with 3 notches on N. & S.
edges; from which
An oak 6 ins. diam. bears N. 11° W. 23 lks.
dist. marked T.1 S.R. 11 E.S. 13 B.T.
An oak 5 ins. diam. bears S. 24° W. 12 lks.
dist. marked T.1 S.R. 11 E.S. 24 B.T.
Thence I run;
S. 89° 42' W. on a true line bet. Secs. 13 & 24
40.06 Set a basalt stone 14 X 12 X 10 ins., 11 ins.
in ground for 1/4 Sec. Cor. marked
1/4 on N. face; from which
A pine 18 ins. diam. bears N. 57° W. 4 lks.
dist. marked 1/4 S.B.T.
A pine 10 ins. diam. bears S. 28° E. 79 lks.
dist. marked 1/4 S.B.T.
80.12 The corner to Secs. 13, 14, 23 & 24.
Land hilly. Soil 1st & 2nd rate.
Heavily timbered with oak & Pine.
Dense Oak undergrowth

Figure 2-2. Historic Vegetation. Source: Public Land Survey notes, 1855 to 1886.



2.3) Settlement and Development Timeline

Table 2-1. Settlement and Development Timeline. (Source: *Chaff in the Wind,* Friends of the Maupin Library, 1986)

DATE	EVENT
10,000 BC	First evidence of humans.
Early 1800s	Area occupied by Sahaptin-speaking peoples.
1824-1825	Peter Skene Ogden travels on "Old Indian Trail" hunting beaver for Hudson's Bay Company. Describes White River/Deschutes confluence: "We reached a fine plain; sand soil covered with wormwood, we crossed over to this place, (camping site) a large fork of the River of the Falls (Deschutes); another fork of the same was also seen near, taking its course S.E."
1835	Nathaniel Wyeth camps on Wapinitia Creek, near the present day site of Wapinitia, returning through Juniper Flat in 1835.
1843	John C. Fremont and Kit Carson travel through area on route from Fort Dalles to California.
1845	Barlow-Palmer-Rector wagon train finds overland route to Willamette Valley. Barlow Road was the only major land route to Willamette Valley until Columbia River Highway completed in 1916.
1855	US Government signs treaty with Tenino and Wasco Indian Peoples, who cede most of traditional lands to USA, while reserving exclusive right to fish within Indian reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.
1856	Butler and Shamrock families are the first to settle in Tygh Valley. Daniel Webster Butler establishes trading store in 1857.
1858	Jondreauz and McDuffey plant orchards in Tygh Valley.
1860	At least 8 white families in Tygh Valley.
1860-1864	Construction of first bridge at Sherar's Falls, allowing Oregon Trail immigrants to bypass The Dalles and head directly for the Barlow Road from Cottonwood Canyon.
1862	Duncan Pratts settles at present day site of Wamic, which was first known as Prattsville.
1868	Post Office established at Sherar's Falls.
1869	Oak Grove Wagon Road connects to Barlow Road from Juniper Flat.
1872	Howard and Perry Maupin establish first ferry at Maupin.
1873	First post office in Tygh Valley.
1878	The Dalles-Wapinitia stage run established.
1879	Post office established at Prattsville. Closed a year later and reopened in 1884 under the name of Wamic (named after Womack family).
1881	Clear Lake Lumber and Irrigation Company formed.
1883	Cascade Forests proclaimed Cascade Range Forest Reserve.
1889	Population of Wamic was 100 with a blacksmith, brickyard, two sawmills, a church and a grange hall.
1893	Joseph Sherar establishes 33-room hotel, livery stable and blacksmith shop at Sherar's Bridge. Also built flour mill at White River Falls, and improved roads into canyons.
1901	Construction begun at White River Power Plant – Power generation began in 1902.
1903-1912	Hop Mill operates at Tygh Valley – known for high quality hops.
1905	First deep well drilled on Juniper Flat. Further wells drilled from 1906-1915.
1904	Joseph R. Keep obtained private land on Clear Creek and filed for right of way for dam, reservoir and ditch. Rights and property would change hands several times before Juniper Flat Irrigation Ditch would be completed and functioning in 1916.
1906	Cascade Range Forest Reserve: 7 sheep permittees with 21,185 head, and 37 cattle permittees with 2,633 head.

Table 2.1 (continued): Settlement and Development Timeline

DATE	EVENT
1908	Cascade Range Forest Reserve becomes Oregon National Forest (name changed in 1924 to Mt. Hood NF).
1909	Post office established at Maupin.
1909-1911	Oregon – Washington Railroad & Navigation railroad built by Harriman Lines on east bank of Deschutes. Oregon Trunk Line railroad built on west bank of Deschutes by Porter Brothers. Both lines joined at North Junction. Line completed to Bend in 1911.
1911	Shattuck Lumber and Grocery.
1911	First school house in Maupin.
1912	Wooden bridge constructed at Maupin.
1912	Hunt's Ferry Warehouse on east bank of Deschutes is incorporated with a grain capacity of 100,000 bushels of wheat.
1913	Maupin Community Club holds first meeting.
1914	Oregon-Wapinitia Cattle Growers Association organized with 32 members and 1000 head on National Forest.
1916	First water sent down ditch from Clear Lake to Wapinitia. Ditch and reservoir owned and operated by Wapinitia Irrigation Company. Work continues for several years on extensions to reach the lower Flats. Sawmill located near Clear Lake provides lumber.
1916	Pine Grove platted and Wapinitia Irrigation Company hires crew to construct first buildings.
1917	Maupin Warehouse Company grain elevator is completed with capacity of 50,000 bushels – grain can now be stored in bulk, rather than sacks.
1917	Flour mill constructed with railroad spur line for loading.
1919	Oak Springs Fish Hatchery established with one pond by Deschutes River Anglers Association.
1920	DAIRIES: First dairy in Maupin. Dairies continue operating and offering home delivery through 1946.
1921	Maupin Fire burns fifteen buildings, including post office, bank and grocery.
1922	County incorporates town of Maupin.
1922	Standard Oil installs station in East Maupin.
1923	100 miles of track are retired when railroad traffic is consolidated to a single set of tracks on west side of river. Kelly Hotel and Woodcock's Flour Mill suffer loss of business. Hunt's Ferry warehouse shuts down.
1923	Construction on Frog Creek feeder line completed.
1924	Oak Springs Fish Hatchery begins period of growth.
1926	Maupin electrified.
1928	Work begins on new 15 foot high dam at Clear Lake.
1929	New Maupin Bridge dedicated.
1929	Mount Hood Land and Water Company takes over ownership of irrigation ditch from Wapinitia Irrigation Company. Dam on Clear Lake completed. Timber is flooded rather than salvaged in violation of conditional use permit. Forest Service blocks delivery of water. Legal battles interfere with delivery of water through 1937.
1934	Single turbine and generator power plant built at Oak Springs Fish Hatchery by Woodcock Brothers.
1936	Mount Hood National Forest: 33 cattle permittees.
1937	Water Users Corporation of Juniper Flat takes ownership of Juniper Flat irrigation system. Works with Forest Service to meet conditional use stipulations.
1938	Clear Lake dam bursts while being filled.
1940's	At least 13 sawmills located in or near Pine Grove. 56 million board feet sold between 1941 and 1945.
1941	Mount Hood National Forest: 50 cattle permittees.
1942	Southern Wasco Soil and Water Conservation District organized.
1946	Mount Hood National Forest: 23 cattle permittees.

Table 2.1 (continued): Settlement and Development Timeline

DATE	EVENT
1948	Mount Hood National Forest Management Plan prepared that called for harvest of 27 million board-feet per year from the entire forest.
1952	Bureau of Reclamation gets involved in effort to build Clear Lake Dam. Bureau reveals that all land surrounding Clear Lake was withdrawn from National Forest in 1915.
1952	Water Users Corporation of Juniper Flat reorganizes as Juniper Flat District Improvement Company. They receive loan of equipment from Southern Wasco Soil and Water Conservation District.
1952	Wapinitia Lumber Company in Maupin burns down. Sid Casteel, owner, trades property, contracts, and lease to Mountain Fir Company.
1955	Oak Springs Fish Hatchery has 24 ponds. Power plant is closed down.
1959	Maupin citizens form the Deschutes River Park Commission, establishes Maupin City Park.
1965	Ten more ponds, pipeline, and circular ponds completed at Oak Springs Fish Hatchery.
1978	Mount Hood National Forest (entire forest): 5 cattle permittees with 610 head.
1986	Mount Hood National Forest (entire forest): harvesting 52 million board feet per year.
Current:	Mt Hood NF (entire forest): 20million b.f., 10million for eastside, 6 permittees, 4 allotments, 830 pairs, 4,567 AUMs

2.4) Land Use

Farming

Agricultural lands in the watershed receive less than 20" precipitation as rain or snow annually, most occurring from October through March. Irrigation ditches supply water from late spring into early fall. Farmland in the watershed totals about 47,490 acres. Of these, 38,500 acres are non-irrigated crops. Irrigated farmlands comprise only 8,640 acres, and orchards comprise 350 acres.

"Minimum till" is the most prevalent dryland farming method used in the watershed, comprising 29,060 acres. Wheat and barley are the most frequently grown crops. Mustard and canola are grown for seed as well, and sometimes used in crop rotations. Farmlands using "no till" methods total 5,050 acres. Farmlands that have been converted to pasture crops, or are in the Conservation Reserve Program total 4,390 acres.

Grazing

Rangeland represents approximately 90,000 acres in the watershed. Grazing allotments are issued on public lands by Oregon Department of Fish and Wildlife (ODFW), the Bureau of Land Management (BLM), and the U.S.Forest Service (USFS). Grazing also occurs on private lands. Grazing is concentrated on uplands, intermittent streams and irrigation ditches.

Overgrazing prior to World War II resulted in much of the damage seen today. The earliest grazing occurred as travelers on the Barlow Trail stopped at rest points and camp sites. Immigrant Springs and areas along Gate Creek are examples of early grazing locations. As European settlers arrived with their herds grazing intensified with sheep at the highest locations and cattle at low and middle elevations.

After the Forest Service was created in 1905, individual grazing allotments were established within the National Forest. Grazing peaked during and just after World War II.

ODFW owns and manages the White River Wildlife Management Area. Benefits to wildlife are the top priority within the Wildlife Management Area, and grazing permits for livestock are allotted as well. Livestock numbers are kept low enough to provide spring and winter forage for wildlife. Pastures are rested to allow recovery, and the degree of grazing allowed is tailored to the tolerance of plant species present.

The BLM has 10 allotments along the White River canyon rim.

Mt. Hood National Forest (USFS) has 4 grazing allotments with 6 permits total. These are the Badger allotment (2 permits), the Grasshopper allotment (1 permit), White River allotment (2 permits), and Wapinitia allotment (1 permit). Parts of Badger, Grasshopper and White River allotments lie within Late Successional Forest Reserves (LSRs). Monitoring plots are established within Forest Service allotments to measure "utilization levels" of vegetation, and to reveal long term trends in vegetation and soil conditions. On all allotments, springs have been fenced, as well as some meadows and stream reaches, to protect riparian and aquatic resources. Areas of most concern in the National Forest are in the Rocky Burn, around Clear Lake and the riparian area at Camas Prairie.

Grazing practices are pertinent to upland, riparian, and aquatic conditions in the watershed. Grazing is discussed further in Chapter 10.

Timber Management

Forest covers approximately 188,000 acres in the watershed. Closed canopy forest covers 106,000 acres, and open canopy forest covers 70,000 acres. Regenerating forest covers approximately 13,000 acres.

Current USFS timber management practices emphasize managing for "sustainability" of natural resources. Late Successional Reserves protect late successional and old growth forest ecosystems and the species that depend upon these forest types. Riparian Reserves provide protection along all perennial and seasonal streams, wetlands, ponds and lakes. Several categories of protection apply, depending on the situation and site conditions (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). Riparian Reserves, which include the transition area from wetlands to uplands, are important to terrestrial as well as aquatic species, particularly for dispersal habitat. In these protected areas land use activities can occur but are restricted to particular situations.

Outside the National Forest logging on private land is regulated by the State of Oregon's Forest Practices Act.

Intensive timber harvesting in the 1970s and 1980s resulted in compacted soils in logged areas. Compacted soils affect plant and soil health, reducing nutrient cycling and growth rates. Water is less able to infiltrate compacted soils, leading to increases in run off, erosion and sedimentation. Within the National Forest soil compaction has been considered a significant problem in Rock, Threemile, Gate, Clear, and Boulder, McCubbins and middle White River drainages. Improved logging techniques, de-commissioning of roads, and a de-compaction program on unneeded skid trails are reducing these soil impacts.

Thinning and under-burning are important management tools. Suppression of fire has resulted in forests with high levels of understory and ladder fuels. Fires under these conditions are more severe and can do considerable damage to property and habitat. The natural fire regime served to reduce fuel loads, favored fire tolerant plant species and habitat conditions, recycled nutrients and re-set the successional clock. Mechanical thinning and under-burning are used hand-in-hand to reduce build up of understory and ladder fuels, and to reduce the incidence of stand replacement fires.

The Rocky Burn of 1973 was such a stand replacement fire that damaged a large area directly west of Rock Creek Reservoir. Most of the Rocky Burn is on National Forest. The burn area was extensively salvage logged and grazed prior to 1980. In the 1980s a management shift to protection of riparian resources occurred. The area is still slowly regenerating. Some reaches along Rock, North Fork Rock, Gate, and Threemile creeks are fenced to exclude cattle. (Gary Asbridge, January 17, 2003, pers. comm..)

Recreation

The White River was designated as a National Wild and Scenic River in 1988 and became one of 40 Oregon rivers that are included in the National Wild and Scenic Rivers system. The Mt. Hood National Forest manages 26.9 miles of the River's corridor from the headwaters on the east slope of Mt. Hood to the National Forest boundary. Between the National Forest boundary and the White River's confluence with the Deschutes, the corridor is managed by the Bureau of Land Management, excluding 0.6 miles at White River Falls. Under the Wild and Scenic Rivers Act, rivers are classified as wild, scenic, or recreational, depending on the level of development and access present along the river. The White River is designated as recreational, except for a stretch designated as scenic between the confluence with Deep Creek on National Forest, and the confluence with Threemile Creek, below the Forest boundary. (W.R. Wild and Scenic River Management Plan, 1990.)

Demand for recreation opportunities in the watershed is increasing, which in turn increases the need to manage and protect land and water resources affected by recreation use. Popular recreational pursuits include snow sports, boating, fishing and hunting, camping, horseback riding and off-highway vehicle touring (OHV). On National Forest the US Forest Service manages recreational uses, including site restoration and design of new facilities. The BLM and ODFW also offer recreational opportunities on public lands. The White River Wildlife Management Area, owned and managed by ODFW, is used primarily by hunters.

On public lands, sites near water, especially around lakes and reservoirs, show the greatest impact. Soil compaction, damage to or lack of vegetation, and bare soil are problems in high use areas. Campgrounds also show wear.

Impacts from horse use are relatively low. As of 1995, Bonney Meadows showed the most damage due to heavier use. Introduction of weeds from feces and hay is the primary concern for this activity.

Off road vehicle use is another high impact activity that causes damage to soil and vegetation, potentially contributing to erosion and water quality problems. An often forgotten consequence of off-highway vehicle use is disturbance to wildlife. High use areas can effectively keep wildlife such as deer, elk, bear, and nesting birds from being able to use valuable habitat. For example, in the McCubbins Gulch area an OHV Plan was developed to protect winter range of deer and elk. Of a total of 10 square miles west and north of the National Forest boundary 4 square miles of winter range were made off limits to off-road vehicles. The 6 square miles that are used by off-highway vehicles still affect summer use by deer, elk, bear, cougar, and bobcat. (White River Watershed Analysis, USFS 1995.) Off-road vehicle use will need to be carefully planned for by public land managers. Off-highway vehicle use is sometimes a concern on private land as well.

Recreation on private lands includes similar activities. Fishing, boating, hunting, and camping are prevalent. The Rock Creek and Pine Hollow reservoirs are favorite fishing sites. Private game preserves for hunters are increasing in popularity.

3) Stream Flow and Water Rights

3.1) Stream Flow

Stream flow has been monitored at various locations at various points in history by either the US Geological Survey or the Oregon Water Resources Department. The longest running record is on the White River near Tygh Valley, where stream flow was recorded from 1917 to 1990. The highest flow recorded on the White River was 11,000 cfs in January 1923 (Table 3-1).

Flows have also been recorded on various irrigation ditches from 1968 to 1989 (Table 3-2).

High flows typically occur in February and March, with rain on snow events in the high country. Low flows occur from August to November, when flows vary between 50 and 100 cfs (WRD Website, www.wrd.state.or.us).

Table 3-1. Stream gages and recorded high flows for streams in White River Basin. Source: Oregon Water Resources Department website: http://www.wrd.state.or.us

Stream Gage Location	Dates of Records	Highest Flow (cfs)	Date of High Flow
Badger Creek near Tygh Valley	04/1918-07/1918	115	May 1918
Clear Creek above Wapinitia Intake	05/1934-10/1935	65	June 1934
Clear Creek below Clear Lake	06/1968-08/1973	46	July 1973
Clear Creek above Clear Lake	11/1940-09/1941	11	May 1941
Clear Creek near Pine Grove	07/1967-08/1973	360	February 1970
Gate Creek near Mouth	12/1926-07/1927	125	March 1927
Hazel Hollow	10/1926-09/1927	320	March 1927
Rock Creek	04/1936-06/1938	50	April 1938
Wapinitia Canyon	05/1930-09/1934	26	June1930
White River above Mineral Creek	08/1928-09/1930	29	September 1928
White River above Rock Creek	10/1924-06/1933	1,600	June 1933
White River below Tygh Valley	10/1917-09/1990	11,000	January 1923
White River near Government Camp	07/1969-01/1982	2,300	December 1977

Table 3-2. Stream gages and recorded high flows for ditches in White River Basin. Source: Oregon Water Resources Department website: http://www.wrd.state.or.us

Stream Gage Location	Dates of Records	Highest Flow (cfs)	Date of High Flow
Badger Ditch	04/1968-09/1989	50	January 1970
Clear Creek Ditch	06/1968-08/1973	70	June 1972
Highline Ditch “above Tygh Creek”	05/1968-09/1969	13	May 1969
Highline Ditch from Badger Creek	05/1968-09/1989	41	May 1985
Highline Ditch from Tygh Creek	04/1969-09/1989	15	August 1988

The US Forest Service recorded flow on various tributaries from 1983 to 1984. Their data is provided as averages in table 3-3. Flows in these years were somewhat above average on the White River. Highest flows in Lower White River and Tygh Creek occur from January to March.

Upper White River experiences high flows from January through June, followed by relatively high summer baseflows, a function of being a glacier-fed stream. Flows from July through September average 30% of the flows from March to June on Upper White River.

Tygh Creek, by contrast, experiences relatively low flows during the summer, dropping to 6% of the January-March high flows. Tygh Creek is a lower elevation stream, characterized by a “rain-on-snow” hydrologic pattern. The same pattern likely applies to Badger, Threemile and Wapinitia creeks.

Nena Creek, Winter Water Creek and Oak Springs originate at lower elevations and accumulate little winter snowpack. Their hydrologic pattern is dominated by surface runoff, mitigated by soil infiltration.

During the summer, surface flows in Nena Creek and Oak Springs become intermittent. Most of the flow is subsurface, except in places where bedrock or canyon constrictions force the water to the surface.

Table 3-3. Average stream flows from July 1983 to September 1984 on White River and selected tributaries. Source: USFS, June 1985.

	Lower White River[1]	Upper White River[2]	Clear Creek	Boulder Creek	Tygh Creek
July-Sept 1983	157	75	22	2	8
Oct.-Dec. 1983	241	115	32	12	67
Jan-Mar 1984	801	239	--	--	166
April-June 1984	528	248	43	51	67
July-Sept 1984	166	93	23	4	10

[1] Measured at White River Falls
[2] Measured at confluence with Buck Creek

Figure 3-1 summarizes flow levels at the mouth of White River before and after water withdrawals. The "before" values are based on hydrologic models. It also notes instream water rights in the White River Watershed. Oregon Water Resources Department does not yet have similar information for Wapinitia Creek, Nena Creek, or any of the tributaries to White River.

3.2) Water Rights

Oregon Water Resources Department allocates water rights for a given month as long as water is available based on the 80% exceedance level. The 80% exceedance level refers to the stream flow that is expected to be exceeded 80% of all years. In other words, 4 out of 5 years, the streamflow will be higher than the 80% exceedance level. Figure 3-1 shows the available water calculations for each month at the mouth of the White River.

Table 3-4. Water Availability Report, 80% Exceedance Level, White River Basin. Data is in cubic feet per second. Source: Oregon Water Resources Department Modeling, website: www.wrd.state.or.us .

	Average Natural Flows	Natural Flows, 80% Exceedance	After Withdrawals and Storage (80% exceedance)	Instream Water Rights	Water Available for water rights
January	453	250	237	60	177
February	613	366	348	100	248
March	565	376	351	145	206
April	602	452	402	145	257
May	666	477	356	145	211
June	430	290	178	100	78
July	225	192	114	60	54
August	179	159	96	60	36
September	166	148	93	60	33
October	169	149	104	60	44
November	199	151	146	60	86
December	327	211	203	60	143

Figure 3-1. Long-term average stream flows before and after withdrawals at the mouth of White River. Source: Oregon Water Resources Department Modeling.

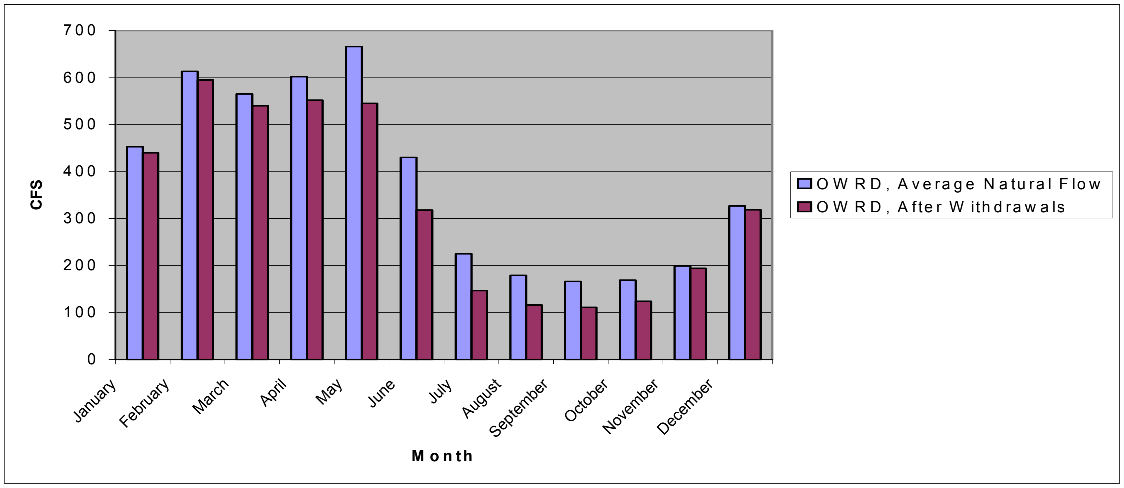


Figure 3-1 implies that flows at the mouth of the White River could fall as low as 93 cfs one out of five years in the month of September (4th column). The lowest flow ever recorded at White River Falls was 66 cfs in January 1979, followed by 68 cfs in September 1977 (WRD website, www.wrd.state.or.us).

The data summarized in table 3-1 shows that water is available for stream water right allocation every month in the White River, based on streamflows at the mouth of the White River. However, because the Deschutes River needs the flow from the White River to meet all the water rights at the mouth of the Deschutes, the Water Resources Department is constrained in issuing new water rights for any tributary stream of the Deschutes Basin, including the White River. A moratorium on water rights in the Deschutes subbasin is in effect from April 15th to September 30th, to protect fish upstream of Bonneville Dam (pers. comm., Larry Toll, Wasco County Watermaster, 10/3/03). Based on streamflow data available for the mouth of the Deschutes (Oregon Water Resources Department website), and taking into account the moratorium, water is potentially available for allocation in tributaries of the Deschutes during the month of March and the first half of April.

Water is available for storage rights in the Deschutes Basin from January through April 15th. Storage water rights are calculated differently than stream water rights. Storage water rights apply to water that is collected in a reservoir, but not taken out of a stream. Storage water rights are calculated based on a 50% exceedance level, rather than the 80% exceedance level used for water rights on streams.

New water rights must also be found not to cause "injury" to other water right holders (OAR 690-380-0100(3)).

Typically, the Water Resources Department would calculate available water for the individual tributaries of the White River, as well as various locations along the White River. However, this work has not yet been completed by the Water Resources Department. Therefore, there is currently no calculation of available water in the various tributaries of the White River.

Oregon Water Laws

The following information was provided by the Water Resources Department unless otherwise noted.

Like most western states, two concepts define and guide Oregon's water law: the doctrine of prior appropriation and the concept of beneficial use. The prior-appropriation doctrine is the basis of water law for most of the states west of the Mississippi River. This means the first person to obtain a water right on a stream is the last to be shut off in times of low stream flows. In water-short times, the water right holder with the oldest date of priority can demand the water specified in their water right regardless of the needs of junior users. If there is a surplus beyond the needs of the senior right holder, the person with the next oldest priority date can take as much as necessary to satisfy needs under their right and so on down the line. The date of application for a permit to use water usually becomes the priority date of the right.

Beneficial use means a water user must put a right to beneficial use, or lose that right. Traditionally, domestic use, mining, and irrigation constituted beneficial uses. The beneficial use requirement was intended to ensure that users did not hold rights to water they did not need. With passage of the Instream Water Rights Act in 1987, instream flows were legally recognized as being a beneficial use of water as well. This law gives landowners more options in deciding how to best use water.

In recent years the importance of instream flows to fish populations and aquatic habitat has become increasingly recognized. Oregon has also encountered drier conditions in recent years. Particularly in drought years, available stream water in the Watershed falls short of the levels required to fully meet the needs of both irrigators and aquatic habitat. Solutions are being sought to find balance between these competing interests.

Property value

Water rights are valuable property rights. A water right certificate vastly increases the value of irrigated crop-land, especially in Eastern Oregon. The value of the water right represents a high percentage of the equity in irrigated land that is used as collateral for property mortgages. For example, in Wasco County, the market value for irrigated cropland is $1,850 per acre, while Class 3 non irrigated tillable land is valued at $537 per acre (Wasco Co. Assessor's office, 9/4/2003). Thus, water rights account for about 71% of the value of irrigated land in Wasco County. In some parts of Eastern Oregon, the water right attached to irrigated land can represent more than 95% of the land's value (Whittsett, Water for Life, Inc. 9/2/2003).

Water rights remain valid as long as beneficial use of the water is continued without a lapse of five or more consecutive years. By Oregon law, if any portion of a water right (except those for municipal purposes) is not used for five or more consecutive years, that portion of the right is forfeited and reverts to the public.

Transfers to Instream Use

The Instream Water Rights Act provides the alternative of choosing to use one's water rights for instream purposes. Water rights may be voluntarily transferred to instream uses, temporarily or permanently, at the discretion of the landowner. Water rights can be transferred in several ways; by direct leases, by direct sales, and through the "Saved Water" statute.

Leases transfer water rights to instream uses temporarily, for various periods of time. Leases of instream rights must show that a beneficial use will be made of the water during the lease period, such as fish habitat or flow augmentation. These transferred rights become instream water rights with the priority date of the original right.

Leases may be associated with the Conservation Reserve Enhancement Program (CREP) or other conservation contracts. "Time limited transfers" can be for the length of a CREP contract or longer. "Short term" instream leases have a maximum term of 5 years, with renewability. The advantage of instream leases is that the landowner retains ownership of the water right, while still allowing for instream uses.

When water rights are sold, ownership is permanently transferred. This method is considered the most controversial, particularly in over-allocated watersheds.

Organizations such as the Deschutes Water Exchange can assist landowners with arrangements for short-term leases and long-term or permanent transfers.

The "Saved Water" Statute was established by the State of Oregon to allow water saved through conservation projects to be proportionally allocated based upon the costs born. When costs are shared by state and local groups, the percentage paid by the State goes towards purchase of the same percentage of instream water rights. The remaining percentage goes towards out-of-stream water rights. In such cases the instream water right is assigned precedence over the out of stream water right.

"Win-Win" situations

For example, the Lost and Boulder Ditch piping project of fall, 2002 was funded by both state and private sources. Lost and Boulder Ditch is an open ditch with considerable seepage. Before the piping project, the entire flow of Boulder Creek was being diverted during the irrigation season. The project consisted of installing 2200' feet of HDPE pipe, as well as other improvements. Over this distance 0.77 cfs was being lost to seepage. Of 0.77 cfs saved by the project, 0.44 cfs has been converted to an instream water right in Boulder Creek.

Grants from the Oregon Watershed Enhancement Board (OWEB) covered 60% of the project's costs. The remaining 40% was funded by the Deschutes Resources Conservancy, the Bureau of Reclamation and local interests. Fifty-seven percent of the water saved by piping the ditch was allocated for instream flow. The remaining water saved was allocated for the ditch and its users. The project is a "win" situation for both ditch users and for instream habitat.

4) Irrigation and Water Management

Irrigation is critical to agriculture in the White River Watershed. The climate is characterized by hot, dry summers. Total annual precipitation in the agricultural area averages 11 to 12 inches, most of which occurs during the winter months. Precipitation during the peak growing season of June, July and August averages 1.3 inches. The growing season has a high percentage of sunny days, which are conducive to growing hay, pasture, and small grains.

Farmers grow both dryland crops and irrigated crops. In general, irrigated crops yield higher profits. However, water available for irrigation generally does not meet crop needs for full season irrigation, and yields are correspondingly less than full yields.

There are several irrigation districts in the White River Watershed. These include Juniper Flat Irrigation District, Lost & Boulder Irrigation District, Rock Creek Irrigation District, and Badger Creek Irrigation District.

4.1) Irrigation Districts

Juniper Flat District Improvement Company

Irrigation developed slowly in the White River Basin, due to limited surface water, and the costs involved in construction of irrigation facilities. In 1904 Joseph R. Keep obtained private land on Clear Creek and filed for right of way for a dam, reservoir and ditch to provide water for his sawmill. Rights and property would change hands several times before Juniper Flat Irrigation Ditch would be completed and functioning in 1916, when the first water was sent down the ditch from Clear Lake to Wapinitia. At this time the ditch and reservoir were owned and operated by Wapinitia Irrrigation Company. Work continued for several years on extensions to reach the lower Flats. In 1923 construction on the Frog Creek feeder line was completed.

Work began on a new 15 foot high dam at Clear Lake in 1928. In 1929**,** Mount Hood Land and Water Company took over ownership of the irrigation ditch from Wapinitia Irrigation Company. The dam on Clear Lake was also completed this year. However, the Forest Service blocked delivery of water from the dam, due to a violation of a conditional use permit contingent on salvaging timber rather than flooding it. Legal battles interfered with delivery of water through 1937.

Water Users Corporation of Juniper Flat took over ownership of the Juniper Flat irrigation system in 1937, and began work to meet Forest Service stipulations. In 1938, Clear Lake Dam burst while being filled.

In 1952, the Bureau of Reclamation became involved in the effort to build Clear Lake Dam. The Bureau discovered that all land surrounding Clear Lake was withdrawn from the National Forest in 1915, and therefore was not subject to Forest Service regulations after all. Water Users Corporation of Juniper Flat reorganized as Juniper Flat District Improvement Company (JFDIC) in 1952**.** JFDIC, a user owned and operated public utility, has continued to manage Juniper Flat Irrigation District to the present.

In 1999 JFDIC published a Water Management/Conservation Plan, which examines the current water management situation and the feasibility of alternatives for increasing water use efficiency. The following information is from this source.

JFDIC holds water rights for 2108 irrigable acres, and a storage right for 1400 acre-feet (AF) in Clear Lake Reservoir. There are 55 water users in the District. Juniper Flat Irrigation District is bordered on the north by the White River canyon and on the south by the Nee Nee's, a range of mountains along the north boundary of the Warm Springs Indian Reservation. To the east is the Deschutes River, and to the west, Mt. Hood National Forest.

Irrigated crops in the District are mainly hay (62%), winter wheat (33%), and pasture (5%). Organic row crops are also grown on a small scale (<0.1%). Water delivered for irrigation is considered to be in deficit of what is required for normal crop yields. Yields for all three major crops are approximately 70% of what full season irrigation would produce. After mid June, water is typically not available in adequate quantity for crop needs, and is considered a "partial season" supply.

The primary sources of water for the District are Clear Creek, Frog Creek, and Clear Lake Reservoir. Clear Lake Reservoir is a natural mountain lake that has been dammed. The reservoir is located 12 miles south of Mt. Hood at an approximate elevation of 3500'. The drainage area for Clear Lake Reservoir covers 8 square miles and is fed by precipitation, mainly winter snowfall. During the summer a number of springs feed the lake.

Clear Creek also is fed by springs between Clear Lake Reservoir and the Clear Creek ditch diversion located 3 miles downstream from the reservoir. Frog Creek, a secondary water source fed by Frog Lake, is diverted by Frog Creek Feeder Ditch into Clear Creek below Clear Lake Reservoir.

Water is then carried from Clear Creek diversion works through the Main Ditch to McCubbin's Gulch. McCubbin's Gulch, a natural watercourse, carries water to the western edge of the District where the Main Ditch resumes.

JFDIC operates and maintains 35 miles of ditch outside the District boundaries, and 72 miles of ditch inside the District. Inside the District three canals- the main ditch, the middle ditch, and the south ditch- provide water to "laterals" and users.

Irrigated cropland is spread out throughout the District, resulting in many miles of ditches. In between irrigable lands are non-farmable "scab lands" with rocky, shallow soils. Many ditches in the District convey relatively small flows for long distances. For example, 24,000 feet of open ditch deliver water to just 26.34 acres. (p.5 JFDIC Water Management/Conservation Plan.) These are generally open, un-lined ditches that lose water to both evaporation and seepage into the ground. Ditch losses in some parts of the district are estimated to be as high as 65%. Lava tubes and fractures in rock underground are believed to account for some of the loss. Flat grades in the District contribute to losses from evaporation. Irrigable fields, which are interspersed with "scab lands" are very irregular in size and shape. This has implications for efficiency of water application methods as well.

Water losses outside the District

An estimated 10-40% of water diverted into ditches is lost before entering the district. The measurement station used to gauge supply is outside the District, located in the JFDIC Main Ditch on the east side of Highway 26 (referred to as "diversion at highway"). Water supply measured at this location averages 8564AF per year. It is estimated that 7137AF enters the District in an average year. Therefore, in an average year, 1427AF is lost before entering the District. Losses occur due to seepage into the ground, evaporation into the air, and evapotranspiration through plants.

Water losses inside the District

In an average year, of 7137 acre-feet (AF) entering the District, 1057 AF is lost from ditches before delivery to end users. Of 6,080 AF delivered to users, an estimated 3286AF is attributed to on-farm losses related to irrigation methods. The remaining 2794 AF is used by crops.

Table 4-1. Estimated water losses within Juniper Flat Irrigation District. Source: JFDIC Water Management/Conservation Plan.

Location	Water Supply (Acre-Feet) in-Average Year	Losses
Diversion at highway	8564AF(100%)	
		1427AF(17%) lost outside district
Delivery to District	7137AF	
		1057AF(12%) distribution losses
Delivered to users	6080AF	
		3286AF(38%) on-farm losses
Crop water use	2794AF(33%)	
		5770AF(67%) Total Losses

Distribution Losses
Distribution losses consist of seepage and evaporation from open, unlined ditches.

On-farm losses
On-farm losses are accounted for by inefficiencies inherent in irrigation methods. Industry standards were used to estimate efficiency ratings.
-Surface irrigation (a.k.a. flood irrigation) is estimated to have an efficiency rate of 40%.
60% of water applied is lost to runoff (30%) and deep percolation (30%).
1308 acres in the District are irrigated by surface irrigation.
-Sprinkler irrigation is estimated to be 60% efficient.
40% of water applied is lost to deep percolation (20%) and evaporation (20%).
800 acres in the District are irrigated by sprinkler.
-Micro irrigation (a.k.a. drip irrigation) is rated as 85% efficient. (Micro irrigation is only appropriate for row crops.)
15% of water applied is lost to deep percolation and evaporation.
1 acre in the District is under drip irrigation.

A few individuals use pump-back systems to re-use collected runoff on existing irrigated fields. Surface flow which is not used by natural vegetation collects in farm ponds and small wetlands.
Deep percolation losses occur where runoff has collected (in open ditches, farm ponds, and wetlands) and seeps into the ground. It also occurs where non-uniform soil depths are present, which is common in the Juniper Flat area. Eventually deep percolation re-enters the groundwater table.

Table 4-2. Irrigation methods, estimated efficiencies and on-farm losses. Source: JFDIC Water Management /Conservation Plan.

Water Delivered		Irrigation Efficiency	Estimated Crop Use	On-Farm Losses
Surface irrigation:	4310AF	40%	1732.0AF	2580.0 AF
Sprinkler irrigation	1767AF	60%	1060.0AF	710.0 AF
Micro irrigation	~3AF	85%	~1.5AF	(not significant)
Totals:	6080AF		2794.0AF	*3290.0 AF

*Discrepancies between totals in Tables 10.1 and 10.2 were present in source data.
~Discrepancies present in source data.

Water Management Alternatives

Farmers would like to increase availability of water for irrigation, in order to lengthen the irrigation season for crops. JFDIC's Water Management/Conservation Plan examines several alternatives for increasing irrigation water supply.

- The possibility of increasing reservoir capacity or building new reservoirs was examined and discarded, due to environmental issues and construction costs. The land that would be used for such projects is on the National Forest.

- Use of groundwater was found to be economically impractical at this scale (approximately $90/acre), and is reserved as a last resort.

- Reducing demand for irrigation water by taking land out of production was considered to be unfeasible as well. The agricultural community (as represented in the JFDIC report) is committed to continuing a rural/agricultural landscape and economy, and continuing to grow irrigated crops. Juniper Flat Irrigation District plans to maintain existing water rights for the foreseeable future, and water demand is expected to remain about the same. If greater efficiency results, the District intends to apply available water towards crop production, resulting in better yields and increased profitability for farmers.

- Switching to crops with lower water requirements is not considered a desirable alternative, because such crops generally do not provide adequate returns on the market. However, **if** crop species or varieties were discovered that would have sufficient market value grown with less water, such hypothetical crops could be a desirable alternative for farmers.

- Improve efficiency of water delivery and irrigation methods. This alternative is considered highly desirable. Ditch improvements and improvements to irrigation efficiency have been and continue to be encouraged by JFDIC. Voluntary technical improvements to water use efficiency appear to be the most desirable alternative for increasing water availability. However, as funds within the District are limited, partnerships with local, state, and federal agencies are crucial to carrying out improvements. Several ditch improvement demonstration projects have been undertaken to date.

Conservation Programs

Ditch improvements

Due to extensive lengths of ditch that need piping or lining, the costs are beyond the reach of JFDIC's resources. Very little ditch has been piped or lined. The District has pursued funding from Oregon Water Resources Department and the Bureau of Reclamation for ditch lining, pipeline, and flow measurement projects.

In 1997 JFDIC and the Bureau of Reclamation (BOR) conducted a ditch-lining demonstration project. A 1,000 foot section of the Main Ditch with high seepage losses was lined with a bituminous material called TERANAP. JFDIC provided equipment and labor for the installation. BOR provided money for site preparation and materials, and assisted with installation. Results have been monitored to provide a basis for future ditch lining projects.

Demonstrations of piping open earth ditches were undertaken during 1998 to 1999. JFDIC worked in cooperation with BOR and the Natural Resource Conservation Service (NRCS) to install corrugated plastic pipe in two selected ditches that had high seepage losses. NRCS provided field survey and pipeline design, JFDIC provided equipment and personnel for installation, and BOR provided money for materials. Results have been monitored in order to provide a basis for future piping projects.

Irrigation method upgrades

Losses to deep percolation from surface irrigation can be reduced by converting to sprinkler irrigation. However, existing limitations to profitability for farmers make the costs of converting to sprinkler irrigation a barrier for most surface irrigators.

Costs of installation and operation of sprinkler systems were estimated in 1999 to be $1500 per acre. Additional costs include installation of holding ponds and power lines to the pump site, energy/electricity costs of $25-30 per acre per year, plus increased labor involved in operating the system.

Irrigators would still have a partial season water supply, but, distribution uniformity would improve and crop yield would increase. More efficient water use by enough irrigators could result in a longer irrigation season, with storage in the Reservoir extended longer into the summer.

It is unlikely that all irrigators would convert from surface irrigation to sprinkler irrigation, due to costs of installation and operation. For those who continue to use surface irrigation methods there are still some on-farm conservation practices that could reduce run-off and deep percolation. Seepage in head ditches could be reduced by using gated pipe, and "lengths of run" could be shortened to provide better control of flow.

However, JFDIC encourages users to convert, and has set a goal to see 25% of users convert voluntarily over a 10 year period (by 2010). The payoff for these irrigators would be better control of water distribution, more water actually used by plants, and increased crop yields. Information was not available regarding how long it would take for the investment to pay for itself. Farmers are only likely to invest in new technology if greater profits from crops can be expected. Availability of funds from sponsoring agencies could greatly facilitate this process.

Potential Savings

Estimated water savings for completed and proposed projects (as of 10/1999) are shown below:

Estimated Water Saved	**AF**
Lining Main ditch (1000')	12
Piping Gutzler ditch(7000')	84
Piping Larkin ditch, 1999(1600')	130
Total	**226**AF

…………………………………………………………………………….

Potential Water to be Saved	**AF**
Potential ditch lining of isolated spots	100
Potential piping of selected ditches (151,320' of 11 ditches)	596
Total	**696**AF

…………………………………………………………………………….

Voluntary on Farm conversion of 25% surface irrigation to sprinkler over next 10 years:

327 acres	**360**AF

……………………………………………………………………………..

Total for proposed projects:	**1282**AF

If all proposed projects listed above were completed, 30% of present losses inside the District would be prevented. Out of the total 5770AF lost both inside and outside the District, 1282AF (22%) would be saved.

Irrigators who convert to sprinkler irrigation would increase efficiency of water use on their property by 50% (from 40% efficiency to 60% efficiency).

The proposed projects listed above represent the first priorities for the District. Once these projects are completed, new priorities would be set.

Lost & Boulder Ditch Improvement District

Unless otherwise noted, the following information is provided by the Lost and Boulder Ditch Improvement District.

Lost and Boulder Ditch Improvement District consists of 16 users, serving 3,600 acres (Lost and Boulder Piping Overview, prepared for the U.S. Forest Service by Wasco County SWCD, March 15, 2001). The District was founded in the late 1890's to serve the community of Smock Prairie on the Barlow Trail. At that time Smock Prairie consisted of approximately twenty families, a church and a school. Agriculture consisted of small plots of vegetables, fruits, dairy, meat, and cereal grains. A fourteen mile open, low-gradient ditch was built by hand, horse, and later by wood fired steam shovel, from Lost and Boulder Creeks to Smock Prairie. The water was used for irrigation, stock and domestic consumption. Residents used flood irrigation and each had a cistern for domestic water. Today the water is used for wildlife, fish rearing, stock, pasture, hay, and orchards.

The ditch delivery system was first known as Lost and Boulder Ditch Company. It was registered in The Dalles in 1901 and again in 1911. It consisted of landowner shares and was governed by a board of three directors, elected for terms of three years. The company was reorganized in the 1990's as the Lost and Boulder Ditch Improvement District. There are no shares but voting is based on the old 1901-1911 acres. There is still a 3 member board of directors elected for 3 years.

Filing of water rights came with development of the area. The first 1901 and 1911 rights were filed in The Dalles and later transferred to Salem under the Water Resource Department. These rights were for diversion of water from Lost Creek and Boulder Creek. (Boulder Creek was also known as Crane Creek.) Additional rights were filed in the 1950's for supplemental water from Forest Creek. (Forest Creek was also known as Cedar Creek.) A ditch was built to transfer water from Forest Creek to the diversion of Boulder Creek. The U. S. Dept. of Agriculture engineered the project, which diverted the water to upstream of the main Boulder Creek diversion. The three diversions which are still used today are Forest Creek, Boulder Creek and Lost Creek. Since the 1950's several individual water rights have been filed on the same streams. In the 1980's additional supplemental acres and water rights were filed by the district on the same streams. In the 1990's ODFW filed for in-stream water rights. Local observations suggest that Lost, Boulder and Forest Creeks have been over-allocated, leaving no water during irrigation season available for further development. (Van Conklin, pers. comm.. January 2004).

Projects

Several major conservation (aka efficiency) projects have been achieved in the past 100 years. In the 1940's mechanical farming created more demand for water. At that time a system based on percent of acres irrigated was developed by The U. S. Dept. of Agriculture and implemented by the District. The wooden structures were modernized in the 1970's. The next large project after construction of Forest Creek Ditch was the rerouting of the main ditch. This development was in response to soil loss and water loss by a high gradient section of the main ditch. The Soil Conservation Service (SCS) engineered this change which was implemented by the district in the 1960's. In the 1980's and 1990's, the development of sprinkler irrigation allowed farmers to irrigate more acres and to better know their real water needs. A system was developed by SCS to measure and allocate water to users and avoid delivering water that would be wasted. In the 1990's the directors could see that a lot of what was diverted never got delivered due to ditch loss. The first project to reduce ditch loss was the piping of upper Forest Creek Ditch. A twenty-four inch PVC pipe was bedded in the worst ½ mile of this ditch. One year later another ½ mile section was piped. These projects were funded by a grant from Farm Service Agency (FSA) and engineered by SCS. The district has lined several hundred feet of the Forest Creek ditch on its own. This ditch still has many feet of open ditch that are a prime candidate for piping.

In September of 2002 the least efficient section of Boulder Ditch was piped. The project took place just above Forest Service Road 4800 and consisted of 2250' of 36" diameter UHMW poly pipe. The project was funded by the Deschutes River Conservancy, Oregon Watershed Enhancement Board, Wasco County SWCD, NRCS and Lost and Boulder District. The piping of this section provided water savings of 0.78 cfs. Of the savings 0.40 cfs was converted to an in-stream water right in Boulder Creek. (Larry Toll, Wasco Co. Watermaster, pers. comm., January 2004.) The instream water right provides the only late season flow in a three mile section of creek down to the confluence with the White River. A water measuring device was also installed at the point of diversion to monitor flows into the ditch.

The latest piping of the Boulder Ditch also allowed access by road up the pipe to the diversion point. The District can now build passage and screening for fish. Funding for this project will be provided by the District, and grants from ODFW and USFS (Payments to Counties Program). The project will be implemented in August of 2004.

With 14 miles of open ditch and only 2 miles of pipe there is great opportunity to conserve water by installing more pipes. If the ditch is assumed to be sixty percent efficient and twelve miles were all piped, and average delivery is 15 cfs, then potentially there is a savings of 10 cfs (Van Conklin, pers. comm., January 2004).

In addition to water conservation through piping, there is opportunity for energy conservation. Many sections of the L & B ditch could be converted to gravity pressure, therefore eliminating the need for pumps, and generating power at the same time (Van Conklin, pers. comm., January 2004).

Rock Creek District Improvement Company

The following information is from the 2001 Water Measurement Improvement Grant Application submitted by Wasco County SWCD to the Oregon Water Resources Department, and the Rock Creek Ditch Piping Project Proposal, submitted by Wasco County SWCD to the Deschutes Resources Conservancy on September 7, 2000.

Rock Creek District Improvement Company is governed by a board of directors. The oldest water right in the District dates back to 1870. The District has 14 users and serves 4,115 acres. Rock Creek Reservoir is the multi-purpose storage facility serving the main ditch. It is located in the natural drainage of Wildcat Creek and Rock Creek, Section 14, Township 4 South, Range 11 East. The District has additional water rights from Threemile Creek to the North and Gate Creek to the South. The water distribution system consists of 8 miles of open, low gradient ditch, and 1,700' of 24 HDPE pipe. Agricultural crops include hay, wheat, pasture, carrot seed, onion seed and garlic seed. Ditches are in fair to good condition, with some sections needing annual maintenance.

Rock Creek District Improvement Company has requested the assistance of Wasco County SWCD in developing an Agricultural Water Conservation Plan (Water Measurement Improvement Grant Application, 2001).

Rock Creek District Improvement Company has expressed an interest in supplementing its water requirements in drought years with water from the White River or its tributaries. The District has requested that the available water in the various tributaries of the White River be calculated by the Oregon Water Resources Department.

As described in Section 3, Streamflow and Water Rights, water rights in the White River Watershed are currently allocated based on streamflow data from the mouths of the White River and the Deschutes River. Water right allocation within the Deschutes subbasin is limited by stream flows at the mouth of the Deschutes. In addition, Oregon Water Resources Department has placed a moratorium on all water rights on tributaries of the Deschutes from April 15th to September 30th. Based on streamflow at the mouth of the Deschutes, and the moratorium, water is potentially available for consumptive water rights in tributaries of the Deschutes only during the month of March, and the first half of April.

Water is available for storage rights in the Deschutes Basin from January through April 15th. Storage water rights are calculated differently than stream water rights. Storage water rights apply to water that is collected in a reservoir, but not taken out of a stream. (See discussion of storage water rights in Section 3, Streamflow and Water Rights.)

Until streamflow measurements from the tributaries of White River are available from the Oregon Water Resources Department, Rock Creek District Improvement Company or its individual members may still apply for new water rights for the months listed above.

Rock Creek District Improvement Company has also requested that this assessment address their concerns regarding the White River access road. "We would also like the assessment to prioritize the White River access road for repair and modification. This road should be maintained for proper travel, as it is the only other year round exit/entry point for Wamic besides the Wamic grade road that runs to Tygh Valley." The road currently presents a severe hazard for winter travelers. (Letter from Stan Shephard, President, Rock Creek Improvement District, 9/23/03.)

Projects

The Rock Creek Ditch Piping Project was undertaken during September and October of 2002. The project piped 1,700 feet of open ditch from the outlet of Rock Creek Reservoir to Forest Road 4800, providing an estimated water savings of 4 to 6 cfs. This site was considered by the RCDIC and the U.S. Forest Service to be the most leaky stretch of the Rock Creek irrigation ditch. A valve and flow measuring device was installed at the end of the new pipe, replacing an older structure that was inaccurate for measuring low flows. An inspection vault, an air vent, and a pressure relief valve were also installed. The project was funded by the Deschutes Resources Conservancy (DRC), with in-kind contributions from Rock Creek District Improvement Company, Wasco County SWCD, NRCS, and the U.S. Forest Service.

Badger Improvement District

Unless otherwise noted, the following information is from the Project Overview, 2003, by Wasco County SWCD for the proposed Badger Ditch piping project.

The Badger Improvement District ditch system is managed by 2 companies; Badger Improvement District, and Pine Hollow Cooperative. Pine Hollow Cooperative was formed in the 1960s in order to apply for a loan from the Farm Home Administration to build Pine Hollow Reservoir. The two companies have identical membership. The oldest water rights in Badger Improvement District date to 1893. Sources of water for the District are Badger Creek, Badger Lake, Threemile Creek, and Pine Hollow Reservoir. Badger Ditch, also known as Highland Ditch, starts in the Mt. Hood National Forest at the diversion point on Badger Creek, three miles above Bonney's Crossing campground. Fourteen miles of open ditch flow east, serving 24 users. The ditch irrigates 3600 acres of agricultural land from the White River Wildlife area to Tygh Valley.

Proposed Projects

A proposal is underway to pipe the first 2.5 miles of Badger Ditch through Badger Canyon. The ditch runs along the north side of the canyon, with slopes averaging 150%, and nearly vertical in some locations. The ditch has had a history of blowouts that erode massive amounts of sediment into the wilderness stream below. An incident occurred several decades ago in which an employee of the ditch company fell to his death while trying to repair a blowout. The goals for piping this section of the ditch are to minimize future erosion, maximize conveyance efficiency, and reduce the risk of blowouts and consequent repairs.

Sixty feet of head accumulate in this section. If the pipe were continued for another 1.1 miles, totaling 3.6 miles of pipe, another 165 feet of head would be gained at the end of the pipe. The maximum water right for Highland ditch is 50.3 cfs. During mid summer irrigation the water diverted drops to 10 cfs or less.

Funding is currently being sought for this project. Organizations collaborating on the project include the Barlow Ranger District (USFS), Wasco County SWCD, Natural Resources Conservation Service (NRCS), and Oregon Department of Fish and Wildlife (ODFW). The Irrigation District is also working with ODFW to install a fish screen.

Highline Ditch

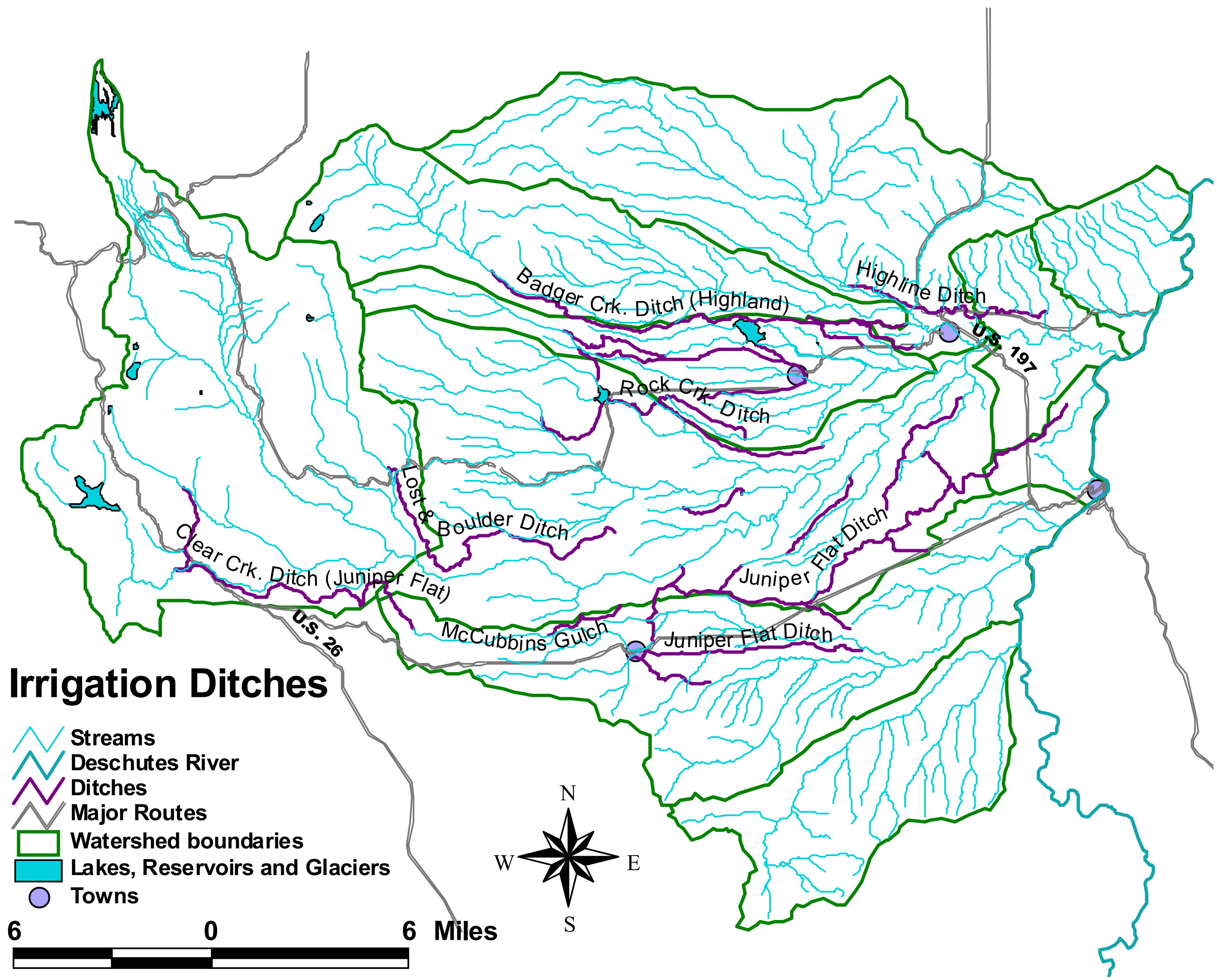
Highline Ditch serves several individuals in the community of Tygh Valley, and is fed by Tygh Creek. The Highline Ditch is not incorporated as a District Improvement Company, or other governing body. The headgate is controlled by the Wasco County Water Master. The oldest water rights on Highline Ditch date to 1909. One individual owns approximately 90% of the water rights on the ditch, and uses the water for agriculture and livestock.

Projects

At the road crossing where Butler Creek passes under Highway 197, the creek was blocked by gravel deposits during the flood of 1996. This caused water to be diverted along the side of the road to Highline Ditch, causing the ditch to overflow, and creating a hazard for residents along the ditch. One resident has repeatedly requested that the crossing be cleared of gravel deposits. However, clearing the culvert will not address the source of the sediment problem.

In Fall and Winter of 2002 and 2003 a restoration project was completed on Butler Creek at the gravel quarry upstream of the highway crossing to address the source of the sediment. The stream bank and floodplain were planted with trees and seeded with grass to improve riparian function of the creek and to prevent erosion. This project was a collaboration between ODOT, Wasco County SWCD, and the quarry landowner.

Figure 4-1. Irrigation Ditches in White River Watershed. Source: GIS aerial photos and USDA hydrographic data.



5) Runoff and Erosion

5.1) Runoff Due to Land Use

Runoff is the difference between precipitation and storage. Storage takes place primarily in the soil. Where soil infiltration rates are high, and soil moisture holding capacity is high, runoff may not occur except in very intense storms. Changes in soil structure or vegetation that affect the infiltration rate will alter runoff intensity. These changes can affect magnitude, duration and impact of floods. Land use changes that lead to widespread changes in the type of vegetation on a landscape, such as agriculture, fire, grazing, or timber harvest, can be a significant factor in altering runoff patterns. This analysis will model historical changes to runoff levels in the part of White River Watershed zoned for agriculture. This model is based on the USDA Soil Conservation Service Technical Release 55 (June 1986) runoff model, “Urban Hydrology for Small Watersheds” and the Engineering Field Manual, Chapter 2, “Estimating Runoff and Peak Discharge” (August 1989).

Methods

Soils were mapped using data from the Northern Wasco County Soil Survey (USDA NRCS, 1986), Mount Hood National Forest (USFS, 1977) and the Soil Survey of Warm Springs Indian Reservation, Oregon (USDA NRCS, 1993). Soils were grouped into four categories, A, B, C, D, based on texture and depth. “A” soils have the fastest infiltration rates and the least surface runoff. In the White River Watershed, “A” soils were only found on a few soils on the Mount Hood National Forest. “B” soils have the second fastest infiltration. Typically, “B” soils are deep silt-loams. Most croplands in the White River Watershed are on “B” soils. “D” soils have the slowest infiltration rates and the most runoff. “D” soils tend to be the heavier or shallower soils in the White River Watershed, typically clay loams and “scabs” (figure 5-1). “C” soils are intermediate in all properties, and are typically “loam” soils.

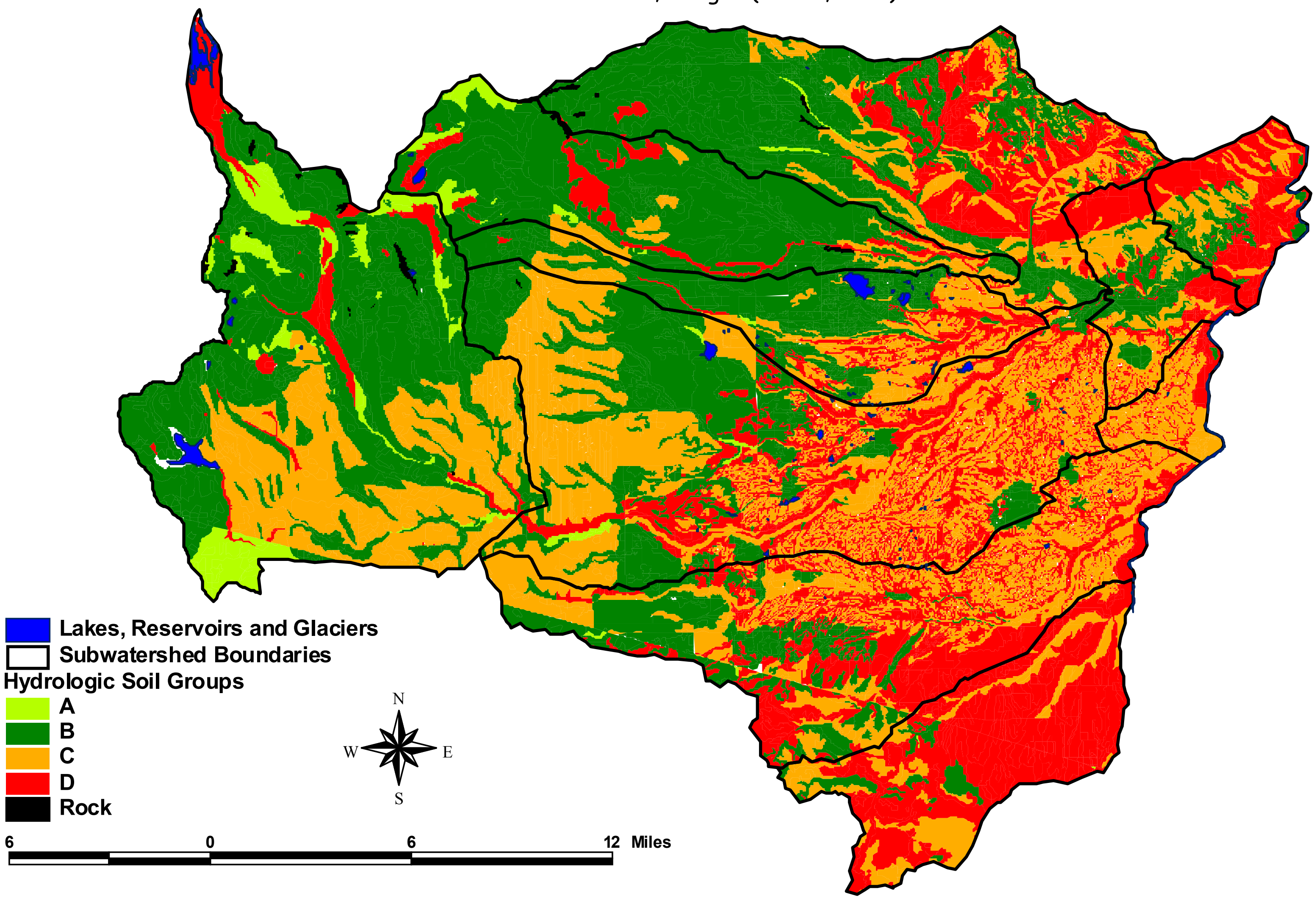
There are some noticeable differences in soil interpretation between the various soil surveys. In particular, the US Forest Service tends to identify more soils as “A” and “B” soils, and fewer soils as “C” or “D” than do either of the NRCS documents. Therefore, estimates of runoff based on US Forest Service soil mapping tend to be lower, even on soils that are physically the same.

Cover types were determined using aerial photos and records from the Farm Services Agency. Cover types included small grain, grass, open-canopy woods, closed-canopy woods, irrigated crops, orchards, hay, brush and buildings. Cover types were modeled for 1850 based on historic surveyors’ notes (Figure 5-2). Figure 5-2 shows cover types for 1850 and for the current condition.

Based on soil, cover and quality, “Runoff Curve Numbers” were assigned which vary from 1-99, based on the infiltration rate of the soil-cover combination. Higher numbers imply lower infiltration rates and thus higher runoff levels. Open water and solid rock have the highest runoff curve numbers (99). Bare soil has a runoff curve number between 77 and 94, depending on soil texture. Lower numbers retain moisture in the landscape, and thus mitigate both flood and drought events. 1 would mean that there is 100% infiltration, i.e. zero runoff under any circumstances. This state is impossible to achieve. Brush or closed-canopied woods in good condition have the lowest runoff curve numbers – as low as 30 on porous “A” soils.

Based on the runoff curve number, the projected runoff depth was calculated in inches for the two-year, 24-hour precipitation event (heaviest one-day storm for an average year). Runoff depth was then calculated for 1850 and for 2003.

Figure 5-1. Hydrologic Soil Groups in White River Watershed. Note discontinuities at Forest Service and Reservation boundaries. These discontinuities represent differences in the three soil surveys, rather than true differences in soils. Sources: Northern Wasco County Soil Survey (USDA, 1986); Mount Hood National Forest Soil Resource Inventory (USFS, 1977), Soil Survey of Warm Springs Indian Reservation, Oregon (USDA, 1993).



Results

Table 5-1 shows the modeled runoff rates in inches for a 2-year, 24-hour storm event in 1850 and 2003. Percent change is listed in the right-hand column. Figure 5-2 shows cover types that were modeled for 1850 and 2003. Figure 5-3 maps changes in runoff rates from 1850 to 2003, according to the model.

In absolute measurements, none of the subwatersheds showed increases in runoff that are likely to lead to exaggerated flooding or changes to stream hydrology.

On a percentage basis, the analysis shows that the subwatershed with the greatest increase in runoff levels since 1850 is the Upper White River subwatershed (Table 5-1). This result is due to the checkerboard pattern of timber cuts throughout the National Forest.

The other subwatersheds that showed notable increases in runoff were Tygh/Jordan Creek, Threemile Creek and the Oak Springs/Maupin area (Table 5-1). All three of these watersheds are impacted most heavily by the introduction of dryland agriculture. Runoff rates from dryland agriculture are dependant on management techniques, particularly crop rotations and tillage methods. No-till or direct seed has runoff rates similar to annual grasses, whereas runoff rates in minimum-till are somewhat greater, and runoff rates under full tillage with moldboard plows are extremely high. The prevalent tillage method in the White River Watershed is minimum-till. Crops are raised on a biennial basis, with a fallow year between each crop. During the fallow year, the land is maintained free of vegetation to conserve moisture. Water is stored in the soil profile, rather than being taken up by plants. However, the increased tillage required to maintain the field free of vegetation reduces organic matter in the soil, and vastly decreases infiltration rates. (Organic matter is crucial to soil's water holding capacity.) Ironically, the long term effect of this practice is to reduce the soil's ability to absorb precipitation.

The effects of dryland agriculture on runoff are somewhat mitigated by the effects of irrigated agriculture (Figures 5-2 and 5-3). Irrigated agriculture reduces runoff, compared to native grasslands or sparse forestlands. Irrigation in the White River is most often used to produce hay, although orchards are gradually becoming more common. Both of these types of agriculture maintain a thick, living ground cover throughout the year. This leads to increased organic matter and infiltration rates, and reduced runoff from precipitation events. Of course, irrigation water itself can run off a site if the soil is saturated or the water is applied too quickly for the soil to absorb.

Table 5-1. Average depth of 2-year, 24-hour runoff events by subwatershed in inches and as a percentage of 1850 values.

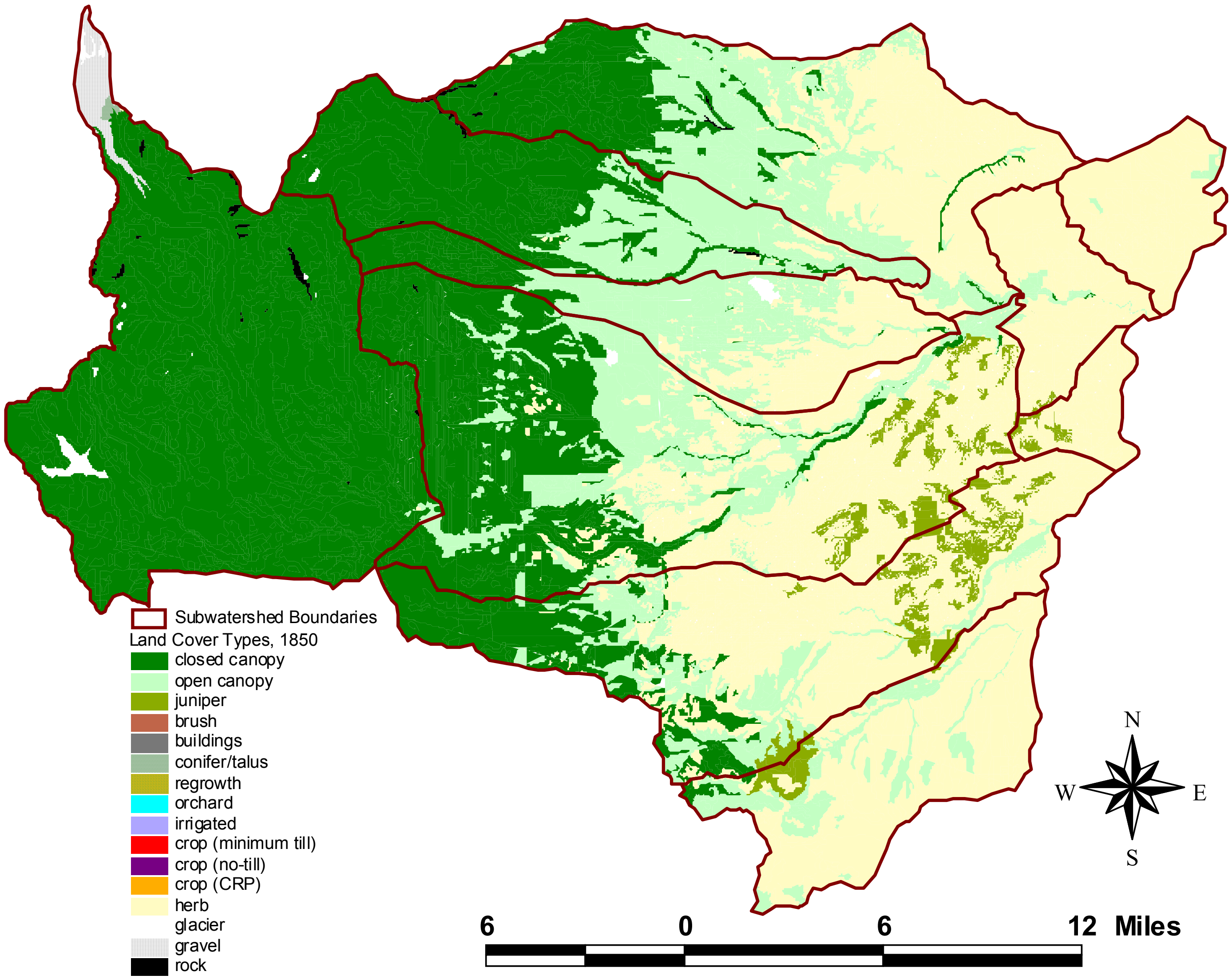
Subwatershed	1850	2003	Percent Change
Tygh	0.115	0.135	17.5%
Badger	0.039	0.043	10.4%
Threemile	0.133	0.158	18.2%
Upper White	0.231	0.290	25.3%
Middle White	0.267	0.289	8.2%
Lower White	0.263	0.279	5.9%
Wapinitia	0.165	0.189	14.0%
Nena	0.263	0.275	4.5%
Winter Water	0.087	0.104	0.5%
Oak Springs	0.218	0.256	17.7%

Confidence in the Accuracy of the Results

As noted above, the model is based on some assumptions that are difficult to test and may or may not be accurate. 1850's cover types were determined from historic public land survey records. These records were not sufficiently detailed to identify the locations of small natural clearings. Therefore, the model assumes that forest canopies in the upper elevations of the White River Watershed were unbroken by natural clearings (Figure 5-2). Most likely, there were some naturally occurring clearings due to fire, flood, landslide or other disturbances. Therefore, the model can be assumed to overstate to an unknown extent, the increase in runoff in the Upper White River subwatershed, and the western ends of Badger Creek and the Middle White River subwatershed.

The US Forest Service modeled runoff in the upper half of the Watershed as part of the White River Watershed Analysis (USFS 1995, Appendix H). They compared the existing condition to the “fully forested” condition, similar to the analysis completed here. Their results suggested a 3.4% average increase in runoff compared to the “fully forested” condition. The Forest Service found the greatest change in the Rock, Threemile and Gate Creek drainages, a somewhat lower increase for the White River mainstem, and no change at all in the Badger, Jordan and Tygh Creek drainages. Therefore, the results summarized above are notably higher than those found by the US Forest Service

Figure 5-2. Historic and current cover types for White River Watershed. Sources: Current cover types were determined with aerial photography and some field verification. Historic cover types were inferred from historic survey records.



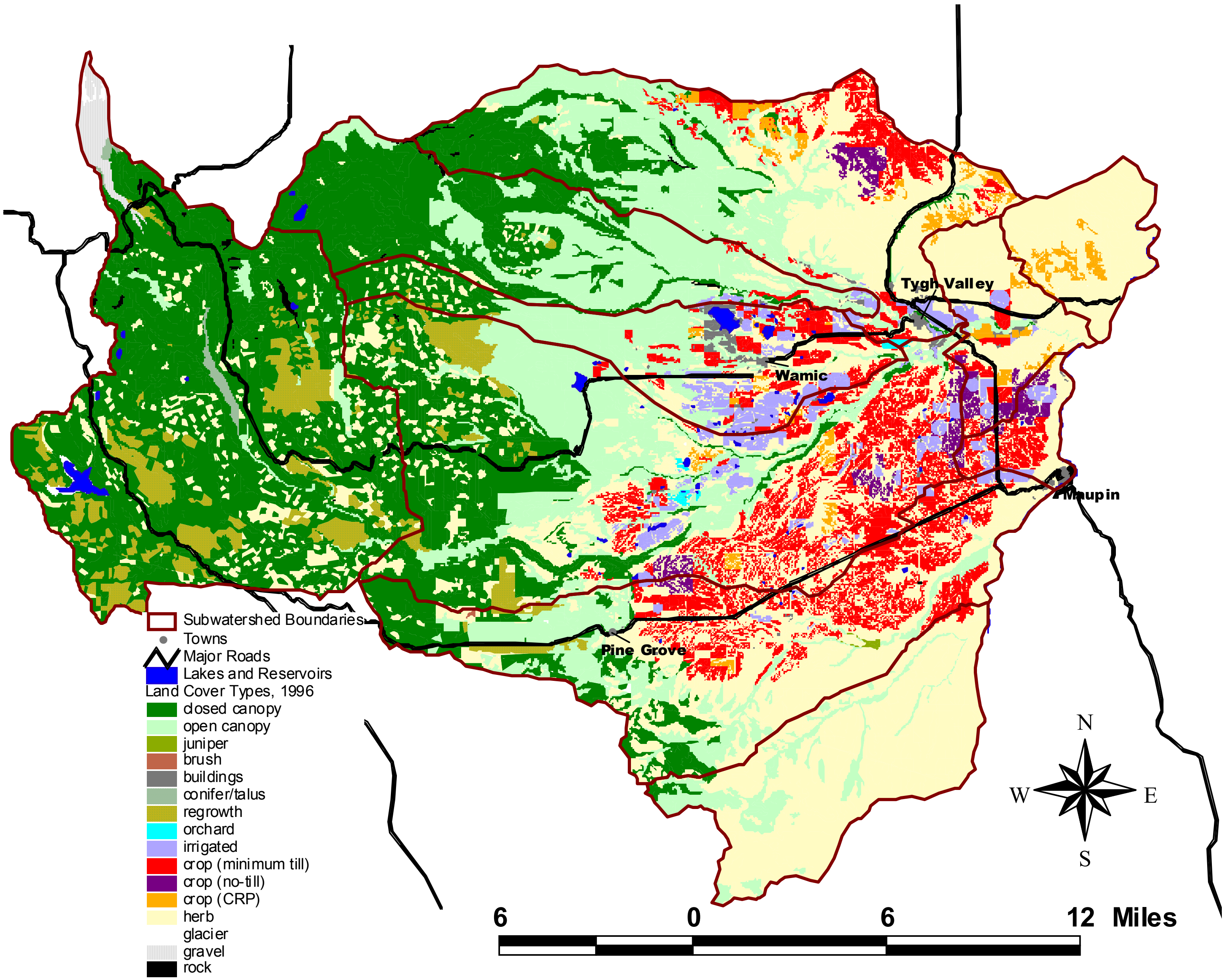
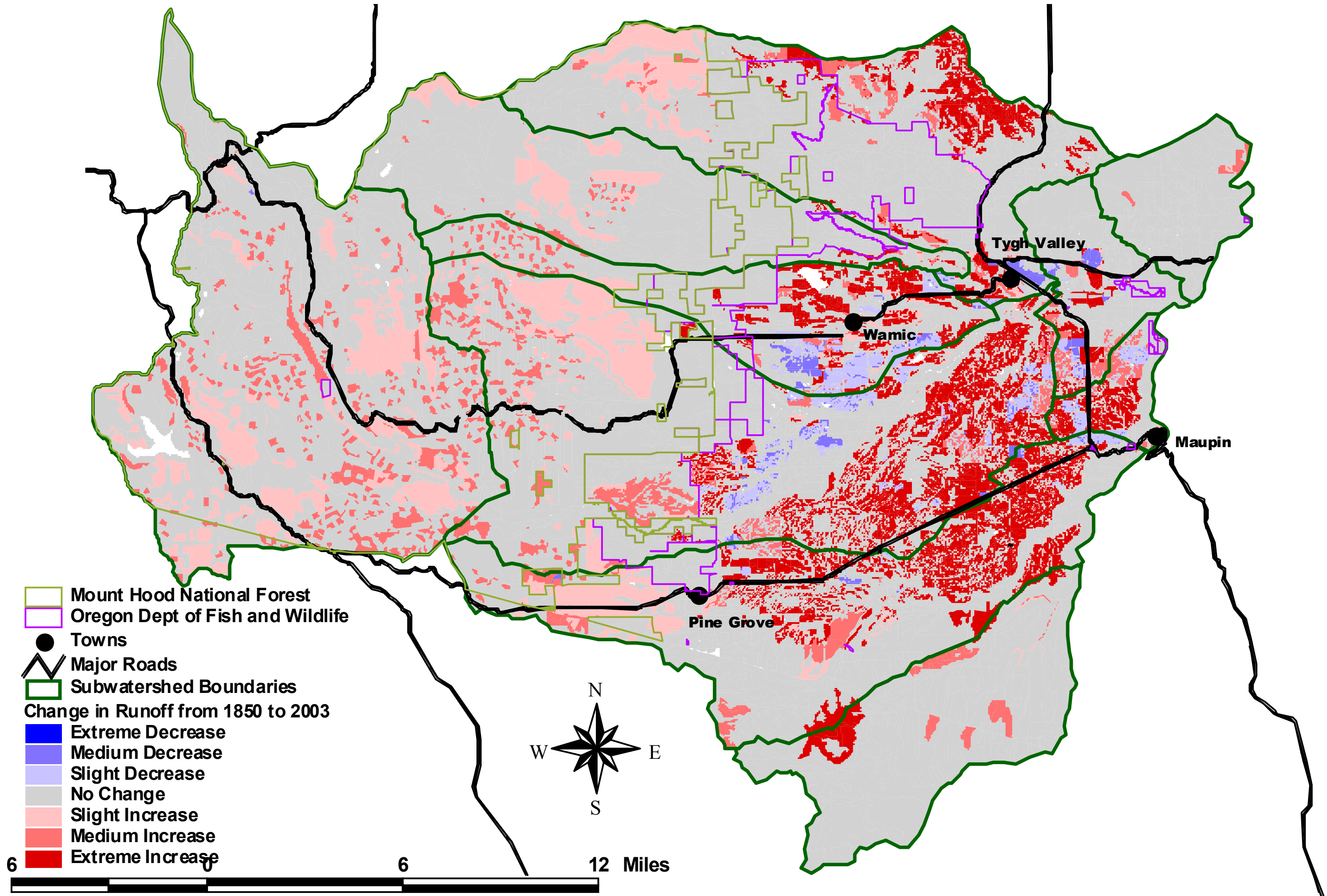

Tygh Valley
Wamic
Maupin
Pine Grove
Subwatershed Boundaries
Towns
Major Roads
Lakes and Reservoirs
Land Cover Types, 1996
closed canopy
open canopy
juniper
brush
buildings
conifer/talus
regrowth
orchard
irrigated
crop (minimum till)
crop (no-till)
crop (CRP)
herb
glacier
gravel
rock
N
W
E
S
6
0
6
12 Miles

Figure 5-3. Change in runoff ratings from 1850 to 2003 based on vegetative cover and soil types in White River Watershed.



5.2) Nonirrigated Cropland Erosion

There are approximately 38,500 acres of non-irrigated cropland in the White River Watershed. Erosion from non-irrigated crop fields is a potential contributor to stream sedimentation. Cropland erosion occurs as either sheet and rill erosion or concentrated flow or gully erosion. The first is a gradual process of downhill creep across the entire field. It is difficult to detect and difficult to measure except under controlled experimental conditions. Such experimental conditions have been used for more than 50 years by the Agricultural Research Service to develop and improve the Revised Universal Soil Loss Equation (RUSLE). RUSLE is used to predict the long-term average soil loss due to sheet and rill erosion from any given field under a particular crop rotation and management style. Sheet and rill erosion does not translate directly into stream sedimentation, because soil lost from a field may not be entirely delivered to a stream. The delivery ratio is a factor of distance from a stream and intervening topography, land cover, and other factors. It is not well understood and is too complex to be completed here.

Concentrated flow or gully erosion is erosion caused by flowing water collected in streams in a vulnerable field. It leads to clearly visible and measurable gullies in the field, and has a very high delivery ratio, usually near 100%. This is a very site-specific phenomenon. Practices that reduce sheet and rill erosion also reduce gully erosion, as do structural practices. Because it is so visible and disruptive to farm operations, gully erosion has been substantially addressed over the years by both vegetative and structural practices, such as sediment basins, terraces and grassed waterways.

This assessment used RUSLE to predict soil loss due to sheet and rill erosion in tons per acre per year based on soil erodibility, length and slope of field, vegetation and rainfall equivalent.

Methods

The Revised Universal Soil Loss Equation is written thus:

$$A=(Req)(LS)(C)(K)(P)$$

WHERE A IS SOIL LOSS IN TONS PER ACRE PER YEAR,

Req is a *rainfall equivalent* that takes into account both annual rainfall levels and local precipitation patterns,

LS is a combination of the *slope* and the average *length* of slope,

C is the *vegetative cover factor*, usually determined individually for each crop rotation (see table 6-2),

K is the *inherent erodibility* of the soil,

P is the *practice factor* that takes into account such things as terraces, strip cropping and contour plowing. Structural practices are not well mapped in the White River Watershed. According to RUSLE, structural practices as used in White River Watershed reduce sheet and rill by no more than 10%. Therefore, P was held at 1 in this calculation.

The database developed for the hydrology model (see above) was cropped to include only lands currently in dryland crop production. Each of these fields was assigned Req, LS, C and K factors. These were multiplied together to get A, the predicted long-term soil loss under current conditions. C factors were then assigned for the each field under 1850, and All-No-till conditions, to provide for comparison. Table 5-2 shows “C” factors used in this analysis.

The Soil Loss Tolerance is the maximum annual erosion that a soil could sustain over the long term with no reduction in productivity. This value is designated as “T”. “T” is highly dependent on soil depth. Fields that erode at a rate less than “T” for that soil are considered to be building soil, and are considered to be managed sustainably.

Table 5-2. Vegetative Cover ("C") Factors used in this Assessment

"C"	Crop Rotation	Assumption
0.180	Winter Wheat/Summer Fallow with Moldboard Plow	Typical practice in 1950; Maximum extent of dryland crops
0.100	Winter Wheat/Summer Fallow with Chisel Plow & 20% residue after planting	"Minimum Till", Typical practice under current management.
0.020	Winter Wheat/Chemical Fallow with no tillage and standing stubble after planting	"Direct Seed" or "No-till", currently adopted on approximately 5,050 acres.
0.001	Perennial grass	CRP, pasture or native condition

Results

Under 1850 conditions (native grasses), no area had any erosion rates greater than 0.25 tons per acre per year.

By 1950, when dryland crop acreages had reached their maximum extent, the average erosion rate had reached 5.16 tons per acre per year, with a maximum of 38 tons per acre per year on the most highly erodible fields (Table 5-3). Since 1950, cropland management has improved with the nearly universal adoption of minimum-till and residue management. In addition, many fields have been converted to permanent grass cover through the Conservation Reserve Program, or for use as pastures. Currently, 4,393 acres have been converted to grass. No-till or direct seed techniques have been adopted on an additional 5,050 acres. Table 5-3 shows current management of nonirrigated croplands in White River Watershed.

Figure 5-4 shows current erosion levels for nonirrigated crop fields. Blue or yellow colors indicate fields with less than 5 tons per acre per year. These fields meet the standard in paragraph **(OAR 603-095-0640(2)(a)(C)** of the Lower Deschutes Agricultural Water Quality Management Area Rules. (The Lower Deschutes Agricultural Water Quality Management Area Rules are part of the Oregon Administrative Rules (OARs) which are set by various State agencies to interpret and enforce the Oregon Revised Statutes. OARs have the force of law.) Blue fields are those with less than 2 tons per acre per year of soil. Fields marked in red have soil loss of at least 5 tons per acre per year, and dark red indicates soil loss of at least 10 tons per acre per year.

Figure 5-5 shows the ratio of current erosion levels to the sustainable level, "T". Green fields are those that are eroding at sustainable rates. Red fields are eroding at unsustainable rates.

Table 5-3 shows average erosion rates and acreages at various levels of erosion for 1850, 1950, current management and projected under all no-till conditions.

There are currently 14,169 acres (36.8%) of croplands in the White River Watershed with erosion rates below the soil loss tolerance. This includes all fields enrolled in the Conservation Reserve Program or otherwise converted to perennial cover, and nearly all of the Direct Seeded fields. If direct-seed techniques were adopted on all dryland crop acres, then 99.7% of the dryland crop acres would have erosion rates below the soil loss tolerance.

The adoption of minimum-tillage methods has reduced soil erosion rates markedly. In 1950, 31,700 acres (82.3%) had erosion rates more than twice their soil loss tolerance –reaching as high as 38 tons per acre per year. Currently, just 11.9% of the dryland crop acres have erosion rates more than twice their soil loss tolerance. However, 63.2% still erode at unsustainable rates (erosion greater than T), and some fields have erosion rates as high as 19 tons per acre per year. Were Direct Seed to be adopted on all crop fields in the White River Watershed, only 112 acres would continue to erode at an unsustainable rate. Most of these acres are on Tygh Ridge in the Friend area, on extremely shallow soils and steep slopes.

The majority of croplands with unsustainable erosion rates are located in Middle White River and Wapinitia subwatersheds, although many of the highest erosion rates are located in the Tygh/Jordan Creek subwatershed, near Friend. Threemile Creek also has significant acreages eroding at unsustainable rates.

Table 5-3. Average erosion levels and acreages at various erosion levels through time.

Erosion Levels	**1850**	**1950**	**Current Management**	**All Direct Seed and CRP/Grass**
Ave (t/ac/yr)	*0.029*	*5.16*	*2.206*	*0.497*
Breakdown of erosion levels:	acres	acres	acres	acres
Less than "T"	100%	5.7%	36.8%	99.7%
T to 2T	0%	12.0%	51.3%	0.3%
Greater than 2T	0%	82.3%	11.9%	0%

Confidence in the Accuracy of the Results

Croplands were determined by USDA Farm Service Agency records, which are updated every year based on aerial photos and confirmed by the landowners. Erosion is highly dependent on percent slope and slope length. This variable should be measured in the field. For this study, an average ls factor was used for each soil. This may have led to some site-specific inaccuracies, although confidence in the overall conclusions remains high.

Figure 5-4. Current Management of Nonirrigated Croplands in White River Watershed. Source: Dusty Eddy, NRCS, pers. comm. 2003.

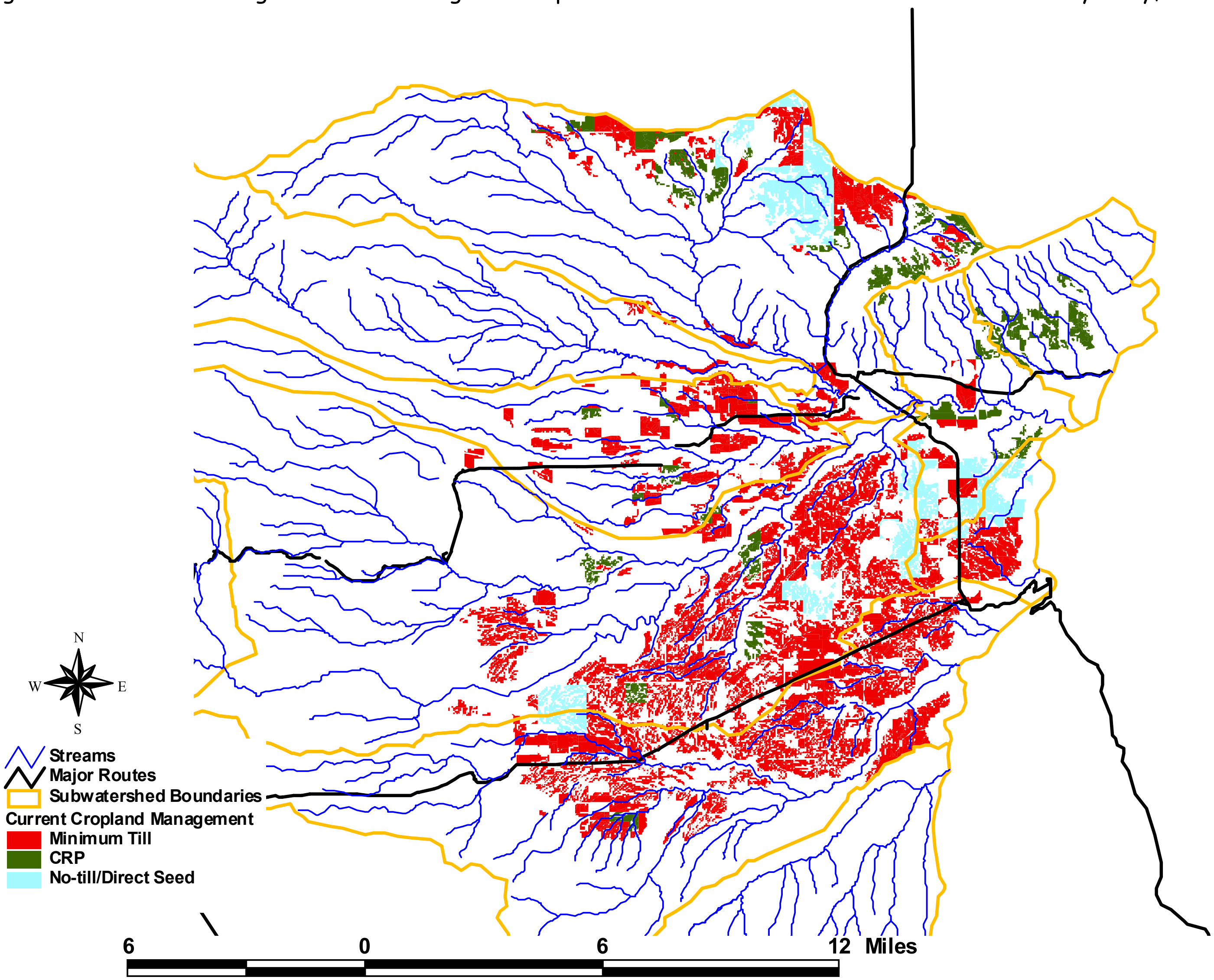


Figure 5-5. Long-Term Average Erosion Levels under Current Management for Nonirrigated Crop Fields in White River Watershed.
Source: Analysis using USDA Revised Universal Soil Loss Equation (RUSLE).

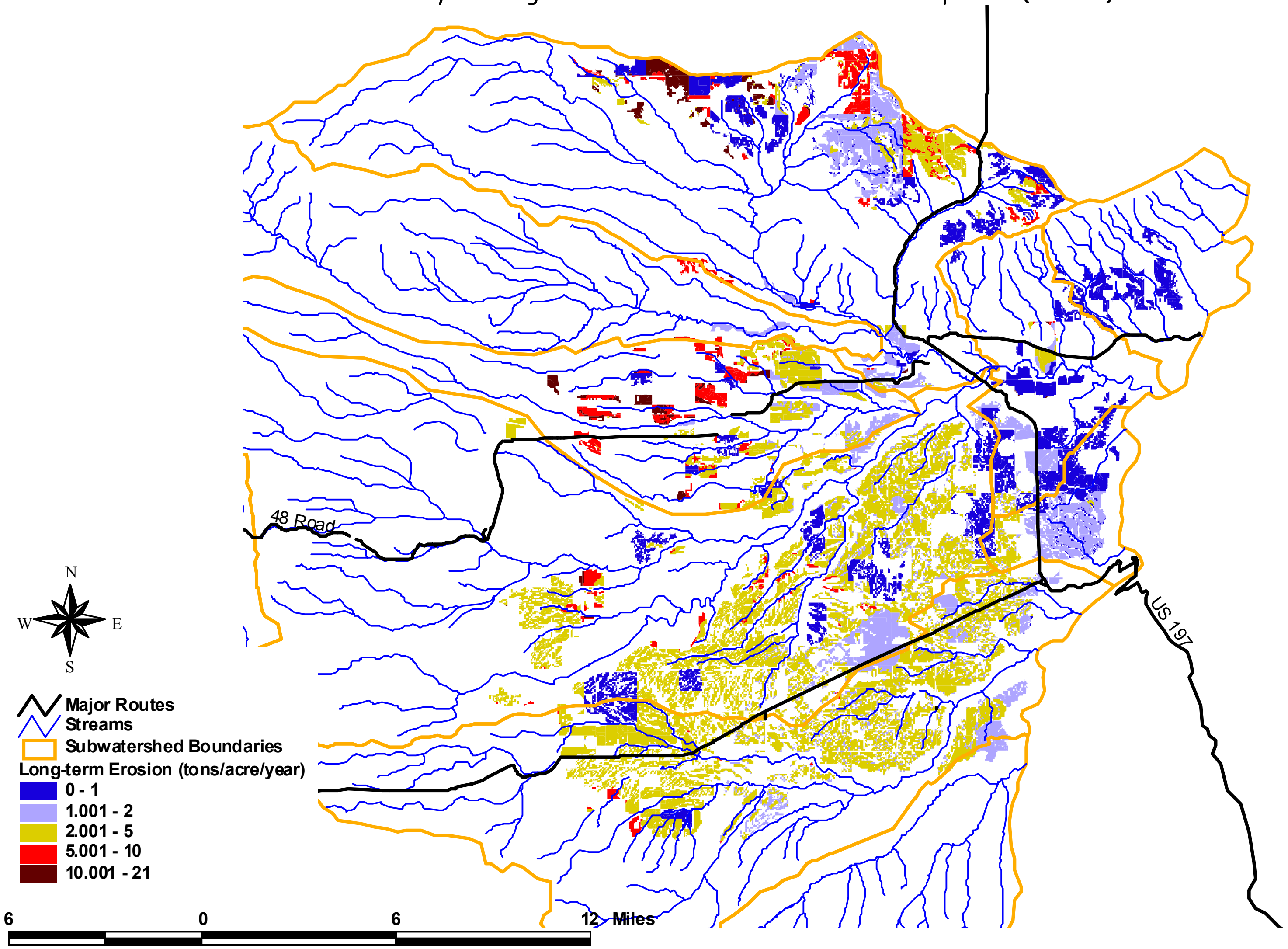
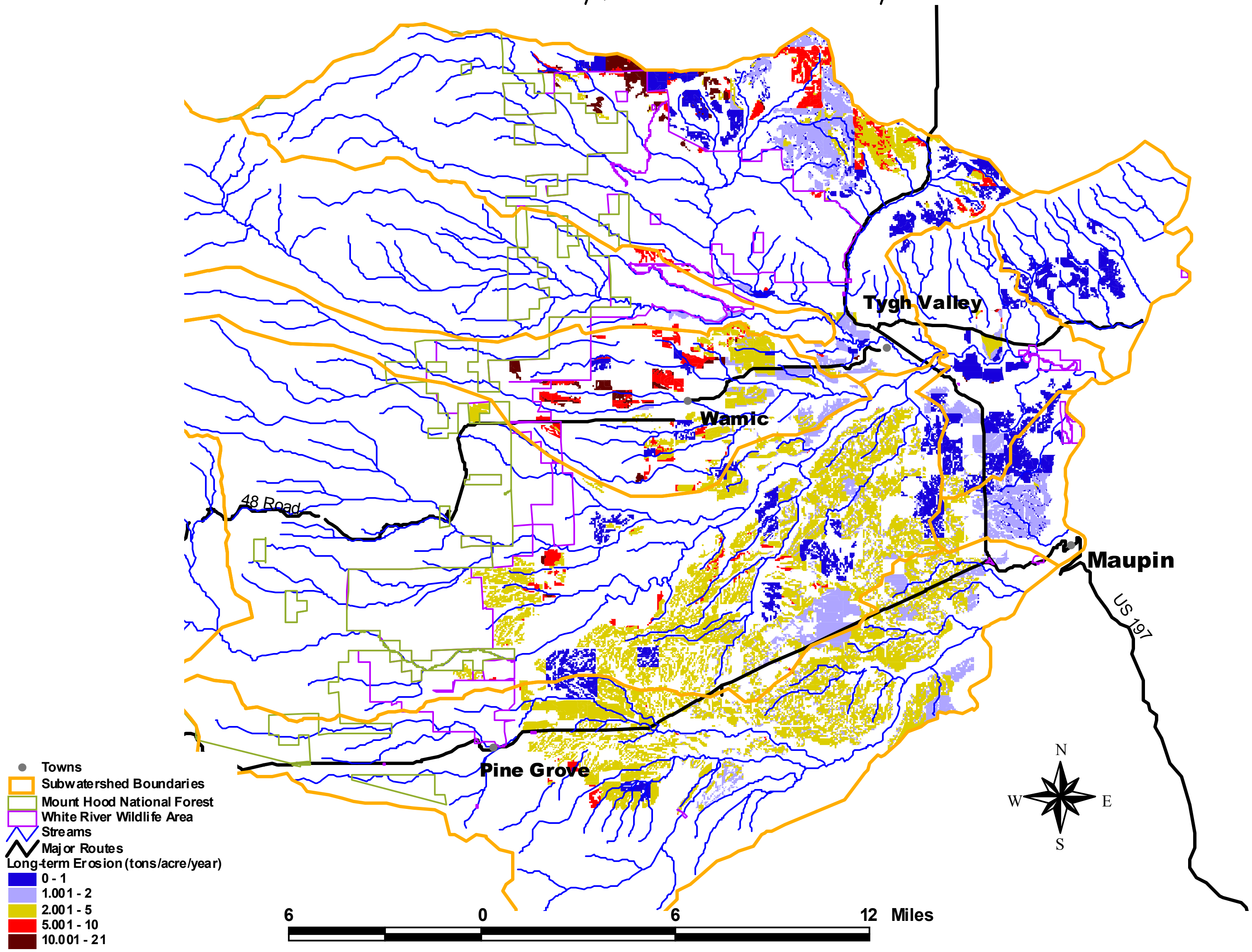


Figure 5-6. Current Erosion Levels on Nonirrigated Croplands Compared to Soil Loss Tolerance, "T". Source: RUSLE "T" values taken from Soil Survey for Northern Wasco County.



5.3) Roads

Roads were analyzed for two different effects in this assessment. Overall density of roads may have an effect on peak flows, while roads within 200 feet of a stream may have a localized effect on sediment delivery to a stream.

Runoff due to Roads

Road density is an indicator of potential hydrologic change (and sediment delivery) within a watershed. Urban, rural and forest roads alike convert natural areas into permanent openings and compacted surfaces with little or no infiltration. Roadside ditches intercept, channel and re-route subsurface and surface runoff, allowing it to enter streams more quickly. As watershed road density increases, runoff is funneled quickly and directly to streams, affecting the ability of the watershed to slow and store runoff. Different types of roads have greater or lesser effects on hydrology, depending on their width, degree of compaction, condition, location, design, and the amount of impervious surface associated with a given amount of roads.

Methods

ArcView GIS was used to build and refine a roads data layer for each subwatershed based on black and white aerial photography from 1995 and from 2002. All roads of any kind that could be seen or inferred on the aerial photos were digitized, along with roads marked on USGS topographic maps. This included paved and unpaved roads, forest roads, "jeep trails", driveways, and major traffic areas in orchards. Some roads that have recently been closed may still be visible on aerial photography. Roads were not differentiated based on size or surface, as this information was incomplete. See figure 5-7 for a map of all identified roads.

Subwatersheds were analyzed separately. Based on studies conducted in Pacific Northwest watersheds (Bowling and Lettenmeier, 1997), the Oregon Watershed Assessment Manual assigns a high degree of concern in rural areas when more than 8% of a given watershed is covered by roads. The Assessment Manual assumes that roads in rural areas average 35 feet in width, including hardened area, shoulders and ditches. Such an assumption is probably relatively accurate for county roads, but exaggerates the size of farm and field roads. Based on the previous two assumptions, a subwatershed was rated high potential for impact if road densities exceeded 12.2 mi./mi^2 (This equals 8% of the surface area). Medium ratings were assigned for half the density of a high rating (6.1 mi./mi^2).

More information regarding the basis for this analysis is available online from the Oregon Watershed Assessment Manual (www.oweb.state.or.us).

Results

Road densities in various watersheds and land use zones are summarized in table 5-4. Analysis shows a low overall potential for impact from rural roads in each subwatershed. Localized effects may still occur. In particular, see the section on sedimentation for an analysis of riparian roads.

Confidence in the Accuracy of the Results

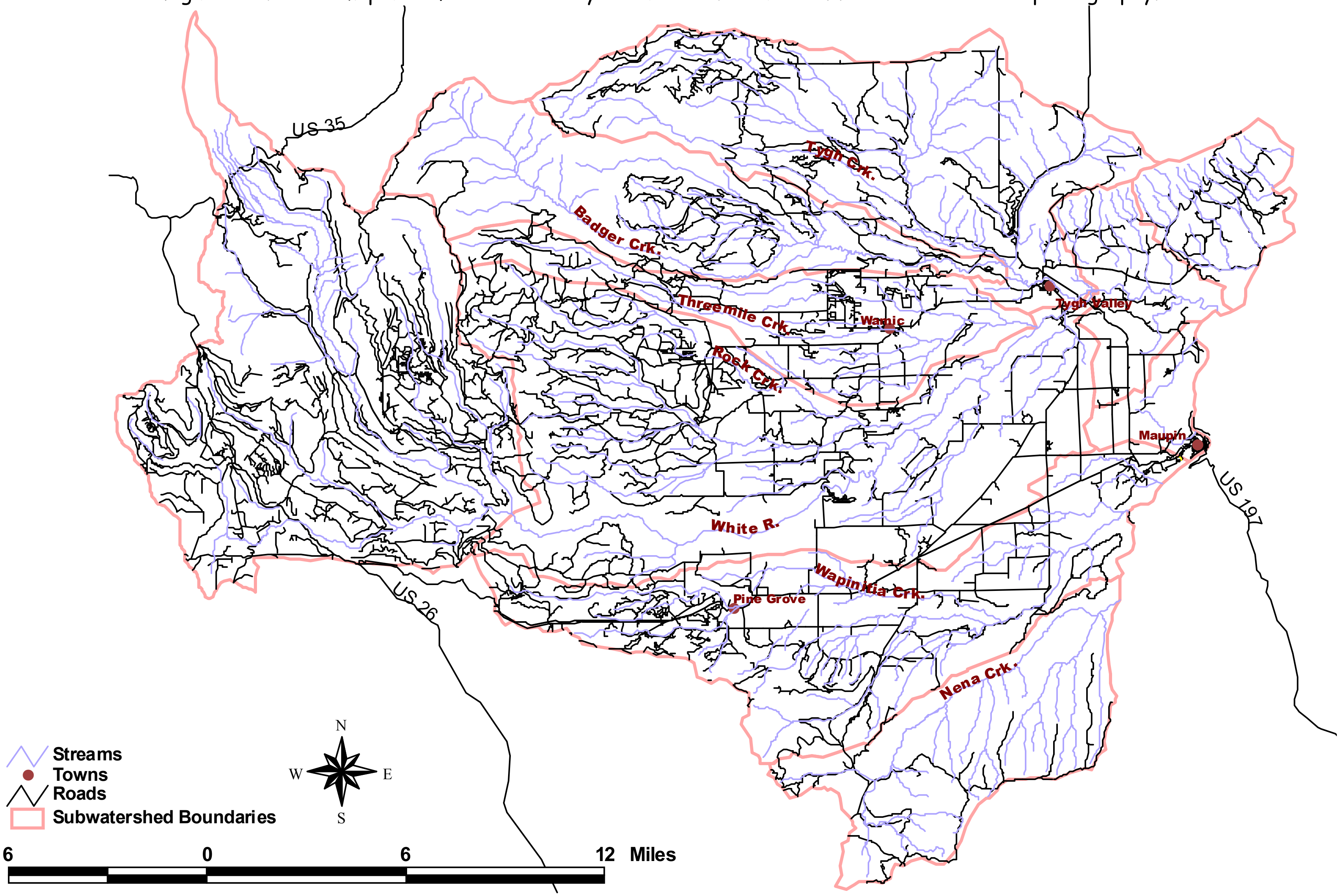
Roads were surveyed by aerial photography, but were not confirmed on ground. Not all roads are equal. No analysis was conducted of the state of repair of the roads, which may have a significant effect on their runoff impacts.

Table 5-4. Roads Density Summary.

Subwatershed	**Miles Roads**	**Area (mi.^{2})**	**Road Density** *(mi./mi^2)*	**Potential for Impact***
Tygh	138.7	75.32	1.84	Low
Badger	90.1	50.61	1.78	Low
Threemile	111.6	35.53	3.14	Low
Upper White	369.2	112.44	3.28	Low
Middle White	313.3	117.37	2.67	Low
Lower White	50.7	17.44	2.90	Low
Wapinitia	195.31	74.15	2.63	Low
Nena	44.3	40.48	1.10	Low
Winter Water	32.05	16.10	1.99	Low
Oak Springs/Maupin	11.1	7.75	1.44	Low

* A medium potential for impact corresponds to 6.1-12.2 mi/mi^2 in rural zones (8% of surface area – Bowling and Lettenmeier, 1997), and 4.2-5.5 mi/mi^2 in urban zones (May, et. al, 1997).

Figure 5-7. Roads map used for road density calculations. Source: 1995 and 2002 Aerial photography.



Sedimentation due to Roads

Fine sediments can enter a stream through a variety of natural and human-related causes. Natural sources include landslides and burns. Sedimentation can also be related to land use through road runoff (urban or rural) or road failure, and surface erosion on crop or rangeland. This portion of the assessment focused on sedimentation due to road location.

Rural roads in poor repair can add sediment to the streams by triggering landslides. Culverts in poor repair can trigger road failure (Figure 3-2). Oregon Department of Forestry has developed a protocol for road and culvert condition surveys. They make this protocol available to private foresters and local forestry agencies.

Riparian Roads

While the last section looked at overall road-density throughout the watershed, this section looks at road density within the riparian corridor. Roads within 200 feet of the stream can contribute significant amounts of sediment through concentrated road runoff, even when the road itself is in good repair. The Oregon Watershed Assessment Manual provides a protocol for quantifying this effect by cataloging all roads within 200 feet of the stream, and then further categorizing them based on the steepness of the slope above them. Roads on or below slopes greater than 50% pose a higher potential for problems, because they are more prone to failure and collect more sediment than do roads on shallower slopes.

Methods

The USDA streams data layer (that used throughout this assessment) was updated carefully for accuracy against the USGS topographic maps and aerial photos using ArcView. Where the two did not agree, the streams layer was updated to agree with the aerial photo. Using ArcView 3.2, a 200' buffer was created on either side of all streams. The updated roads layer was clipped based on the streams, creating a data layer that only included roads with 200 feet of a stream. The riparian roads layer was then carefully examined with the topographic layer in the background. Each road segment was catalogued as to whether the slope above it was more or less than a 50% slope. The density of riparian roads was calculated in terms of road miles per stream mile to give an intuitive measurement of relative impact.

Results

The highest percentages of riparian roads were in Winter Water subwatershed (Table 5-5). Primitive roads follow many of the draws up toward the ridgeline. Nearly 40% of these roads were on slopes over 50% (Table 5-5). The second highest percentage of riparian roads was found in Wapinitia, but far fewer of these were on steep slopes. The lowest percentage of riparian roads was in Nena Creek.

Any segment of riparian road may or may not cause a sedimentation problem, depending upon its design and state of repair. Each of the identified segments of riparian road (Figure 5-6) should be surveyed beginning with those on steep slopes to determine if it is contributing excess sediment to the stream.

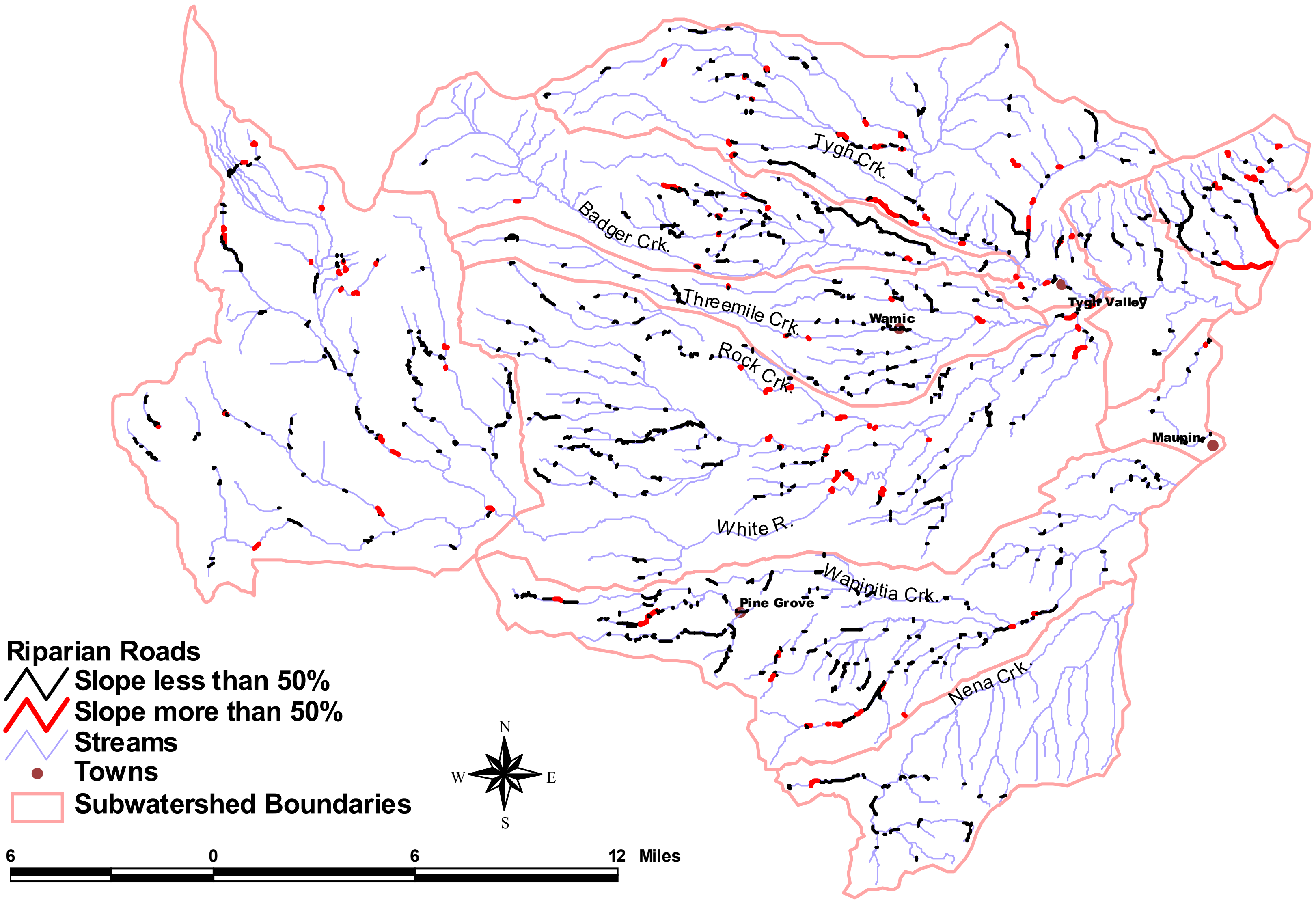
Confidence in the Accuracy of the Results

This study was based on aerial photos rather than on-the-ground surveying. As noted above, surveys should be completed to find the true trouble spots.

Table 5-5. Riparian road densities and riparian roads on steep slopes (>50%)

Subwatershed	**Stream Length**	**Riparian Roads (within 200'of stream)**		**Riparian Roads with slope >50%**	
	Miles	Miles of riparian road	mi. roads per mi. stream	Miles of steep roads	% riparian roads
Tygh	121.49	19.63	0.16	3.89	19.8%
Badger	85.36	13.26	0.16	1.32	10.0%
Threemile	65.02	9.20	0.14	0.48	5.3%
Upper White	117.22	17.24	0.15	2.38	13.8%
Middle White	153.33	23.91	0.16	3.34	14.0%
Lower White	24.66	3.33	0.13	0.00	0%
Wapinitia	109.44	23.62	0.22	2.45	10.4%
Winter Water	30.68	9.53	0.31	3.7	38.8%
Nena	67.26	5.02	0.07	0.29	5.9%
Oak Springs/Maupin	5.46	0.92	0.17	0.04	4.2%
OVERALL	**779.92**	**125.66**	**0.16**	**17.89**	**14.2%**

Figure 5-8. Riparian roads with note of those on or below slopes greater than 50%. Source: USGS topographic maps and aerial photos, 1995.



6) Water Quality

The term "water quality" includes a number of factors that can negatively affect beneficial uses of water. These factors include chemical contamination, temperature, algae, and others. Data on pesticide levels or other chemical contaminants is not included in this assessment, and represents a data gap.

The Oregon Department of Environmental Quality (ODEQ) is required by the Federal Clean Water Act (1972) to establish water quality standards to protect the beneficial uses of the State's waters. Based on the water quality standards, ODEQ is then required to: identify stream segments where the standards are not being met, develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards. The most current 303(d) list for Oregon is dated 2002.

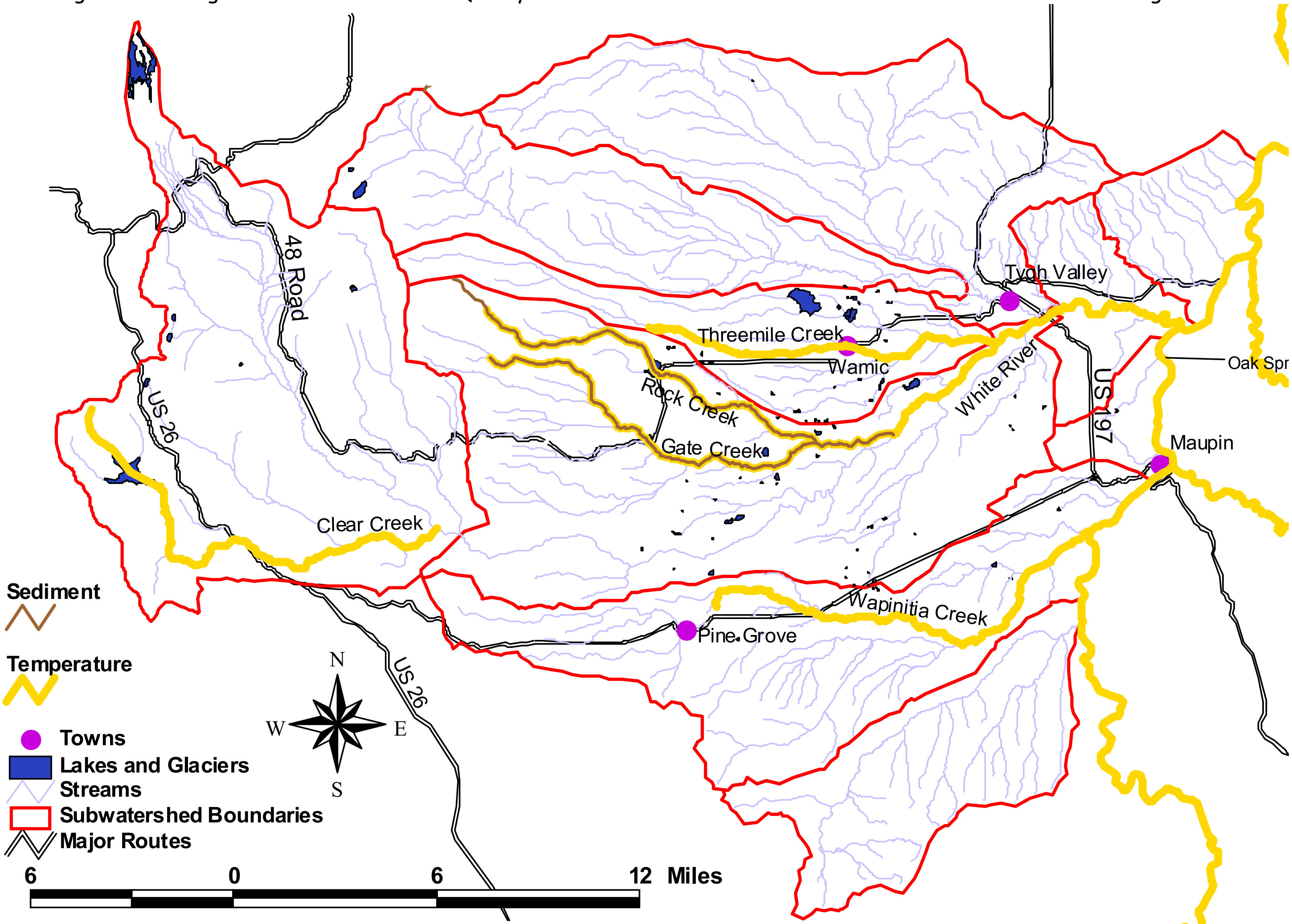
Concerns about the quality of the water in streams are based on the potential impacts on the beneficial uses of the water in that stream. The designated beneficial uses listed by DEQ for the waters in the White River Watershed are: anadromous fish passage, resident fish and aquatic life, salmonid fish spawning, and salmonid fish rearing (OAR 340-41-522). Aquatic life, particularly salmonid spawning and rearing, is considered one of the most sensitive beneficial uses.

In 2002, stream reaches in White River Watershed were included on the 303d List for not meeting the state's water quality standards for stream temperature and sediment, (2002 303(d) list) (table 6-1).

Table 6-1. Water Quality Limitations in the White River Watershed (2002 OR 303(d) list).

Reach	Parameter	Supporting Data
Clear Creek, Mouth to RM 15.1	Temperature	USFS site at Rd 42 in 1995, 7 day aver. max. temperature was 65.5°F, exceeded temperature standard of 64°F.
Gate Creek, Mouth to RM 14.3	Temperature	USFS Data (Site below FS Road 48): 7 day average of daily maximums of 69/75 with 29/69 days exceeding standard (64) in 1993/1994 respectively. In 1995, site at mouth was 69.6 °F
Gate Creek, Mouth to RM 14.3	Sediment	Redband trout is a USFS sensitive species, percent surface fine sediments are excessive (White River Watershed Analysis (USFS, 1995)).
Rock Creek, Mouth to RM 8.1	Temperature	USFS Data (Site at National Forest boundary): 7 day average of daily maximum of 73.4/79.3/67.1°F exceed temperature standard (64) in 1993/94/97. 1993 and 1994 were drought years, however, the stream also exceeded the temperature criteria in 1997.
Rock Creek, Mouth to RM 15.9	Sediment	White River Watershed Analysis (USFS, 1995).
Rock Creek, RM 8.8 to RM 14.1	Temperature	USFS Data (Site below burn): 7 day average of daily maximum of 66.9°F in 1997 did exceed temperature standard (64)
Threemile Creek, Mouth to RM 11.3	Temperature	USFS Data (Site at Forest Boundary): 7 day average of daily maximums of 64/68 with 4/26 days exceeding standard (64) in 1993/1994 respectively.
Wapinitia Creek, Mouth to RM 14.4	Temperature	BLM Data (3 Sites: site near mouth): 7 day average of daily maximums of 71.6/64.4 with 52/7 days exceeding standard (64) in 1993/1994 respectively; upper site in 1994 was 70.3°F and lower site in 1994 was 65.2°F.
White River, Mouth to RM 12	Temperature	BLM Data (2 Sites): 7 day average of daily maximums of 71.2/nd/64.3 with 45/nd/3 days at National Forest Boundary and 74.8/70.8/75.2 with 100/58/72 days below Lower Falls exceeding standard (64) in 1992/1993/1994 respectively.

Figure 6-1. Oregon State Listed Water Quality Limited Streams in the White River Watershed. Source: Oregon 303d List



6.1) Temperature

The most commonly documented water quality problem in the state of Oregon is temperature. Elevated water temperatures are detrimental to cold water fish species and other aquatic life. Elevated temperatures can kill fish directly through the breakdown of physiological regulation of vital bodily processes such as respiration and circulation. The most common and widespread cause of thermally induced fish mortality, however, is attributed to indirect effects, such as: interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior; increased exposure to pathogens (viruses, bacteria and fungi); decreased food supply (impaired macroinvertebrate populations); and increased competition from warm water tolerant species (Brett, 1952; Hokanson et.al., 1977). Cold water fish include trout, salmon and steelhead. Warm water fish include bass and bluegill, artificially introduced species found in reservoirs and farm ponds.

Stream temperature is affected by both natural and human-related factors, such as the climate, geographic location, temperature of the groundwater and springs feeding the streams, stream flow volume, stream morphology and levels of shade afforded by streamside vegetation. While climate and geographic location are outside of human control, riparian condition, channel morphology and stream flow volume are affected by land use activities. Specific land use activities which might increase summertime stream temperatures in the White River Watershed include:

- Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface;
- Reduced summer stream flows due to withdrawals for irrigation or domestic water supply;
- Localized channel widening increases the stream surface area exposed to solar heating;
- Impoundment of water behind dams alters the natural thermal profile of the water downstream of the dam depending on how and when water is released from the dam.

Given that a stream is fed by a spring with a fairly steady year-round temperature, water will heat up more the longer it is exposed to warm air and sunlight. A stream with lower flows or less shade will heat faster than a stream with higher flows or more shade. In addition, channel morphology affects the rate of heat transfer. Given the same volume, a wide, shallow stream will heat faster than a narrow, deep stream, due to the greater surface area exposed to heating sources, such as warm air and sunlight. Lateral erosion during a high flow event can create wide, shallow stream channels with minimal vegetation, and thus cause an increase in the summer temperature of the stream. Recovery occurs over time as riparian vegetation is reestablished, reinforcing the banks, narrowing the active channel, and reducing exposed surface area.

Temperature Standard

The stream temperature standard is designed to protect cold water fish rearing and spawning as the most sensitive beneficial use. Several numeric and qualitative trigger conditions invoke the standard. Numeric triggers are based on temperatures that protect various salmonid life stages, such as 64^{o}F for salmonid rearing and 55^{o}F for salmonid spawning, egg incubation and fry emergence. These numeric triggers are based on a seven-day moving average of the daily maximum temperatures. The use of this type of average recognizes that fish can likely tolerate a day or two of higher temperatures, as long as elevated temperatures are not sustained for a longer period of time (such as a week).

Qualitative triggers specify conditions that deserve special attention, such as the presence of threatened or endangered cold water species, dissolved oxygen violations and/or discharge into natural lake systems. The occurrence of one or more of the stream temperature triggers will invoke the temperature standard.

Once the temperature standard is invoked, a water body is designated as water quality limited for temperature (Table 6-1). For such water quality limited water bodies, the temperature standard specifically states that "no measurable surface water temperature increase resulting from anthropogenic activities is allowed" (OAR 340-41-525(2)(b)(A). In the development of a TMDL for temperature, the natural thermal dynamics of the system and anthropogenic contributions to stream heating are assessed.

6.2) Sediment

Sediment is another water quality parameter of concern because of the effects it can have on aquatic life. (The following information was provided by Bonnie Lamb, DEQ Water Quality Specialist, 2002.)

1)Sediment can be suspended in the water column. In this form, it reduces visibility and may reduce fish survival by affecting their ability to find food or breath. High levels of suspended sediment can reduce macroinvertebrate production. Suspended sediment can be measured by filtering a sample of water and measuring the particulate material collected on the filter. Suspended sediment can also be measured indirectly by analyzing the turbidity of the water. Turbidity is a measurement of how well light passes through a sample and it is much easier and cheaper to measure than suspended sediment. A correlation between suspended sediment and turbidity can be developed for a particular stream so that turbidity measurements can be used to estimate suspended sediment. Suspended sediment can also be a factor for drinking water quality. High suspended sediment concentrations in the White River occur naturally due to glacial melt. In tributary streams, high suspended sediment concentrations may occur during and following high flow events, when streambank erosion or overland run-off occurs, or due to point source pollution, such as construction or spills.

2)Sediment eventually settles to the bottom. Fish require clean gravels to spawn. They lay their eggs in the gravel, in riffles, where the oxygenated water can flow through the gravel, and the eggs and fry can breath. Where excess sedimentation has occurred, fry may die of asphyxiation. Generally, the category of sediment that is of concern is inorganic sediments smaller than 2mm in size (Gary Asbridge, pers. comm., December 10th, 2002).

Sedimentation Standard

The water quality standard for sedimentation is a qualitative, narrative standard [(OAR 340-41-525(2)(j)]. It states: "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed". To be listed for sediment, there must be documentation that sedimentation is causing impairment for a beneficial use.

6.3) Wastewater

In addition to the concerns identified in the 303(d) list, fecal contamination is a potential concern around various communities in the White River Watershed.

Fecal contamination is monitored by sampling water for coliform bacteria. Coliform bacteria can enter waterbodies due to high wildlife concentrations (for example, geese), or can be a sign of leaky septic systems or overflowing wastewater treatment plants. Greg Pettit, DEQ Water Quality Laboratory, comments that septic tanks generally do not contribute to surface water pollution unless there is a direct discharge, such as overland flow, to the water body, or they are installed improperly into a course sand aquifer (pers. comm., 5/28/03).

The community of Sportsman's Park at Rock Creek Reservoir has a wastewater treatment plant, as does Maupin. Residents of Tygh Valley rely on septic tanks. No wastewater problems have been identified at these communities, according to DEQ and Wasco County Public Health Department personnel. However, one resident in Tygh Valley knows of septic systems close to the White River which have experienced problems.

Wamic

Wamic residents have long been aware of wastewater problems in the community. In March of 1997 Wamic volunteers, DEQ, and Wasco/Serman County Health Department conducted a Sanitary Survey of the town's septic systems. Nearly 70% were found to be failing, with untreated wastewater found to be surfacing in low-lying areas, and overflowing into Threemile Creek. The town's small lot sizes and shallow water table have made approved, functioning septic systems prohibitively expensive, and has curtailed new development. Health and environmental concerns prompted residents to begin the process of establishing a centralized sewage treatment plant.

With the help of WyEast Resource Conservation and Development Board, the Wasco County Planning Office, the Wasco/Sherman County Health Department, and the Mid-Columbia Economic Development District, the community developed a plan for a treatment facility. The Wamic Water and Sanitary Authority was organized to run and govern the treatment plant. As of June 3rd, 2003, construction was expected to be completed by June 30.

Pine Hollow Reservoir

Water quality in Pine Hollow Reservoir has been the subject of local speculation due to septic tank leakage, combined with a large goose population. Soils surrounding Pine Hollow are Wamic loams and Hesslan-Skyline complexes, both of which are severely limited in their ability to absorb septic tank leachate (Northern Wasco County Soil Survey, p80). The concern, therefore, would be from septic tank overflow or other direct discharge.

Oregon Department of Environmental Quality has never sampled for fecal coliform bacteria in the lake. Wasco County Public Health Department took two samples in May 2002, both of which were within normal ranges (Glenn Pierce, Wasco County Public Health, pers. comm.. 5/28/03). However, Greg Pettit (DEQ Water Quality Laboratory) cautions against making interpretations of fecal coliform levels based on one or two samples. Fecal coliform can vary greatly over short distances and within brief timeframes. To determine conclusively whether there is a human health concern, he recommends at least 20 samples, taken throughout the year (pers. comm. 5/28/03). Periods of the year when one would typically expect the highest bacteria counts would be during low water, warm temperatures, and heaviest residential use. July and August would therefore be the logical target period for monitoring.

7) Channel Types

The Oregon Watershed Assessment Manual presents a classification system to divide streams into "channel habitat types" to evaluate habitat conditions and productive potential (Watershed Professionals Network, 1999). This classification system uses features such as valley shape, degree of confinement, gradient, substrate, channel pattern and geology. The most influential factors are stream gradient and channel confinement.

Each channel habitat type has predictable attributes that influence fish use, sensitivity to disturbance and potential for improvement. Gradient determines whether a particular stream reach or segment is predominantly a deposition, transport or source area for sediment and large woody debris. Low gradient reaches (less than 2%) are depositional zones for woody debris and sediment, including spawning gravel. Depositional areas are highly productive for fish, offering a wide range of habitat elements. Moderate gradient reaches (2-4%) are transport areas for sediment and wood and are moderately productive for fish, although localized areas may be highly productive. High gradient reaches (4-10%) are transport zones with only fair productivity for fish, but high productivity for amphibians. Reaches with gradients over 10% are not usually fish-bearing (USFS, 1996).

Confinement is also a factor in determining channel habitat type. Confinement refers to the ratio of the channel width to the floodplain width. Unconfined channels (those with a floodplain width more than 4 times the width of the channel) have room to meander, and thus develop more diverse instream habitat than confined channels (those with a floodplain no more than 2 times the width of the channel). Unconfined channels will also have wider riparian areas. Flood velocities will be buffered as the flow spreads over the wide floodplain. Moderately confined channels are those with floodplains between 2 and 4 times the width of the channel. Channels can be confined naturally by steep, narrow valley walls, or natural terraces. Channels can become confined due to downward erosion caused by flood events or by diking, removal of large woody debris, and channelization activities.

Channel habitat types vary in how they adjust to changes in flow, sediment, woody debris and other inputs, and some channel habitat types are more sensitive to land use activities and restoration activities than others. Low gradient, less confined areas are most likely to show physical changes in channel pattern, location, width, depth, sediment storage, and bed roughness from land use effects and from restoration attempts. Research indicates that high gradient, highly confined channels are more resistant to human impacts including timber harvest and woody debris additions than lower gradient reaches (USFS, 1996).

Intermittent streams were also classified in this analysis.

7.1) Channel Habitat Type Classification

Methods

Channel habitat types were delineated for 775 miles of streams, including perennial, intermittent and seasonal drainages, using USGS topographic maps (digital raster graphs viewed using ArcView 3.2). Channel habitat types were based on slope and confinement, as well as position within the Watershed. Channel habitat type designations and related data were recorded in an ArcView database and mapped. The streams defined in this section were used throughout the later components of the watershed assessment. Aerial photographs were used to further determine confinement.

Results

12 channel habitat types were identified in the Watershed (table 7-1). In order of prevalence, these are MH (moderate gradient headwater), MC (moderate gradient, confined), SV (steep headwater, confined), LC (low gradient, confined), MV (moderately steep, narrow valley), LM (Low gradient, moderately confined), VH (very steep headwater), MM (moderate gradient, moderately confined) GL (glacial outwash), FP3 (small floodplain), AF (alluvial fan), and FP2 (Medium sized floodplain).

Low gradient stream reaches constitute 21.8% (169.6 miles) of the stream network and include four channel habitat types: FP2, FP3, LM and LC. However, localized areas of low gradient can occur within stream reaches designated by steeper channel habitat types. Moderate gradient stream reaches constitute 40.5% (314 miles) of the stream network and include 4 channel habitat types: AF, MM, MC and MH. 35% (271 miles) of the Watershed consists of moderately steep to very steep v-shaped channels (MV, SV and VH) with gradients greater than 10%. These steepest channel types are mostly found on seasonal drainages, draining the uplands and ridges (table 7-2 and figure 7-1). The channel just below the White River Glacier is a unique channel type characterized by extremely high course sediment loads and unstable channels. More than 20 miles of braided channels flow out of the White River Glacier.

Table 7-1. Descriptions of channel habitat types found in White River Watershed

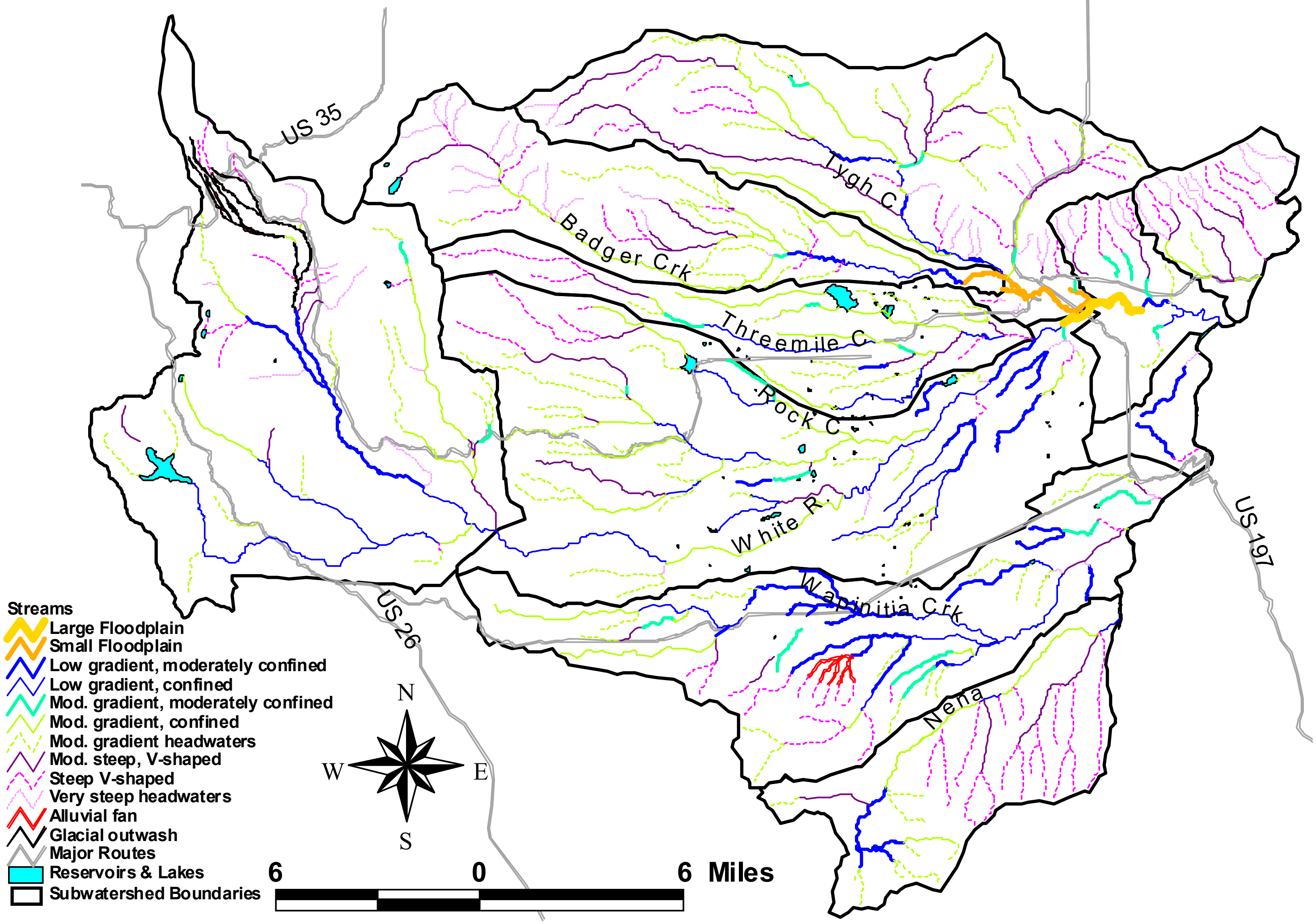
		Average Stream gradient in Watershed	Valley shape	Channel pattern	Confinement	Position in drainage	Dominant Substrate
Low Gradient Systems							
FP2	Wide Floodplain	0.57	Broad, flat floodplain	Sinuous, braided channels	Unconfined	Mainstem and lower end of main tributaries	Sand to cobble
FP3	Small Floodplain	0.70	Broad, flat floodplain	Sinuous, braided channels	Unconfined	Mainstem and lower end of main tributaries	Sand to small cobble
LM	Low gradient, moderately confined	1.17	Broad, generally much wider than channel	Single w/ some multiple channels	Variable	Mainstem and lower end of main tributaries	Fine gravel to bedrock
LC	Low gradient, confined	1.47	Moderate gradient hill slopes w/ limited floodplain	Single channel, variable sinuosity	Confined by slopes or high terraces	Generally middle to lower in large basin	Boulder, cobble, bedrock with pockets of sand, gravel, cobble
Moderate Gradient Systems							
AV	Alluvial Fan	2.9	Wide depositional areas where hillslopes open into broad valleys	Single to multiple channels spread across the fan surface	Variable	Lower end of small tributaries	Fine gravel to large cobble
MM	Moderate gradient, moderately confined*	3.36	Narrow valley with floodplain or narrow terrace	Single channel, low to moderate sinuosity	Variable	Middle to lower	Gravel to small boulder
MC	Moderate gradient, confined**	3.15	Gentle to narrow V-shaped valley	Single channel, straight or conforms to hill-slope	Confined	Middle to lower	Course gravel to bedrock
MH	Moderate gradient headwaters	4.63	Open, gentle V-shaped valley	Low sinuosity or straight	Confined	Upper, headwater	Sand to cobble, bedrock; possibly some boulders
Steep Headwaters							
MV	Moderately steep, V-shaped valley	5.69	Narrow, V-shaped valley	Single channel, relatively straight	Confined	Middle to upper	Small cobble to bedrock
SV	Steep V-shaped valley	11.58	Steep, narrow V-shaped valley	Single channel, straight	Confined	Middle to upper	Large cobble to bedrock
VH	Very steep headwaters	23.95	Steep, narrow V-shaped valley	Single channel, striaght	Confined	Middle to upper	Large cobble to bedrock
Naturally Unstable channels							
GL	Glacial Outwash	4.4	Wide floodplain of unstable gravel	Multiple channel, very unstable	Unconfined	Upper – slopes of Mount Hood	Gravel to cobble, some boulders

* "Moderately confined" means floodplain two to four times as wide as stream channel at bank-full.
** "Confined" means floodplain no more than twice as wide as stream channel at bank-full.

Table 7-2. Summary (in miles) of channel habitat types for stream channels in White River Watershed. Channel habitat types listed in order of frequency.

Subwatershed	MH	MC	SV	LC	MV	LM	VH	MM	GL	FP3	AF	FP2	TOTAL
Tygh	18.64	23.14	21.99	6.19	28.8	2.26	10.47	2.32	0.00	5.49	0.00	0.00	**119.30**
Badger	21.08	18.47	10.74	2.86	9.64	3.25	17.38	0.48	0.00	1.46	0.00	0.00	**85.36**
Three-mile	13.34	19.13	8.36	10.13	5.28	1.06	0.14	2.22	0.00	0.00	0.00	0.00	**59.66**
Upper White	21.96	15.99	9.87	18.24	7.77	11.06	10.81	1.41	20.14	0.00	0.00	0.00	**117.25**
Middle White	45.60	29.16	10.22	33.83	13.00	13.62	2.90	3.82	0.00	0.00	0.00	1.49	**153.64**
Lower White	2.29	0.00	6.60	3.17	2.37	1.19	6.68	3.02	0.00	0.00	0.00	1.67	**26.99**
Wapin-itia	19.48	12.19	15.42	14.93	5.58	26.82	1.21	9.07	0.00	0.00	4.80	0.00	**109.5**
Nena	9.28	12.04	30.34	1.45	8.77	5.42	0.00	0.00	0.00	0.00	0.00	0.00	**67.3**
Winter Water	1.49	2.85	10.83	0.00	5.58	0.00	9.96	0.00	0.00	0.00	0.00	0.00	**30.71**
Oak Springs	0.00	0.00	0.93	0.00	0.00	3.93	0.61	0.00	0.00	0.00	0.00	0.00	**5.47**
Total miles	**153.2**	**133.0**	**125.3**	**90.8**	**86.8**	**68.6**	**60.1**	**22.3**	**20.1**	**7.0**	**4.8**	**3.2**	**775.2**
% of Water-shed	*19.8*	*17.2*	*16.2*	*11.7*	*11.2*	*8.8*	*7.6*	*2.9*	*2.6*	*0.90*	*0.62*	*0.41*	***100%***

Figure 7-1. Channel habitat types in White River Watershed based on slope, floodplain width and position in Watershed.



7.2) Channel Modification

"[Stream] channels are dynamic systems that modify themselves in response to changes in physical watershed features" (Oregon Watershed Assessment Manual, pVIIA). Such changes may be due to manmade or natural factors. Typical manmade channel modifications include dikes, riparian roads, stream crossings, dams, etc. Flooding is a natural factor that modifies the channel of a stream.

Generally, where a stream has adequate riparian vegetation and access to its floodplain, a flood will not change the channel habitat type, although it may change the location of specific meanders. On the other hand, an unusually large flood or one that occurs where riparian vegetation has been removed or suppressed may cause erosion and down-cutting, thus restricting the channel within a deep gully and cutting the stream off from its natural flood plain.

Where a stream is in close relationship with its floodplain, the water table of that floodplain is often close to the surface, resulting in a sub-irrigated state on the floodplain. The floodplain generally buffers the stream during large flood events, allowing the water to spread and slow down, reducing the power of the flow, and thus reducing streambank erosion. Stream channels with wide floodplains generally feature more meanders, slower flow, and a greater diversity of fish habitat (pools, riffles, oxbows, etc.) than streams without floodplains.

In cases where a stream loses access to its floodplain, either by a manmade structure or through downward erosion, the water table will drop, resulting in a loss of the subirrigated conditions and thus a loss of productivity on the floodplain. Furthermore, the stream flow is then confined within its eroded banks, even in high flows, resulting in further streambank erosion and/or downcutting, sedimentation of the stream, continued damage to riparian vegetation, and loss of fish habitat. In the absence of further disturbances, floodplain function will eventually reappear when streambank erosion has created a new floodplain at a lower elevation.

Floodplains have been used extensively throughout the West for agriculture and residential development. Channels are often realigned to flow past the edge of the floodplain, and are diked or lined in an attempt to protect infrastructure from flooding.

Channels are often modified to accommodate roads. Roads may be built alongside streams in narrow canyons, restricting floodplain access and channel width. In other places, simple dirt roads may be graded up the bottom of ephemeral canyons. During the rainy season, runoff may follow these roadbeds, leading to erosion and sedimentation.

Streams may also be realigned to flow through culverts. This type of modification directly affects a very short segment of stream, but may have indirect affects both downstream and upstream, if the stream loses its ability to accommodate high flows. Culverts can also be a barrier to fish migration and can block movement of woody debris.

Methods

Channels within 50 feet of a road were identified using ArcView GIS software. Aerial photographs and topographic maps were used to identify channels that had been straightened or otherwise removed from the natural channel.

Results

Total miles of modified channels are summarized in Table 7-3. Locations are shown in figure 7-2.

Approximately half the modified channels had been diked or ditched to accommodate agricultural fields in Tygh Creek, Badger Creek, Wapinitia Creek, McCubbins Gulch and various tributary waterways.

Approximately 25% of modified of stream paralleled roads, either in roadside ditches, or by running directly down ruts in dirt trails. Another 25% flowed through culverts under roads.

Winter Water subwatershed had the most modified channels, as a percentage of total channels. Winter Water subwatershed was heavily impacted by the presence of primitive roads in its ephemeral draws. Other subwatersheds with relatively high rates of modified channels were Threemile, Tygh/Jordan and Wapinitia, in that order. Each of these subwatersheds included extensive reaches that had been realigned to accommodate agriculture and roads.

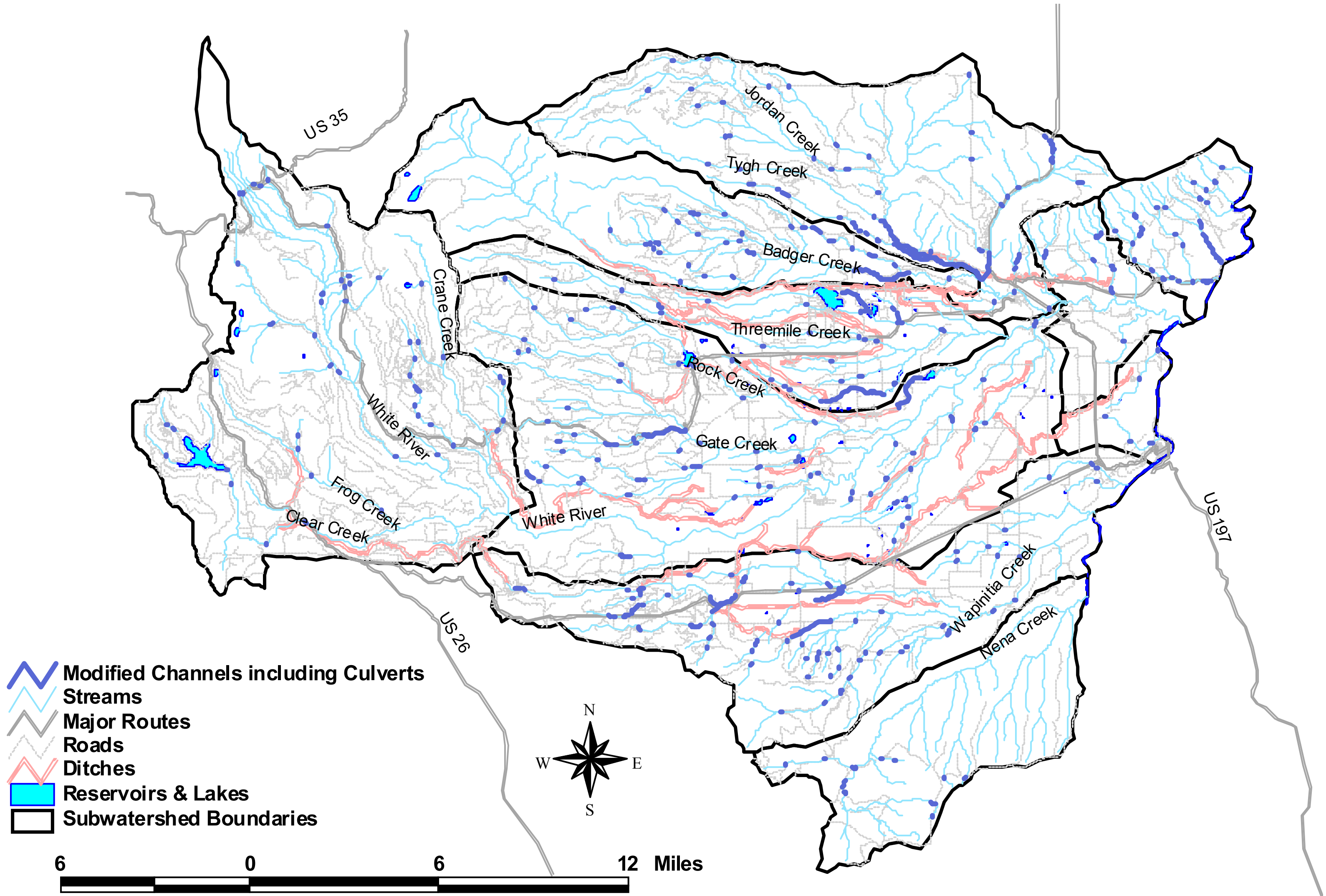
Table 7-3. Summary of Modified Channels by Subwatershed

Subwatershed	Modified Channels (miles)	% of Total Channels in Subwatershed
Tygh	9.5	7.5%
Badger	4.0	4.7%
Threemile	4.8	8.0%
Upper White	2.4	2.1%
Middle White	7.0	4.6%
Lower White	0.75	2.8%
Wapinitia	8.5	7.4%
Nena	0.86	1.3%
Winter Water	2.8	9.1%
Oak Springs	0.22	4.0%
TOTAL	40.83	5.2%

Confidence in the Accuracy of the Results

This analysis is based on inspection of aerial photos only, and has not been field verified. Therefore, the level of confidence that should be placed in these results is relatively low. This data should be used as a guide for further studies, rather than an identification of specific “problem areas”.

Figure 7-2. Modified channels and stream crossing sites in White River Watershed. Information based on 2003 aerial photos.



8) Riparian and Wetlands Conditions

This chapter summarizes a riparian vegetation assessment and presents a map of wetland areas in the White River Watershed.

8.1) Riparian Vegetation

Riparian vegetation is important as a source of shade and large woody debris, and to filter out sediment from storm events. Large woody debris (large tree trunks, stumps or branches) is an important structural element for fish habitat. Shade affects stream temperature. Riparian vegetation serves to filter out fine sediments carried by runoff that can smother eggs in spawning gravels, and is the source for organic matter needed by the aquatic food chain. Trees, shrubs and other riparian vegetation also help stabilize streambanks.

The purpose of this assessment is to evaluate current riparian vegetation along stream channels in the Watershed compared to the site potential. This information can be used to identify areas where riparian vegetation has been degraded and where it is in good condition, and thus prioritize areas for riparian restoration or protection.

Methods

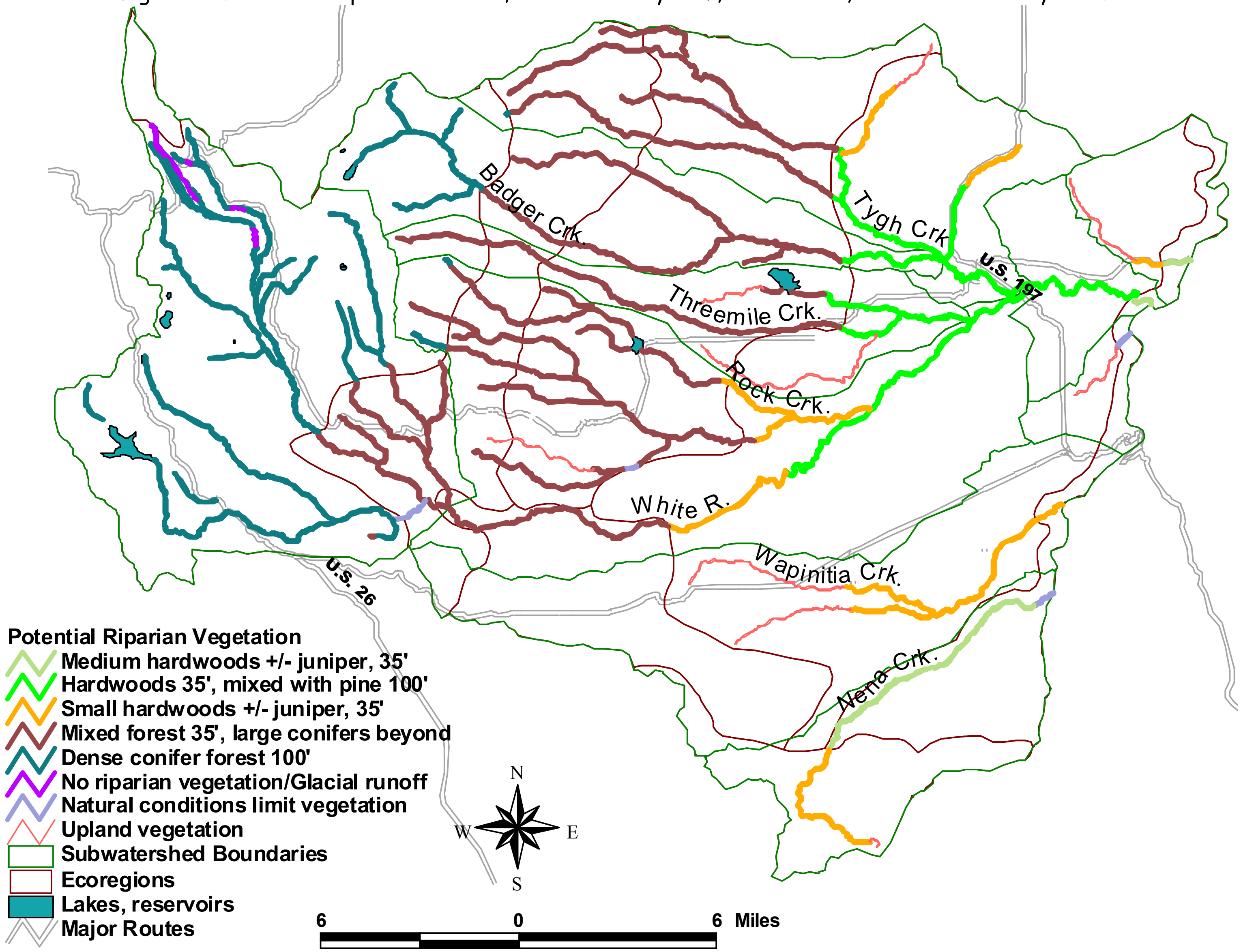
This analysis looked at all major streams and channels, including intermittent streams and seasonal drainages. Riparian vegetation was evaluated using black and white aerial photography taken in summer 1995, augmented by georectified color aerial photography taken in summer 2001 when available. Riparian condition units (RCUs) are segments of the riparian area for which vegetation type, size and density remain approximately the same. Each side of the stream was evaluated separately. Riparian vegetation was considered up to 100 feet from the stream. Each RCU was classified by its vegetation type (conifer, hardwood, mixed, brush, grass or none), tree size class (<4 inches trunk diameter, 4-12 inches, 12-24 inches, >24 inches or nonforest), and stand density (<1/3 ground exposed, >1/3 ground exposed, or nonforest). Each RCU was classified twice, once for the vegetation within 35 feet of the stream, and once for the vegetation 35 to 100 feet away from the stream.

Each RCU was then classified by Potential Vegetation (Figure 8-1), based on historic forest data, ecosystem and observation of surrounding areas in the aerial photos. In seasonal drainages, the expected vegetation was typically the same as the upland vegetation – grass or upland forest. Tree species was difficult to determine from aerial photos, and was therefore not considered in defining expected vegetation.

Each RCU was then rated by whether it had the potential vegetation or not. Where the condition of the riparian vegetation did not meet vegetative potential, and no known restoration efforts have been undertaken, recommendations for restoration efforts were given.

Known riparian restoration efforts are reflected as a recommendation to continue present management. Restoration efforts by Oregon Department of Fish and Wildlife (ODFW), the US Forest Service and private landowners in the Conservation Reserve Enhancement Program (CREP) are included in this category.

Figure 8-1. Potential Riparian Corridor, based on ecosystem, observation, and historic survey data.



Results

Results are summarized in tables 8-1 and 8-2, and mapped in figures 8-2 through 8-4. Out of a total of 688.5 total streambank miles, including right and left banks, 621.5 met vegetative potential for riparian vegetation. Aerial photographs (from 1995 and from 2001 where available) and field observations were used to determine vegetative conditions.

Only 9% of stream miles did not meet vegetative potential (Table 8-1). Middle White River subwatershed has the highest number of stream miles not meeting potential (24.09), followed by Tygh and Threemile subwatersheds (13.83 and 13.62). Upper White River subwatershed follows with 11.22 total streammiles not meeting potential. In contrast, Badger Creek subwatershed has only .75 stream miles, which do not meet vegetative potential, and lower White River has .78 miles. Threemile Creek, middle White River and Tygh Creek subwatersheds also have the highest percentages within their boundaries of stream miles not meeting potential (21%, 15%, and 13%).

Because they are seasonal drainages, Wapinitia Creek, Nena Creek, and Oak Springs have a vegetative potential comparable to upland. All reaches in these subwatersheds were found to be meeting potential for upland vegetation in their ecoregions. However, for some seasonal stream reaches improvements to riparian conditions may still be advisable as part of individual Conservation Plans. Seasonal streams contribute run-off, sediment and woody debris while they are flowing, and thus do have an impact on water quality and aquatic habitat downstream. (Conservation Plans are offered by the Natural Resource Conservation Service (NRCS) in partnership with local Soil and Water Conservation Districts (SWCDs). A Conservation Plan is a voluntary, comprehensive plan of action designed to meet the needs of the client while addressing impacts to natural resources. Ideally, the Conservation Plan would be part of a Resource Management System which would address all resource concerns on the site.)

Though Middle White River subwatershed has the most stream miles below vegetative potential, 80% of these affected stream miles can be attributed to the Rocky Burn, also known as the Rocky Fire of 1973. The remaining miles in the Middle White River drainage are primarily affected by logging. Tygh Creek subwatershed's affected stream miles are attributed to a mix of uses including agriculture, pasture, range and logging, with logging accounting for approximately 40% of the affected stream miles in this drainage. In Threemile Creek subwatershed, "range" uses account for more than half of the affected 13.6 stream miles, followed by "logging" and "pasture". In the upper White River subwatershed 95% of affected stream miles are attributed to logging.

Although Badger Creek subwatershed is presently meeting its riparian vegetation potential, the health of its vegetation is of concern. A large percentage of trees are dead or diseased. (Chris Rossel, USFS, pers. comm., 7/18/03)

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Figure 8-2. Stream reaches meeting and not meeting vegetative potential based on 1995 aerial photos.

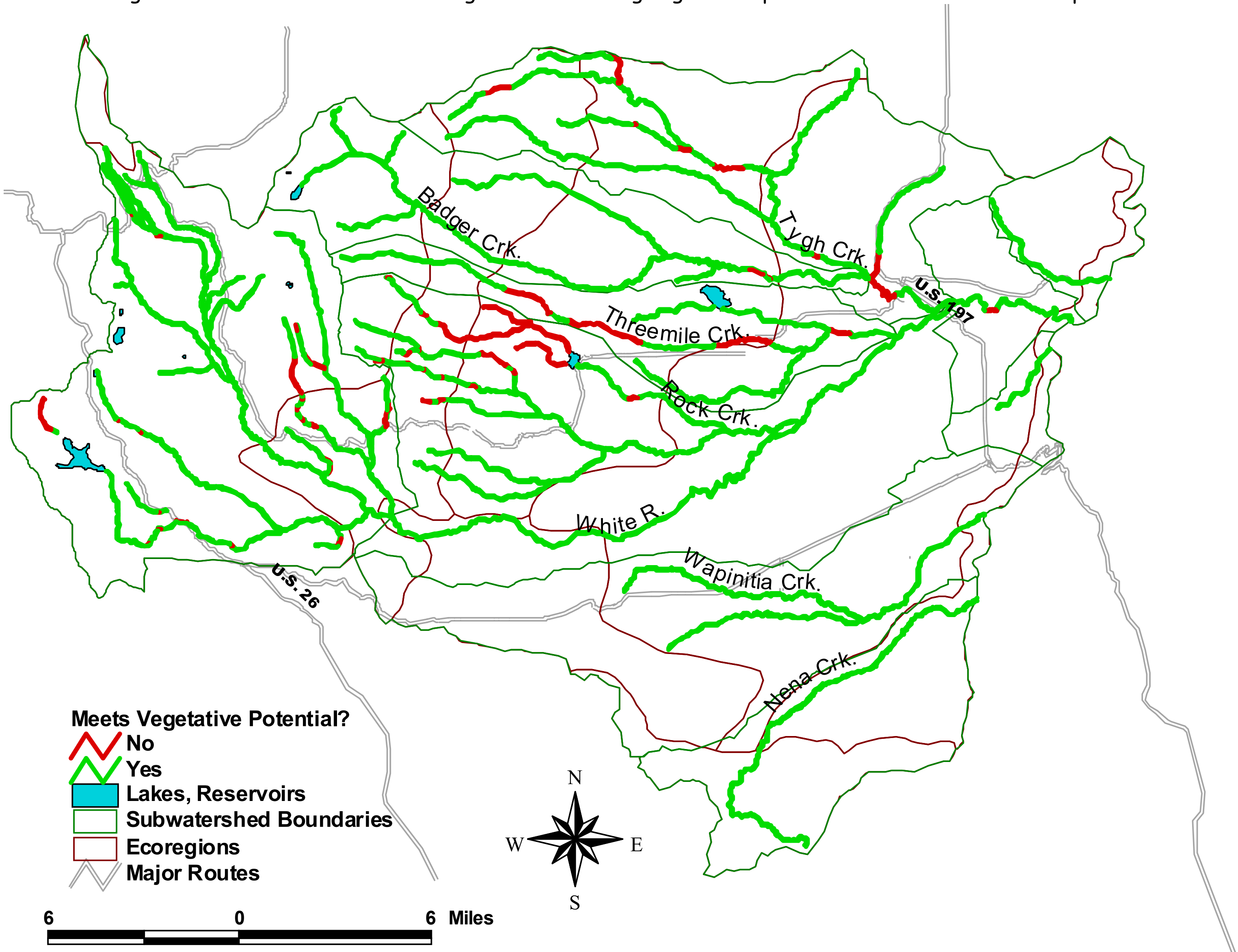
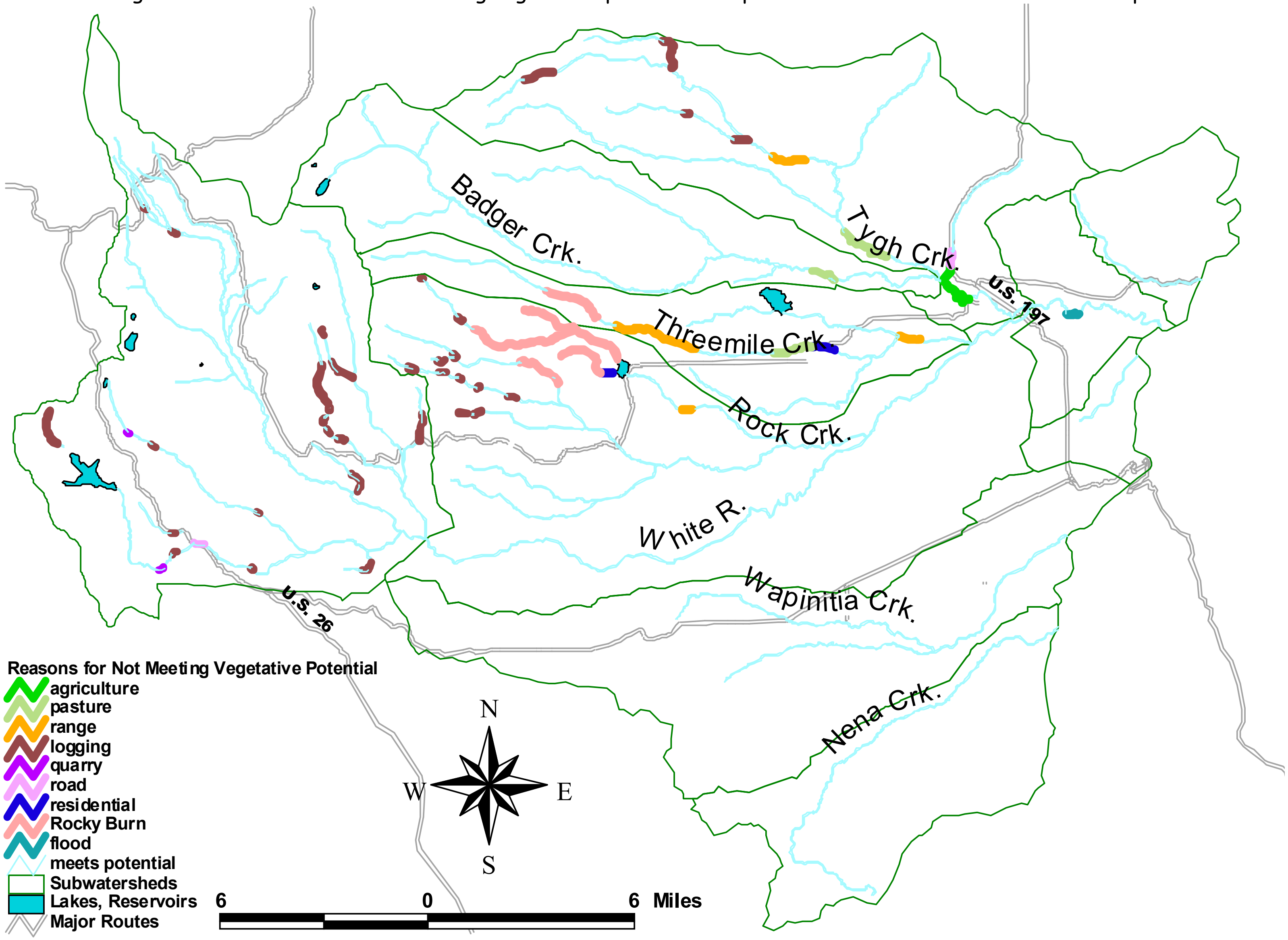


Table 8-1. Stream miles not meeting vegetative potential and probable causes.

Subwatersheds	Total Miles	Miles Not Meeting Potential	Agri-culture	Pasture	Range	Logging	Quarry	Road/ Resid-ential	Rocky Burn/ Flood
Tygh	104.116	13.833(13%)	3.768	3.204	2.111	5.094		.851	
Badger	74.588	.750(01%)		.750					
Threemile	66.224	13.624(21%)		2.332	6.381			1.420	3.491
Lower White	10.550	.784((07%)			.580				.784
Middle White	159.093	24.092(15%)				3.620		.719	19.173
Upper White	183.796	11.220(06%)				10.621	.2620	.337	
Wapinitia	43.306								
Nena	30.385								
Oak Springs	5.692								
Winter Water	10.753								
Totals	688.503	62.760(09%)	3.768	3.548	9.072	19.335	0.262	3.327	23.448

Figure 8-3. Stream miles not meeting vegetative potential and probable causes. Source: USGS aerial photos.



Recommendations

Recommendations to bring stream miles up to vegetative potential are shown in Table 8-2 and Figure 8.4. Recommendations include addressing conservation goals with a Farm Plan, establishing or widening buffers, restoring stream channels, replanting forest, and continuing present management practices. "No Action Needed" indicates that vegetative potential is met.

The recommendation to "continue present management" applies to stream reaches where riparian restoration is in progress, or natural regeneration is underway. Where regeneration of logged areas is evident in the aerial photos, continuation of present management is recommended.

Riparian fencing has been established by Oregon Department of Fish and Wildlife along several reaches in the Tygh, Threemile, and middle White River drainages (pers. comm., Ray Johnson, 12/27/02). These reaches are shown in Figure 8-4 and recommended for "continuation of present management". In 2 cases (one on Tygh Creek downstream from the confluence with Pen Creek, and one on Threemile Creek directly north of Rock Creek Reservoir) a wider buffer is encouraged.

A stream reach in the Continuous Conservation Reserve Program (CCRP) on Threemile Creek, just downstream of the confluence with Pine Hollow Creek, is also recommended for "continuation of present management."

Stream reaches affected by the Rocky Burn of 1973 are predominately owned and managed by the U.S. Forest Service. Vegetation has not fully recovered since the fire, but is currently managed under the Northwest Forest Plan to protect and restore riparian values. These reaches are included in the "continue present management" category as well. (See section on Forest Management for information on Riparian Reserves.)

While it is recognized that 100' buffers may not be practical in residential areas, the recommendation to "establish or widen" vegetative buffers was made to encourage the use of "naturescaping". "Naturescaping" is an approach to residential landscaping that aims to protect streams and rivers by reducing runoff and erosion and enhancing habitat using native vegetation (East Multnomah Soil and Water Conservation District.). Generally, the wider the buffer, the greater are the benefits to water quality and habitat.

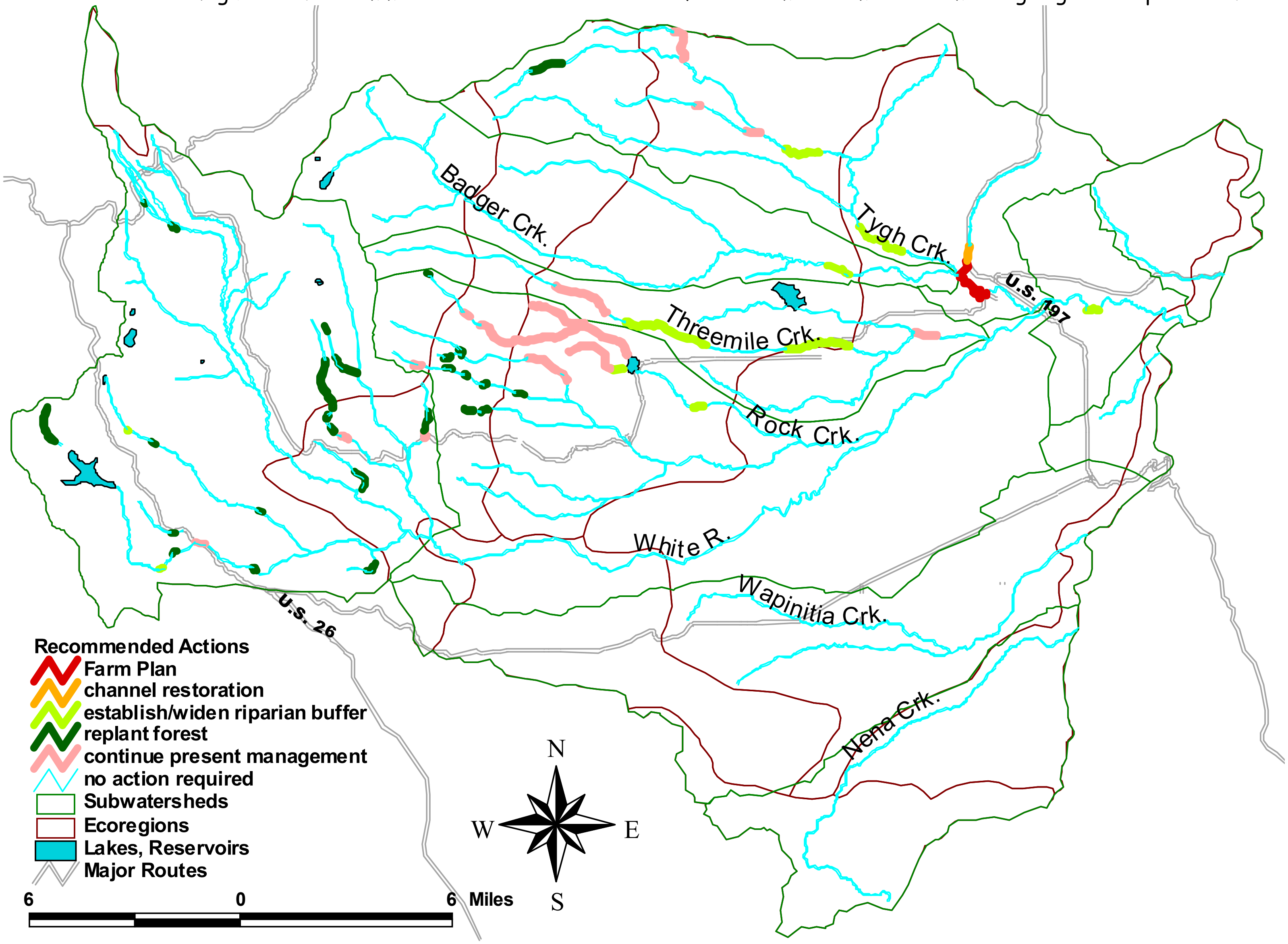
Confidence in the Accuracy of the Results

Riparian zone conditions were not extensively field verified. Field observations were used to verify size, type and density of riparian vegetation in a sampling of locations. These were locations that were easily accessible by road, primarily at middle and lower elevations of the watershed. Impacts to underbrush such as would result from livestock grazing were not visible in aerial photos of areas with mature trees. Georectified aerial photos from 2001 were only available for the lower half of the watershed at the time of this report. Since the 1995 aerial photos, the Flood of 1996 has occurred, as well as lesser floods. Riparian areas have undoubtedly been affected by flooding, and are in the process of regenerating. Logged sites will also have regenerated considerably since 1995. When more recent aerial photos become available, an updated riparian assessment can be undertaken.

Table 8-2. Recommended restoration activities for remaining stream bank miles not meeting vegetative potential.

Sub-watersheds	Total Miles	Miles not Meeting Potential	Farm Plan	Establish/ Widen Buffer	Channel Restoration	Replant Forest	Continue Present Management	No Action Needed
Tygh	104.116	13.833	3.768	3.956	.851	3.333	3.304	87.545
Badger	74.588	.750		.750				73.838
Threemile	66.224	13.624					4.816	52.600
Lower White	10.550	.784		.784				9.766
Middle White	159.093	24.092		1.299		2.783	20.010	135.001
Upper White	183.796	11.220		.262		9.702	1.256	172.576
Wapinitia	43.306							43.306
Nena	30.385							30.385
Oak Springs	5.692							5.692
Winter Water	10.753							10.753
Totals	**688.503**	**64.303**	**3.768**	**7.051**	**0.851**	**15.818**	**29.386**	**621.462**

Figure 8-4. Recommended restoration activities for stream bank miles not meeting vegetative potential.



8.2) Wetlands

Wetlands contribute to critical functions in the health of a watershed. They provide a means of storing, filtering, and slowing water during high flow events, and also provide a means of recharging the groundwater table, thereby helping to maintain streamflows. Additionally, wetlands provide critical habitat for fish, amphibians, birds, and many other types of wildlife. Wetlands are legally protected by federal, state, and local regulations. Determining the location and extent of wetlands in the watershed is essential in planning for growth, development, or any kind of project.

Methods

The major source for this inventory was the National Wetlands Inventory (NWI) of the U.S.Fish and Wildlife Service. National Wetlands Inventory categorizes wetlands by system, substrate or vegetation, seasonality, and as natural or constructed. The Inventory identifies three system types in the White River Watershed; lacustrine wetlands (lake systems), riverine wetlands (stream systems), and palustrine wetlands ("swamps"). Each is further categorized.

Wetlands are "areas that are transitional between terrestrial and aquatic ecosystems, where the water table is at or near the surface, or the land is covered by shallow water." (Wetland Plants of Oregon and Washington, Jennifer Guard, 1995.) Three attributes are used to identify wetlands; presence of water loving vegetation, hydric soils, and a hydrologic regime involving inundation or saturation for 2 weeks or longer during the growing season. (Soils that develop under saturated conditions are known as "hydric" soils.) The National Wetlands Inventory also categorizes open water such as lakes, reservoirs and farm ponds, as wetlands.

Lakes, both natural and man-made, and reservoirs are considered lacustrine wetlands. Riparian areas can also be considered wetlands where hydric soils are present. These are known as riverine wetlands. Palustrine wetlands are defined by the type of vegetation they support. They can occur beside lakes and rivers, or as isolated wetlands within upland areas. Palustrine wetlands (also known as "vegetated" wetlands) include natural and man-made ponds, marshes, wetland prairies, shrub swamps, and wooded wetlands.

Results

White River Watershed has a relatively high percentage of wetlands for its area compared with other watersheds in Wasco County. This is not surprising, considering the origins of the White River on the glaciated slopes of Mt. Hood. Wetlands cover 3000.02 acres in the White River Watershed, or 0.9% of the total area of the Watershed. However, nearly a quarter of these wetlands are comprised by Clear Lake, Rock Creek Reservoir, and Pine Hollow Reservoir. When these three man-made bodies of water are subtracted, including bordering palustrine wetlands, 2181.6 acres of wetland remain, covering 0.62% of the Watershed. This percentage is still higher than that of the other watersheds in Wasco County. Mosier watershed is next, with 0.5% of its acreage as wetlands when the man-made lakes bordering the Columbia River are subtracted. (Based on data from Mosier Watershed Assessment, Wasco County SWCD.)

Naturally occurring wetlands comprise 1626.9 acres of wetland in the Watershed, while 1373.1 are constructed. Of these constructed wetlands, 724.7 acres are man-made lakes and reservoirs, and 648.4 acres are man-made ponds and sediment basins.

Seasonal wetlands comprise 1595.2 acres of the Watershed, or 51% of total wetland acres, and 81% of wetlands with Clear Lake and the reservoirs subtracted. The total is likely higher, as 202.5 additional wetland acres have been constructed which are not included in the National Wetlands Inventory and have not been rated for seasonality. These recently constructed wetlands are located mainly in middle White and Threemile subwatersheds.

Most of the wetlands are found in three subwatersheds; upper White River subwatershed, middle White River subwatershed, and Threemile Creek subwatershed. Clear Lake, Rock Creek Reservoir and Pine Hollow Reservoir are located in these three subwatersheds and make up 23% of total wetland acres. Excluding these three large reservoirs, the same subwatersheds still make up 75% of wetland acres. These three subwatersheds also have the most total acres of natural wetlands (including natural lakes, riverine and palustrine wetlands), and the most acres of naturally occurring palustrine wetlands. In the upper White River subwatershed this relative abundance of water can be attributed to glacial melt and higher rainfall present in the mountains of the Cascade Crest ecoregion. In Threemile and Middle White River subwatersheds wetlands occur mainly in the flatter land of the Umatilla Plateau ecoregion, where water can collect.

Naturally occurring lakes in the Watershed total 107.4 acres. They are all located in the upper Watershed. Badger and Jean Lakes are at the headwaters of Badger Creek in the Badger Creek subwatershed, and comprise 49.5 acres. Upper White River subwatershed has several small natural lakes. Upper and Lower Twin Lakes, Boulder and Lower Boulder Lakes, and Frog, Green and Catalpa Lakes comprise 57.9 acres.

Wapinitia subwatershed ranks fourth for total wetland acres, while Badger Creek subwatershed ranks fourth for acres of natural wetlands and lakes. Tygh Creek subwatershed ranks fourth for acres of naturally occurring palustrine wetlands. Lower White River subwatershed has the most riverine wetlands, which occur in the floodplain of the White River. Nena Creek, Oak Springs and Winter Water subwatersheds have the least wetlands, both manmade and natural.

Confidence in the Accuracy of the Results

The purpose of this assessment was to inventory wetland locations, types, and approximate acreage in the Watershed using existing data. On-the-ground surveys will be necessary to verify the extent and condition of wetlands if the White River Watershed Council identifies wetland restoration as a priority.

Irrigation practices and infrastructure create many seasonal man-made wetlands that may or may not have been included in the National Wetlands Inventory data.

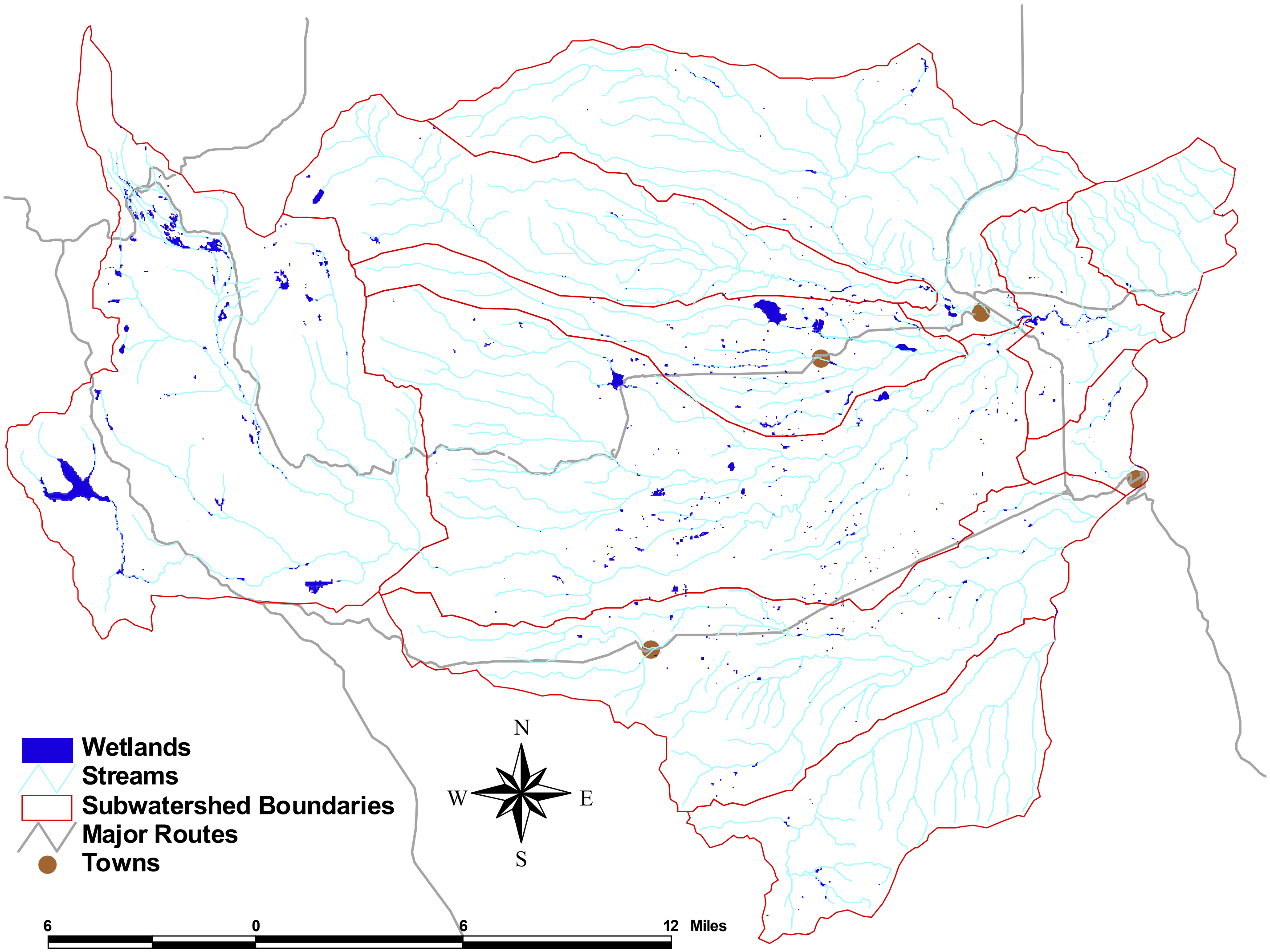
Table 8-3. Wetland acres by subwatershed (including Mount Hood National Forest). Sources: National Wetlands Inventory and USGS aerial photos from 2001.

		Total Wetland Acres	Lakes and Reservoirs		Riverine Wetlands	Palustrine Wetlands	
Subwatershed	*Total Acres*		*Natural*	*Constructed*		*Natural*	*Constructed*
Tygh	48,347.0	126.4			7.5	87.0	32.0
Badger	32,347.7	120.9	49.5		2.9	57.0	11.5
Threemile	22,719.2	556.9		210.2		178.7	167.9
Lower White	11,159.0	109.3			46.7	51.0	11.6
Middle White	75,233.4	528.2		64.8	3.9	167.4	292.0
Upper White	71,963.8	1357.7	57.9	449.6	26.0	773.7	50.4
Wapinitia	47,462.7	131.4			1.7	57.6	72.1
Nena	25,900.6	37.6			5.2	32.2	.3
Oak Springs	4,958.8	25.9				15.2	10.6
Winter Water	10,288.9	5.9				5.9	
Totals	350,381.1	3000.2	107.4	724.6	93.9	1425.7	648.4

Table 8-4. Wetland acres by subwatershed (Minus reservoirs and Clear Lake)

	Total	**Percent**
Upper White	847.8	(38.9%)
Middle White	441.0	(20.2%)
Threemile	335.4	(15.4%)
Wapinitia	131.4	(6.0%)
Tygh	126.4	(5.8%)
Badger	120.9	(5.5%)
Lower White	109.3	(5.0%)
Nena	37.6	(1.7%)
Oak Springs	25.9	(1.2%)
Winter Water	5.9	(.3%)
Total	2181.6	(100.0%)

Figure 8-5. Wetlands in the White River Watershed. Source: National Wetlands Inventory, US Fish and Wildlife Service – http://www.nwi.fws.gov.



Hydric Soils

All wetlands have hydric soils, but not all hydric soils are considered wetlands. The location of hydric soils gives an indication of where wetlands may have been present at some time in the past. They may, but do not necessarily, represent wetlands that have been lost as a result of impacts occurring from human settlement.

Hydric soils are formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions, i.e., a lack of oxygen. Soils that are sufficiently wet because of artificial measures are also included in the concept of hydric soils. Conversely, soils which have been drained (artificially modified) are also considered hydric if the soils, in an unaltered state, were hydric. (NRCS Field Office Technical Guide: Section II-iii-M – Hydric Soil Interpretations, 9/01). Hydric soils are mapped in NRCS Soil Surveys, but not in the Forest Service Soil Resource Inventory for Mt. Hood.

Hydric soils are identified in the field by the presence of certain observable features that may form in the absence of oxygen. Such features include oxidized root channels, mottles, (colored splotches and streaks), and gleying (grayish or blueish colors). These features indicate chemical differences in the soil due to varying oxygen concentrations. The particular features that are present depend upon which elements or compounds are found in the “parent material” (rock) and vegetation of the site, as well as duration of saturation, and other factors. (USDA NRCS, Field Indicators of Hydric Soils, Version 3.3, 1996, and Michigan Department of DEQ, www.michigan.gov/deq).

Soils considered hydric in the White River Watershed are identified in the NRCS Soil Survey for Wasco County, Oregon, 1982, and the Soil Survey of Warm Springs Indian Reservation, Oregon, 1993. The Forest Service has not mapped hydric soils separately from wetlands. Any changes to hydrology that have occurred since the most recent soil surveys were completed will not have been mapped.

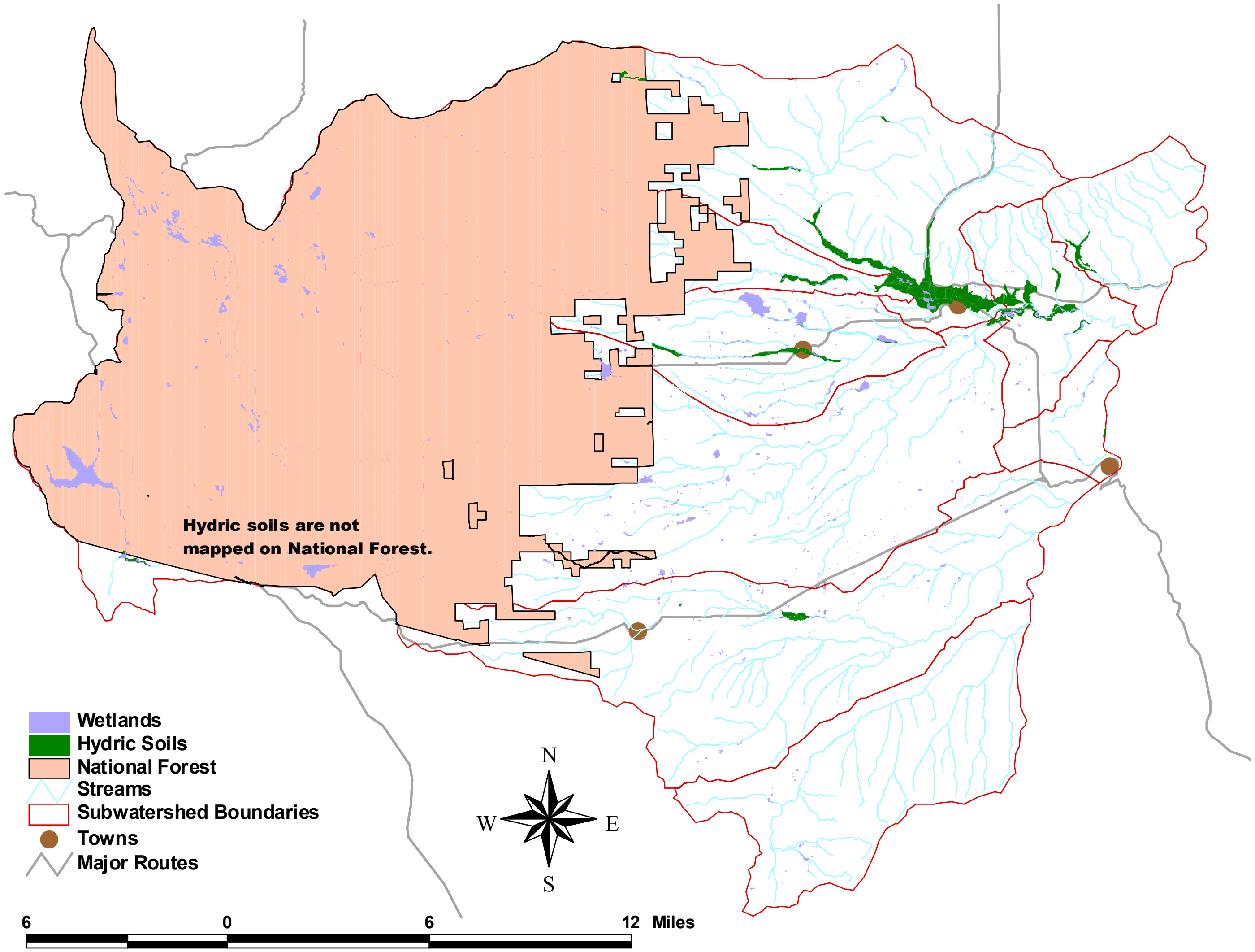
Figure 8-6 shows the location of hydric soils in the White River Watershed below the National Forest, in relation to wetlands. Hydric soils are identified at locations along several streams in the Watershed, particularly in Tygh Valley. In most cases these soils occur next to and overlapping with wetlands.

Hydric soils compose approximately 3,030 acres of the Watershed below the National Forest. Of these, 2,790 acres are not considered to be wetlands.

Wetlands compose approximately 1515 acres in the Watershed below the National Forest. Of these, only 240 acres are mapped as hydric soils. Of the remaining wetlands, approximately 850 acres are man-made. This leaves approximately 425 acres of natural wetlands which were not identified as hydric soils in the last soil survey. They may represent small areas that were included in the surrounding predominant soil types.

Analysis of figure 8-6 indicates that wetlands may once have been more extensive than they are now, most notably in and around Tygh Valley, including Tygh Creek, Badger Creek, lower Jordan Creek, lower White River above the falls, and Butler Canyon. Winter Water drainage, Threemile Creek, Wapinitia Creek and Clear Creek also have locations where hydric soils are mapped.

Figure 8-6. Hydric Soils in the White River Watershed. Sources: Soil Survey of Wasco County, Oregon, March 1982, and Soil Survey of Warm Springs Indian Reservation, Oregon, 1998, USDA NRCS.



9) Aquatic Habitat

9.1) Native Species

Redband Trout

Unless otherwise noted, the following information on fish species is taken from the Aquatic and Riparian Ecology Report in the White River Watershed Analysis (USFS, 1995). Redband trout, a cold-water salmonid, is a "scientifically un-described" subgroup of inland rainbow trout (Steve Pribyl, pers.comm., 9/20/2003). Redband trout are typically found in the high desert areas of the inland northwest. Rainbow trout and steelhead are considered to be different forms of the same species, *Oncorhynchus mykiss.* Steelhead are anadromous (ocean-going), while rainbow and redband trout are not.

Throughout the White River Watershed endemic redband trout is the primary management species. There are three major reasons for this: 1) White River Falls restricts the range of anadromous salmonids, including steelhead, to the lower two miles of White River. 2) The redband trout of the White River Watershed are genetically isolated from steelhead and other redband by the White River Falls, which prevents migration into the Watershed. 3) White River Watershed boasts 217 miles of spawning and rearing habitat suitable for redband trout.

Redband are present in most of the major creeks of the Watershed, as well as many of their smaller tributaries (Figure 9-1). Before reservoir construction and fish stocking, Clear and Badger Lakes may have had populations of endemic redband trout. There are no remaining populations of endemic redband in the lakes of the Watershed that have not been influenced by introduced trout. According to one source, non-native rainbow potentially hybridize with redband throughout much of the Watershed, threatening genetic integrity of redband populations (Currens, K. 1990). Upper Rock, Gate, Jordan and Threemile creeks have retained genetic integrity of endemic redband trout. Protection of the genetic integrity of endemic redband trout in these creeks is considered a high priority for fisheries management in the White River Watershed (USFS, 1995). Redband trout is listed by the State of Oregon and the United States Forest Service as a "Sensitive" species (Regional Forester's Sensitive Animal List, 11/2000).

Endemic redband are generally smaller at maturity than steelhead, and require finer gravel to spawn. Redband spawn in the spring, timing their reproduction to avoid annual peak flows and glacial sediment deposition by the White River. Redband first spawn at age 3 or 4. They continue to grow after they mature.

The most important spawning, rearing and over-wintering areas for redband trout occur in low gradient stream reaches of the Tygh Valley and the lower White River. Historically, Tygh Valley was the most productive area in the Watershed. Potential spawning, rearing and over-wintering occur throughout much of the Watershed where gradients are less than 8%. Limited spawning and rearing opportunities exist in the 8 to 16% gradient range. Reaches with gradients greater than 16% have very limited rearing potential.

Resident fish rear in the mainstem White River in August and September, despite high turbidity caused by glacial melt. Lower mainstem White River appears to be an important rearing area for native trout in the summer. Fish catches in upper White River suggest movement of trout from upper White River into clearer water tributaries, or into lower White River. Trout collected from the lower White River showed a substantial increase in growth which corresponded to their migration into the lower river from July to October.

Anadromous Salmonids

Anadromous (ocean-going) fish are restricted from most of the White River Watershed by White River Falls, located just two miles from the mouth of White River. However, the lower two miles of White River provides spawning and rearing habitat for summer steelhead (*Onchorhynchus mykiss*), and spring chinook (*Onchorhynchus tshawytscha).* Summer steelhead is listed under the Endangered Species Act as a threatened species in the Mid-Columbia Evolutionarily Significant Unit (ESU), which includes the Deschutes and White Rivers.

Other Native Fish

The Watershed is home to sculpin (Cottus sp.), mountain whitefish (*Prosopium williamsonii*), longnose dace (*Rhinichthys cataractae*)., and various species of minnow. Data available showed limited distribution of mountain whitefish and longnose dace. Mountain whitefish, a salmonid species, composed 1% of resident fish in a 1984 study, while longnose dace was shown inhabiting Pine Hollow Creek between the reservoir and confluence with White River (White River Falls Fish Passage Project, ODFW and USFS, 1984).

Native sculpins of various species are the second most numerous fishes in the White River Subbasin, second only to redband trout. Sculpin are eaten by redband trout and other trout species, as well as by Giant Salamander. Certain species of sculpin are found in cold, fast water habitats at elevations above 2500 feet, while others are found in streams and lakes. Sculpins spawn in coarse substrates and are sensitive to fine sediment levels. They may be good indicators of aquatic habitat conditions.

Pacific lamprey (*Lampetra tridentata*) are known to occupy the Lower Deschutes system and use the White River below White River Falls. Historically, White River Falls is a traditional Native American gathering area for lamprey. (Fara Currim, Off Reservation Habitat Biologist, Confederated Tribes of Warm Springs, pers. comm. 3/22/2004.) The species is culturally significant for Native Americans, including the Warm Springs Tribes.

Pacific lamprey is an anadromous species, and has declined precipitously in the upper Columbia and Snake basins in recent decades. Pacific lamprey use similar spawning gravel as anadromous salmonids. Lamprey juveniles may spend up to six or seven years in the soft substrate downstream from the nest. Rapid or prolonged water withdrawals that dry out edgewater habitat are the greatest risk to larval lamprey. Currently, Pacific lamprey is listed as a “State – Sensitive” species.

According to the Confederated Tribes of the Warm Springs, there is also a potential for Western Brook lamprey. There have not been sightings since the 1980's, but due to identification difficulties, the possibility cannot be discounted. (Fara Currim, Off Reservation Habitat Biologist, Confederated Tribes of Warm Springs, pers. comm. 3/22/2004). Western brook lamprey is relatively common in forested coastal basins in Oregon, but is thought to have largely disappeared from Columbia River basins above Bonneville Dam. Western brook lamprey lives, spawns, and dies in freshwater streams, and tends to prefer small tributaries, rather than main stem habitat. They are likely to have distinct population segments because they do not move much within or between basins. Western brook lamprey cannot withstand severe pollution or habitat changes, so are likely restricted to less disturbed sections of stream systems. http://www.onrc.org/info/lamprey/description.html)

Lamprey can often pass barriers that are impassable to other anadromous fish. (Draft Deschutes Sub basin Plan, 2004, Deschutes Coordinating Group.) There is a possibility that either or both species of lamprey are present above White River Falls, but this cannot be confirmed due to lack of survey data.

“Listed” Fish Species

State and federally listed fish species include:

Oncorhynchus mykiss ssp.	redband trout	State - Sensitive
Lampetra tridentata	Pacific lamprey	State - Sensitive
Oncorhynchus mykiss	summer steelhead	Federal – Threatened

(Sources; Oregon Natural Heritage Foundation, 2/2003, and Regional Forester’s Sensitive Animal List, 11/2000, USFS)

Amphibians

Several native amphibian species present in the Watershed rely upon aquatic habitat for breeding, food and cover. Six of these species are considered rare or at-risk, and are state and/or federally listed (Oregon Natural Heritage Foundation, 2/2003, and Regional Forester’s Sensitive Animal List, 11/2000, USFS).

Amphibians are aquatic as juveniles, then develop lungs and become terrestrial as adults, though they still may spend much time in or near water. Different species use differing types of aquatic habitat, from seasonal (vernal) pools, to streams and rivers (Atlas of Oregon Wildlife, Csuti, et. al., 1997). Habitat requirements for some amphibians are similar to that of salmonid species, including water clarity, cool temperatures, gravels free of silt for egg laying, instream and riparian cover, and food sources such as aquatic invertebrates. Based on existing sediment, water temperature and stream flow data, there is reason to suspect viability of amphibians and their habitats are potentially at risk (White River Watershed Analysis, USFS). Amphibian species in the Watershed that rely on aquatic habitat are listed below.

Require year-round aquatic habitat:

Northwestern salamander (*Ambystoma gracile*)
  Breed in ponds, lakes, and slow streams. Spend most of their life near water.
  Preyed on by introduced trout.

long-toed salamander (*Ambystoma macrodactylum*)
  Breed in ponds, lakes and streams. Live near water as adults.

Pacific giant salamander (*Dicamptodon tenebrosos*)
  Juveniles live in cold, clear water of streams, rivers, lakes, and ponds. Larval stage can last 2 years. Sensitive to siltation and removal of riparian vegetation.

Cope's giant salamander (*Dicamptodon copei*) - **State Sensitive**
  Require cold, clear streams or ponds with gravel bottoms and instream cover.
  Usually remain aquatic and do not develop lungs. Terrestrial adults are extremely rare.

rough-skinned newt (*Taricha granulosa*)
  Breed in ponds, lakes and streams. Live near water as adults.

tailed frog (*Ascaphus truei*) - **Federal Species of Concern**
  Restricted to cold, fast flowing permanent streams. Sediment and loss of riparian vegetation can render streams unsuitable. Impacts from timber harvest are thought to cause extinction of local populations and fragmentation of habitat .

red-legged frog (*Rana aurora*) – **Federal Species of Concern**
  Breed in ponds, marshes, streams. Live near water as adults.
  Favor dense ground cover and aquatic or overhanging vegetation for cover.
  Preyed upon heavily by bullfrogs .

Cascade frog (*Rana cascadae*) - **Federal Species of Concern**
  Closely associated with water, found in and near lakes, ponds, and small streams that run through meadows, above 2600'. Populations have declined dramatically since the 1970s.

Northern leopard frog (*Rana pipiens*) – **State Sensitive**
  Live in ponds, wet meadows, marshes, ditches and slow streams. Prefer quiet water.
  Hybernate underwater in cold weather. Uncommon in Oregon. Preyed upon by bullfrogs.

spotted frog (*Rana pretiosa*) - **State sensitive, Federal Candidate**
  Highly aquatic species, found near cool, permanent, slow-flowing streams. Once common, now found only at sites that do not have bullfrogs.

Require seasonal aquatic habitat:

Western toad, (*Bufo boreas*)
  Require seasonal or permanent wetlands for breeding. Found in many habitats, including deserts, chaparral, grasslands, woodlands, and forests, from sea level to above timberline.

Great Basin spadefoot toad, (*Scaphiopus intermontanus)*
  Use a variety of seasonal or permanent waters for breeding. Found from sagebrush deserts through pine-juniper woodlands into open conifer forests, usually near water.

Pacific chorus frog, (*Pseudarcis regilla)*
  Require seasonal or permanent water for breeding. Live in a variety of habitat types, from sagebrush deserts and grasslands, to forests, from sea level to 11,000 feet.

9.2) Introduced Species

Non-native species of fish have been stocked in both streams and lakes in the Watershed. Though Oregon Department of Fish and Wildlife no longer stocks streams within the White River subbasin, the high lakes are still stocked annually or biannually, and some stocked fish escape into streams. Non-native species present in the Watershed include coastal rainbow trout, brook trout, largemouth bass, smallmouth bass, bluegill, and brown bullhead. The latter four species are warm water fish, and are found mostly in farm ponds and Pine Hollow Reservoir. They are predaceous and competitive with other native fishes and amphibians, and have been illegally introduced. Prior to the fall of 2002 these species were also found in Rock Creek Reservoir. In October of 2002 the fish population of Rock Creek Reservoir was eliminated when the Reservoir was drained during a re-piping project. A relatively small population of largemouth bass has populated Threemile Creek from Pine Hollow Reservoir. Distribution of non-native fish species is shown in Figure 9-2.

The coastal rainbow and brook trout are more significant, as they inhabit the same type of habitat as the native redband trout and compete for resources. Coastal rainbow trout can hybridize with redband, threatening the genetic integrity of the redband populations. Introduced coastal rainbow and brook trout have escaped from stocking locations and reproduced throughout much of the Watershed.

In the uppermost reaches, brook trout appear to have a predaceous and competitive advantage over redband and coastal rainbow trout. This may be because brook trout are better adapted to low water temperatures. An alternative explanation is that brook trout are better adapted to the low velocity pools found in these upper reaches. (Schroeder, Kirk R.) In the lower subbasin, coastal rainbow and redband trout have an advantage because they are able to thrive in water temperatures that are too warm for brook trout.

All the introduced and exotic game fishes compete with native redband, sculpins, and amphibians in the upper Watershed, and on whitefish and long-nosed dace in the lower Watershed. The exotic game fishes also predate on young trout and amphibians.

Bullfrog, an exotic, is a serious pest species. Native to eastern North America, bullfrogs have become established throughout the western states. Adults are voracious carnivores, and are thought to be responsible for the decline of a number of native aquatic species in Oregon, including spotted frog, and native fish. Bullfrogs are present in the Watershed throughout the irrigation network, including Rock Creek Reservoir.

Table 9-1. Summary of trout stocking history in the White River Watershed from 1934-2002. Sources: White River Falls Fish Passage Project, 1985, ODFW 2003.

	Rainbow Trout	**Brook Trout**
Badger Creek	1934-1972	
Badger Lake	1939-2002	
Boulder Lake		1938-2002
Lower Boulder Lake		1953-2002
Catalpa Lake		1952-2002
Clear Creek	1938-1963	
Clear Lake	1953-2002	1934-1968
Frog Lake	1952-2002	1934-1956
Green Lake		1953-1955
Jean Lake		1938-2002
Pine Hollow Reservoir	1970-2002	
Rock Creek Reservoir	1953-2002	
Smock Prairie Reservoir	1976-2002	
Upper Twin Lakes		1939-2002
Lower Twin Lakes		1953-2002
Tygh Creek	1936-1938	
White River	1934-1984	

Figure 9-1. Redband trout distribution and relative importance of habitat based on channel habitat type. Sources: USFS 1995, and Oregon Watershed Assessment manual, p.IX-9

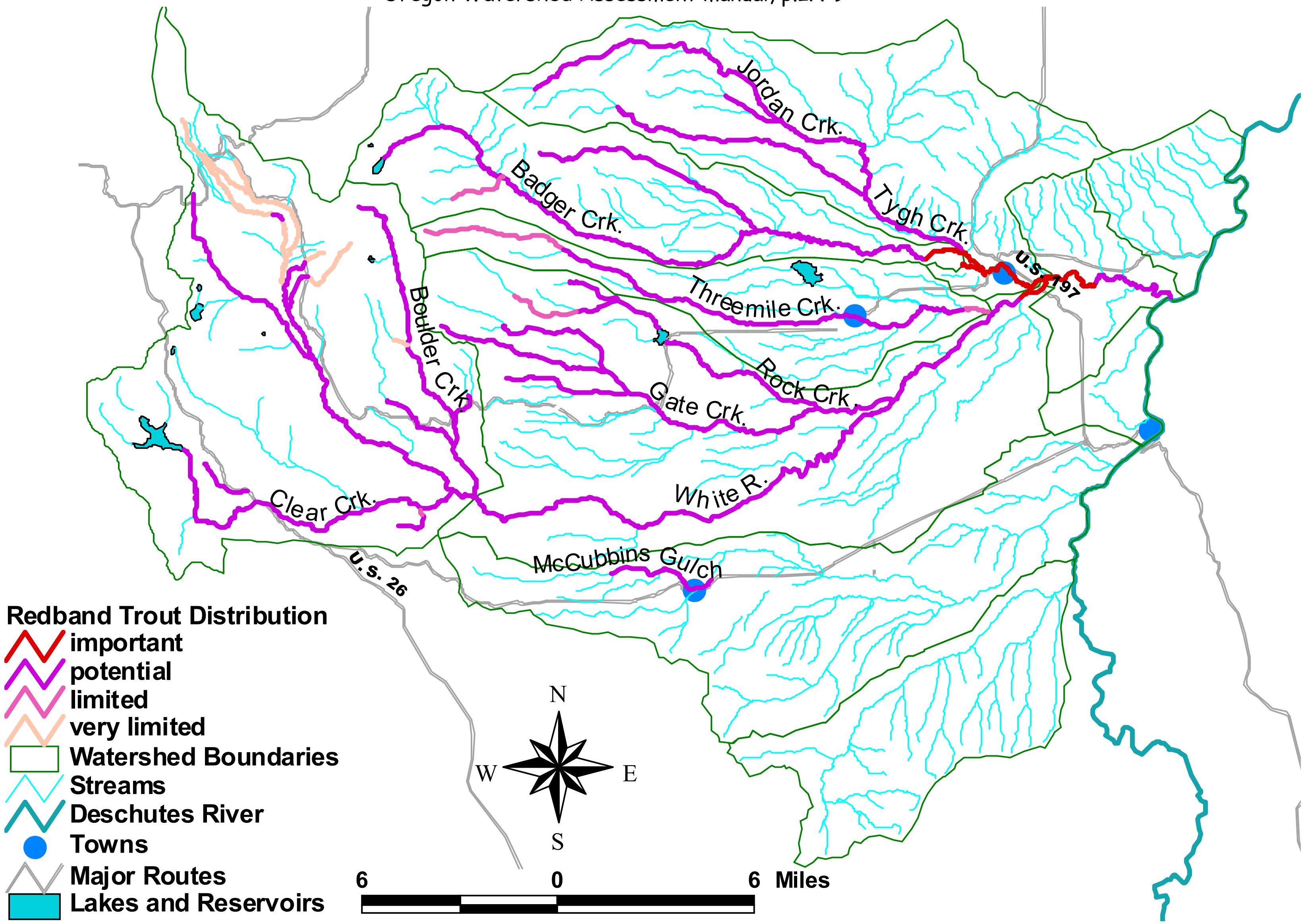
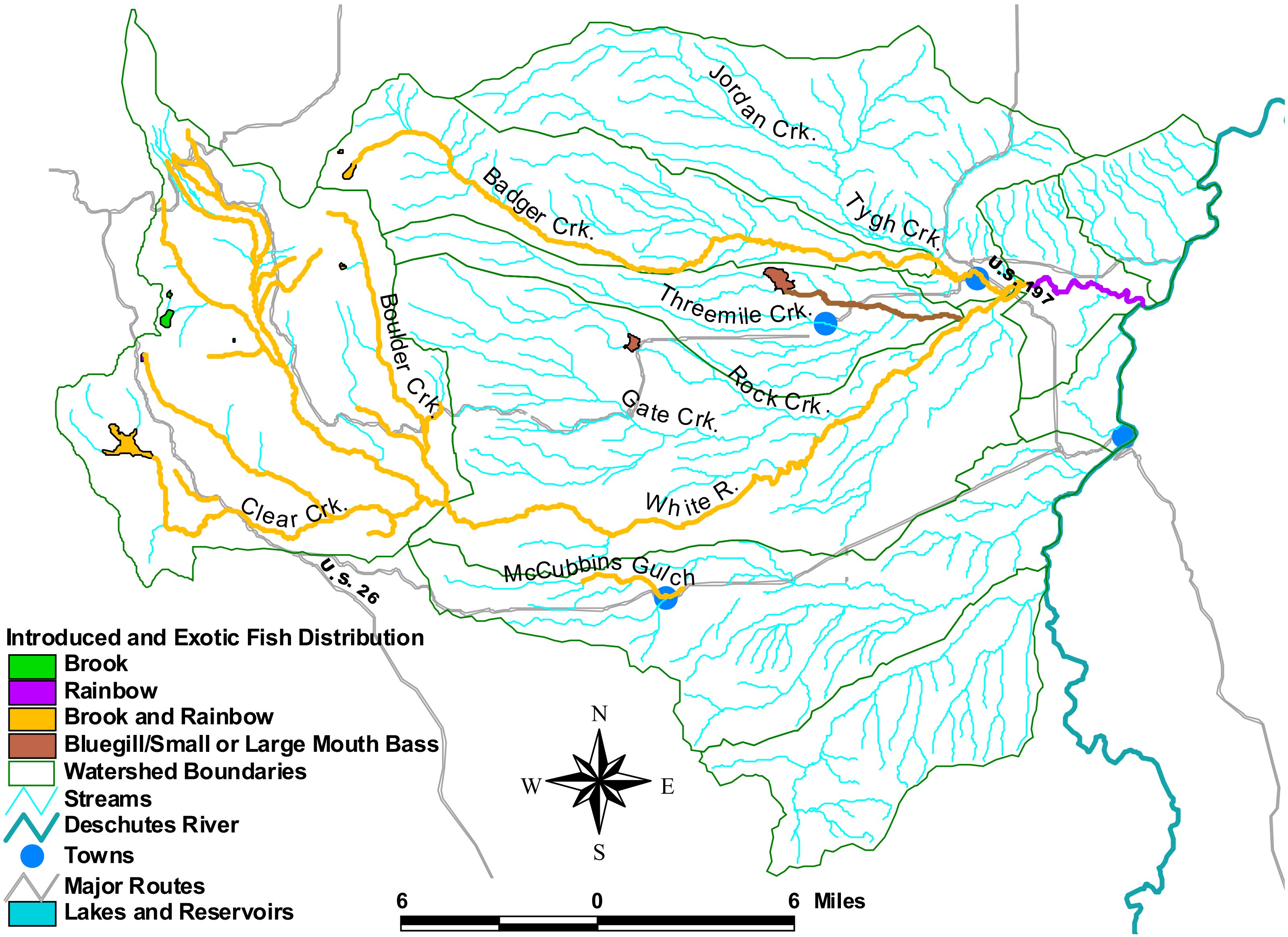


Figure 9-2. Introduced and exotic fish distribution Source: White River Watershed Analysis, USFS, 1995).



9.3) Habitat Conditions

Habitat Requirements

Salmonids, which include salmon, trout (including steelhead), and whitefish, are typically the fish species most sensitive to habitat conditions, and therefore serve as an indicator for habitat conditions within the watershed. Water temperature and water clarity are critical parameters for salmonids. Optimal riverine habitat is characterized by clear, cold water and relatively stable water flow, water temperature, and stream banks. Salmonids also require specific conditions for spawning, raising young, and over-wintering. These include clean gravels for spawning, instream "cover", and presence of both pools and riffles. A stream bed with a high percentage of clean gravels present with a low percentage of silt is required for spawning. Eggs are deposited in redds (nests) made in the gravel. Eggs depend on gravelly substrates and high dissolved oxygen levels during development, and are suffocated when sediment becomes too fine. Both juvenile and adult fish require instream "cover" for protection from predators. Cover can be provided by boulders, logs, aquatic plants, water depth, turbulence, and overhanging banks. Pools are of particular importance for providing cover and shelter from fast moving water. Adult redband trout often over-winter in deep pools with extensive cover in headwater streams.

The following indicators are used in evaluating fish habitat.

Canopy cover- Riparian conditions along the stream bank contribute to instream habitat in several respects. Vegetation provides shade, which cools and stabilizes water temperature. Larger vegetation provides the greatest benefits.

Bank stability and % erosion- Vegetation also holds the soil, preventing erosion and filtering nutrients and other contaminants which otherwise could wash into the stream. "Percent of eroded bank" is considered to be a predictor of salmonid productivity (www.wfs.sdstate.edu).

Large woody debris- Vegetation provides another benefit by contributing "large woody debris" (LWD) to the stream system. Large woody debris such as logs and large branches provide cover, and can create and maintain pools.

Pools and riffles- Both pools and riffles are essential habitat features. Streams with deep, low velocity pools containing extensive cover have the most stable trout populations. Redband trout generally select redd sites at the downstream edge of a pool or the head of a riffle, with moderate water velocities and a gravel substrate. For a given reach, a pool to riffle ratio of approximately 1:1 is considered ideal. A range within 40:60 to 60:40 is considered favorable for salmonids, though streams with 30:70 have been found to be productive as well. Higher pool to riffle ratios can also support a high biomass of salmonids. Streams that are high in riffles generally support a greater diversity of invertebrates (www.on.ec.gc.ca/wildlife/docs/addriparian.htm).

Stream Survey Data

Two major studies of stream habitat in the Watershed have been compiled since 1985, and are summarized below. Additional stream surveys have been completed by the U.S.Forest Service since.

White River Fish Passage Project, 1985

Methods

In the early 1980's the White River Fish Passage Project was funded by the Bonneville Power Administration to examine the feasibility of introducing anadromous steelhead into the Watershed to mitigate for population declines within the Columbia River Basin. For a variety of reasons the proposal was ultimately found to be unfeasible. Information gathered for the project continues to be a valuable record of stream habitat conditions.

In the summer of 1983 and winter of 1984 ODFW surveyed 94 kilometers of the lower reaches of seven tributaries below the boundary of the Mt. Hood National Forest. The surveys were conducted on state (ODFW) and private lands on Tygh, Jordan, Pen, Badger, Threemile, Rock, and Gate creeks. Though the research done for the Fish Passage Project was intended to evaluate habitat quality for anadromous fish, the findings have relevance for resident species as well. Data from these stream surveys is displayed in Table 9-2. The data will be 20 years old in 2004 and many changes will have occurred (such as from the Floods of 1996 and 1998). However, it does provide a picture of stream conditions at the time the data was gathered.

Table 9-2. Habitat conditions on seven streams in the White River Watershed in 1984. Source: White River Falls Fish Passage Project, Vol.III, Fisheries Report, 1985.

Stream Reach	Pool: Riffle Ratio	Gravel / Silt (substrate composition of riffles)	% Shade (average of transects)	Bank Stability (% of reach affected by Erosion)
Tygh I (km 0-8.9)	58:42	58% / 0%	28%	13% (fencing & rip rap noted)
Tygh II (km 8.9-15.0)	36:64	60% / 0%	31%	19% (some active bank erosion
Tygh III (km 15.0-24.1)	36:64	41% / 1%	60%	8% (erosion noted in several areas)
Jordan I (km 3.5-12.1)	40:60	22% / 0%	44%	13%
Jordan II (km 3.5-12.1)	44:56	17% / 6%	40%	13% (erosion and undercutting noted)
Pen I (km 0-3.2)	38:62	50% / 0%	48%	19%
Badger I (km 0-4.1)	50:50	37% / 0%	37%	5% (erosion due to grazing, undercutting)
Badger II (km 4.1-7.2)	30:70	20% / 0%	45%	5%
Badger III (km 7.2-9.7)	33:67	25% / 0%	40%	13% (heavy grazing responsible for erosion)
Threemile I (km 0-19.3)	51:49	38% / 13%	52%	19% (erosion noted due to grazing, fire)
Threemile II (km 19.3-20.5)	65:35	32.5% / 2.5%	63%	5% (some erosion from grazing)
Rock I (km 0-4.8)	48:52	15% / 20%	11%	7% (no evidence of grazing)
Rock II (km 4.8-10.5)	50:50	46% / 30%	41%	25% (erosion due to grazing noted)
Gate I (km 0-7.3)	51:49	31% / 3%	39%	23% (erosion and grazing evident)
Gate II (km 7.3-8.9)	65:35	65% / 0%	70%	40% (very little grazing noted)

Standards: Habitat Benchmarks, Kelly Moore, ODFW, 1997, unless otherwise noted

Pool:Riffle ratio- Optimal range is approximately 1:1, or within 40:60 to 60:40. (www.on.ec.gc.ca/wildfile/docs/addriparian.htm)

Gravels(0.25-14.9cm)	Desirable:	>35%	Silt/sand(<0.25cm)	Desirable:	<12%
	Acceptable:	15-35%		Acceptable:	12-25%
	Undesirable:	<15%		Undesirable:	>25%
Stream shading-	Desirable:	>50% (USFS > 80%)			
	Acceptable:	30-50%			
	Undesirable	<30%			

Bank Erosion- No standard exists, however, percent of eroded bank is considered to be a predictor of salmonid productivity (www.wfs.sdstate.edu).
USFS goal is < 20%.

Results

Pool:riffle ratio-

Nine out of the 15 reaches surveyed were within the range for optimal conditions. None were below a ratio of 30:70.

Gravels-

Nine reaches fell within the desirable range of >35%. The remaining 6 reaches were all within the acceptable range. None were in the undesirable range of <15%.

Silt/sand-

Thirteen reaches fell within the desirable range of <12% silt and sand. One reach was in the acceptable range, and one reach was in the undesirable range of >25% silt and sand.

Stream shading-

Four reaches were in the desirable range of over 50% stream shading. Nine reaches were in the acceptable range of 30% to 50% stream shading, and 2 reaches were in the undesirable range below 30%.

Bank stability and erosion-

Percent of reach affected by erosion ranged from 5% to 40%. The average per reach was 15%. Grazing was noted as a contributor to erosion in 7 out of 15 reaches.

Overall habitat quality was described as “fair to good”. Upper White River has poor pool and spawning habitat due to unstable stream banks directly below the glacier. The upper tributaries are fed by wetlands and have extensive off- channel rearing habitat with high levels of shade and large woody debris providing the principal structure for fish habitat. The middle White River has structure provided by boulders and bedrock, and flushes sediment to maintain quality habitat. In spite of summer water temperatures that are near the high end of salmonid preference, the lower mainstem is an important rearing area for native trout in the summer. The lower tributaries have greater fluctuations in water levels, less forested land, and higher water temperatures than the upper tributaries. The lower tributaries rely heavily on large woody debris for structure.

Limits for introduced anadromous fish would have been passage barriers, summer water conditions, and glacial silt. Of these, summer water conditions and passage barriers are considered to be concerns for endemic trout in the Watershed currently.

Aquatics Report, White River Watershed Analysis, 1995

Methods

A compilation of research on watershed conditions within the National Forest is presented in the White River Watershed Analysis by the U.S. Forest Service, 1995. Stream survey data included in the Analysis was collected by the Forest Service through 1994. The reaches surveyed do not match those in the Fish Passage Report, though there may be some overlap. The surveys are almost entirely on Forest Service land, but include some ODFW owned land on Badger and Little Badger creeks, and small amounts of private land on Gate Creek.

Stream survey data included in the Aquatics Report was collected with the aim of identifying the range of natural conditions throughout the Watershed. The Aquatics Report uses an alternate set of habitat benchmarks that are thought to better reflect the true range of natural conditions in the Watershed than LRMP and PIG standards. (See **Stream Surveys Since 1995** for definitions of LRMP and PIG standards.) Streams with less human impact such as those within the Badger Creek Wilderness Area were used to establish the benchmarks.

Results

Large woody debris (LWD)-

The estimated range of natural conditions for large woody debris (LWD) in the White River Watershed was found to be 38-103 pieces/mile. This estimate may be on the high side of historic levels in some areas, such as the Badger Wilderness, due to fire suppression. Stream survey data in the Cascade Crest and Transition (Grand Fir) zones of the Watershed show that large wood loadings are below the estimated range of natural conditions for

106 miles of streams, and above the range of natural conditions for 2 miles of stream. This data suggests riparian areas in the Crest and Transition zones should be managed to increase the potential for LWD in streams.

Probable factors contributing to the decline in LWD from historic levels include fire exclusion, grazing and logging. Riparian areas once dominated by stands of hardwoods such as cottonwoods are now composed of younger trees that are predominately conifers. Conifers are generally longer lived than cottonwoods and therefore require a longer time period before contributing LWD.

Primary pools-

Much of the data collected is aimed at assessing the quality and quantity of pool habitat. When stream flows are adequate fish can use small pools. However, deep high volume pools become critical refuges for fish when stream flows are too low, water temperatures are too high, or when sediment levels are beyond tolerance range. Pools equal to or greater than 3' in depth are defined as deep or "primary" pools.

Forty out of 68 reaches surveyed had no primary pools (Table 3 of Aquatics Report). The Aquatics Report states that "the White River Watershed has serious low flow and de-watering problems" below water diversions in several stream reaches that lack adequate numbers of primary pools. Frequency and size of pools are influenced by natural conditions such as stream width, gradient, substrate, and geomorphology. Large woody debris also contribute to forming pools when debris jams occur during floods. However, the most practical means of maintaining pool volume is to avoid diverting water from reaches lacking primary pools during periods of low stream flow. (Streams with reaches lacking primary pools included Barlow, Bonney, Forest, Clear, Frog, Gate, and SF Gate, Souva, Threemile, Green Lake, NF Iron, Jordan and Pup creeks.)

Sediment-

A "biologically significant" standard for sediments is recommended. According to Bjornn and Reiser (1991), fish embryo survival is affected by particles as large as 6mm (Aquatics Report p.18). Several sites on 8 creeks met the sediment recommendation of <20% surface fines <1mm, but exceeded the biologically significant recommendation of <20% surface fines <6mm. Fourteen out of 35 reaches sampled did not meet the <20% below 1mm recommendation. Twenty three out of 35 reaches failed to meet the biologically significant recommendation of <20% surface fines < 6mm. This data suggests that sediment levels may be a concern inside the National Forest boundary in the riparian areas surveyed. Several of the streams surveyed were within the area affected by the Rocky Burn of 1973. (Streams surveyed included Deep, Rock, NF Rock, Little Badger, Gate, Souva, Boulder, and Forest creeks.)

Canopy cover-

The Aquatics Report recommends a new standard for stream shading to "maintain or promote >70% canopy closure in mountain hemlock/silver fir and Douglas fir/grand fir dominated stands, and >50% canopy closure in pine-oak dominated stands, or range of natural conditions." (Note: This recommendation is higher than the criteria used to evaluate riparian vegetation in chapter 6 of this document.) Stream survey data from 1989-92 covering 41 stream reaches within the Mt. Hood National Forest found 22 to be below 50% canopy cover. This data suggests that riparian vegetation was below potential at the time the reaches were surveyed. Lack of adequate canopy would also support the finding that LWD levels are low.

Streambank stability / % eroded banks-

With the exception of the upper White River floodplain, >95% stability was found to be within the range of natural conditions for stream banks in the White River Watershed. Using the proposed recommendation for streambank stability of >95%, 29 out of 33 reaches sampled were found to be meeting this recommendation, and 4 reaches were found to be below the recommendation. (Streams surveyed included Bonney, Gate, Jordan, NF Iron, Pup, SF Gate, SF Gate tributary, Souva, and Green Lake creeks.)

Changes to range management on National Forest lands are recommended in the USFS White River Watershed Analysis (1995). According to the report, "Current grazing management is not protecting streambanks and lakeshores from excessive erosion and damage to vegetation in sensitive areas." Rock, Gate, South Fork Gate, and Souva creeks in the Rocky Burn, and the riparian area at Camas Prairie are the most critical areas identified for changes in range management on the National Forest. Cattle exclosure fences are in place in several locations on Rock Creek (RM 9.2-10, 8.8-9.0, and 13.5-14.0), and on Threemile Creek (RM 12.25-13.7). Installation of cattle barriers, cattle exclosures, and off-stream water sources are planned or in progress for several reaches on Threemile, Gate, Souva, and Forest creeks.

Stream Surveys Since 1995

Since the White River Watershed Analysis was completed in 1995, streams continue to be surveyed every year by the Forest Service. Portions of the following streams have been surveyed since (and including) 1995. Approximately 4 miles of 35.4 stream miles surveyed are on private land.

1995	Rock, NF Rock, and Swamp creeks
1997	Frog and Tygh creeks
2002	Boulder creek
2003-2004	Camas, Pine, Gumjuwas, and Threemile creeks.

Methods

The surveys refer to LRMP and PIG standards in assessing stream habitat conditions. Mt. Hood National Forest's Land and Resource Management Plan (also known as the Forest Plan) contains management standards and guidelines for the Mt. Hood National Forest, including guidelines for assessing stream habitat. These are known as LRMP standards. The Columbia River Policy Implementation Guide (PIG, 1991) is an interagency agreement establishing parameters for anadromous fish habitat and water quality. These are known as PIG standards.

Reports for each stream survey are summarized below. Reports for streams surveyed in 2003 and 2004 will be available in the future.

Results

Rock Creek, August 1995- 2.2 stream miles

Above Rock Creek Reservoir 2.2 stream miles were surveyed. Redband trout were present in reaches 1 through 6, none more than 4 inches in length.

The stream did not meet LRMP Standards for frequency of woody debris in any reaches. PIG standards were met in 2 reaches where restoration projects have occurred.

LRMP standards were not met for pool frequency. PIG standards were met in 2 out of 6 reaches.

Banks were highly susceptible to erosion and downcutting. Heavy loads of fine sediment were present in reaches 1, 2 and 3. Very little tree cover exists throughout the area of the Rocky Burn at RM 6.1.

The report recommends that cattle be excluded until vegetation recovers, or perhaps permanently. Riparian re-vegetation has occurred on Rock Creek since 1986, and should continue.

North Fork Rock Creek, October 1995- 2.1 stream miles

Northwest of the Reservoir, 2.1 stream miles were surveyed on North Fork Rock Creek, a tributary of Rock Creek. Approximately 83% of the miles surveyed were on National Forest, and the remaining land (0.35 miles) is privately owned. Redband trout were observed up to RM 1.3, and may be present farther upstream.

Frequency of woody debris is low. LRMP and PIG standards were not met in any reaches. The entire basin has been logged, with only snags left in the area.

Pools were below LRMP standards in all reaches, with no primary pools.

Past grazing has caused bank erosion and is a source of sedimentation. Undercut banks are also present.

A culvert at RM1.0 is a low flow barrier, possibly a total barrier.

The report recommends continuation of revegetation. Cattle exclosure fences are in place. Consider replacement of culvert to improve fish passage.

Swamp Creek, August 1995 2.6 stream miles

Swamp Creek is a tributary to Boulder Creek in the upper White River subwatershed. The lower 1.1 miles flow through private land, and the remainder is on National Forest.

Frequency of woody debris did not meet LRMP or PIG standards. Frequency of primary pools was below PIG standards by 40% in reach 1 and 60% in reach 2.

Timber had been clearcut on both sides of channel in upper slopes of both reaches, with no regeneration present. Sediment associated with areas of erosion, bank failure, and runoff from uplands was present. Road runoff trenches emptying into the stream were observed near culverts at RM .5 and RM 1.25. A wooden bridge at RM .95 created ideal erosion and runoff conditions from connecting roads above. The most heavily impacted areas are on private land. Although Swamp Creek has no fish, it is a tributary to Boulder Creek. The high sediment load in Swamp Creek could have adverse affects in Boulder Creek.

The Forest Service report recommends bank revegetation and improvement of bank stability along swamp creek, which will help to decrease runoff from uplands and roads. Bank revegetation will also help with stream shading.

Amphibian surveys are also recommended to identify species of salamanders and frogs which were observed.

Frog Creek, June 1997- 8.1 stream miles

Between Frog Lake and Clear Creek, 8.1 stream miles were surveyed.

LRMP standards for frequency of woody debris were not met in any reaches. PIG standards were met in all reaches.

Overall pool numbers were low, and only 2 primary pools were identified. LRMP and PIG standards for pool frequency were not met in any reach.

Clearcuts and regeneration stands are prevalent, with an estimated 70% of Frog Creek basin having been harvested for timber. Frog Creek basin is highly impacted by logging roads.

Bank stability is not a major problem. Cattle appear to be causing some stream bank erosion in one location.

The report recommends an evaluation of grazing activities and their possible impact to streambanks, and an amphibian survey to determine distribution of western toad, a “state sensitive” species which was observed during the survey.

Tygh Creek, October 1997- 9 stream miles

Approximately 28% of the 9 miles surveyed was on private land (2.5 miles). The upper 5 miles are inside the Badger Creek Wilderness. The survey begins 1.6 miles below the Forest Service boundary.

Total in-channel woody debris was low. The LRMP frequency standard was not met in any reach. PIG standards were met only in the last reach, in the Badger Creek Wilderness. Wood numbers also fell well below the recommendations listed in the White River Watershed Analysis. Most of the wood in the stream is in the small size category. However, recruitment potential of woody debris was high, especially in Badger Creek Wilderness.

Primary pools were not common although a few good deep pools were identified. Overall, pool area was lower than riffle area. LRMP and PIG pool frequency standards were not met in any reach.

Bank erosion was significant on the private land, due to grazing and timber harvest. Directly below the wilderness area on Forest Service land, cut banks were common. Forest Service Road 2700-120 crosses the stream at RM13.8 with no bridge or culvert. Extensive erosion is occurring on both banks.

Three barriers to fish passage included a small falls at RM11.3, a diversion structure at RM 15.2, and dry channel at RM 19.2, close to the headwaters.

The Forest Service report recommends that the diversion dam at RM 15.2 be evaluated by ODFW for fish passage improvements. Restricting access and replanting vegetation was recommended for the road crossing at RM 13.8. The majority of issues regarding management on this stream were present on the privately owned land.

Boulder Creek, August 2002- 11.4 stream miles

Boulder Creek was surveyed from the mouth to the headwaters at RM 11.4. The creek did not meet the LRMP standards for woody debris density, but did meet the PIG standards for all but one reach.

Boulder Creek did not meet LRMP pool frequency standards in any reach, but did meet PIG pool standards for 1 out of 5 reaches.

Bank instability was low for all reaches of Boulder Creek, with only 1% of the banks identified as unstable.

Two permanent barriers to fish passage were identified, both waterfalls, at RM 10.8. Potential low flow barriers due to dry channel were identified. The Lost & Boulder Diversion Dam is also a barrier to fish migration, and reduced stream flows diminished available habitat in the lower 3.3 miles at the time of the survey. In the fall of 2002, piping of Lost & Boulder Ditch allowed .40cfs of water to be converted to an in-stream water right, mitigating the low flow situation in the lower 3.3 miles of Boulder Creek.

Barriers to Migration

Several types of barriers can limit migration of fish. Upstream passage barriers include natural features such as waterfalls, chutes, and boulders, and man-made features such as dams and culverts. Low water levels can also be a barrier to migration. These same features may also limit downstream migration, but if water levels are high enough fish can be washed over the top of the barrier. Barriers to fish migration can disrupt dispersal and gene flow of redband trout and other natives throughout their natural range.

Culverts (on National Forest)-

Particular road culverts have been identified on Forest Service lands which are too steep, too long, too small, too high, or lacking a large enough jumping pool to allow fish to migrate upstream. During the summer of 1999 The Barlow Ranger District conducted a survey of road crossings on National Forest throughout the District. The White River Watershed is the largest of three watersheds within the Barlow District. A total of 27 crossings were surveyed during a 2 week period in the White River Watershed during July and August of 1999. Twelve (44%) were found to be passable, 2 (7%) were questionable, and 13 (49%) were considered passage barriers. (Fish Passage Inventory of Road Crossings, Barlow Ranger District, Mt. Hood National Forest, 2001.) Salamander migration may also be limited by the same barriers. (Additional fish passage barriers are noted in Chpt.7 and in the Aquatics Report of the White River Watershed Analysis, USFS, 1995.)

Of the passable crossings, 5 were bridges and 7 were either open bottom culverts or pipe arches. All of the passable culverts were at least 10' in diameter, were set at or near stream grade, and were not perched. In most cases, the reason a culvert was rated impassable was due to high gradient and/or excessive perch heights. Fish passage evaluation criteria used by Barlow Ranger District is based on swimming and overall passage capabilities of the weakest known salmonid, juvenile coho salmon. Other fish species or life stages may be able to ascend through some culverts rated impassable, depending on water level.

The same barriers that limit fish migration can also limit downstream movement of woody debris. Some situations may allow fish to pass but block large wood. Locations of barriers to large wood migration are listed in the White River Watershed Analysis (Table 19 of the Aquatics Report), and in the White River Fish Passage Report (Appendix B. p 20-22).

The Forest Service has a long-term plan to replace culverts that are barriers to upstream migration of fish and salamanders, or to downstream migration of woody debris. Due to the costs involved, one or two highest priority culverts may be replaced each year in the Barlow District.

Table 9-3: Road crossings surveyed for fish passage capability in the White River Watershed on National Forest. Source: Barlow Ranger District, USFS, 2001.

Stream	Road #	Crossing Type	Passage Evaluation	Comments
Little Badger	2710000	C	Questionable	
SF Gate	4830000	C	Questionable	
Badger	2710000	B	Passable	
Boulder	3530000	B	Passable	
Boulder	4800000	PA	Passable	
Cedar	3530000	B	Passable	
Cedar	4800000	OA	Passable	
Clear	2130000	C	Passable	Large culvert
Clear	2600000	B	Passable	
Clear	4200000	OA	Passable	
Clear	4200221	B	Passable	
Frog	2130000	C	Passable	Large culvert
Gate	4800000	C	Passable	Large culvert
Tygh	2700000	OA	Passable	
Cedar	4800260	C	Impassable	
Frog	4300000	C	Impassable	

Table 8-3: Continued .

Stream	Road #	Crossing Type	Passage Evaluation	Comments
Gate	4811000	C	Impassable	
Gate	4813000	C	Impassable	
Gate	4820000	C	Impassable	
Jordan	2700000	C	Impassable	
NF Rock	4810140	C	Impassable	
Rock	4810000	C	Impassable	
Rock	4811000	C	Impassable	
Souva	4811000	C	Impassable	
Threemile	4811000	C	Impassable	
Threemile	4811018	C	Impassable	
Tygh	2700120	C	Impassable	

Crossing Type codes: B - bridge; C - culvert; OA – open bottom arch; PA – pipe arch

Culverts (off Forest)-

A study entitled *Culvert Inventory and Assessment for County-Owned Roads: Deschutes, John Day and Umatilla River Basins* was conducted by ODFW and Oregon Department of Transportation (ODOT) and published in February, 1999. The study methodology includes culverts on streams containing resident as well as anadromous fish. However, data for the White River Watershed was not included in the report for reasons unknown.

In the White River Falls Fish Passage Report of 1984 no culverts are identified as potential migration barriers below the National Forest (Appendix B. p. 20-22).

An on-line listing of migration barriers is noted at the Streamnet website, but was not available to be downloaded. This may be a future source of information. (www.streamnet.gov.)

Dams-

During irrigation season (April-October) impassable irrigation diversion dams prevent upstream migration of redband trout in lower Tygh, Badger and White River downstream of the National Forest boundary. Within the National Forest, irrigation dams may be migration barriers at the ditches originating on upper Tygh, Badger, Threemile, upper Gate, Boulder, Forest, Frog and Clear creeks. Clear Lake and Rock Creek reservoirs have outlet dams that are barriers to upstream migration

Fish screens-

Fish screens are used to prevent fish from entering ditches, and to keep introduced and exotic fish species in lakes and reservoirs from escaping further into the Watershed. The White River Fish Passage Project identified 18 locations on ditches in the Watershed that needed screens (Appendix B. p.26). As of 1995 Clear, Badger, and Jean Lakes, Pine Hollow Reservoir and several ditches had been identified by USFS as priorities for screening to contain exotic species. Ditches identified for screening included Clear Lake, Highland, Frog, Threemile, Lost/Boulder, and Gate. McCorkle Ditch in the Tygh Creek subwatershed has a fish screen installed at the boundary of the Badger Creek Wilderness Area in the National Forest.

Because anadromous fish bearing streams receive highest priority for regional restoration efforts, little progress has been made to date with installing screens in White River Watershed. Opportunities to install screens occur when changes in water right point-of-use or point-of-diversion occur. Recommendations can then be made by ODFW to install fish screens along with the changes to water diversions. Currently Juniper Flat Improvement Company is in the process of making some changes to water diversions (Steve Pribyl, pers. comm. 6/9/03).

Water Levels

Irrigation ditches withdraw water from most perennial streams in the upper Watershed, and all the perennial streams in the lower Watershed. Several streams that were historically perennial (Threemile, Rock, Gate, Lost, and Frog creeks) are de-watered for miles, both inside and outside the National Forest. During summer lowflows, especially during drought years, irrigation withdrawals and lack of riparian canopy cover contribute to elevated water temperatures.

Low stream flows and elevated temperatures can result in significant loss of rearing habitat for "young of the year" fish. These effects are most critical in the area of the Rocky Burn in upper Rock and Gate creeks, where 2 of 3 remaining populations of endemic redband trout reside.

Confidence in the Accuracy of the Results

Stream habitat conditions can change considerably over time, due to events such as floods, growth or removal of vegetation, land use practices, and restoration projects. Stream survey data for the Watershed below the National Forest contained in the White River Fish Passage Project will be 20 years old in 2004. Ideally, stream surveys below the National Forest should be updated to reflect current conditions. (Stream surveys completed by the Forest Service from 1995 through 2002 include approximately 4 stream miles of private land on Tygh Creek, North Fork Rock Creek, and Swamp Creek. Surveys before 1995 are primarily on National Forest, but include some State owned land on Badger and Little Badger creeks, and small amounts of private land on Gate Creek.)

Survey data for the upper Watershed on National Forest lands is more recent. Survey data summarized in the White River Watershed Analysis is from surveys completed in 1993-1994. Additional stream surveys have been completed every year since.

Key Issues

Several key issues for aquatic habitat in the Watershed were identified by USFS in the White River Watershed Analysis. Protecting the genetic integrity of endemic redband trout is defined by USFS as their highest management priority. Threats to endemic trout include competition from non-native trout, migration barriers, riparian conditions within the area of the Rocky Burn, and low summer water levels. Of all of these, low summer water levels is the primary threat. Without adequate water levels other measures to improve habitat conditions are of less benefit.

The following measures can be taken to protect native trout populations:

.-Install fish screens to exclude non-native fish from streams with endemic redband.

-Correct upstream migration barriers. Modify culverts and diversion dams where necessary.

-Modify culverts that impede downstream movement of large woody debris.

-Continue to restore riparian vegetation where affected by timber harvest, grazing, and recreation. Prevent similar damage from occurring in new locations.

-Look for opportunities to restore minimum base flows to streams (such as the Lost & Boulder piping project described in Sections 3.2 and 4.1). Demands for irrigation water will likely continue to increase. Maintaining summer base flows is a challenge that will require careful planning and monitoring.

Qualitative Habitat Assessment(QHA)

The Deschutes Subbasin Planning Group has been using a Qualitative Habitat Assessment model (QHA) to rate aquatic habitat conditions in the watersheds of the Deschutes Subbasin. QHA is a modeling program developed by Mobrand Biometrics. The QHA model "relies on *expert knowledge* of natural resource professionals with local expertise to describe physical conditions in a target stream, and to create an hypothesis about how the habitat would be used by a given fish species" (QHA User Guide Version 1.1., Mobrand Biometrics. 2003). Eleven attributes are rated for each stream reach within a watershed, for current conditions, and for reference conditions existing before European settlement. These attributes are:

Riparian condition
Channel structure
Habitat diversity
Fine sediment
High flow
Low flow
Oxygen
Low winter temperature
High summer temperature
Pollutants
Artificial obstructions

Comparing current conditions to reference conditions, each stream reach within the watershed is given an overall ranking of its priority for habitat protection (higher quality habitat) and its priority for habitat restoration (lower quality habitat).

On October 15th and 16th of 2003 a working group met to "build" a model of redband trout habitat in the White River Watershed. Results from the QHA modeling are included in the Appendices of this assessment. The top 10 reaches found to be in need of restoration are listed below. Note that this list corresponds fairly closely to the reaches shown in Figure 8-3 in Chapter 8 of this assessment.

Restoration Habitat Ranking (in need of restoration), Top 10

	Reach Name	*Location*
1.	Threemile Creek-1	Mouth at White River to Diversion Dam.
2.	Rock Creek-2	Confluence with Gate Creek to Rock Creek Reservoir Dam.
3.	Gate Creek -1	Mouth at Rock Creek to Diversion Dam.
4.	Rock Creek-1	Mouth at White River to Gate Creek.
5.	Tygh Creek-2	Badger Creek to Jordan Creek.
6.	Tygh Creek-1	Mouth at White River to Badger Creek.
7.	Gate Creek-3	Diversion Dam to 3100 ft. level.
8.	Jordan Creek-3	Falls #51404 to Pen Creek.
9.	Badger Creek-1	Mouth at Tygh Creek to Little Badger Creek.
10.	Rock Creek-5	Top of reservoir to 3200 ft. level.

10) Upland Habitat

Sources used to describe upland habitat, plant communities and wildlife in the White River Watershed are the White River Watershed Analysis (USFS 1995) and Wildlife-Habitat Relationships in Oregon and Washington, Johnson and O'Neil et. al, 2001, unless otherwise noted.

Land uses on uplands in the Watershed are also described in Section 2.4. An overview of farming, grazing, timber management and recreation in the Watershed is given in this Section.

10.1) Plant Communities

White River Watershed has a wide range of vegetation communities within a short distance. The Watershed changes from shrub-steppe/grassland plant communities to alpine plant communities within approximately 17 miles. Cottonwood gallery riparian forest, juniper woodland, and sagebrush/grassland plant communities are found primarily on private lands in the lower half of the Watershed. The remaining forested ecosystem types occur on public lands, mainly on National Forest.

Vegetation in the Watershed has been significantly altered from pre-1855 conditions by grazing, farming, timber management and fire suppression. Species composition and distribution of plant species have been altered in all ecoregions of the Watershed. In turn, changes to vegetation communities and landscape patterns have changed how wildlife species use the landscape.

While human settlement has caused the decline of native ecosystems, it has created habitat as well. Buildings and farm structures provide nest sites for certain birds, roosts for bats, and shelter for other small animals. Shelterbelts, windbreaks and hedgerows provide tree habitat for migratory birds in a landscape which is often lacking in tree canopy. Some species, such as sandhill cranes and western meadowlarks, breed in open fields which are structurally similar to native grassland ecosystems.

Changes to native grasslands and sage/steppe

Native bunchgrasses, including Idaho fescue and bluebunch wheatgrass, and native perennial forbs are major components of biscuit scablands, grasslands, and shrub-steppe plant communities in the White River Watershed. However, areas that were historically dominated by native bunchgrasses have been converted to agricultural use, or altered by over-grazing of livestock to become annual grasslands. Cheatgrass in particular, introduced in the late 1800s, has replaced native bunchgrasses and changed the composition of shrub-steppe communities throughout the West. Conversion of sage/steppe and native grasslands to annual grasslands has resulted in lower diversity of species. Loss of the shrub layer eliminates habitat for shrub nesting birds and affects species that depend on sagebrush for forage. Conversion of native forbs and perennial bunchgrasses to exotic annuals results in a less stable food base for small herbivores and loss of cover for some ground nesting birds and small mammals.

Cheatgrass, a winter annual, has a competitive advantage over native bunchgrasses. Winter annuals germinate in the fall of the previous year, begin growth in early spring, and use the available moisture in the upper soil layer before native species begin growth. Annual grasses are valued by farmers and wildlife managers for early spring forage. However, winter annuals are more shallow rooted, die early in the season, and therefore are not as effective for erosion control or forage. They are also less nutritious and less palatable than native bunchgrasses.

Other common grasses that are competitive with native bunchgrasses include orchard grass (Dactylis glomerata), timothy (Phleum pratense), intermediate wheat (Agropyrum intermedium), bulbous bluegrass (Poa bulbosa), and voodoo grass (Ventanata dubia). Orchard grass, timothy and intermediate wheat have long been used for range improvement, wildlife forage, and erosion control. These species generally do not spread far, but occupy habitat that natives would otherwise.

Several meadows in the Watershed are still predominately native grasses and forbs, though no grassy areas are entirely free of introduced species (White River Watershed Analysis Botany Report, USFS).

Rangeland

A survey of existing rangeland conditions and grazing practices in the White River Watershed has not been undertaken. This represents a data gap.

Potential range conditions

The following information on potential range conditions is taken from the USDA SCS Soil Survey of Wasco County, Oregon, 1982, and from the NRCS Range Site Descriptions handbook, 1989.

Healthy range conditions are indicated by vigorous stands of perennial bunchgrasses. Annual grasses predominate when over-grazing has occurred, and indicate a degraded condition. Ideally rangeland is managed to reduce impacts to soil, water and plant communities. Grazing is timed by season and duration to allow perennial grasses and forbs a long enough growing season to maintain plant vigor. A resting year is generally necessary at intervals. The interval depends on site conditions.

Soils that have the capacity to produce the same kinds, amounts, and proportions of range plants are grouped into range sites. The "climax" plant community within a range site is the plant community that will exist without "abnormal" disturbance. Historically, natural disturbances, such as fires, floods, windstorms, and insect epidemics are part of the "regime" that plant communities develop within. Plant communities will usually recover from natural disturbances. Examples of "abnormal disturbance" include overuse by livestock, excessive burning, erosion, or plowing. Abnormal disturbance alters the climax plant community, and if intense enough, the plant community may be destroyed.

Each range site supports distinct potential plant communities. Range sites are determined largely by soil types, which describe the capacity of the soil to supply moisture and nutrients for plant growth. Several similar soil types may be associated with a particular range site.

Each soil type is rated for potential productivity; the amount of vegetation in pounds per acre that can be expected from well-managed range that is capable of supporting the climax plant community. Potential productivity for "favorable", "normal", and "unfavorable" years is shown in the Wasco County Soil Survey. The proportion of each plant species is listed as a percentage, in dry weight, of the total annual production of herbaceous and woody pants. The amount that can be used as forage depends on the kinds of grazing animals, and on the season when the forage is grazed.

Range managers can determine which soil types occur on their rangeland by consulting the USDA Soil Survey for Wasco County. The soil survey shows soil types in detail throughout the county, and describes their potential uses and limitations. Once soil types and potential plant communities for a given property are identified, the range managers can compare the potential plant community to the existing conditions, and plan accordingly to improve conditions if necessary.

More than 23 soil types are found in the White River Watershed. Of these, a few of the most prevalent are described below in the context of their ecological range site, as examples.

Rolling hills (renamed as Loamy, 12-14" precipitation**)-**

Bakeoven-Condon 3D soils are included in this range site. These soils occur on the slopes below Tygh Ridge. They are well drained silt loams and very fine sandy loams that formed as loess and volcanic ash on broad ridgetops and rolling uplands. They can be steep, or nearly level. Average annual precipitation is 10-14 inches. Permeability is moderate to moderately rapid, and water supplying capacity is 6 to 12 inches. Forage grasses begin to grow about March 20.

Where this site is in poor condition, big sagebrush and an understory of Sandberg bluegrass increase in proportion in the stand. Bluebunch wheatgrass and Idaho fescue will have been nearly eliminated. If deterioration is severe, cheatgrass, squirreltail (a native grass), and annual weeds invade and dominate.

Bakeoven-Condon 3D:	Productivity: 800lbs/acre; "normal" year	
	bluebunch wheatgrass	65%
	Idaho fescue	20%
	Sandberg bluegrass	10%
	silky lupine	2%
	longleaf phlox	1%
	yarrow	1%
	other perennial forbs	1%

Droughty steep south (shallow south 10-14" precipitation)-

This range site is on Lickskillet and Sherar soils. Lickskillet 31F is found on the slopes above Tygh Creek and lower White River, as well as along Nena Creek. It also occurs on the slopes that drain into the Deshutes River. These soils are well drained, extremely stony loams and very cobbly loams that formed in loess and colluvium. These are very steep and have south-facing slopes. Runoff is rapid, and the potential hazard of erosion is severe. Permeability is slow to moderate, and the water supplying capacity is 2 to 5 inches. Major forage grasses begin to grow about February 20.

Where this site is in poor condition, broom snakeweed, rabbitbrush, and big sagebrush have nearly replaced the stand of forage bunchgrasses. Cheatgrass and low-value forbs are dominant. If deterioration is severe, much of the ground is bare and rocky. Special improvement measures generally are not suited to this site because the soils are steep, extremely stony or very cobbly, and very droughty.

Lickskillet 31F:	Productivity: 300 lb/acre; "normal" year.	
	bluebunch wheatgrass	80%
	Sandberg bluegrass	10%
	Thurber needlegrass	5%
	silky lupine	1%
	yarrow	1%
	hangingpod milkvetch	1%
	arrowleaf balsamroot	1%

Shrubby rolling hills (renamed as Loamy, 12-14" precipitation**)-**

Watama 54B and Maupin 32A soils are included in this range site. Maupin and Watama soils are often found in complexes with Bakeoven scabland soils. These soils occur in the vicinity of Smock Prairie and Juniper Flat. They are well drained loams and silt loams that formed in volcanic ash and colluvium. They are nearly level to moderately steep, and are on uplands. Permeability is moderate or moderately slow, and the water supplying capacity is 6 to 14 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, bluebunch wheatgrass and Idaho fescue have been nearly eliminated from the stand. Low value shrubs increase and juniper from adjacent areas may invade the site. If deterioration is severe, annual weeds invade the areas of shallow and eroded soils.

Special improvement measures are suited to this range site. If the range is in poor condition, clearing the juniper or spraying to control brush and seeding grasses are practical. Plans for manipulating brush should consider the amount and value of existing bitterbrush and other forage shrubs.

The plant communities on these soils are mainly comprised of bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, antelope bitterbrush, and yarrow. Small percentages of additional grasses, forbs, and shrubs vary among the soil types.

Maupin 32A:	Productivity: 800lb/acre; "normal" year	
	bluebunch wheatgrass	55%
	Idaho fescue	10%
	Sandberg bluegrass	10%
	antelope bitterbrush	10%
	prairie junegrass	2%
	yarrow	2%
	buckwheat	2%
	big sagebrush	2%
	longleaf phlox	1%
	gray horsebrush	1%
	other perennial forbs	4%
	other shrubs	1%
Watama 54B:	Productivity: 850lb/acre. Similar to 32A with addition of big sagebrush and hangingpod milkvetch. Also, less Sandberg bluegrass (5%) and more antelope bitterbrush (15%).	

Scabland (renamed as very shallow 10-14" precipitation)-

This range site includes Bakeoven 3D, 4C, and 5C soils, which are found on Juniper Flat and Smock Prairie. Scabland soils are well drained, with a surface layer of very cobbly loam or very stony loam, and a subsoil of very cobbly loam or very cobbly clay loam. They formed in loess and in residuum weathered from basalt on uplands. They are nearly level to moderately steep. Permeability is moderately slow, and water supplying capacity is less than 2.5 inches. The major forage grass, Sandberg bluegrass, begins to grow about April 1. Some areas have a distinctive pattern of circular mounds, or "biscuits", surrounded by scabland.

Where this site is in poor conditions, the already sparse stand of bunchgrasses has been nearly eliminated. Sandberg bluegrass is depleted, and stiff sagebrush and forbs have increased. If deterioration is severe, only bare ground, stones, and sagebrush occupy the site. Special improvement measures are not suited to this site. Stiff sagebrush is a natural part of the plant community and provides valuable winter forage.

Bakeoven 3D:	Productivity: 350 lb/acre; "normal" year	
	stiff sagebrush	75%
	Sandberg bluegrass	20%
	bottlebrush squirreltail	1%
	snow erigonum	1%
	serrated balsamroot	1%
	tapertip onion	1%
	bigseed lomatium	1%
Bakeoven 4C and 5C:	Productivity: 350 lb/acre; "normal" year	
	Western juniper	35%
	Sandberg bluegrass	45%
	bottlebrush squirreltail	2%
	snow erigonum	5%
	bluebunch wheatgrass	2%
	Oregon bluegrass	5%
	bigseed lomatium	2%
	Thurber needlegrass	2%
	other shrubs	2%
	big sagebrush	1%

Pine-Oak-Fescue (renamed as Loamy 14-20" precipitation)-

This range site includes Wamic soils 49C and 49B which occur in the vicinity of the town of Wamic and Pine Hollow Reservior. Wamic soils are sometimes interspersed with scabland. These soils are well drained loams, silt loams, and fine sandy loams that formed in loess, volcanic ash, and alluvium on ridgetops and uplands. Water supplying capacity is 8 to 14 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, competition from dense shrub and oak reproduction can crowd out understory plants, especially grasses. If deterioration is severe, cheatgrass and other low-value plants dominate and much soil is bare. Special management is suited to this site to improve plant resources. After a fire, seeding native grasses and forbs before fall rains is recommended to stabilize the soil and prevent excessive oak and shrub reproduction. This range type provides important habitat for wildlife such as the Western gray squirrel, and winter range for elk and deer.

Wamic 49B and C:	Productivity: 800lb/acre; "normal" year	
	Idaho fescue	45%
	bluebunch wheatgrass	10%
	Sandberg bluegrass	5%
	other perennial grasses	4%
	arrowleaf balsamroot	2%
	other perennial forbs	8%
	antelope bitterbrush	10%
	other shrubs	6%
	tree seedlings	10%

Changes to Forest Structure

Suppression of fire, timber management, and grazing have all played a part in altering forest structure and composition from conditions before European settlement.

Historically, eastside forests were influenced by fire at a return interval of 7 to 20 years in ponderosa pine forest, and 50 to 100 yrs in grand fir/douglas fir forest. The frequency of fire kept fuel loads and understory to a minimum which prevented fires from reaching the overstory and killing trees. This regime favored more fire tolerant trees in the overstory (ponderosa pine and garry oak) and bunch grasses in the understory, plants well adapted to frequent low severity fires. Dense overstory and understory conditions prevelent today provide vertical fuel "ladders" for fire to spread from understory to tree crowns. Consequently fires today are more severe, burning entire forests over much larger areas. These "stand replacing fires" do considerable damage to property, and to ecosystems.

Forests that are over-crowded are more susceptible to attacks of insects and disease. Epidemic levels of dwarf mistletoe, fir engraver beetle, spruce budworm beetle, and root diseases exist in some areas. Recent droughts have increased stresses on forest health and the risk for catastrophic wildfires and insect epidemics.

Such fires could potentially eliminate what little old-growth remains, and have detrimental effects on wildlife. High severity fires can damage the soil and promote shrub species adapted to a hot fire regime which shade out tree species and delay their establishment.

Livestock grazing in the forest over the past century has also contributed to fire suppression by reducing continuity of understory vegetation and preventing low intensity fires from spreading in their normal pattern. "Grazing continues to affect forest ecology in terms of succession species composition, and species diversity. Influences on forest structure have been increased tree numbers, decreased native grasses, increased accumulation of downed woody material, increased spread of exotic and noxious weeds, and increased forest floor duff." (Johnson and O'Neil, et. al., Wildlife-Habitat Relationships in Oregon and Washington.)

Riparian hardwood forest-

Riparian hardwood forest that once typified the streamside plant community is absent within the National Forest boundary, and reduced elsewhere. Instead, grazing and fire exclusion have favored conifer regeneration in the riparian zone. This has had consequences for wildlife that depend upon hardwoods for habitat needs. Loss of riparian hardwoods also contributes to the decrease in historic levels of large woody debris. Hardwoods live for a shorter time than conifers and shed branches more frequently.

Riparian communities below irrigation diversions have narrowed from their previous extent, due to lower water flows. The sponge-like function of the floodplain to store and gradually release water is therefore reduced, potentially resulting in increases in runoff and sediment, and less stable banks.

Ponderosa pine and pine/oak forest-

No old growth forest remains. Isolated pines over 200 yrs old comprise a remnant overstory. Thickets of pine less than 10" in diameter that are over 80 years old predominate. These smaller pines are crowded and stagnant in growth. Lack of fire has changed the understory from a predominance of native bunchgrasses to a predominance of litter duff and downed wood. Non native grasses and forbs have replaced bunchgrasses in many areas.

Grand fir mixed forest-

This is the most heavily clearcut portion of the Watershed. Forest habitat has been fragmented into many smaller patches where clearcutting was most intensive. Elsewhere forest density has increased, resulting in stagnant growth and prevalence of disease. Riparian forest is also fragmented, and larger trees along streams are greatly reduced in numbers.

Cascade crest zone-

Types of forest remain similar by percentage, but have been fragmented, resulting in smaller habitat patches. Wildlife species requiring larger habitat patches experience a reduction in habitat.

10.2) Plant Species

"Listed" Plant Species

Plant species included below are federally, state or regionally (Forest Service) listed. These plants are associated with several unique habitat types. Habitats include wetlands, cedar swamps, riparian zones, rock outcrops, vernally moist scablands, wet meadows and dry meadows.

Table 10-2. "Listed" Plant species known or suspected to occur in the White River Watershed. (Sources: White River Watershed Analysis, 1995, US Fish and Wildlife Service, 2001.)

Species	Status	Federal Status	Reg. Status	ONH Location and Habitat
Agoseris elata (susp.), tall agoseris		Sensitive		Cascade crest, wet meadows.
Allium campanulatum, Sierra onion		local conc.	4	Cascade crest, dry soils.
Allium douglasii var. nevii		local conc.	4	
Allium macrum		local conc.	4	
Arabis furcata, Cascade rockcress		local conc.	4	Crest and grand fir zones, high ridges.
Arabis sparsiflora var.atrorubens, sicklepod rockcress		Sensitive	2	Pine-Oak woodlands, open rocky areas.
Astragalus howellii, Howell's milkvetch	SC		1	Pine-oak woodlands, endemic to Sherman and Wasco Co.s.
Astragalus tyghensis, Tygh's milkvetch	SC		1	Umatilla plateau, local endemic found in lower White River canyon.
Botrychium minganense		Sensitive	2	Grand fir zone, deep shade by creeks.
Botrychium montanum		Sensitive	2	" "
Calamagrostis brewerii, Brewer's reedgrass		Sensitive	2	Cascade crest, moist locations.
*Chaenactis nevii (*susp.*),* John Day chaenactis			4	Grand fir zone, high rocky ridges in Badger Wilderness.
Claytonia umbellata		Local conc.	4	Dry rocky talus.
*Collomia larsenii (*susp*),* collomia			4	Grand fir zone, high rocky ridges.
Coptis trifolia, goldthread		Sensitive	2	Grand fir zone, deep shade.
Delphinium nuttallii, Nuttall's larkspur		Local conc.	3	Cascade crest zone, basalt talus
Hackellia diffusa var. cottoni, Diffuse stickseed		Local conc.	4	Ponderosa pine, grand fir zones, shaded cliffs and talus.
Huperzia occidentalis, fir club-moss		Sensitive	2	Grand fir zone, wet areas.
Lewisia Columbiana var.Columbiana Columbia lewisia		Sensitive	2	Cascade crest zone, gravelly slopes.
Linanthus bakeri		Local conc.	3	Umatilla plateau, biscuit-scab land.
Lomatium watsonii (susp.), *Watson's desert-parsely*		Sensitive	2	Ponderosa Pine forest, rocky hillsides.
Lycopodium annotinum,, stiff club-moss		Local conc.	4	Grand fir zone, wet areas.
Scribnaria bolanderi,, Scribner's grass		Sensitive	2	Ponderosa pine forest, vernal swales.
Vaccinium oxycocus, wild cranberry		Local conc.	4	Grand fir zone, bogs, Camas Prairie.
Utricularia minor (susp.), Lesser bladderwort		Sensitive		Standing or slowly moving water.

Federal listings, February 2001:
(SC)- Species of Concern. Conservation status is of concern, but further information is needed.
Regional listings: Species designated as "Sensitive" are potentially eligible for threatened or endangered status. "Local Concern" indicates conservation status is of concern, but further information is needed.

Oregon Natural Heritage ratings, August 1993:
(These ratings do not necessarily correspond to Federal, State, or Regional listed species.)
1 Species that are threatened with extinction or presumed extinct throughout their range.
2 Species that are threatened with extirpation or presumed extirpated from the State of Oregon. May be common elsewhere.
3 Species for which more information is needed, but which may be threatened or endangered in Oregon or throughout their range.
4 Species which are declining in numbers but are not currently threatened or endangered.

Noxious Weeds

According to Wasco County Weedmaster, Merle Keys, the top problem species in the White River Watershed currently are diffuse and spotted knapweeds, houndstongue, tansy ragwort and scotchbroom. Next are yellow toadflax, Russian knapweed, and meadow knapweed (pers.comm. 5/15/03).

Table 10-1. Noxious weed species known or suspected to occur in White River Watershed: (USFS 1995.)

Species	Class	Location
*tansy ragwort – *Senecio jacobea*	A	grand fir and cascade crest
*spotted knapweed – *Centaurea maculosa*	A	all zones
Canada thistle – *Cirisium arvense*	B	all zones
*diffuse knapweed –*Centaurea diffusa*	B	all zones
St.Johnswort – *Hypericum perforatum*	C	pine/oak and grand fir
*houndstongue –*Cynoglossum officianale*	A	cascade crest zone
*scotchbroom	B	
dalmatian toadflax – *Linaria dalmatica*	B	pine/oak eastwards
*yellow toadflax – *Linaria vulgaris*		grand fir eastwards
leafy spurge-	A	
musk thistle *Carduus nutans*	A	pine/oak eastwards
yellowstar thistle – *Centaurea solstitialis*	B	pine/oak eastwards
rush skeletonweed -	B	
white top – *Cardaria spp.*	B	
Scotch thistle		
*Russian knapweed	B	
*meadow knapweed – *Centaurea.pratensis*	A	
poison hemlock – *Conium maculatum*	C	pine/oak eastwards
perennial pepperweed – *Lepidium latifolium*	C	pine/oak eastwards

(*= Noted by Wasco County Weedmaster as worst problems. Classifications are from Wasco County WeedMaster.)

Weed classifications used by Wasco County classifies weeds by strategy for control. “A” pests are “known to occur in the county in small enough infestations to make eradication practical. “B” pests are of limited distribution within the county and subject to intensive control or eradication at the county level. “C pests are more widely spread, and should be controlled in areas that warrant special attention. There is also a “Q” list. These are weeds on a watch list that are present but not currently considered to be a threat.

10.3) Wildlife Species

Changes in plant communities have reduced habitat in quality or quantity for a number of species in the Watershed. Species that are dependent on open canopy stands of ponderosa pine, mixed conifer forest, and riparian cottonwood communities have experienced reduced habitat. According to Altman, there are 16 landbird species with significantly declining populations in the east slope cascade mountains.
Though not listed here, the same may be true for species associated with shrub-steppe, biscuit scablands and perennial grasslands. (Sources for the following information include: Altman, American Bird Conservancy, 2000, and Ray Johnson, ODFW, pers. comm. 7/2003, in addition to the sources previously referenced.)

Ponderosa Pine Forest- Species dependent on open canopy ponderosa pine forest are listed below. Eighty-five native landbird species are considered to be "regularly associated breeding species" in ponderosa pine habitat. Several species are obligate or near obligate, meaning, they are rarely found in other forest types. These include pygmy nuthatch and white-headed woodpecker. Both white-headed woodpecker and Lewis' Woodpecker are in decline.

Birds	Mammals
flammulated owl	fisher
great gray owl	long-eared myotis
white-headed woodpecker (obligate)	pallid bat
pygmy nuthatch (obligate)	
loggerhead shrike	
Williamson's sapsucker	
Lewis' woodpecker	

Mixed Conifer Forest (late successional) - Eighty-five native landbirds are considered to be regularly associated breeding species in this type of habitat. Species associated with this habitat type include:

Birds
pileated woodpecker
northern goshawk
brown creeper
olive-sided flycatcher
Hammond's flycatcher
Vaux's swift
blue grouse
golden-crowned kinglet
varied thrush

Oak-Pine Woodland- One hundred native landbird species are regularly associated breeding species in oak-pine woodland habitats. Species most associated with this habitat include:

Birds
Lewis woodpecker
western bluebird
white-breasted nuthatch
ash-throated flycatcher (obligate or near obligate)
acorn woodpecker (obligate or near obligate)

Riparian Cottonwood Forest- Downy woodpecker relies on black cottonwood for cavity excavation. Scarcity of beaver within the National Forest is tied to the lack of large hardwoods. Species dependent on cottonwood riparian communities include:

Birds	Mammals
yellow warbler	beaver
red-eyed vireo	
black phoebe1 `	
downy woodpecker	
western tanager	
Bullock's oriole	

Most historical information available is about larger mammals ("megafauna"). Little information is available on reptiles, amphibians, birds, small mammals or invertebrates. Wolves and grizzly bears were once present, and probably lynx. These species have since been extirpated. Wolverine, rare in Oregon, has been sighted in the Watershed in recent years. Pine martins & fishers have declined in numbers, but are still present. Beaver were once more abundant, especially in the upper half of the Watershed. Pronghorn antelope were relatively abundant in the eastern third of the Watershed. Deer and elk populations are higher today, in part due to loss of predator species. They are managed as game species. Ditches have dispersed wildlife & fishes into new areas.

Habitat corridors and connections

Wildlife species require not only sufficiently large areas or patches of habitat, but also the ability to move between these areas. The lands allowing wildlife to move freely from one area to another are referred to as "corridors". Species require the ability to disperse to new sites as conditions change, and to exchange genetic material for species viability. Some species, including many amphibians, primarily use aquatic habitat but rely on upland habitat as well for dispersal.

For example, the population of spotted frogs at Camas Prairie was once connected to a larger meadow system that included Clear, Timothy and Clackamas Lakes. Damming at Clear and Timothy Lakes fragmented this larger ecosystem. Camas Prairie currently provides adequate habitat for the spotted frog population, but if this habitat were reduced the population could be threatened. Spotted frogs are now extinct in British Columbia, but remnant populations remain in Oregon and Washington in several locations.

Many species in the Watershed for which life cycle information is known appear to have sufficient habitat for breeding, rearing and dispersal at present. Sufficient breeding habitat is uncertain for white-headed woodpeckers, pygmy nuthatch, and flammulated owl. It is believed that Cope's giant salamander and spotted frogs no longer have sufficient dispersal habitat throughout their original range. (Though aquatic in their juvenile stage, amphibians travel across upland habitat as adults to disperse to new breeding sites.)

The Watershed provides an important north-south link for northern spotted owl. The National Forest is managed to maintain this corridor, and others. White River Watershed may be a habitat link to wolverine populations in Washington.

“Listed” Upland Wildlife Species

Table 10-3. State or federally listed wildlife species present in White River Watershed (Wasco County, 2001; Regional Forester’s Sensitive Animal List, 2000; White River Watershed Analysis, USFS, 1995)

Animals Common name	Species	Federal Status	Oregon Status
northern goshawk	Accipiter gentilis	SC	Sensitive
swainson’s hawk	Buteo swainsoni		Sensitive
ferriginous hawk	Buteo regalis	SC	Sensitive
peregrine falcon	Falco peregrinus	E	Endangered
sandhill crane	Grus Canadensis		Sensitive
bald eagle	Haliaeetus leucocephalus	T	
flammulated owl	Otus flammeolus		Sensitive
northern pygmy owl	Glaucidium gnoma		Sensitive
northern spotted owl	Strix occidentalis	T	
great gray owl	Strix nebulosa		Sensitive
Lewis’woodpecker	Melanerpus lewis		Sensitive
Williamson’s sapsucker	Sphyrapicus thyroideus		Sensitive
white-headed woodpecker	Picoides albolarvatus		Sensitive
three-toed woodpecker	Picoides tridactylus		Sensitive
black-backed woodpecker	Picoides arcticus		Sensitive
pileated woodpecker	Dryocopus pileatus		Sensitive
pygmy nuthatch	Sitta pygmaea		Sensitive
western bluebird	Scialia mexicana		Sensitive
Townsend’s big-eared bat	Plecotus townsendii	SC	Sensitive
pallid bat	Antrozous pallidus		Sensitive
American marten	Martes Americana		Sensitive
fisher	Martes pennanti	SC	Sensitive
wolverine	Gulo gulo		Threatened
white-tailed jack rabbit	Lepus townsendii		Sensitive
Reptiles			
Sharp-tailed snake	Contia tenuis		Sensitive
California mountain kingsnake	Lampropeltis zonata		Sensitive
Amphibians			
Cascade frog	Rana cascadae	CF	Sensitive
Cope’s giant salamander	Dicamptodon copei		Sensitive
Red-legged frog	Rana aurora	SC	Sensitive
Spotted frog	Rana pretiosa	CF	Sensitive
Tailed frog	Ascaphus truei	SC	Sensitive

(Note: Amphibians are included in this list as they also make use of upland habitat as adults.)

Federal listings: (E)- Endangered (T)- Threatened (CF)-Candidate for federal listing as endangered or threatened (SC)-Species of Concern; conservation status is of concern, but further information is needed.
State listings: ODFW maintains species ratings for the State of Oregon. Threatened, Endangered, or Sensitive State listings do not necessarily overlap with Federal listings. Species designated as “Sensitive” are on a watch list for potential eligibility as state Threatened or state Endangered.
Regional listings: USFS maintains regional species ratings which do not necessarily overlap with State or Federal listings.

Introduced species

ODFW has introduced several game bird species. These include wild turkey, red legged partridge, Hungarian partridge, ring necked pheasant and chukar.

Two birds native to the western states, but not to the Cascades, have expanded their range westwards in response to habitat changes. These are the barred owl, and the brown-headed cowbird.

There are several interactions noted between non-native species and native wildlife.

-Turkey/western gray squirrel. Wild turkeys share food sources with western gray squirrel (acorns and ponderosa pine seeds). Competition for food does not appear to be limiting gray squirrel populations currently.

-Turkey/ponderosa pine. Pine seeds are a preferred food. There is some evidence that turkey can reduce ponderosa pine regeneration from seed.

-cattle/native plants. Cattle can have a preference for some native species, which potentially can be overgrazed.

-barred owl/northern spotted owl. The barred owl has spread from its original range to the east into the cascades. A close relative of the spotted owl, it appears to be better adapted to fragmented and late successional forest than the spotted owl. Where there is competition for space the barred owl would have the advantage.

-Brown-headed cowbird/neotropical migrants. The cowbird has expanded its range from the east and is a parasite on other bird species.

-starling/cavity nesting birds. Starlings can take over cavities from less aggressive species, particularly bluebirds. Providing more snags for cavity nesters may help.

11) Evaluation

Table 11-1. Major issues identified by watershed assessment and potential responses.

Issue	Where	Why	Potential Responses
Limited water available for irrigators (4)	Entire Watershed.	Limited by water rights at mouth of Deschutes River.	-Improve water use efficiency. -Acquire new water rights.
Water quality (6.1-6.2)	Nine stream reaches. (Table 6-1.)	Exceed water quality standards for temperature and sediment.	-Riparian and channel restoration. -Grazing management. -Increase base flows.
Riparian conditions (8.1)	Several reaches. (See Figure 7-4.)	Lacking adequate riparian vegetation.	-Riparian restoration. -Grazing management.
Aquatic habitat (9)	Various locations in Watershed.	Barriers to migration, Competition from exotics, Lack of pool habitat (low LWD), Low summer baseflows.	-Correct upstream barriers. -Install fish screens. -Modify culverts that block LWD. -Improve water use efficiency in uplands. -Acquire Instream water rights or leases.
Forest fuel loads (2.4)	Mt. Hood National Forest.	Suppression of fire has resulted in a build up of fuels.	-Manage forests to reduce excess fuel loading. Thinning, controlled burning.
Cropland erosion (5.2)	Tilled lands on shallow soils and/or steep slopes.	Eroding at "unsustainable" rates.	-Encourage Direct Seed and CRP where appropriate.
Impacts from recreation (2.4)	Lakefronts,camp-sites, OHV routes.	Impacts to soil, vegetation and water resources.	-Identify most impacted/sensitive sites, restore/protect as necessary.
Impacts to native plant communities (10.1)	Entire Watershed.	Spread of invasive exotic plants. Soil disturbance from various activities.	-Continue weed management. -Increase public awareness of value of native plant communities and measures to protect or restore them.
Condition of roads (4.1)	White River access road, in particular.	Unpaved road, 1 of only 2 access roads to Wamic in poor condition.	-Identify parties responsible for repair, pursue funding.

Table 11-2. Data gaps and incomplete sections:

Parameter	Notes
Riparian roads have not been surveyed for potential sedimentation problems (5.3).	State of repair has a significant effect on runoff impacts.
Potential water quality concerns at Pine Hollow Reservoir need follow-up (6.3).	"No Swimming" signs have been posted periodically. Water sampling for an extended period may be warranted.
Update riparian assessment when current aerial photos become available (8.1).	Photos available for most of the Watershed were from 1995.
Wetland conditions have not been assessed (8.2).	Wetlands found to be degraded or at-risk could be considered for restoration or protection.
Stream survey data on aquatic habitat for the lower half of the Watershed is nearly 20 years old (9.2).	An updated stream survey for non Forest Service lands is needed.
Need update on fish screens from USFS and ODFW (9).	Data in USFS Watershed Analysis is from 1995.
Culvert data for County owned roads is unavailable (9.2).	Not included in ODFW/ODOT culvert inventory.
Survey of range conditions is missing from this assessment.	Data needed from both public and private sources.
Pesticide levels in water resources was not assessed (6).	
Calculation of stream flow in W.R. tributaries (3.1).	Hasn't yet been done by Water Resources Dept.

Terms and Acronyms

Terms

CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
ESU	Evolutionarily Significant Unit
NWI	National Wetlands Inventory
OARs	Oregon Administrative Rules
OHV	Off-highway Vehicle
RCU	Riparian Condition Unit
RM	River Mile
RUSLE	Revised Universal Soil Loss Equation
TMDL	Total Maximum Daily Load

Agencies and Organizations

BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CTWSRO	Confederated Tribes of the Warm Springs Reservation
DEQ	Department of Environmental Quality
DRC	Deschutes Resources Conservancy
JFDIC	Juniper Flat District Improvement Company
NRCS	Natural Resource Conservation Service
ODEQ	(Oregon) Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	(Oregon) Department of Transportaion
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
SWCD	Soil and Water Conservation District
USFS	United States Forest Service
WRD	(Oregon) Water Resources Department

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Appendix A
Qualitative Habitat Assessment

Ecological Province:	Columbia Plateau South
Watershed:	Deschutes
Stream:	White River and tributaries
Focal Species:	Redband Trout
Date:	Oct-03

Contributors	e-mail	Phone
Jim Newton		
Rod French	rod.a.french@state.or.us	541-296-4628
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About Qualitative Habitat Assessment- The Qualitative Habitat Assessment tool (QHA) facilitates a structured ranking of stream reaches and attributes for subbasin planners. QHA relies on the expert knowledge of subbasin planners to describe physical conditions in the target stream and to create an hypothesis about how the habitat would be used by a focal species. The hypothesis is the "lens" through which physical conditions in the stream are viewed. The hypothesis consists of weights that are assigned to life stages and attributes, as well as a description of how reaches are used by different life stages. These result in a composite weight that is applied to a physical habitat score in each reach. This score is the difference between a rating of physical habitat in a reach under the current condition and the condition of the reach for the attribute in a reference condition. The result is that the current constraints on physical habitat in a stream are weighted and ranked according to how a focal species might use that habitat.

Qualitative Habitat Assessment

Contact: Chip McConnaha
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A Qualitative Habitat Assessment of the White River Watershed was conducted by the Deschutes Subbasin Planning Group during October of 2003. Results are shown in the following chart.

The chart ranks habitat scores. The highest weighted score in either protection or restoration categories is ranked 1 and is formatted in red. On the protection side the number 1 rank goes to reaches or attributes that are in the best shape (hence highest protection ranking), whereas for restoration, the number 1 rank goes to the reach or attribute that is in the worst condition relative to the reference condition. Scores are weighted by the Habitat Hypothesis and are not strictly a measure of distance from the reference condition.

Qualitative Habitat Assessment (QHA) - **White River Watershed**

Restoration Habitat Ranking — **Habitat Characteristics**

Reach Name	Reach Description	Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
White R MS-2	Lower Falls to Upper Falls (above gaging station)	31	3	3	3	3	3	1	3	3	2	3	3
White R MS-3	Upper Falls to Tygh Cr	22	6	2	3	8	7	1	8	8	3	8	5
Tygh Cr-1	Mouth at White R MS to Badger Cr,	6	5	2	2	8	7	2	9	9	1	9	5
Badger Cr-1 (Tygh)	Mouth at Tygh Cr MS to Little Badger Cr	9	4	4	6	8	7	1	9	9	3	9	2
Little Badger Cr	Mouth at Badger Cr (Tygh) MS to 3100 ft level	35	3	4	4	1	4	4	4	4	2	4	4
Badger Cr-2 (Tygh)	Little Badger to Diversion Dam	19	6	7	2	4	4	1	7	7	3	7	7
Badger Cr-4 (Tygh)	Diversion Dam to Pine Cr	41	2	2	2	2	1	2	2	2	2	2	2
Pine Cr	Mouth at Badger Cr (Tygh) MS to 4600 ft level	44	1	1	1	1	1	1	1	1	1	1	1
Badger Cr-5 (Tygh)	Pine Cr to Badger Lake Dam #51837	41	2	2	2	2	1	2	2	2	2	2	2
Tygh Cr-2	Badger Cr to Jordan Cr	5	6	1	3	7	7	2	9	9	3	9	3
Jordan Cr-1	Mouth at Tygh Cr MS to Falls #51404	17	7	1	3	1	3	3	8	8	6	8	8
Jordan Cr-3	Falls #51404 to Pen Cr	8	3	2	4	8	4	4	9	9	4	9	1
Pen Cr	Mouth at Jordan Cr MS to forks in section 8	13	6	3	4	7	4	1	9	9	1	9	8
Jordan Cr-4	Pen Cr to 4400 ft level	11	6	1	2	3	7	5	9	9	8	9	3
Tygh Cr-3	Jordan Cr to Falls	21	4	1	5	1	7	3	8	8	5	8	8
Tygh Cr-5	Falls to section line 10/15	16	7	1	5	4	8	2	9	9	5	9	3
White R MS-4	Tygh Cr to Threemile Cr	18	2	5	1	7	6	2	7	7	4	7	7
Threemile Cr-1	Mouth at White R MS to Diversion Dam	1	6	4	2	4	9	1	7	9	2	7	11
Threemile Cr-3	Diversion Dam to trib (24K) in section 35	24	3	1	2	4	6	7	8	8	5	8	8
White R MS-5	Threemile Cr to Rock Cr	28	5	4	3	5	5	1	5	5	2	5	5
Rock Cr-1	Mouth at White R MS to Gate Cr	4	7	4	4	2	8	1	6	8	3	10	11
Gate Cr-1	Mouth at Rock Cr MS to Diversion Dam	3	6	4	4	2	8	1	6	8	3	10	11
Gate Cr-3	Diversion Dam to 3100 ft level	7	5	1	7	1	8	3	9	9	3	9	5
Rock Cr-2	Gate Cr to Rock Creek Reservoir Dam #50362	2	6	2	5	2	9	1	7	10	4	11	7
Rock Cr-5	Top of Rsv to 3200 ft level	10	4	1	3	7	8	6	9	9	1	9	4
White R MS-6	Rock Cr to Boulder Cr	29	4	4	3	4	4	1	4	4	2	4	4
Boulder Cr-1 (White)	Mouth at White R MS to Forest Cr (stream called Crane Creek in 100k hydro layer and is not on topo Map?)	26	4	4	4	4	4	1	4	4	3	4	2
Forest Cr-1	Mouth at Boulder Cr (White) MS to Diversion Dam	14	6	7	4	3	7	1	7	7	5	7	2
Forest Cr-3	Diversion Dam to Unnamed Trib in NW corner section 28	32	3	3	2	3	3	3	3	3	3	3	1
Forest Cr-4	Unnamed Trib in NW corner section 28 to road crossing in SE corner of section 8	28 9	1	1	1	1	1	1	1	1	1	1	11
Boulder Cr-2 (White)	Forest Cr to Diversion Dam	25	4	4	4	4	4	1	4	4	3	4	2
Boulder Cr-4 (White)	Diversion to tribs entering just below 42100 ft level	44	1	1	1	1	1	1	1	1	1	1	1
White R MS-7	Boulder Cr to Clear Cr	29	3	4	4	4	4	1	4	4	2	4	4
Clear Cr-1	Mouth at Boulder Cr (White) MS to Frog Cr	23	3	4	4	1	4	2	4	4	4	4	4
Frog Cr-1	Mouth at Clear Cr MS to Diversion Dam	20	4	5	5	1	5	2	5	5	3	5	5

Frog Cr-3	Diversion to Frog Lk	36	2	3	3	3	3	11	3	3	3	3	1
Clear Cr-2	Frog Cr to Diversion Dam	15	4	4	4	2	4	1	4	4	3	4	4
Clear Cr-4	Diversion Dam to Wasco Dam #51292 at Clear Lake	12	5	5	5	2	4	1	5	5	3	5	5
Clear Cr-8	Unnamed Trib to Clear Lake--from lake to 3750 ft level	41	2	2	2	1	2	11	2	2	2	2	2
White R MS-8	Clear Cr to Barlow Cr	33	1	4	2	4	4	4	4	4	2	4	4
Barlow Cr	Mouth at White R MS to Palmateer Creek near section 4/33 line	33	2	1	5	5	3	5	5	5	5	5	3
White R MS-9	Barlow Cr to Bonney Cr	37	2	2	1	2	2	2	2	2	2	2	2
Bonney Cr	Mouth at White R MS to 3800 ft level	27	4	2	5	2	5	5	5	5	5	5	1
White R MS-10	Bonney Cr to Iron Cr	37	2	2	1	2	2	2	2	2	2	2	2
Iron Cr	Mouth at White R MS to forks (North and South Iron Cr) near HWY 35	44	1	1	1	1	1	1	1	1	1	1	1
White R MS-11	Iron Cr to Mineral Cr	37	2	2	1	2	2	2	2	2	2	2	2
Mineral Cr A	Mouth at White R MS to forks (North and South Mineral Cr)	44	1	1	1	1	1	1	1	1	1	1	1
Mineral Cr B	from confluence with mainstem Mineral Creek to HWY 35 crossing	44	1	1	1	1	1	1	1	1	1	1	1
White R MS-12	Mineral Cr to Hwy 35	37	2	2	1	2	2	2	2	2	2	2	2

Protection Habitat Ranking

Habitat Characteristics

Reach Name	Reach Description	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
White R MS-2	Lower Falls to Upper Falls (above gaging station)	45	8	3	6	10	5	6	1	1	3	9	10
White R MS-3	Upper Falls to Tygh Cr	40	3	9	4	11	7	6	1	1	4	10	7
Tygh Cr-1	Mouth at White R MS to Badger Cr,	32	6	4	7	3	7	7	1	1	11	5	10
Badger Cr-1 (Tygh)	Mouth at Tygh Cr MS to Little Badger Cr	27	8	4	5	3	9	10	1	1	7	6	11
Little Badger Cr	Mouth at Badger Cr (Tygh) MS to 3100 ft level	10	7	1	5	4	9	8	1	1	6	9	11
Badger Cr-2 (Tygh)	Little Badger to Diversion Dam	17	5	1	9	4	10	10	1	1	6	7	7
Badger Cr-4 (Tygh)	Diversion Dam to Pine Cr	2	8	1	5	1	11	5	1	1	5	9	9
Pine Cr	Mouth at Badger Cr (Tygh) MS to 4600 ft level	4	7	1	5	1	9	8	1	1	5	9	9
Badger Cr-5 (Tygh)	Pine Cr to Badger Lake Dam #51837	7	8	1	5	1	10	5	1	1	5	9	11
Tygh Cr-2	Badger Cr to Jordan Cr	33	6	4	7	3	7	9	1	1	9	4	11
Jordan Cr-1	Mouth at Tygh Cr MS to Falls #51404	25	6	3	5	3	11	10	1	1	9	6	6
Jordan Cr-3	Falls #51404 to Pen Cr	31	8	4	5	3	10	9	1	1	7	6	11
Pen Cr	Mouth at Jordan Cr MS to forks in section 8	28	6	4	5	3	9	11	1	1	8	6	9
Jordan Cr-4	Pen Cr to 4400 ft level	26	6	5	8	3	9	9	1	1	4	6	11
Tygh Cr-3	Jordan Cr to Falls	18	7	3	5	3	10	10	1	1	5	7	7
Tygh Cr-5	Falls to section line 10/15	23	7	6	4	3	9	9	1	1	4	8	11
White R MS-4	Tygh Cr to Threemile Cr	42	6	8	9	11	5	6	1	1	3	10	3
Threemile Cr-3	Diversion Dam to trib (24K) in section 35	13	8	4	7	3	11	5	1	1	6	8	8
White R MS-5	Threemile Cr to Rock Cr	34	4	7	3	11	7	9	1	1	4	10	4
Gate Cr-1	Mouth at Rock Cr MS to Diversion Dam	46	4	7	6	8	5	11	2	1	8	10	2
Gate Cr-3	Diversion Dam to 3100 ft level	30	9	3	5	3	8	10	1	1	7	6	11

Rock Cr-5	Top of Rsv to 3200 ft level	**29**	8	4	6	3	9	6	1	1	9	5	11
White R MS-6	Rock Cr to Boulder Cr	**36**	3	5	3	11	7	8	1	1	5	10	9
Boulder Cr-1 (White)	Mouth at White R MS to Forest Cr (stream called Crane Creek in 100k hydro layer and is not on topo Map?)	**11**	6	1	5	1	8	11	1	1	7	8	10
Forest Cr-1	Mouth at Boulder Cr (White) MS to Diversion Dam	**36**	3	5	5	8	5	9	1	1	3	9	11
Forest Cr-3	Diversion Dam to Unnamed Trib in NW corner section 28	**8**	7	1	8	1	9	5	1	1	5	9	11
Forest Cr-4	Unnamed Trib in NW corner section 28 to road crossing in SE corner of section 8	**1**	8	1	5	1	9	5	1	1	5	9	9
Boulder Cr-2 (White)	Forest Cr to Diversion Dam	**11**	6	1	5	1	8	11	1	1	7	8	10
Boulder Cr-4 (White)	Diversion to tribs entering just below 42100 ft level	**2**	8	1	5	1	9	5	1	1	5	9	11
White R MS-7	Boulder Cr to Clear Cr	**38**	3	9	4	11	7	8	1	1	4	10	4
Clear Cr-1	Mouth at Boulder Cr (White) MS to Frog Cr	**14**	6	1	4	7	7	11	1	1	4	7	7
Frog Cr-1	Mouth at Clear Cr MS to Diversion Dam	**16**	6	1	4	7	7	11	1	1	5	7	7
Frog Cr-3	Diversion to Frog Lk	**9**	8	1	5	1	9	5	1	1	5	9	11
Clear Cr-2	Frog Cr to Diversion Dam	**22**	5	1	4	6	6	11	1	1	10	6	6
Clear Cr-4	Diversion Dam to Wasco Dam #51292 at Clear Lake	**24**	5	1	4	6	9	11	1	1	9	6	6
Clear Cr-8	Unnamed Trib to Clear Lake--from lake to 3750 ft level	**5**	8	1	4	4	9	4	1	1	4	9	9
White R MS-8	Clear Cr to Barlow Cr	35	5	9	8	11	7	1	1	1	4	10	5
Barlow Cr	Mouth at White R MS to Palmateer Creek near section 4/33 line	6	8	4	5	1	10	5	1	1	5	9	11
White R MS-9	Barlow Cr to Bonney Cr	39	6	9	7	11	8	1	1	1	1	10	5
Bonney Cr	Mouth at White R MS to 3800 ft level	15	7	3	8	3	10	5	1	1	5	9	11
White R MS-10	Bonney Cr to Iron Cr	41	6	9	6	11	8	1	1	1	1	10	5
Iron Cr	Mouth at White R MS to forks (North and South Iron Cr) near HWY 35	19	7	5	6	11	10	3	1	1	3	7	7
White R MS-11	Iron Cr to Mineral Cr	43	8	8	6	11	7	3	1	3	1	10	3
Mineral Cr A	Mouth at White R MS to forks (North and South Mineral Cr)	19	7	5	6	11	10	3	1	1	3	7	7
Mineral Cr B	from confluence with mainstem Mineral Creek to HWY 35 crossing	19	7	5	6	11	10	3	1	1	3	7	7
White R MS-12	Mineral Cr to Hwy 35	43	8	8	6	11	7	3	1	3	1	10	3

Definitions of Habitat Characteristics

Riparian Condition	Condition of the stream-side vegetation, land form and subsurface water flow.
Channel Stability	The condition of the channel in regard to bed scour and artificial confinement. Measures how the channel can move laterally and vertically and to form a "normal" sequence of stream unit types.
Habitat diversity	Diversity and complexity of the channel including amount of large woody debris (LWD) and multiple channels.
Key Habitat	The complex of habitat types formed by geomorphic processes (incl LWD) within the stream (e.g. pools, riffles, glides etc.).
Sediment Load	Amount of fine sediment within the stream, especially in spawning riffles.
High Flow	Frequency and amount of high flow events.
Low Flow	Frequency and amount of low flow events.
Oxygen	Dissolved oxygen in water column and stream substrate.
Temperature	Duration and amount of high summer water temperature or low winter temperatures that can be limiting to fish survival.
Pollutants	Introduction of toxic (acute and chronic) substances into the stream.

Habitat characteristics are rated relative to an optimum condition for the stream in its ecological province.