Mosier Watershed Assessment

Prepared by
Wasco County Soil and Water Conservation District

For
Mosier Watershed Council

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Copies of the Mosier Watershed Assessment are available from Wasco County SWCD at 2325 River Road, Suite 3, The Dalles OR 97058 or (541) 296-6178 x119. Electronic copies may be obtained via e-mail. Call for a current e-mail address.

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- Hood River County Department of Forestry, Hood River OR.
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- Wasco County Weed and Pest Management Office, The Dalles OR.
- Grant Wilson – Mosier resident

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- Wasco County Soil and Water Conservation District
- Mosier Watershed Council
- Gorge Trust, Hood River OR.
- Northwest Service Academy, Trout Lake WA.

Evaluation Committee:

Drafts of the Mosier Watershed Assessment were reviewed by a committee consisting of the following individuals:

- Alan Cheney, SDS Lumber
- Pete Dalke, Department of Environmental Quality and Mosier Resident
- Ken Galloway, Hood River County Forestry Department
- Steve Hanson, Longview Fibre
- Gay Jervey, Geologist and Mosier Resident
- Matthew Koerner, City of Mosier Water Manager
- Greg Koonce, Hydrologist and Mosier Resident
- Mark Kreiter, US Forest Service Hydrologist
- Bryce Molesworth, Orchardist and Mosier Resident
- Steve Pribyl, Oregon Department of Fish and Wildlife
- Lynda Sacamano, Columbia Land trust and Mosier Resident
- Doug Theises, Oregon Department of Forestry

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Introduction

This document provides an assessment of critical watershed health parameters for the Mosier, Rock and Rowena Creek Watersheds. All of these are located in Northwestern Wasco County, Oregon. Mosier and Rock Creeks both have some headwaters in Hood River County. All three enter the Columbia River in or near the City of Mosier, Oregon. The assessment was coordinated by Wasco County Soil and Water Conservation District (SWCD) at the request of the Mosier Watershed Council. The watershed assessment will be used to set priorities for watershed restoration projects in the Mosier area. The assessment looks not only at the health of perennial streams, but also at the health of major seasonal reaches and upland areas, focusing on water quality and quantity issues, with their effects on aquatic habitat. Upland habitat is also addressed, but wildlife populations are not.

The watershed assessment generally follows the format and protocols described in the Oregon Watershed Assessment Manual, developed by Watershed Professionals Network for the Governor's Watershed Enhancement Board (now the Oregon Watershed Enhancement Board). The Assessment Manual was developed in support of the Oregon Plan for Salmon and Watersheds.

Wasco County SWCD had access to ArcView 3.1 Geographic Information Systems software and electronic data, including most significantly, georectified aerial photos and USGS topographic maps. These were used extensively in the assessment, and in some cases, the protocols described in the Assessment Manual were altered to take advantage of the electronic tools. Whenever possible, results of aerial photo analysis were verified with field visits. The entire assessment was conducted from September 2000 to January 2002, with review by the SWCD, Watershed Council and general public.

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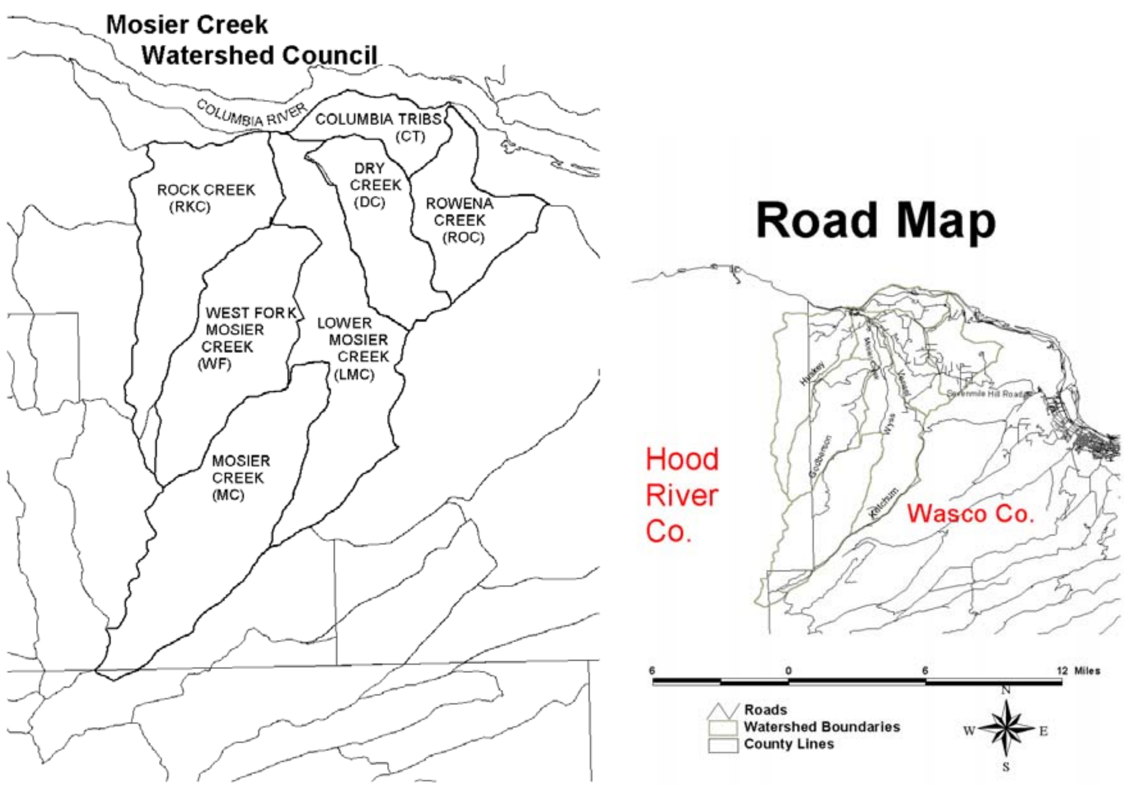
Figure 1-1. Watershed and sub-watershed boundaries used in the Assessment.



1) Watershed Description

The Mosier Creek Watershed is located on the east slope and in the eastern foothills of the Cascade Range. The area considered by this report includes the Rowena Creek, Mosier Creek and Rock Creek drainages. The total drainage area is 49,659 acres, or ~78 square miles. Rowena Creek is a short, high gradient, stream approximately five-mile long, that flows west and then north from Oregon White oak covered hills into the Columbia River near the community of Rowena (RM 182). This short stream drops approximately 2000 feet in elevation from headwater to mouth. Rowena Creek is bounded on the south by Chenoweth Creek, on the east and north by the Columbia River and on the west by Mosier Creek. Mosier Creek originates in the Mt. Hood National Forest near Gibson Prairie. It flows north out of mixed pine/fir forest through fruit orchards to enter the Columbia River at the town of Mosier (RM 176). The watershed is approximately ten miles long and two to eight miles wide. Elevation change from headwater to mouth is approximately 3300 feet. Mosier Creek is bounded on the south by Mill Creek, on the east by Chenoweth and Rowena Creeks, on the north by the Columbia River and on the west by Rock Creek and the Hood River subbasin. Rock Creek originates in mixed pine/fir forest and flows north to enter the Columbia River at the town of Mosier (RM 176). The Rock Creek watershed is a much wetter, more west-side eco-type than the other two watersheds. Rock Creek watershed is approximately seven miles long and one to two miles wide, and drops approximately 2900 feet from headwater to the mouth. Rock Creek is bounded on the east by Mosier Creek, on the north by the Columbia River and on the west and south by the Hood River subbasin (ODFW, 2000). These three watersheds taken together comprise the Mosier Watershed Council Area, here after referred to as "Watershed".

To assess habitat conditions, the stream network was divided into individual sub-watersheds with similar size. Because the word "watershed" can be used to refer to both large and small drainages, the assessment process assigns specific terms to different drainage levels using the U.S. Geological Survey Hydrologic Unit Code (HUC) system. It is based on watershed hierarchy and size and helps avoid confusion about what land area is being discussed. The smallest level used in this assessment is the "sub-watershed" corresponding to drainages with an average size of around 5,000 acres. A total of seven *6th* field sub-watersheds make up the Mosier Creek subbasin. The *6th* field watershed designations used are (1) West Fork Mosier Creek (WF); (2) Lower Mosier Creek (LMC); (3) Upper Mosier Creek (MC); (4) Rock Creek (RKC); (5) Rowena Creek (ROC); (6) Dry Creek (DC); and (7) Columbia Tributaries (CT). Watershed and sub-watershed boundaries used in the Assessment are shown in Figure 1-1. Sub-watershed boundaries used in this assessment were adapted from US Forest Service data provided by Mt. Hood National Forest GIS sources (USFS, 2000) and online from the Columbia Gorge National Scenic Area website (CGNSA, 2000).

Conditions in the creeks are controlled by the geology, climate, hydrology and land use of their surrounding drainage area from ridge-top to ridge-top. The Watershed is a dynamic system with steep terrain. Active faults are present in the watershed. Mosier Creek Watershed includes areas of The Dalles Formation and Bretz flood sediments. The Dalles Formation is a unit of mixed sedimentary material and volcanic ash deposited on top of the underlying basalt in the Mosier Syncline (low). Mosier Creek collects a lot of sand and fine sediments from The Dalles Formation. On the other hand, Rock Creek includes very little fine material, because its geology is dominated entirely by basalt formations. Hence, the Mosier Creek delta is built out of sands transported by Mosier Creek, while Rock Creek builds itself a bird's foot "groin" or jetty out of cobbles. The sand on the Rock Creek delta comes from Mosier Creek via long-shore current down the Columbia. A historic aerial photo from 1948 showed not only that neither creek had a delta, but also that the entire area of Mosier Creek below Pocket Falls was flooded with deep water, forming a sort of harbor (Jervey, 2001), that part of the creek being navigable to small boats until the 1964 flood (Wilson, 2000).

The Rock Creek watershed is a large, active fault. The area is being compressed, which causes some places to be uplifted (anticlines) and other areas to be pressed down (synclines). When an area is uplifted too much, it fails, creating a fault. Water tends to cut deeply through rock that is being uplifted (Jervey, 2001). Most stream channels in the Watershed have moderate or high gradients (3-16% or more) and are confined in narrow valleys or between terraces. Most streams are single-thread channels of low sinuosity and have a limited floodplain area. Boulder-rubble substrates dominate the streambeds (USFS 1996).

Climate varies across the Watershed because of its transitional location between weather dominated by wet marine airflow to the west and the dry continental climate of eastern Oregon. Areas of climate and landscape similarity called eco-regions have been defined as a common framework for ecosystem management in the U.S. (Pater et al. 1998). The entire Watershed is within the Eastern Cascades Slopes and Foothills (9c) eco-region. The annual rainfall varies from 35 or more inches at the headwaters of Mosier Creek, down to 19 in. in the eastern portion of Rowena Creek (Figure 1-2).

Due to its transitional location, the Mosier area, and the Columbia Gorge in general are very ecological diverse. The Columbia Gorge is home to fifteen endemic species of wildflower, five of which are found in the pine-oak woodlands (Jolly, 1988).

Social and Economic Background

Population

The watershed lies on the border of Hood River and Wasco Counties. The two-county area has a current (1998) population of approximately 43,600. The average annual growth rate between the two counties was .32% between 1980 and 1990, and 1.16% from 1990 to 1998 (CGEDA 1998). The Counties' population is projected to be 45,000+ by 2000. The population is dispersed, with many County residents living outside of urban growth boundaries (CGEDA 1998).

In the Year 2000, The City of Mosier had a population of approximately 335. The city's population is projected to grow to as much as 378 by 2020 (Tenneson Engineering Corp., August 1999).

Land Use and Ownership

For this assessment, land use has been grouped into five categories: agriculture, forestry, range, rural residential and urban (see fig. 1-2). Land use was determined based on Wasco and Hood River county zoning. Agriculture and range areas are zoned for 40 to 160 acre lots, used for commercial agriculture. Forestry areas are zoned for 40-80 lot size, zoned for commercial forestry. Rural residential areas are zoned for 2-20 acre lot sizes, and are either in RR (Rural Residential) or FF (Forest-Farm) zones.

Approximately 14.5% of the watershed is publicly owned, with nearly 50% of that in federal ownership and 50% City/County/State. A large percentage of the private land is zoned as Forest Land. An overview of current land use is provided in Figure 1-3. For the purpose of this assessment, the Watershed was broken down to 74.8% Forest, 19.3% Agriculture/Range, 5.1% Rural Residential and 0.8% Urban.

Agriculture is the leading industry in the watershed followed by forestry and tourism. In the lower watershed, irrigated orchards growing mostly cherries and apples make up approximately 1,440 acres. Pears, peaches and other produce are also grown in smaller amounts. The remainder of the lower watershed is dominated by rural residential use and pasture zoned for 20 – 40 acre lots. Most agricultural lands are located on land below 2,000 feet in elevation. Outdoor recreation and tourism has remained steady in the watershed. Recreational use of Mosier Creek may rise as population grows in the Columbia River Gorge area. Factors such as new businesses and the planned Mosier Waterfront Project could increase visitation to the Watershed. The lower portion of the Watershed lies within the Columbia River Gorge National Scenic Area. A strong link between forestry, agriculture and land development in the watershed is noted by historians and continues today (Gholston, *Date Unk.*, see also USFS 1996).

The upper watershed is mostly used for forestry (see Fig. 1-2). Of 49,659 acres total for the Watershed, ~37,000 (~75%) is zoned Forestry. ~7,442 acres (84%) in the Rock Creek sub-watershed are zoned Forestry. SDS Lumber is by far the largest single owner of land in the Watershed. They own ~ 8,345 acres, Longview Fiber comes in second in total land ownership with ~4,472 acres. The US government is next in line with ~3,224 acres. Small private landowners share ~29,494 acres. The remaining ~4,000 acres are split between State, County and City (see Table 1.1 and Fig. 1-3)

The Confederated Tribes of the Warm Springs Reservation (CTWS) hold federally-reserved rights in the Columbia River and the Mosier Watershed. These rights arise from the Treaty with the Tribes of Middle Oregon signed June 25, 1855. The CTWS is the legal successor to signatories of the 1855 Treaty, under which seven bands of Wasco and Sahaptin-speaking Indians ceded ownership of million acres of tribal land, including the Mosier Creek watershed, to the United States. In exchange for these lands, the

Treaty reserved to the Tribes an exclusive right to fish within Indian reservation boundaries and the right to fish in common with citizens of the USA at all other usual and accustomed places, including ceded lands. Ceremonial, commercial and subsistence fishing remains an essential part of tribal culture and economy. Treaty fishing opportunities have become limited because of low abundance and the need to protect weak or threatened stocks. Tribal and non-tribal fishing is regulated or co-managed by CTWS 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 CTWS is actively involved in habitat protection, restoration, fisheries enforcement, enhancement and research activities.

Figure 1-2. Current land use as defined for the watershed assessment. Source: Wasco County and Gorge Scenic Area Zoning.

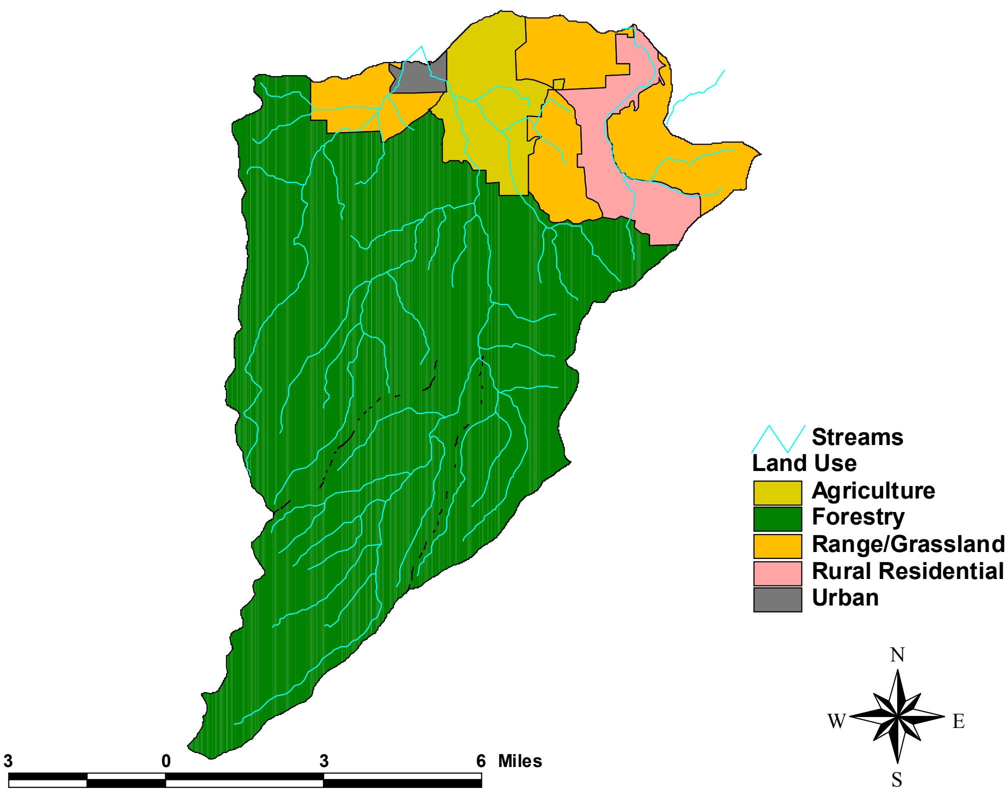
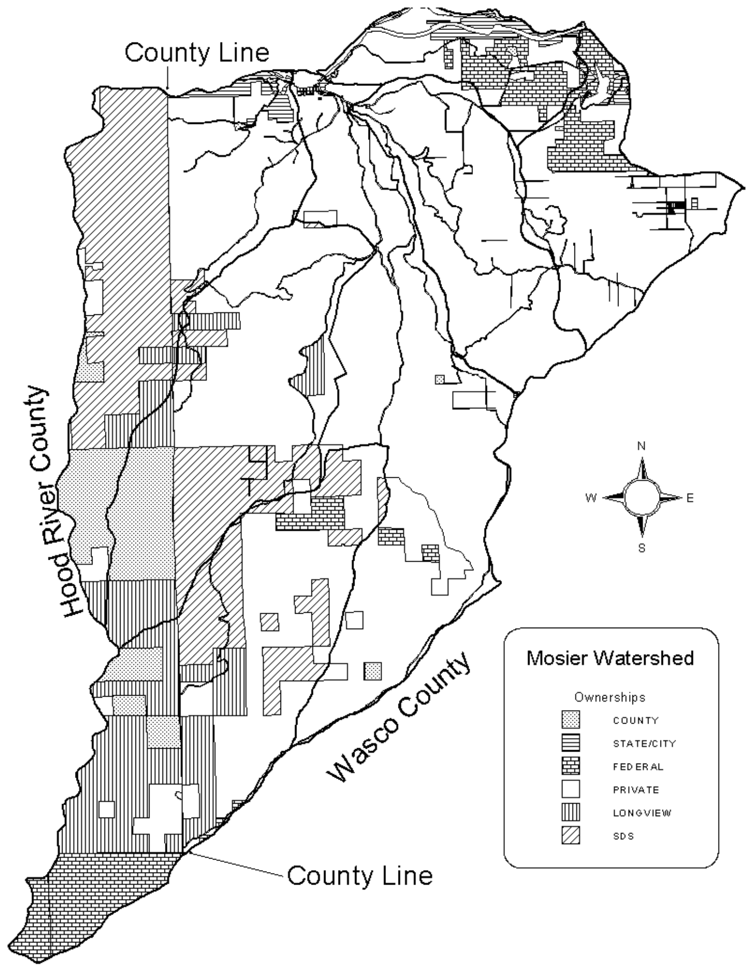


Table 1-1: Land Ownership by Subwatershed

Landowner	Upper Mosier	Lower Mosier	Rock Creek	West Fork	Dry, Rowena & Columbia	TOTAL
SDS	1,900	756	3,900	1,788	0	8,345
Longview Fibre	2,872	0	509	1,090	0	4,472
US Government	1,699	101	0	0	1,424	3,224
Other public	499	73	1,129	1,100	1,199	4,000
Other Private	3,788	8,881	3,320	4,067	9,601	29,655
TOTALS	10,758	9,811	8,858	8,045	12,224	49,696

Fig. 1-3. Ownership in Mosier Creek Watershed



2) Watershed Conditions at the Time of Settlement

This chapter summarizes available information on historic conditions and changes in land use. While the Watershed has been permanently altered and restoration to a pre-European settlement condition is not a goal, knowledge of historic conditions and the cumulative effects of land use can help guide restoration actions and improve their chances for success. Documenting how natural, unmanaged streams interact with the streamside forest allows us to see how far we have deviated from optimum fish habitat requirements (Sedell and Luchessa 1981). Much of this chapter was compiled from historical records, local written histories and original survey notes. Grant Wilson, a local resident of pioneer family origin, provided added information.

Vegetation

Since few historical records are available to describe the landscape prior to Euro-American settlement, information from the time of Statehood (1859) to the turn of the century was examined for use in the watershed assessment. During the summer of 1854, Jonah Mosier and a small crew built a sawmill on Mosier Creek to take advantage of the heavy stand of excellent Douglas fir and Ponderosa Pine (Gholston, Date unknown). Government Land Office surveys from the 1880's suggest large trees with under-story brush were found throughout the Watershed. Nearly the entire Watershed was listed as "Heavily timbered" or "Densely forested" depending on the surveyor (OUSSG, 1859-1894). Figure 1-5 was created using data from the original survey field notes. Figure 1-5 overlays precipitation data on historic forest data, demonstrating that historic forests are correlated closely with rainfall. Around the time of settlement, tree species in the Watershed appear to have been similar to those present today although their relative proportions differed. Douglas fir dominated the Upper Mosier Creek (MC), West Fork (WF) and upper Lower Mosier Creek (LMC) sub-watersheds. Other species included western hemlock, red cedar, tamarack, Pacific silver, noble and grand fir, and Englemann spruce. Some areas had young or mixed age stands due to fire history. By 1914, 26,400 acres, or more than ½ of the Watershed was identified as being "Non-timber areas", see Figure 1-6 (SFB, 1914). Place names often indicate the landscape features and the native vegetation around the time of settlement. Willow Flat in upper West Fork and Pine Flat in upper Mosier Creek are examples (USGS, 1957). Historic photographs and relict trees can provide other clues to the native vegetation.

On the drier east-side of the Watershed, near Rowena, pine-oak forests were prevalent. Early photographs of Mosier show a mix of mature Douglas Fir/Ponderosa Pine around the town center. The vegetation of undeveloped parcels, and a panoramic photograph looking east from the bluff west of town also attest to this (Leininger, 1980).

Forest type in this transitional zone between "East-side" and "West-side" ecoregions is determined not only by temperature and rainfall patterns, but also by fire regime. Ponderosa pine, Oregon white oak, and Douglas fir are all considered fire resistant species. White fir, spruce and tamarack are not resistant. Pine, oak, and Douglas fir trees are found in regions in which low-intensity fires occur on a relatively frequent basis (Steve Hansen, Longview Fiber, Assessment Evaluation Committee meeting, 10/12/01). Fire resistant trees survive these fires, which clear out understory and developing fir or spruce trees. In the wetter areas, where fire is less common, the fir and spruce eventually shade out the pine and oak, replacing them, until a catastrophic stand replacing fire occurs (once every 100-200 years). The boundaries between these two forest types are complex, and depend not only on elevation and rainfall, but also on slope, aspect and human land management.

Department of Forestry personnel (Doug Theises, ODF, pers. comm.) describe an unharvested ponderosa stand near Mosier Watershed. The pines are widely spaced, and more than 300 years old. In the last century, under the influence of human fire suppression efforts, Douglas fir and white fir have grown into a thick understory.

Oak forests featured larger trees than they typically do now. Steamboats valued firewood from Mosier, where they could collect straight 8' long oak logs. Under current fire suppression practices, oaks grow thicker and remain smaller than historically.

Riparian, Wetland and Stream Channel Habitat Conditions

Downed wood and log jams are common in undisturbed Oregon forest streams and would have created greater hydrologic and stream habitat complexity than exists currently. Large trees were transported into the stream by natural bank erosion, windfall, landslides, floods and other pathways. These trees formed numerous log jams and obstructions, trapped gravel, created pools and hiding cover for fish and a substrate for fungi, bacteria and invertebrates. During the '60s and '70s streams were commonly cleared of Large Woody Debris (LWD) as an encouraged practice (USFS, 1996). Willow, Alder, Oregon Ash and cottonwoods dominated gentler gradient floodplains while conifers dominated the riparian zone in higher gradient areas. Mosier Creek flows are good due to natural ponds and wetland areas in the middle and upper watersheds (ODFW, 2000, also see figure 5-2). Pond construction for agricultural and other purposes occurs throughout the Watershed. Prior to construction of Interstate 84, Mosier City Lake was open of the Columbia River, often deep enough for river boats to land (historic photos). Mosier Creek entered the Columbia in this side channel. From the construction of Bonneville Dam until 1964, there was deep water navigable to small boats all the way up to the bottom of Pocket Falls (Wilson, 2000). The mouth of Mosier Creek currently forms a small wetland with valuable habitat for fish, amphibians, birds and other species of wildlife. Local residents report that Rock Creek was perennial all the way to the Columbia prior to the '50s and additional anecdotal information suggests that several springs that may have contributed flow to lower Rock Creek are now diverted for domestic purposes (Greg Koonce, pers. comm. 2001). The lower mile-and-a-half of Rock Creek has collected a heavy cobble sediment and suffered flood damage. Channel alterations related to the historic gravel pit, overall "flashy" conditions and a natural source of cobble in an old landslide near the top of the quarry share responsibility (Gay Jervey, pers. comm.). Following flood events, cobble was pushed out of the lower portion of Rock Creek with heavy equipment and deposited along the channel, isolating wetlands on either side of Rock Creek.

Natural Disturbance Patterns

Floods, fires, mudflows, landslides, beaver ponds and insect and disease epidemics all occur in the Watershed. Most natural disturbance processes in the Watershed are driven primarily by climate. The Watershed lies entirely within the rain-on-snow elevation zone, which is usually under 4,500 feet. Rain-on-snow flooding, landslides and debris flows are common. Large-scale events can significantly shape riparian and aquatic habitat conditions. Large woody debris and sediment can be transported to the stream. Historically this factor would have added to the in-stream habitat diversity. Less mature riparian vegetation may be found near such disturbances. Stand-replacing fires were a rare event in ponderosa pine habitat; however, frequent natural or man-made low-level fires regularly cleared underbrush and less fire-resistant species, such as white fir and spruce. There were more beaver everywhere in the Northwest before the Hudson Bay Trading Co. arrived. The names Beaver Springs and Beaver Creek lie just west of the Mosier Creek sub-watershed boundary and might be related to beaver presence in the upper Watershed. While historical information about beaver ponds was not found, a beaver dam was present at the mouth of Mosier Creek between I-84 and the Historic Columbia River Highway throughout the winter, spring and summer of 2001.

Patterns of Land Development and Resource Use

There are a number of histories and archeological interpretations for the Columbia Gorge region. Most share enough similarity that the interrelationships are easily observable. Sources for this section are Gholston (*Date unk.*), Leininger (1980) and Wilson (2000). Dates given here are approximate.

By 20,000 to 15,000 years ago the first humans occupied the Pacific Northwest. These low-density populations are characterized as early broad-spectrum foragers. The first travelers living in the Watershed would have been subject to the Bretz floods at a rate of one or two every century until around 12,000 years ago. These gigantic Columbia River events scoured the lower reaches of the watershed, up to 1000 feet in elevation, and removed traces of past campsites.

The local climate became hotter and dryer 8,500 to 5,500 years ago. This restricted the amount of territory available to inhabitants. However; closed and open canopy forest, meadows, lakes and rivers with their associated riparian areas would have provided a range of seasonally available resources.

The first houses documented in the region date to between 5,500 and 5,000 years ago. All of these were semi-subterranean; the walls and roof being built over a hole dug in the ground. Two villages discovered near the north shore of the Columbia each contain more than 10 circular or oval house pits.

Around 2,500 to 500 years ago, the climate became cooler and moister once again. Plants, animals and human inhabitants re-entered these abandoned areas. It is not known if the same cultural groups reoccupied these areas. The Bridge of the Gods Landslide, which occurred during this period, caused flooding, and a cultural break in the area. Before the catastrophe only circular or oval house pits were found, which are related to the Tenino Indians. These Sahaptin speaking tribes had language and customs in common with the more easterly Nez Perce tribes. Sometime later rectangular house pit villages appear which are related to the Hood River and The Dalles Chinookans, a.k.a. the Wascos. Native houses were not noted in the referenced histories for the Watershed, but Native Americans did have gatherings near Mosier. The Mosier Mounds are an archeological site located west of Mosier near the beginning of the newly reopened Mosier Twin Tunnels segment of the Historic Columbia River Highway. The study concluded that these formations were probably vision quest sites with some cultural significance related to the Salishan tribes to the north. These formations are dated at more than 9000 years old.

Throughout the Eastern Gorge, Native Americans maintained huckleberry fields, collected camas, bear grass and other plants, hunted deer, elk and other game, and fished. Temporary camps were set up to collect and prepare foods. Peeled cedars are rare, but still found in the Watershed, the bark of which was used for clothing and basketry. Intentional burning by Native Americans to maintain travel routes and berry patches is well documented in the Eastern Gorge. Major trails across the Cascades and near the Columbia River connected a well-established system of trade routes that were used by Native Americans and later by non-Indians. One well-traveled path became the Jason Lee Cattle Trail of 1838 via Lost Lake, Bull Run and Milwaukee.

Jonah Mosier established the first mill in the Watershed in 1854. He came over the hill from The Dalles because he had exhausted the local tree supply there. The mill, near the mouth of Mosier Creek, was powered by an over shot water wheel. Much of the lumber was transported by sail powered barge or scow. The rest went by lumber wagon over Seven Mile Hill, the only trail to The Dalles. Mosier's mill and home both burned to the ground, twice. A flood washed away his third mill in 1858. After that, Jonah Mosier left the milling business and focused his efforts on cattle and real estate. Timber harvest in the Watershed progressed steadily up the riparian areas. Roads were constructed adjacent to and across streams. The biggest factors altering the vegetative pattern in the lower Watershed were logging, grazing and the growth of the fruit industry, where orchards have replaced mixed species forest and riparian habitat networks. Mosier's men began leaving the logging operation to take up land claims on the newly cleared land. This displeased Mosier somewhat because it meant that he lost experienced men and the new settlers complained about Mosier's cattle getting into their fields. Some of these animals were used in logging operations. Others were grazed and sold for meat. Grazing during the early settlement years was widespread.

The use of portable sawmills was common in the Mosier Watershed, particularly in the 19th century. Mills were transported up creek bottoms to standing timber. Timber was then downed and dragged to the mill location with draft animals. Logs were rarely transported more than 100 yards (Gholston, *Date unk.*). Portable sawmills gradually gave way to permanent mills. Permanent sawmills operated in at least two locations on Mosier Creek, and one location on Rock Creek through the 1950's (Mosier Evaluation Committee, 10/12/01).

Timber harvest cleared streams and riparian corridors of fallen trees and large woody debris that formerly created productive fish habitat. During the 1960s and 1970s, cleaning wood out of streams was encouraged in Oregon and believed to help fish passage.

Figure 1-5. 19th century forest types vs. rainfall inches.

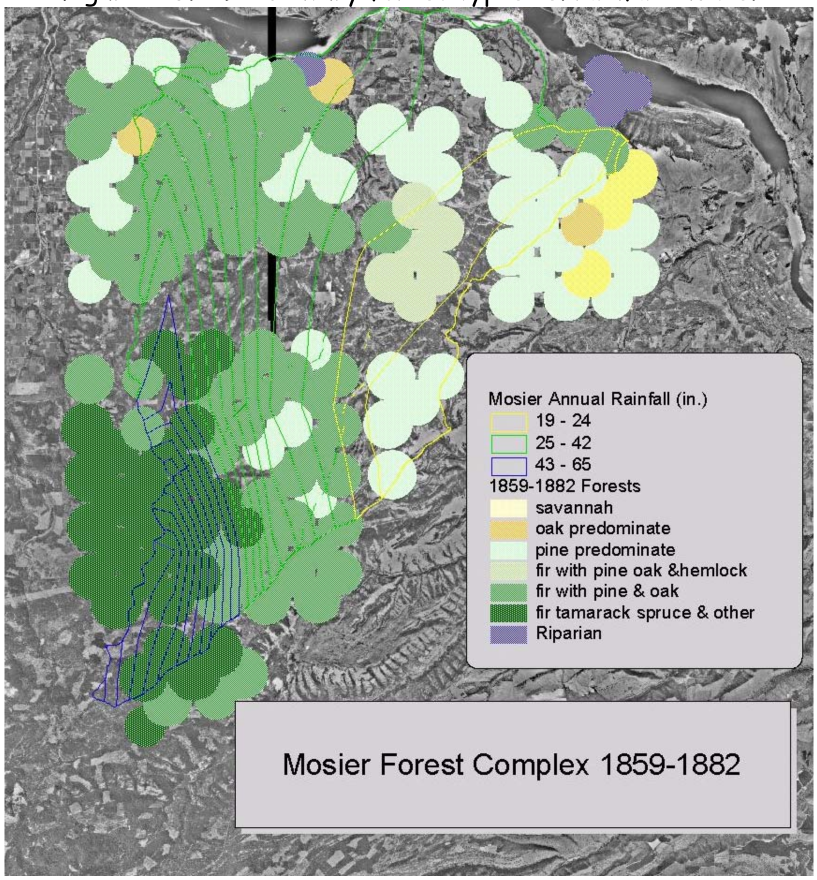
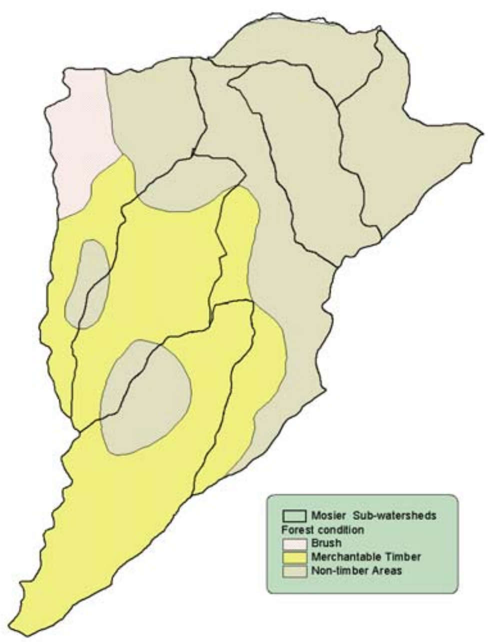


Figure 1-6. 1914 Forest Complex (Source: SFB, 1914)



The use of drain tiles and ditches to drain wet areas for agriculture and roadways was common and continues to the present. Many wetlands and stream channels have been drained or diverted to reduce saturated soil conditions.

Joel Palmer made the first passable wagon road through Mosier to Hood River in 1863. Wasco County improved the road in 1867. In 1882 the railroad came through Mosier. Wood was the fuel for both the steam-driven paddle wheel boats on the river and the locomotives. Mosier became an important fueling stop for both these vehicles. In the winter months many of the early day Mosier farmers spent their time cutting wood and hauling it to the railroad station area and to the steamboat landing. There were two boat landings at Mosier, one 1/4 mile west of Rock Creek, and the other at the Bateham Ranch two miles east of town.

Prior to construction of Bonneville Dam, the shores of the Columbia River were lined with wetland habitat. Mosier Creek flowed into the side-channel which today forms Mosier City Lake. This channel varied seasonally from open water in the early spring to mudflat in the late summer.

Bonneville dam was constructed in 1938. The Bonneville Pool backed water up to the base of Mosier Falls, nearly one mile upstream of the mouth of the creek, creating a navigable harbor, in which local residents built a boat launch. In 1955, Interstate 84 was constructed, initially with two lanes. In 1976, the interstate was widened to four lanes. The interstate and dam together eliminated floodplain habitat from the banks of much of the river, while simultaneously creating lakes on the south side of the road.

The 1964 flood deposited debris behind both the interstate and the historic highway, ending the navigability of this reach. The lower half-mile of the creek now meanders through a well-vegetated and functioning wetland. Further sedimentation has created a delta at the mouth of the creek. Willows and other riparian vegetation are currently establishing themselves on both the delta and the banks of the interstate, recreating some of the floodplain functions that existed before construction of the dam.

Historical Conditions Timeline

10,000 years ago to present: Indian people present in the Watershed and use its natural resources.

1805: Lewis and Clark camp at Fort Rock.

1813: Northwest Company took over Pacific Fur Company trade up river from The Dalles. Trade becomes extensive and highly systematic.

1832: First group of settlers down the gorge led by Nathaniel Wyeth.

1838: Jason Lee Cattle Trail used extensively for commerce.

1838: Methodist mission established at The Dalles

1843: 800 people cross the plains on the Oregon Trail from Independence, MO and arrive in The Dalles.

1845: Barlow, Palmer and Foster lead immigrant party to The Dalles.

1846: Barlow Trail opens land route to Oregon City.

1851: First steamboats appear above the Cascades.

1853: Flood at The Dalles.

1854: Jonah Mosier establishes first sawmill.

1855: Indian lands in Watershed ceded to U.S. in Treaty with Tribes of Middle Oregon.

1858: Jonah Mosier focuses on cattle and real estate.

1859: Flood at The Dalles.

1859: Oregon statehood.

1860: Gold discovered in eastern Oregon and Idaho.

1863: Joel Palmer established first passable wagon road.

1863: Columbia floods.

c.a. 1865: Official record-keeping begins.

1867: Palmer road is improved after being acquired by the State of Oregon.

1870: Columbia floods.

1871: Columbia floods.

1875: The first public school in Mosier.

1876: Columbia floods.

1878: Amos Root puts out the first commercial orchard in the Watershed.

1880: Columbia floods.

1882: The railroad came through Mosier.

1884: Mosier Post Office established.

1891: Mosier became a platted town.

1894: The "Great Flood" at The Dalles.

c.a. 1895: The first water system for Mosier is established.

1903: Homesteader on every quarter section going south of Mosier 8 to 10 miles.

1907: Mosier Fruit Growers formed by Amos Root, J.M. Carroll, Lee Evans and Daniel P. Harvey.

1908: Water system upgraded using salvaged steam and water pipes from the San Francisco earthquake.

1909: Newspaper "Mosier Bulletin" established by Guy H. Kibbe.

1910: Polk Directory lists Mosier population as 500.

1912: Electricity brought to Mosier by Pacific Power and Light Company.

1912: Mosier Telephone Company established.

1912: Mosier library built.

1913: Construction begins on Scenic Columbia River Highway.

1914: Mosier is incorporated.

1918 -1922: HR to TD section of Highway completed.

1919: Fire in Mosier wiped out the business district.

1935: New well drilled, 100,000-gallon reservoir built and new water mains laid.

1938: Bonneville Dam completed -first federal dam on the Columbia River.

1948: Flood at The Dalles.

1955: Highway 84 constructed (two lanes). Later widened to 4 lanes in 1976.

1964: Floods throughout Northwest.

1971: New well drilled, artesian water of excellent quality was found.

1986: National Scenic Area established encompassing 253,500 acres of the Columbia Gorge.

1996: Floods throughout Northwest.

1999: Formation of Watershed Council.

2000: Acquisition of Pocket Park by City of Mosier.

3) Channel Habitat Type Classification

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. The primary spawning and rearing habitat used by anadromous fish typically occurs in areas averaging less than a 2% gradient (NPPC 1990). Moderate gradient reaches (2-4%) are transport areas for sediment and wood and are moderately productive for fish. 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 1996a).

Most stream segments in the Watershed are confined between hill slopes, bedrock canyons, or terraces that restrict lateral movement of the stream channel and prevent meanders and wide floodplains. Lateral movement or channel migration affects habitat quality and is of concern to land managers (Watershed Professionals Network 1999). Unconfined lower gradient streams in wide floodplains may form complex, highly productive spawning and rearing habitats, for example in side channels and sloughs.

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 1996a).

Methods and Results

Channel habitat types were delineated for 111 miles of streams using topographic maps (digital raster graphs viewed using ArcView 3.1) and extensive field verification. Channel habitat type designations and related data were recorded in an ArcView database and mapped. Streams categorized were not always perennial, but were considered to be the major drainages of each watershed. In particular, the Columbia Tributaries Subwatershed contains only seasonal streams. The streams defined in this section were used throughout the later components of the watershed assessment.

Ten channel habitat types were identified in the Watershed (see table 3-1). In order of prevalence, these are SV (steep headwater, confined), MV (moderately steep, narrow valley), MC (moderate gradient, confined), MM (moderate gradient, moderately confined) MH (moderate gradient headwater), VH (very steep headwater), BC (bedrock canyon channel), LM (low gradient, moderately confined), LC (low gradient, confined) and a very small area of AF (alluvial fan) at the mouths of both Mosier Creek and Rock Creek.

Low and moderate gradient stream reaches constitute 26.7% of the stream network and include five channel habitat types: MC, MM, MH, LM, LC and AF. However, localized areas of low gradient can occur within stream reaches designated by steeper channel habitat types.

All channel habitat types in the Mosier Watershed are confined except for three: MM, LM and AF, which together constitute 9.21% of the watershed. MM, moderate gradient, moderately confined, has a floodplain that averages two to four times the bank full width of the stream itself.

The entire watershed transports sediment fairly rapidly, which helps explain the development of the alluvial fans at the mouths of Rock Creek and Mosier Creek, as well as the complex wetland near the mouth of Mosier Creek.

While MM channels most likely serve as the primary spawning and rearing habitat in the Watershed, pockets of important spawning and rearing habitat occur within other habitat types, such as

MC, BC, LM, LC, and AF. For instance, all spawning habitat in Mosier Creek for anadromous (ocean-migrating) fish species occurs in BC, LM and AF habitats.

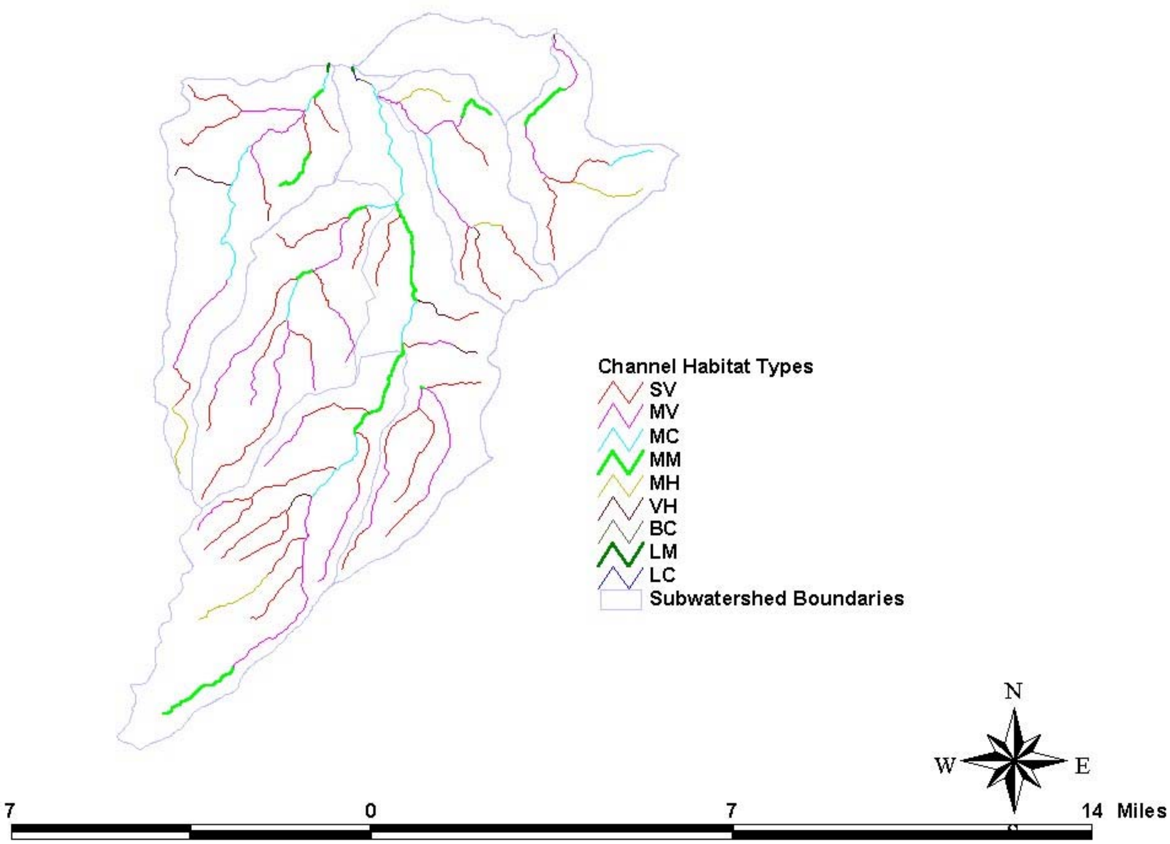
Table 3-1: Descriptions of channel habitat types found in Mosier Watershed

		Stream gradient	Valley shape	Channel pattern	Confinement	Position in drainage	Dominant Substrate
LM	Low gradient, moderately confined	<2%	Broad, generally much wider than channel	Single w/ some multiple channels	Variable	Mainstem & lower end of main tribs	Fine gravel to bedrock
LC	Low gradient, confined	<2%	Moderate gradient hill slopes w/ limited floodplain	Single channel, variable sinuosity	Confined by slopes or high terraces	Generally mid to lower in larger basin	Boulder, cobble, bedrock with pockets of sand, gravel, cobble
MM	Moderate Gradient, Moderately Confined	2-4%	Narrow valley with floodplain or narrow terrace	Single channel, low to moderate sinuosity	Variable	Mid to lower	Gravel to small boulder
MC	Moderate Gradient, Confined	2-4%, may vary up to 6%	Gentle to narrow V-shaped valley	Single, straight or conforms to hill-slope	Confined	Middle to lower	Course gravel to bedrock
MV	Moderately Steep, Narrow Valley	4-8%, may vary between 3-10%	Narrow, V-shaped valley	Single channel, relatively straight	Confined	Mid to upper	Small cobble to bedrock
BC	Bedrock Canyon	>4% (exceptions)	Canyons, gorges, very steep mountain side slopes	Single channel, straight	Tightly confined by bedrock slopes	variable	Bedrock, large boulders
HEADWATERS							
MH	Moderate gradient Headwaters	1-6%	Open, gentle V-shaped valley	Low sinuosity to straight	Confined	Upper, headwater	Sand to cobble, bedrock; possibly some boulders
SV	Steep Narrow Valley	8-16%	Steep, narrow V-shaped valley	Single, straight	Tightly confined	Middle upper to upper	Large cobble to bedrock
VH	Very Steep Headwaters	>16%	Steep, narrow V-shaped valley	Single, straight	Tightly confined	Middle upper to upper	Large cobble to bedrock

Table 3-2: Summary (in feet) of channel habitat types for stream channels in Mosier Watershed by sixth field watersheds. Channel habitat types listed in order of frequency.

6th field watershed	**SV**	**MV**	**MC**	**MM**	**MH**	**VH**	**BC**	**LC**	**LM**	**AF**
Upper Mosier Creek	64,332	45,512	8,730	19,330	8,900	3,369	0	0	0	0
West Fork	51,040	41,994	7,780	4,516	0	0	0	0	0	0
Lower Mosier Creek	47,941	26,752	18,836	12,263	0	6,580	1,799	666	471	40
Dry Creek	25,609	17,908	5,829	4,385	10,246	17,908	0	0	0	0
Rock Creek	32,469	28,389	20,667	6,247	8,000	7,585	0	0	783	30
Rowena Creek	17,017	12,241	5,141	6,086	7,928	604	0	0	0	0
Total Feet	**238,408**	**172,796**	**66,983**	**52,827**	**35,074**	**19,437**	**1,799**	**666**	**1,254**	**70**
Percent of Watershed	*40.5*	*29.3*	*11.4*	*9.0*	*6.0*	*3.2*	*0.3*	*0.1*	*0.2*	*0.01*

Figure 3.1: Channel Habitat Types in the Mosier Watershed



4) Hydrology and Water Use

This chapter characterizes climate conditions and flow history of the Watershed, and assesses the potential effects of land use on natural watershed hydrology. It also describes the nature and extent of water storage and withdrawals for agriculture, municipal and other uses, and assesses their potential impact on fish habitat conditions.

Hydrology

Stream Flow History

Mosier Creek is located in a transition zone between the temperate maritime and semiarid continental zones. Elevation varies between 80 feet and 4000 feet, locating the entire watershed in the rain-on-snow runoff zone. Mean annual precipitation, as shown in figure 4-1, 19 inches in the easternmost portions of Rowena and Dry Creek up to at least 35 inches at the headwaters of Mosier Creek (figure 4.1). US Geological Survey maintained a stream flow gage near the mouth of Mosier Creek from 1963 to 1981. The highest peak flows typically occur during or following rain-on-snow events in mid- to late winter. The highest flows were recorded in 1964, 1974 and 1978, when peak winter flows exceeded 1600 cfs. The lowest flows were recorded in 1977, when peak flows never exceeded 9 cfs, and summer base flows fell to below 1cfs (Oregon Water Resources Department website, www.wrd.state.or.us). Average monthly discharge rates are summarized in table 4-1.

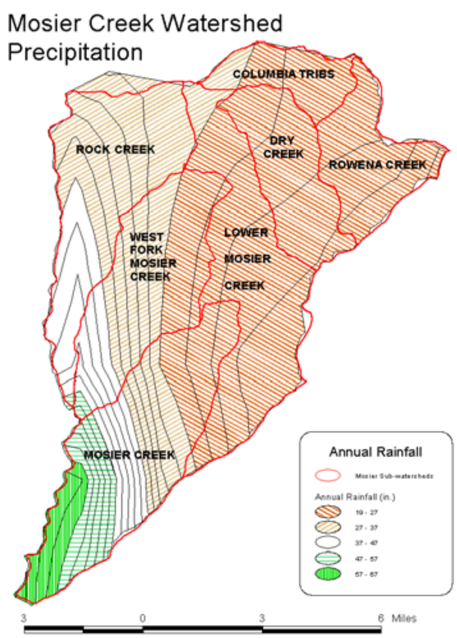
Table 4-1. Average monthly natural stream flows by subbasin in cubic feet per second (based on gaging station data or hydrologic modeling, Oregon Water Resources Department)

	Lower Mosier Ck	Mosier Ck above WF	West Fork	Dry Creek	Rowena Creek	Rock Creek
January	38.30	29.90	6.33	1.60	0.94	5.07
February	64.00	48.50	10.40	3.87	2.46	10.50
March	62.80	45.10	10.30	5.74	3.58	13.20
April	36.60	29.30	6.57	0.64	0.52	3.07
May	11.30	9.46	1.74	0.09	0.10	0.71
June	5.01	4.37	0.63	0.01	0.02	0.16
July	2.41	2.10	0.30	0.01	0.01	0.06
August	2.00	1.75	0.25	0.00	0.00	0.04
September	2.30	2.03	0.27	0.00	0.00	0.02
October	3.30	2.91	0.39	0.00	0.00	0.03
November	5.82	4.99	0.81	0.02	0.02	0.17
December	15.10	11.7	2.31	0.86	0.47	3.20

Figure 4-1. Precipitation: Two sources agree closely on precipitation at lower elevations, but estimates of precipitation at the highest elevations differ from 35 inches up to 67 inches. The map on the right agrees closely with data collected over 14 years at Crow Creek Reservoir in Wasco County.

Source: Water and Climate Center of the Natural Resources Conservation Service

Source: Hood River County Department of Forestry



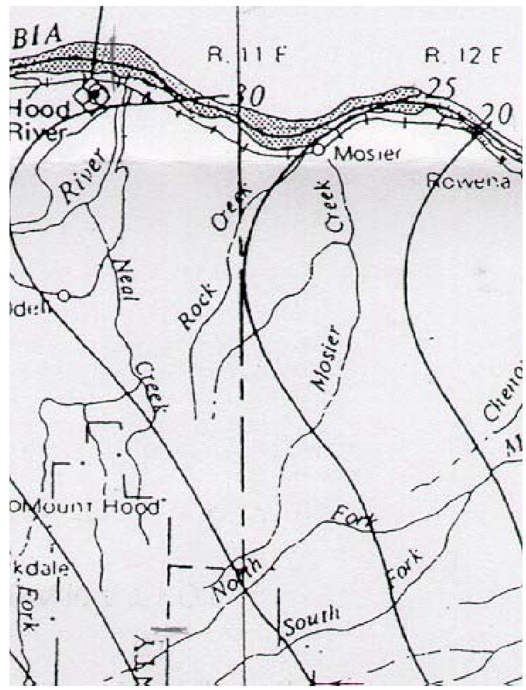
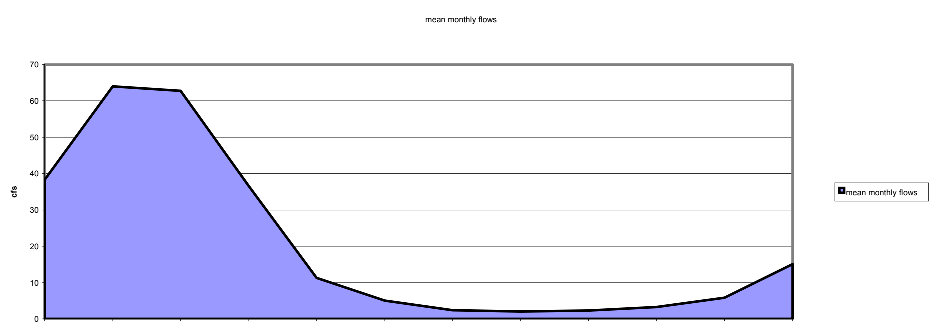


Figure 4-2. Average monthly stream flows at mouth of Mosier Creek (from table 5-1)



Changes in Hydrology due to Land Use

Peak flow alterations are driven by changes in type and density of vegetation, and in soil infiltration rates. These changes can affect magnitude, duration and impact of floods. In both forest and agricultural regions, runoff rates vary inversely with density and health of vegetative canopy. Agricultural land use is a significant factor in the lower portions of Lower Mosier, Dry Creek, and Rock Creek, and throughout the Rowena Creek and Columbia Tributaries subwatersheds. Very little agricultural land is present in West Fork and Upper Mosier.

Methods

The analysis of all rural lands was completed using methods developed by the Natural Resources Conservation Service (USDA 1986). The land is divided into separate map units by soil texture, cover type, treatment practice and condition. Based on this information, each separate unit of land is given a *runoff curve number* from 1 to 100, which represents the hydrologic behavior. Higher numbers release water suddenly, and thus lead to flooding in the wet season and drought in the dry season. Lower numbers retain moisture in the landscape, and thus mitigate both flood and drought events. 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.

Based on the runoff curve number and the two-year, 24-hour precipitation event, the projected runoff depth was calculated in inches. The historic runoff depth was then calculated based on historic vegetation, assuming best quality. The two were compared to determine the effect on runoff from land use.

Brush or closed-canopied woods in good condition have the lowest runoff curve numbers – as low as 30 on porous soil. Historic vegetation was considered to be open-canopied forest, except where current vegetation was closed-canopied forest, brush or talus-rock, in which case, historic vegetation was assumed to be the same. This applies a very high standard to the watershed. In reality, there was likely a certain amount of open land at any given time due to fire.

The most common type of agriculture in Mosier is orchards with mature trees and cover crops. This cover type has similar hydrologic behavior to the historic vegetation – open canopied forests with little underbrush. Good-quality rangeland implies perennial grasses with a ground cover greater than 30%.

Forestry, agricultural and rural residential areas were analyzed separately. Urban areas were analyzed using a separate procedure. Agricultural and rural residential lands were analyzed using black and white aerial photography from 1994. Observations were then field verified. Private forest lands were analyzed twice – once using black and white photography from 1994, and once using color aerial photography from 1999. Comparison of the two allowed a general determination of trend, although the comparison was not perfect, because the black and white photography did not allow determination of groundcover in clearcut areas, while the color photography did. US Forest Service lands were not analyzed, as soils data was not readily available.

Results

The analysis showed that land use in rural lands has not significantly changed the hydrology in any subwatershed (see table 4-2). Figure 4-3 shows cover types, and figure 4-4 compares runoff conditions throughout the analyzed areas of the Watershed. No subwatershed showed a peak runoff enhancement greater than one twentieth of an inch for any land use.

Comparison of aerial photos from 1994 and 1999 revealed that the hydrologic condition of the upper watershed has remained nearly constant, or possibly improved in that five-year period. While 450 acres were clearcut in that time, 996 acres which were clear in 1994 had begun to regrow by 1999.

While those areas classified as “farmsteads” (houses, barnyards, driveways and loading areas) did tend to show increases in runoff depth greater than 0.25 inches, these areas were a very small percentage of the overall area in any given subwatershed.

Confidence Level

This analysis was carried out at a very fine scale, and was extensively field verified in agricultural areas. Personnel from Natural Resources Conservation Service trained the personnel conducting field verification. Forest areas were analyzed using two separate sets of photographs. Therefore, for the areas surveyed, a high level of confidence is assigned.

Figure 4-3. Historic and Current Cover Types in Mosier Watershed. Current Cover types were determined with aerial photography. Historic cover types were inferred from current vegetation and historic survey records.

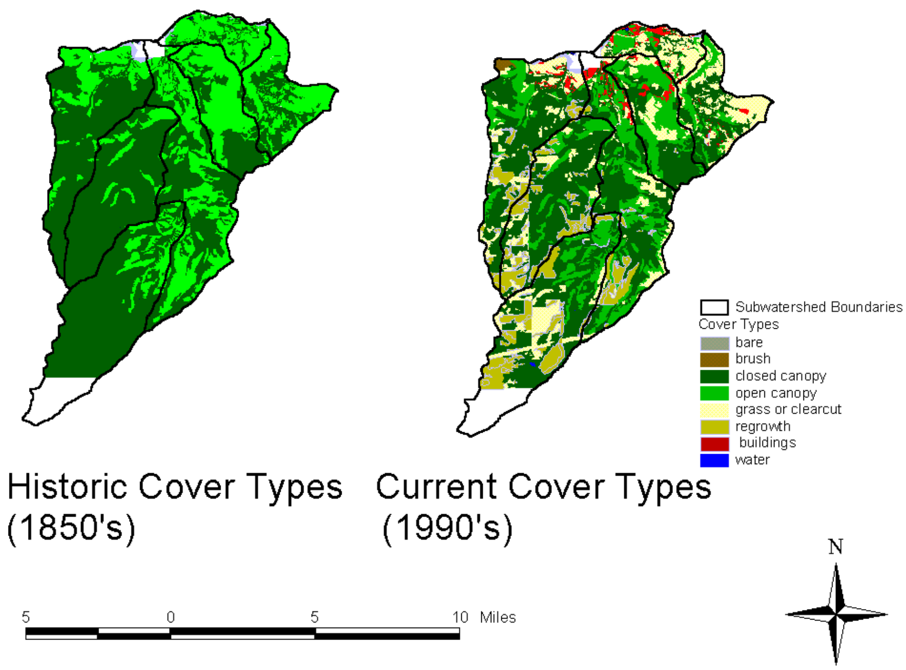


Figure 4-4. Runoff ratings in Mosier Watershed.

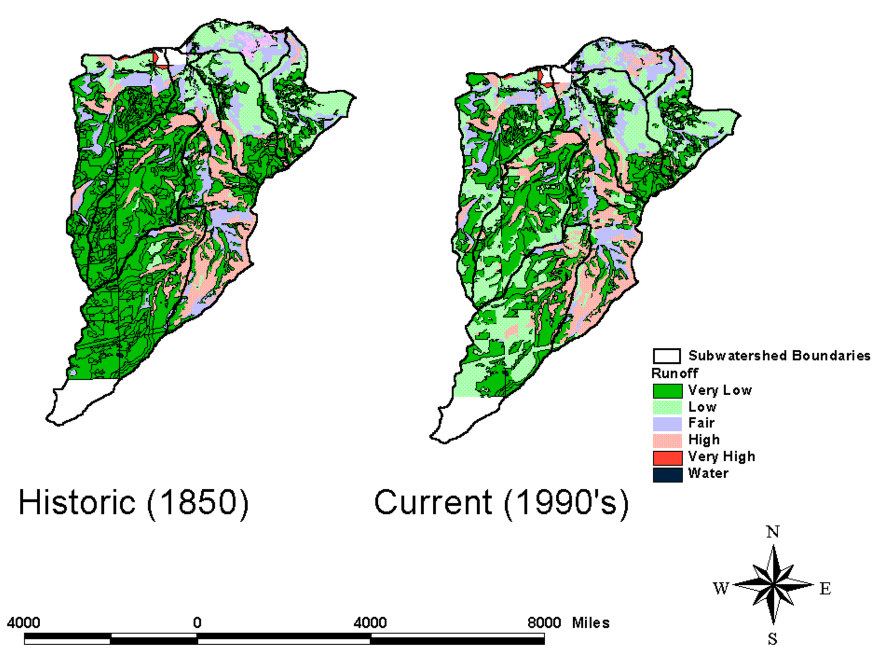


Table 4-2. Average rise in depth of 2-year, 24-hour runoff events due to land use (in inches).

	Rowena	Dry Creek	Lower Mosier	Columbia Tribs	Upper Mosier	West Fork	Rock Creek
Runoff increase:							
Agricultural	0.028	0.032	0.065	0.042	--	--	0.041
Rural Residential	0.031	0.004	--	0.037	--	--	--
Forest Lands	0.001	0.003	0.012	--	0.029	0.012	0.005
Peak flow enhancement	Low	Low	Low	Low	Low	Low	Low

Road Density

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. 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, and the amount of impervious surface associated with a given amount of roads. 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 (Bowling and Lettenmeier, 1997).

Methods

ArcView GIS 3.1 was used to build and refine a roads data layer for each subwatershed based on black and white aerial photography from 1993-1995. 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. See figure 6-1 for a map of all identified roads.

Subwatersheds were analyzed separately, and were divided into four land use areas: forestry, ag/range, urban and rural residential. Each land use in each watershed was assigned a rating for relative potential for impact. This rating was based on Bowling and Lettenmeier (1997) in forestry, agricultural and rural residential zones, and based on May et. al. (1997) in urban areas. The Assessment Manual assumes that roads in agricultural and rangeland areas average 35 feet wide, whereas forest roads average 25 feet wide. In agricultural zones, a watershed was rated high potential for impact if road densities exceeded 12.2 mi./mi^2. In forestry zones, where average road width is assumed to be smaller, a watershed was rated high potential for impact only if road densities exceeded 17 mi./mi^2. Medium ratings were assigned for half the density of a high rating (6.1 and 8.5 mi./mi^2 respectively). Rural residential areas on Sevenmile Hill were assumed to be similar to agricultural areas. In urban areas, most roads are paved and experience high use. In addition, urban areas feature a high percentage of impervious surfaces, due to parking lots, driveways, homes, sidewalks, etc. May et. al. (1997) determined that peak flows in urban areas may be increased when road density exceeds 5.5 mi./mi.^{2}. Road density of 4.2 mi./mi.^{2} represents approximately half the impact of 5.5 mi./mi.^{2}.

Results

Road densities in various watersheds and land use zones are summarized in table 4-2. Analysis shows low potential for peak runoff increase due to road density in forestry zones, medium potential in the ag/range zones and a high potential in urban and rural residential zones. Figure 5-4 maps the potential for impact throughout the watershed.

Confidence Level

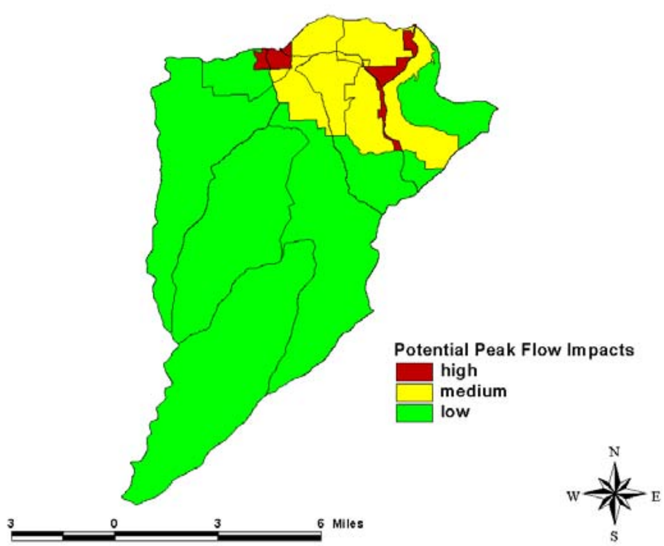
Roads data used in this analysis were based primarily on roads visible on aerial photography from 1993-1995. Since 1995, new roads may have been built, and some roads may have been abandoned. In addition, some roads may exist which were invisible from the air due to dense tree canopy. The estimates of roads density used in this analysis are most likely low in the Forestry zones.

Table 4-2. Roads Summary. Road densities considered medium potential for impact are noted for each land use.

Subwatershed	**Area (mi.^{2})**	**Percent Roaded Area** *(mi./mi^2)*	**Potential for Impact***
Rowena			
Forest	.69	8.0	Low
Ag and Range	3.40	2.9	Low
Rural Residential	3.04	9.1	Medium
Dry Creek			
Forest	2.91	6.0	Low
Ag and Range	4.42	9.8	Medium
Rural Residential	0.20	22.9	**High**
Urban	0.20	17.0	**High**
Columbia Tribs			
Ag and Range	3.38	6.8	Medium
Rural Residential	0.67	22.5	**High**
Urban	0.07	34.9	**High**
Lower Mosier			
Forest	13.40	5.5	Low
Ag and Range	1.58	12.0	Medium
Lower Mosier	0.34	19.0	**High**
Upper Mosier *(Forest)*	16.81	5.1	Low
West Fork *(Forest)*	12.57	4.5	Low
Rock Creek			
Forest	11.63	4.1	Low
Ag and Range	2.01	5.4	Low

* A medium potential for impact corresponds to 8.5-17 mi/mi^2 in forest areas, 6.1-12.2 mi/mi^2 in ag, range and rural residential zones, and 4.2-5.5 mi/mi^2 in urban zones.

Figure 4-4. Potential Impact on Peak Flows from Road Density.



Water Use

Surface Water Use

Stream flow in Mosier Watershed is diverted for irrigation and residential use. Low flows can present problems for fish spawning and rearing by drying up critical reaches, cutting off fish passage and raising stream temperatures. The Oregon Water Resources Department (WRD) maintains a database of water rights throughout the State of Oregon. The WRD divides watersheds into water availability basins (WABs), which correspond closely to the subwatersheds used in this assessment. They then model the streamflow in each basin (WAB) to determine the average flow (also called 50% exceedance) and under drought conditions (80% exceedance, or the streamflow that will be exceeded 80% of the time).

Table 4-3 summarizes water availability in an average year (i.e. 50% exceedance level) for each month in each of the WABs. Zero or negative water availability indicates that this reach can legally be completely dewatered in an average year. Table 4-3 can be compared to Table 4-1 to judge how water withdrawals could potentially affect stream flows. Table 4-3 shows that Rowena Creek and Dry Creek both have negative water availability from May to October. Both of these streams have no natural flow and only negligible water rights throughout most of this period. Rock Creek and West Fork also have very low natural flow in the summer, and negligible water rights. Only Mosier Creek itself, both Upper and Lower, has significant flow throughout the summer. In the Upper watershed, only 16% of the flow can legally be withdrawn in an average August. In the Lower watershed, stream flow can legally be reduced by 69% in a typical August. However, some of the water rights in Lower Mosier Creek are reserved water rights held by Oregon Department of Agriculture. These rights are not actually utilized at the present time (Larry Toll, WRD, pers. comm.).

Table 4-3. Water Availability in cubic feet per second for average year (50% exceedance level) by subwatershed (Water Availability Basins). Source: OWRD website.

	Lower Mosier	Mosier above WF	West Fork	Dry Creek	Rowena Creek	Rock Creek
January	20.50	29.70	6.33	1.51	0.94	5.07
February	34.30	48.30	10.40	3.75	2.45	10.50
March	33.70	44.90	10.30	5.59	3.57	13.20
April	18.90	28.80	6.52	0.51	0.44	3.04
May	4.14	8.24	1.59	-0.12	-0.11	0.63
June	1.03	3.33	0.51	-0.18	-0.16	0.09
July	0.64	1.69	0.26	-0.09	-0.04	0.04
August	0.62	1.47	0.23	-0.08	-0.03	0.03
September	0.78	1.75	0.25	-0.08	-0.03	0.01
October	1.53	2.76	0.39	-0.06	0.00	0.03
November	2.89	4.84	0.81	0.04	0.02	0.17
December	7.91	11.50	2.31	0.78	0.47	3.20

Groundwater Use

Most of the commercial irrigation and virtually all of the drinking water in the Mosier Watershed relies on wells. Overdraft of the aquifers underlying the watershed can reduce summer flows in the creeks by reducing the flow from springs and seeps. The early settlement of the Mosier Watershed centered around artesian wells and springs. Anecdotal evidence suggests that some of the historically important springs have dried up in recent years (Gholston, Mosier Watershed Council minutes, 1/2000). Therefore, despite the fact that groundwater is not addressed in the Oregon Watershed Assessment Manual, it is worth addressing briefly, here. This section relies heavily on Jervey (12/1996). Unless otherwise noted, all information is from Jervey's report.

The geology of the Mosier area is dominated by basalt lava flows. Layers of columnar basalt are sandwiched between layers of "pillow" basalt or vesicular basalt. Pillow basalt occurs at the bottom of the flow, and is formed when basalt lava infiltrates into water-bearing soils and cools very quickly and chaotically. The upper surface of the lava flow also typically cools too quickly to form crystalline columns, and is highly porous. It is referred to as vesicular basalt. While the columnar basalts have very little pore space and very slow lateral permeability, the pillow and vesicular basalts are much more porous and laterally permeable.

Most of the wells in the Mosier area tap into one of three basalt layers: Pomona, Priest Rapids and Frenchman Springs, listed from shallowest to deepest. In the upper watershed, these aquifers are probably recharged by precipitation on Hood River Mountain (the ridge between Mosier and Hood River Watersheds). The lower part of the Mosier Watershed, on the other hand, is heavily faulted and is characterized by many isolated or "perched" aquifers. These areas probably rely on local precipitation for recharge.

The Oregon Water Resources Department believes that the Pomona and Priest Rapids aquifers are overallocated in the orchard area of the Mosier Valley and in danger of decline. They have stopped issuing new water rights for these two aquifers. New wells can be drilled into these aquifers as long as they do not require a water right. Water rights are not required for domestic wells up to 15,000 gallons per day, livestock water, noncommercial irrigation up to ½ acre, and commercial uses up to 5,000 gallons per day (Toll, OWRD The Dalles Oregon, pers. comm.).

Gay Jervey (12/1996) reached a different conclusion than the OWRD. Through extensive well monitoring, she believes that wells drilled into basalt aquifers sometimes decline rapidly in the first few years of use due to the low lateral permeability of columnar basalt. Groundwater simply does not travel laterally through columnar basalt. However, any well that is deepened sufficiently to tap into the pillow basalt at the base of the flow will remain fairly steady. Jervey concluded that most of the aquifers are not being consistently overdrafted at this time, although there are some exceptions where aquifers are isolated by faults. Jervey recommended further monitoring in the area of State Road and Sevenmile Hill, and where well density is highest. This monitoring would assist in creating guidelines for optimal well spacing.

5) Riparian and Wetlands Condition

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

Riparian Areas

The purpose of this assessment is to evaluate current riparian vegetation along stream channels in the Watershed for their ability to provide large woody debris and shade to the stream. This information can be used to prioritize areas for stream restoration. 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 choke spawning gravels, and yet is the source for organic matter needed by the aquatic food chain. Trees also help stabilize streambanks.

Methods

This analysis looked at perennial streams, and major seasonal drainages. No streams were evaluated in the Columbia Tributaries watersheds, as runoff there is too quick to support riparian vegetation.

Riparian vegetation was evaluated using black and white aerial photography taken between 1993 and 1995. Each side of the stream was evaluated separately, and riparian vegetation was considered up to 100 feet from the stream. Riparian condition units (RCUs) were defined as contiguous reaches in which the riparian vegetation was similar. Each RCU was given a code that represented 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). Stream shade was characterized by the amount of the stream bed visible in the photo (>70%, 40-70, <40%), and then each RCU was rated by whether it had adequate vegetation or not. Adequate vegetation was defined as the expected vegetation in that site. In most areas, the expected vegetation was defined as dense stands of trees of greater than 12 inches trunk diameter. On highly seasonal tributaries in oak-dominated areas, sparse tree stands or grasslands were considered adequate on south-facing slopes. In each case where the condition of the riparian vegetation was found to be inadequate, the primary land use affecting the vegetation was noted. Results were field verified following completion of the aerial photo study.

It is possible that tree species have changed in some riparian areas due to land use, catastrophic events, or other causes. In Oregon, this would typically imply a switch from conifers toward quick growing hardwood trees, such as alders. Tree species was difficult to determine from aerial photos, and was therefore not considered in defining adequate vegetation. Nevertheless, field observations showed few pure hardwood stands. Most riparian areas in the lower elevations are mixed, while those in the higher elevations are mostly conifers.

Results

Results are tabulated in Table 5-1 and mapped in figure 5-1. Of 208.5 total stream miles, just over 75% was found to have adequate vegetation. 15% of total stream miles were affected by timber harvests, in which riparian vegetation was removed and was in early stages of regeneration.

The subwatersheds with the highest percentages of adequate vegetation were Rock Creek, Rowena Creek and Dry Creek. The subwatershed with the worst conditions was Upper Mosier. All of the disturbance in this subwatershed was from timber harvest or power line management. West Fork was also impacted by timber harvest, while Lower Mosier Creek was impacted by a mixture of timber harvest, residential development and riparian roads.

Confidence rating

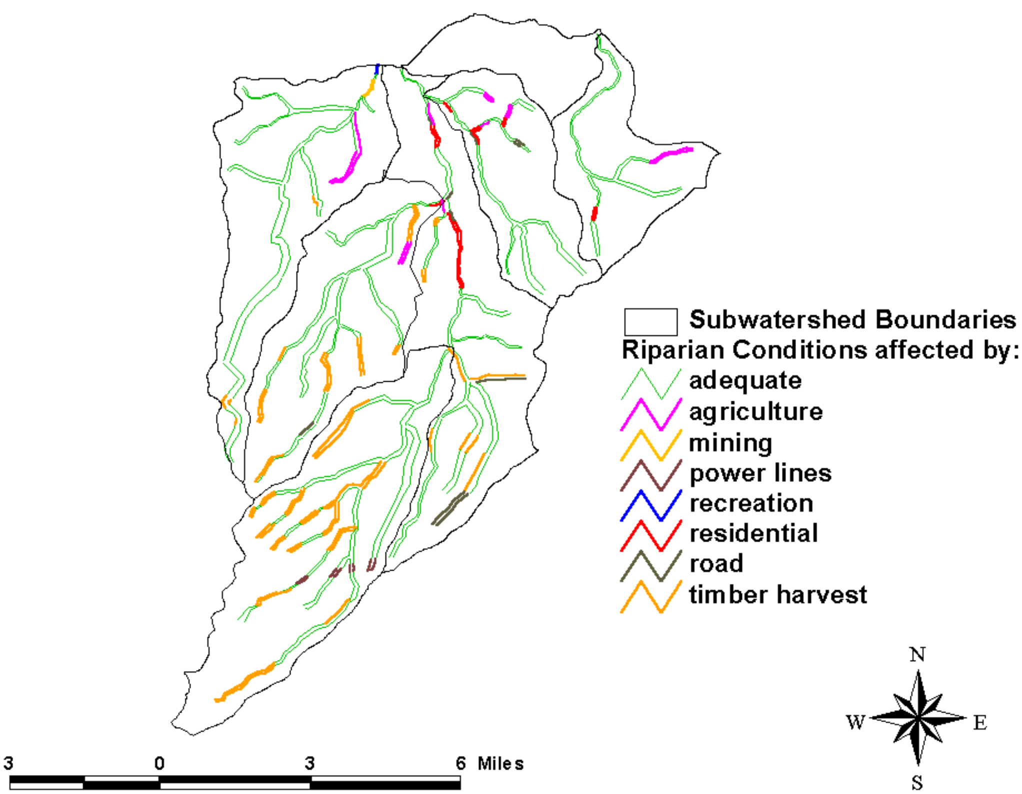
This component was analyzed with a high level of confidence, due to extensive field verification, with the exception of Upper Mosier, which was relatively inaccessible, and may or may not have experienced regeneration since the aerial photos were taken.

Table 5-1. Stream Miles with adequate and inadequate riparian vegetation affected by various land uses.

	TOTAL MILES	Adequate	Timber Harvest	Agriculture	Residential	Roads*	Power Lines	Gravel Mining	Recreation
Rowena	18.1	15.8 (87.3%)	0.0	1.8 (9.9%)	0.5 (2.8%)	0.0	0.0	0.0	0.0
Dry Creek	22.5	19.5 (87.7%)	0.0	1.1 (4.9%)	1.3 (5.8%)	0.6 (2.6%)	0.0	0.0	0.0
Lower Mosier	39.8	27.8 (69.8%)	4.1 (10.3%)	0.7 (1.8%)	3.8 (9.5%)	3.4 8.5%)	0.0	0.0	0.0
Upper Mosier	53.6	33.9 (63.2%)	18.3 (34.1%)	0.0	0.0	0.0	1.4 (2.6%)	0.0	0.0
West Fork	38.1	28.6 (75.1%)	8.0 (21.0%)	0.9 (2.4%)	0.3 (0.8%)	0.3 (0.8%)	0.0	0.0	0.0
Rock Creek	36.4	31.9 (87.6%)	0.7 (1.9%)	2.6 (7.1%)	0.0	0.0	0.0	0.8 (2.2%)	0.4 (1.1%)
OVERALL	**208.5**	**157.5 (75.5%)**	**31.1 (14.9%)**	**7.1 (3.4%)**	**5.9 (2.8%)**	**4.3 (2.1%)**	**1.4 (0.7%)**	**0.8 (0.4%)**	**0.4 (0.2%)**

*Roads may be present in other categories as well.

Figure 5-1. Riparian Conditions and the Land Uses affecting them.



Wetland Areas

Wetlands contribute to critical functions in the health of a watershed. Wetlands are protected by federal, state, and local regulations. Determining the location and extent of wetlands in the watershed is necessary to plan for growth, development or any kind of project. The purpose of this assessment was to inventory wetland locations within the Watershed, and summarize available data on wetlands extent. No attempt was made to characterize wetland condition or restoration opportunities. If wetland restoration is identified as a priority by the Mosier Watershed Council, further studies will be necessary.

Table 5-2. Wetland acreage by Subwatershed

	Rowena	Dry Creek	Columbia Tributaries	Lower Mosier	Upper Mosier	West Fork	Rock Creek	**TOTAL**
Natural	1.3	1.9	12.6	110.2	28.1	12.2	1.2	**167.5**
Constructed	5.1	6.8	71.8	28.4	20.9	8.4	8.9	**150.3**
Total acres:	*6.4*	*8.7*	*84.4*	*138.6*	*49.0*	*20.6*	*10.1*	***317.8***
% of subwatershed	0.14%	0.18%	3.2%	1.4%	0.46%	0.26%	0.11%	**0.64%**

Wetlands are defined as areas with a permanently or seasonally saturated soil, which can be identified by the presence of plants adapted to saturated soil conditions. Wetlands include areas commonly referred to as bogs or swamps. For the purposes of this assessment, seasonal or permanent pools, including manmade ponds, were also considered wetlands. Soils that develop under saturated conditions are known as hydric soils. Hydric soils typically indicate that an area either is or once was a wetland. Riparian areas are generally considered wetlands where hydric soils are present. On the other hand, a riparian area in which the soil does not typically experience saturated soil conditions would not necessarily be considered a wetland.

The two sources for this inventory were the National Wetlands Inventory (NWI), and the Wasco County Soil Survey (USDA 1986). NWI data is available from the internet, and includes information on the substrate and seasonality of the wetlands. The soil survey was used to identify hydric soils, which were then added to the Mosier wetlands inventory. Wetlands were further categorized by natural versus constructed. This information was determined by examination of aerial photography and USGS topographic maps.

The wetlands inventory showed a total of 317.8 acres of wetlands in the Mosier Watershed. Of these,167.5 acres were naturally occurring, while the remainder were constructed ponds and sediment basins with wetlands characteristics. Artificial lakes along the Columbia River accounted for 85 acres. 45 acres consisted of permanent or semipermanent open water, such as ponds and reservoirs. Riparian areas with hydric soils totaled 102 acres. Seasonal marshes and pools made up 84 acres.

Lower Mosier had the largest extent of inventoried wetlands with 138.6 acres. It also had by far the most acres of naturally occurring wetlands with 110.2 acres. Hydric soils along Mosier Creek accounted for 91 acres of these.

The Columbia Tributaries area had the second highest acreage of wetlands with 84.4 acres, but the majority of these (71.8 acres) were lakes created by construction of I84 and the railroad along the Columbia River, which isolated portions of the Bonneville Pool.

The same was true of Rock Creek, where out of 10.1 total acres, 9.6 acres occurred between the highway and the railroad. Only 0.5 acres occurred in the upper watershed.

Upper Mosier had the second highest number of natural wetlands with 28.1 acres of naturally occurring wetlands and 49 acres total wetlands. One of the headwaters of Mosier Creek is a 19.7-acre natural wetland just west of Ketchum Reservoir. Western red cedar grows in this area (Steve Hanson, Longview Fibre, pers. comm.).

Dry Creek, Rowena Creek and Rock Creek all had very low acreages of wetlands, with the majority being constructed.

Western Pond Turtle

An area along Morganson Road has been declared critical habitat for the Western Pond Turtle (*Clemmys marmorata*). The Western Pond Turtle is listed as a Sensitive species by the State of Oregon. The Western Pond Turtle in the Columbia Gorge was studied by Dan Holland in 1991, who believes that this population may be a separate species from populations in other parts of the Pacific West (Holland, 1991). The healthiest population of this potentially separate species is found along Morganson Road in a series of eight ponds, some natural and some constructed. One pond is permanent; the others are seasonal. Wasco County Planning Department, with the assistance of the US Forest Service (Dobson, 1995), developed a management plan for this area of critical habitat, which includes a 600-foot "no-disturbance" buffer surrounding the most important ponds, and paralleling the stream corridor between them. Within this buffer, new development is disallowed and grazing is regulated carefully.

Figure 5-2. Wetlands in the Mosier Watershed. Source: National Wetlands Inventory and Wasco County Soil Survey (USDA, 1982)

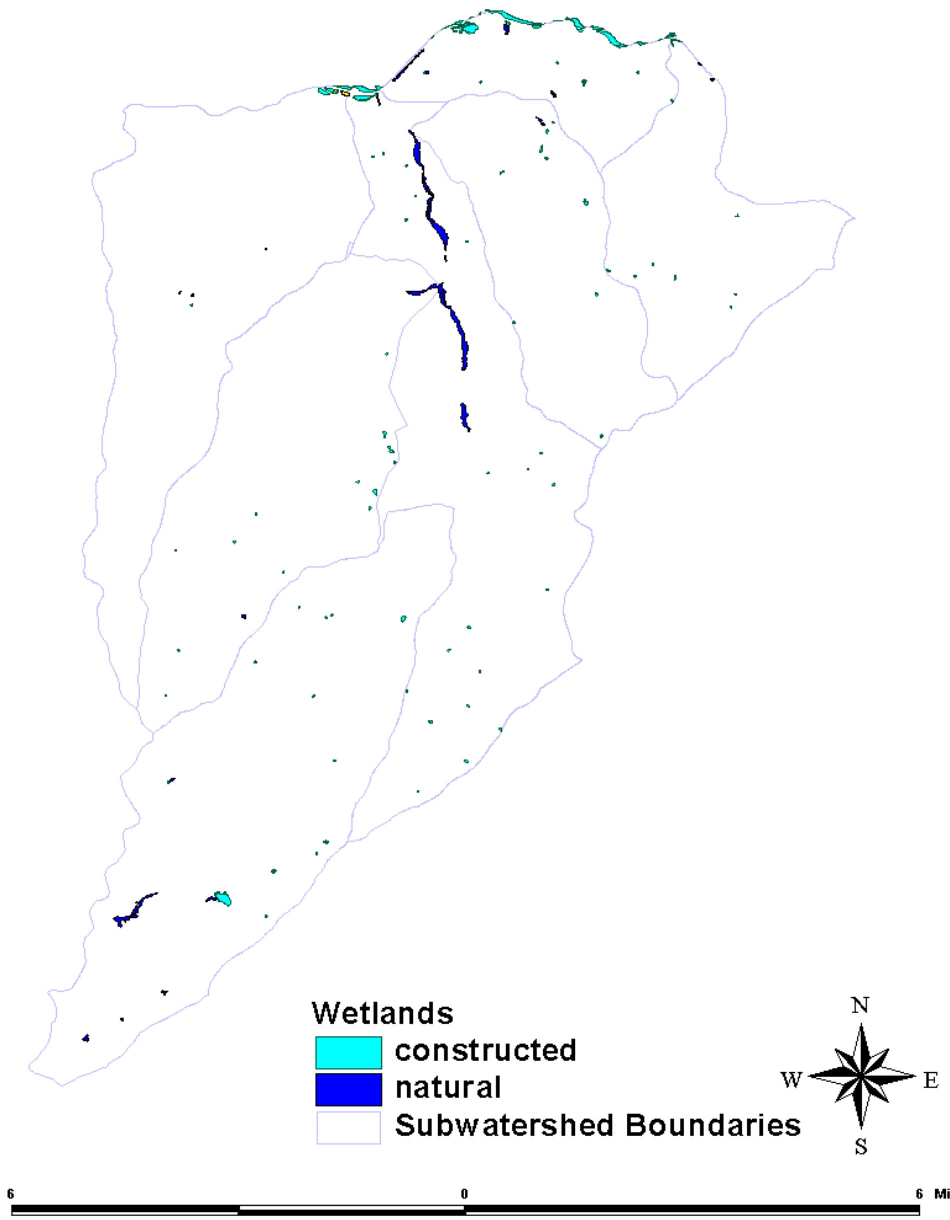
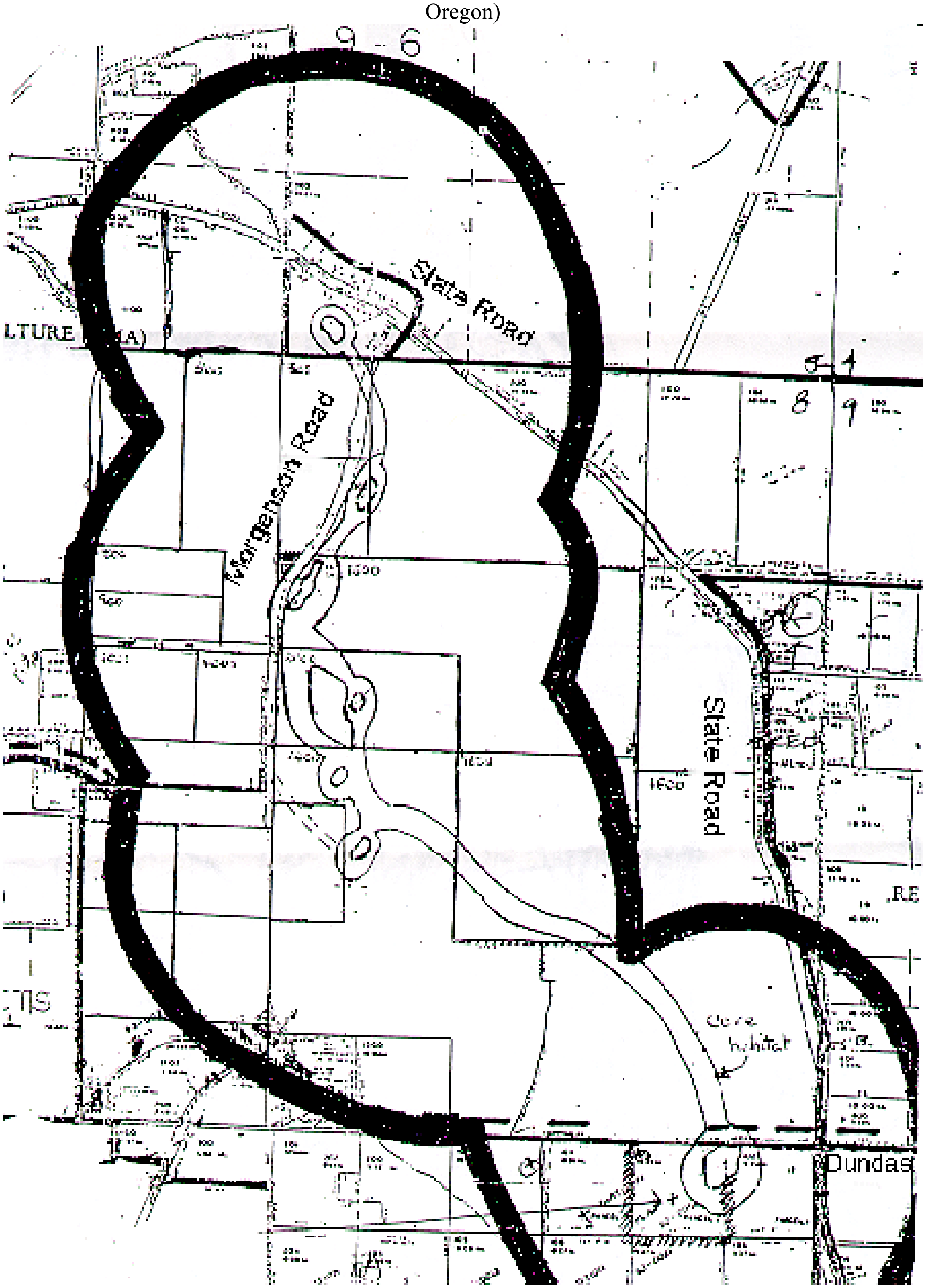


Figure 5-3. Western Pond Turtle Management Area. Landowners within this area should check with Wasco County Planning Department regarding specific land use restrictions (source: USFS, Hood River, Oregon)



6) Sediment Sources

Sediment 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 assessment focused on sedimentation due to land use, in particular, rural roads and croplands.

Roads

Forest Road and Culvert Condition

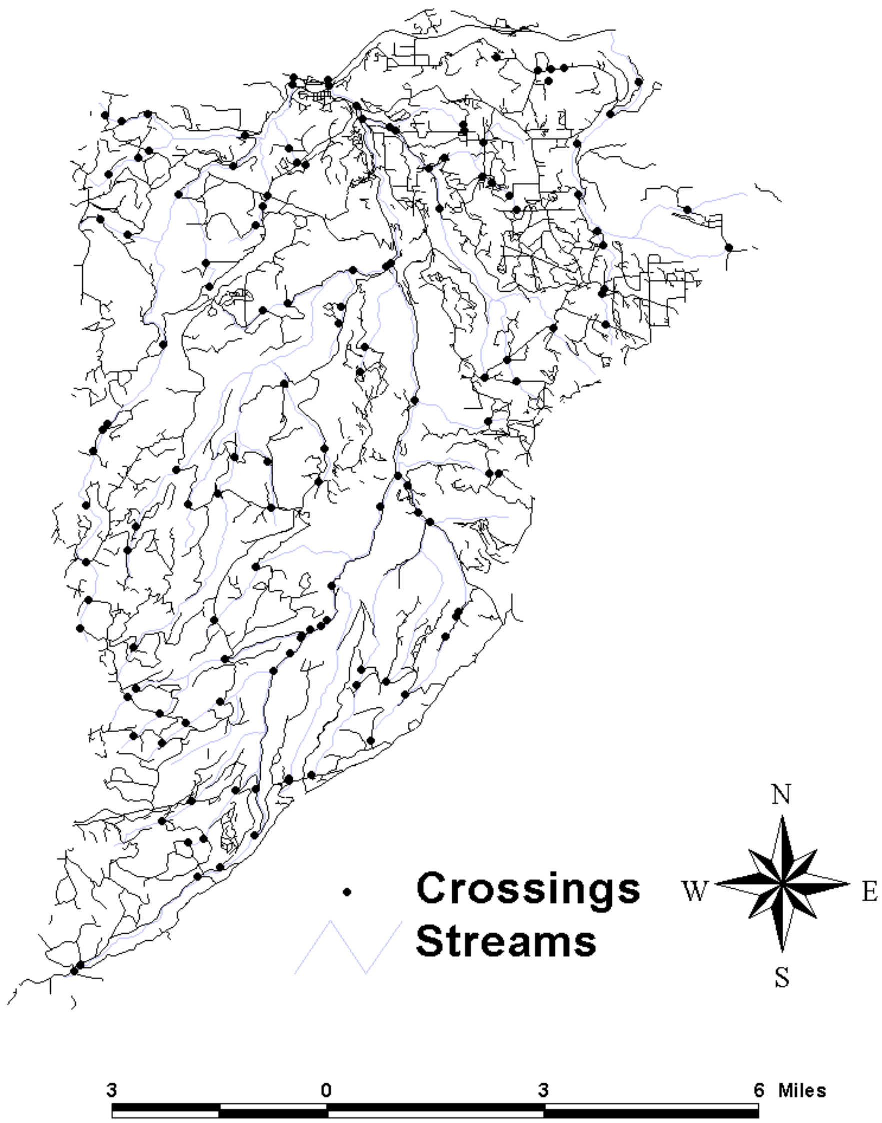
Rural roads in poor repair can add sediment to the streams through by triggering landslides. Culverts in poor repair can trigger road failure. Oregon Department of Forestry has developed a protocol for road and culvert condition surveys. They make this protocol available to private foresters and local forestry agencies. Hood River Department of Forestry has completed a road survey of their lands, and provided that information for the Mosier Watershed Assessment. However, the information was not yet accurately mapped, and so was difficult to interpret. The County plans to GPS this data by spring 2002.

Hood River Department of Forestry is considering surveying roads for some private timber companies. They have offered to include Wasco County lands in the Mosier Watershed (Ken Galloway, pers. comm.). Longview Fibre has just begun surveying roads and culverts in Hood River County. They expect to survey Mosier in the next few years (Steve Hanson, pers. comm.).

As of this writing, Jen Dickson, Americorps volunteer working for Gorge Trust, is in the process of undertaking a road and culvert survey of the public roads in the lower watershed using ODF protocols. Data from this survey is expected to be available by late spring, 2002.

Figure 6-1 shows roads data and stream crossings identified in the course of this assessment. No data has been collected as to the type or condition of either the roads or crossings.

Figure 6-1. Roads and stream crossings. Source: aerial photos, 1993-1995.



Riparian Roads

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 with slopes of greater than 50% above them accumulate more sediment in the road ditches than do roads with shallower slopes.

Methods

The USDA streams data layer (same streams data used throughout this assessment) was checked carefully for accuracy against the USGS topographic maps (digital raster graphics) using ArcView 3.1.

Where the two did not agree, the streams layer was updated to agree with the USGS topo map. Streams were added in the Columbia Tributaries subwatershed where ever a seasonal drainage occurred. A 200-foot buffer was then generated. The updated roads layer was clipped using this buffer, 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 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 miles per square mile (area within 200 feet of stream) and road miles per stream mile to give two measurements of relative impact.

Results

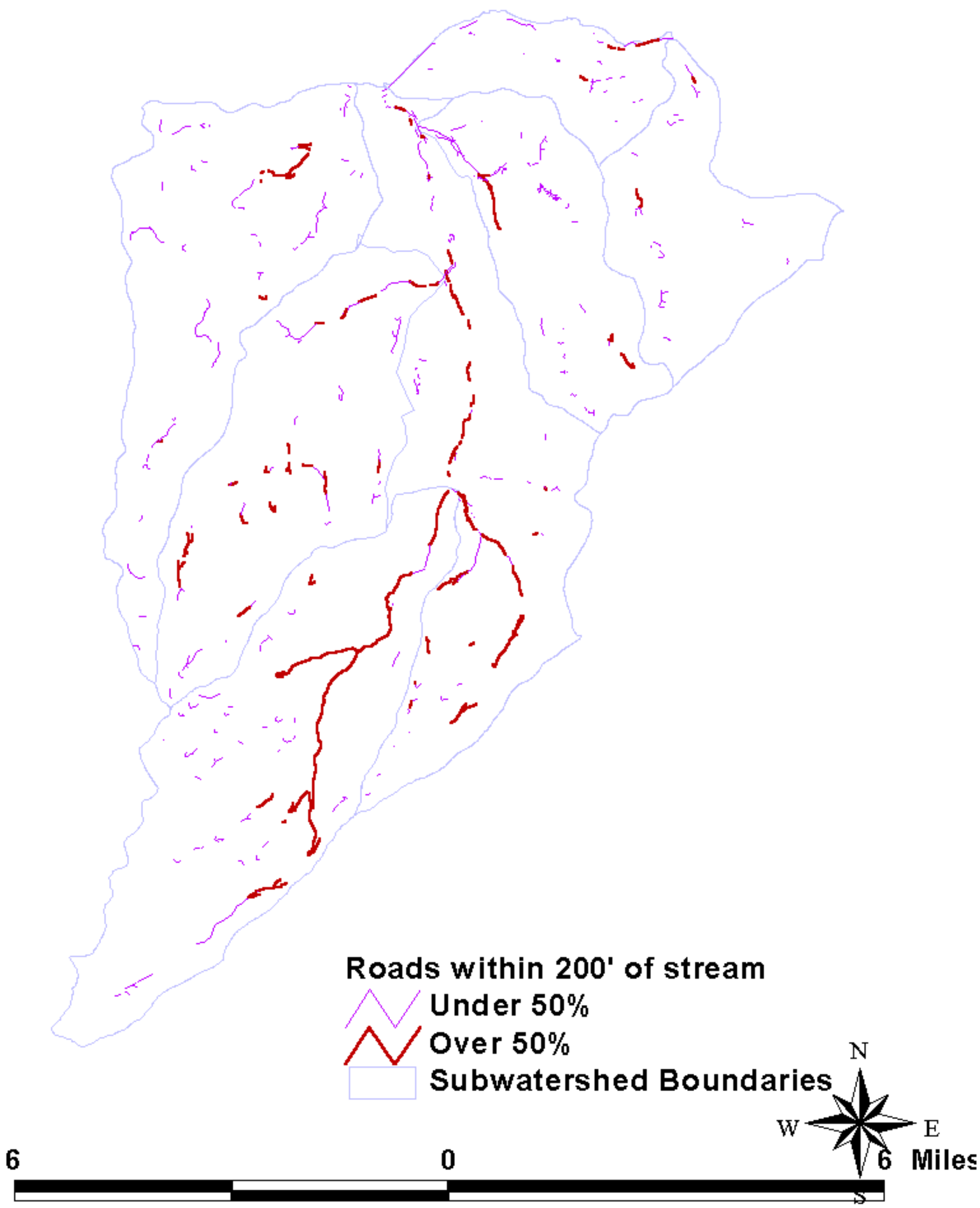
Results are summarized in table 6-1 and mapped in figure 6-2. Note on figure 6-2 that roads can be identified that parallel streams, and others can be identified that cross streams. The former are referred to as “Stream-adjacent parallel roads” in the Washington State Forest and Fish Agreement (Steve Hanson, Longview Fibre, pers. comm.). Stream adjacent parallel roads lead to a much higher density of riparian roads than do crossings. Analysis shows that the highest densities of roads within 200 feet of the streams are in Dry Creek, Lower Mosier and Upper Mosier, each of which has more than half a mile of road for every mile of stream. West Fork and Rock Creek also both approach half a mile of road for every mile of stream. The highest density of riparian roads on steep slopes is found in Upper Mosier, with Lower Mosier and West Fork not far behind.

Rowena Creek and the Columbia Tributaries had the lowest densities of riparian roads. Most of the roads in these watersheds cross riparian areas, rather than following them. Two notable exceptions to this pattern are Interstate 84 and Rowena Dell Road.

Table 6-1. Riparian Road Densities and Riparian Roads on Steep Slopes (>50%)

Subwatershed	**Stream Length**	**Area within** 200’ of stream	**Roads <200’from stream**			**Roads <200’ from stream and slope >50%**	
	Miles	$Mile^2$	Road Length (mi.)	mi./ mi^2	mi. roads per mi. stream	Road Length (mi.)	% riparian roads
Rowena	9.48	0.75	2.83	3.77	0.30	0.36	12.7%
Columbia	12.97	0.85	3.77	4.44	0.29	0.57	15.1%
Dry Creek	12.38	1.80	7.69	7.84	0.62	1.48	19.3%
Lower Mosier	22.80	0.98	13.20	7.33	0.58	6.70	50.8%
Upper Mosier	28.40	2.20	16.30	7.41	0.57	9.50	58.3%
West Fork	20.40	1.50	9.30	6.20	0.46	3.56	38.3%
Rock Creek	20.00	1.60	9.35	5.80	0.46	1.43	15.3%
OVERALL	**126.43**	**9.68**	**62.44**	**6.45**	**0.49**	**23.60**	**37.8%**

Figure 6-2. Riparian Roads with note of those on or below slopes greater than 50%.
Source: USGS topographic maps and aerial photos 1993-1995.



Agricultural Lands

The Oregon Watershed Enhancement Manual outlines a procedure for evaluating farmland erosion that takes into account the erodibility of the soil, slope, and cropping practices. A high quality assessment of this factor requires field observations during the time of year when soil is most susceptible to erosion. Such an opportunity has not yet arisen for the Mosier Watershed Assessment. Therefore, the current description is not based on field observations, and includes no information regarding farming practices on individual farms. However, it was possible to map the extent of farmland in various soil erodibility classes and slope classes, thus generating a description of the relative erosion hazards on cropland within the watershed, given equal farming practices in all locations. This technique was piloted on Dry Creek, being the subwatershed with the largest percentage of croplands.

Methods

A map of crop fields was generated based on data maintained by the USDA Farm Services Agency. Soils data from the USDA Natural Resources Conservation Service was then clipped to the crop fields. In the Northern Wasco County Soil Survey, each soil is assigned a "K" value from 0 to 1, which describes its relative erodibility. For the purposes of this assessment, K values were grouped into three categories: "high", "medium" and "low". Low corresponded to K < 0.20, and high to K > 0.40.

The average slope of each area was then determined, and areas were classified into four slope classes: <10%, 10-20%, 20-40% and >40%. The combination of slope and erodibility was then used to classify each area into hazard classes from 1 to 7, as described in Table 6-2.

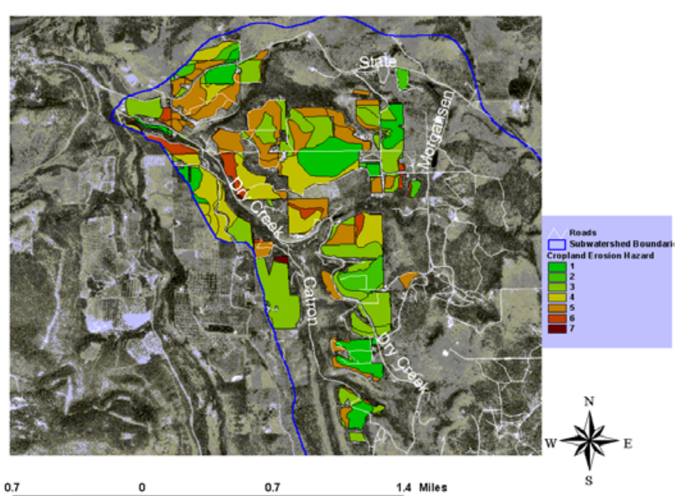
Results

Figure 6-3 shows a map of agricultural lands in Dry Creek, classified by their erosion hazard class. Fields shown in red or brown should be treated with extra caution to prevent erosion.

Table 6-2. Erodibility classifications used in the Mosier Watershed Assessment

Erodibility Class	**Means**
7	Slope>40%
6	Slope 20-40%, soil erodibility HIGH
5	Slope 20-40%, soil erodibility MEDIUM or LOW
4	Slope 10-20%, soil erodibility HIGH
3	Slope 10-20%, soil erodibility MEDIUM or LOW
2	Slope <10%, soil erodibility HIGH
1	Slope <10%, soil erodibility MEDIUM or LOW

Figure 6-3. Farm fields in Dry Creek, classified by erosion hazard.



7) Channel Modification

Extensive channel modification has occurred in Lower Mosier Creek, Rock Creek, and Dry Creek.

Most channel modification in Lower Mosier, and Dry Creek occurs because of rural residences located in the riparian areas. Figure 5-1 notes riparian areas affected by residential use. Figure 6-2 notes a high density of riparian roads in the mainstem of Mosier and Dry Creeks.

In Rock Creek, the lower one-mile of the creek has been channelized and rip-rapped to accommodate the ODOT gravel quarry and several bridge crossings. The City of Mosier and the Mosier Alliance have been considering a restoration project in this area, and have collected some preliminary data on background site condition. Suggested activities include re-creation of a flood plain and development of an off-channel sediment basin to collect flood debris (Mosier Alliance). This activity is currently under discussion. Feasibility analysis and design of such a structure relies on peak flow analysis of the watershed as a whole. Data in the Agricultural Hydrology section of this assessment would be critical in consideration and design of any structural approach to restoration of this reach.

Downstream of the gravel mining area, Rock Creek is further restricted by a private building (Giroux House), the US30 bridge, Union Pacific trestle and Interstate 84 overpass.

Mosier Creek is similarly restricted near its mouth by bridges on the same three roads (US30, railroad and interstate).

8) 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.

Oregon Department of Environmental Quality is mandated by the Clean Water Act to develop a list of water-quality limited waterbodies ("303(d) List") in the State of Oregon, and then develop regulations governing the total maximum daily loads ("TMDLs") of pollutants in the listed streams. Every two years, the 303(d) list is updated. The most sensitive beneficial use in each stream is the one the TMDLs will be written to protect. The designated beneficial uses in Mosier Creek are irrigation, livestock, cold-water fisheries, other aquatic life, water recreation and aesthetic values (DEQ 1988). The most sensitive of these beneficial uses is the cold-water fishery. In 1998, Mosier Creek was considered for the 303(d) list for four pollution types: flow modification, habitat modification, sedimentation and temperature. The creek was not listed for any of these factors due to lack of data (DEQ, 1998). Mosier Creek was not considered for other pollution types, such as chemical contaminants or nutrients. This does not imply that these types of pollution are not present, just that Mosier Creek has not been considered for the 303(d) for these factors yet.

The most commonly documented parameter in the state of Oregon is temperature. Temperature is a critical factor in fish habitat. Warm water holds less oxygen than cold water. Therefore, fish that are adapted to cool water are stressed by warm temperatures both directly and through oxygen deprivation. Cool water fish include trout, salmon and steelhead, all of which are present in the Mosier Watershed. Warm water fish include bass and carp, nonnative species found in the Columbia River and the various artificial lakes created by the interstate and the railroad. Carp, for example, are found in the Mosier City Lake.

Stream temperature is affected by natural factors, such as the temperature of the groundwater and springs, climate, flow volume and levels of shade afforded by streamside vegetation. It is also affected by human factors, such as vegetation removal and hydrological alteration of the watershed. 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 air and sunlight. A stream with lower flows or less shade will heat faster than a stream with higher flows or more shade.

The State Standard for temperature in streams with cool water fisheries is 64^{o}F maximum in summer, with lower temperature standards in the spring and fall. Above this temperature, cool water fish begin to suffer stress and have lower survival rates. This standard is based on the 7-day moving average high temperature. In other words, a stream can exceed 64^{o}F for a day or two, as long as the average high daily high temperature over a seven-day period does not exceed 64^{o}F. Stream temperature is measured in moving water approximately 12-18 inches deep.

Oregon Department of Environmental Quality develops regulations (aka Total Maximum Daily Loads or TMDLs) for stream temperature by modeling the natural temperature of the stream throughout its length, making assumptions about baseline flow and stream shading. Modeling of various streams around the State shows that not all streams will meet the State temperature standard even under ideal conditions. If the model shows that the stream will maintain a temperature below the state standard throughout its length, then some heating is allowed due to human factors. If the model shows that the stream will not maintain a temperature below the state standard throughout its length, then no human factors are allowed to heat the water at all. Allowances are made for existing developments that can not be easily changed, such as urban development, roads or historic channel modification.

The Oregon Department of Environmental Quality collected temperature data in Mosier Creek in 1999 and 2000. Figure 8-1 shows 1999 data and demonstrates that temperature in Mosier Creek exceeded the state standard from July 10 to September 4, 1999. Highest temperatures were recorded downstream of Mosier Waterfall, as would be expected. Similar data was collected for both Mosier and Rock Creeks in year 2000, as is shown in Figure 8-2. Based on this data, Mosier and Rock Creeks will both likely be listed on Oregon's List of Water Quality Limited Waterbodies (303(d) List) in 2002.

DEQ does not currently have plans to model stream temperatures in Mosier Creek. Current plans are to model Fifteenmile Creek and develop a TMDL affecting all of Northern Wasco County based on the Fifteenmile Model.

Mosier Watershed Council plans to undertake a water quality monitoring program on Mosier and Rock Creeks that will measure temperature, turbidity and pH at three sites on Mosier Creek and one site on Rock Creek. Bacteria will be measured at one location near the mouth of Mosier Creek. This program is expected to begin in May 2002 and continue through at least one summer season.

Figure 8-1. Temperature data (seven-day moving average of daily highs) for three sites in Mosier Creek, 1999. Source: Oregon Department of Environmental Quality, Bend OR.

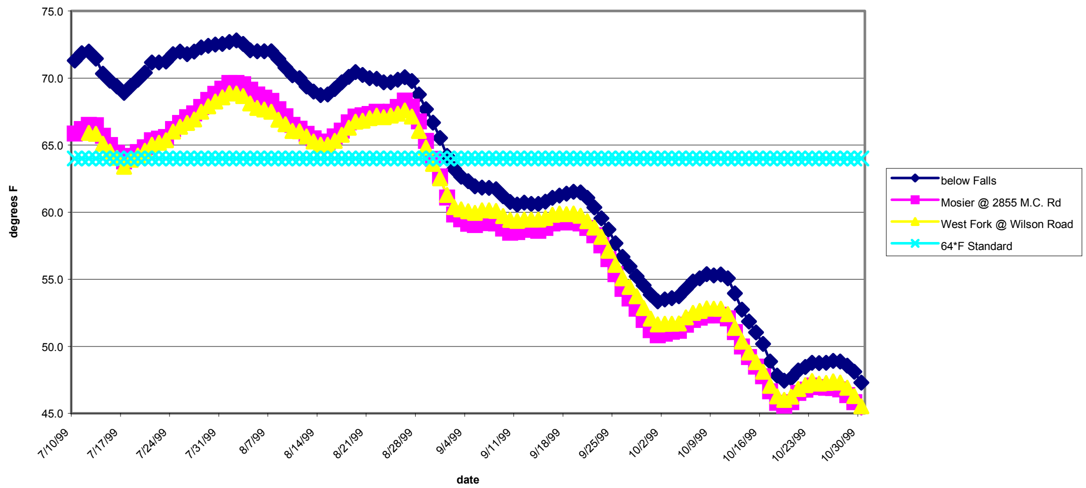


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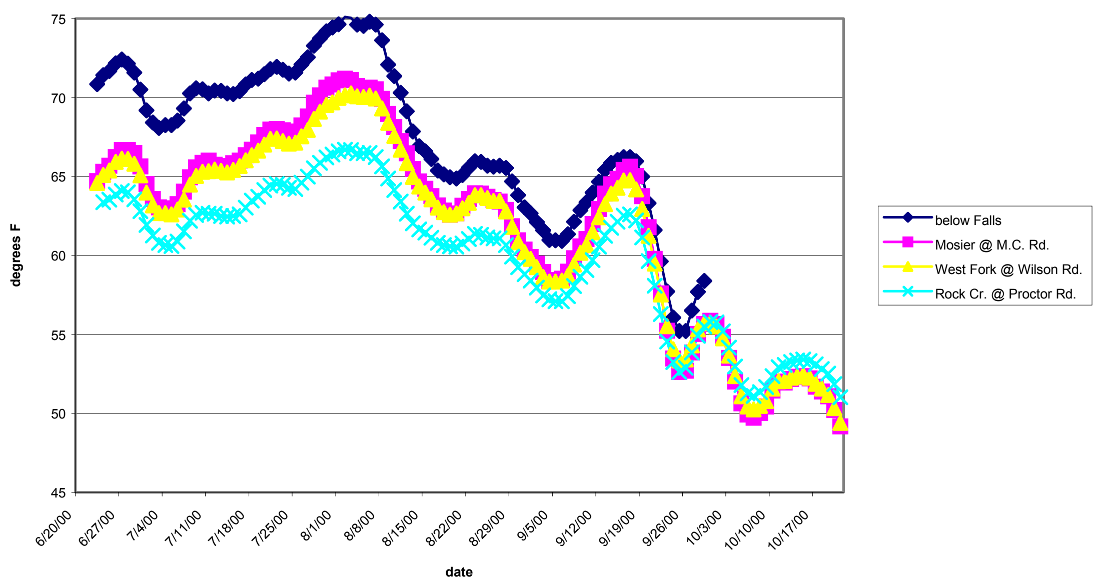
Figure 8-2. Temperature data (seven-day moving average of daily highs) for four sites in Mosier Creek and Rock Creek, 2000. Source: Oregon Department of Environmental Quality, Bend OR.



9) Fish and Fish Habitat

Little information about historic fish populations is available. Waterfalls restrict range of anadromous (ocean-going) species of fish in each watershed. Winter steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) spawn below the impassable waterfalls on Rock and Mosier Creeks. Cutthroat trout (*Oncorhynchus clarki clarki*) exist in both Rock and Mosier Creeks above the Falls. Habitat use in the lower portion of Rock Creek is limited by subsurface flow in mid- to late summer. Upstream portions of the creek flow year-round and provide late-season habitat for fish. ODFW stocked rainbow trout (*O. mykiss*) in Mosier Creek from 1952-1963 and 1968-1971. Rainbow trout can interbreed with cutthroat, compete for resources, and prey on eggs and juveniles. No data exists as to whether rainbow still exist in Mosier Creek, nor whether they have interbred with native cutthroat (Pribyl, ODFW, pers. comm.). Other fish may include sculpins (family COTTIDAE), dace (*Rhinichthys* spp), and mountain suckers (*Catostomus platyrhynchus*) (HRSWCD and HRWG, 1999).

As part of the Oregon Forest Practices Act, Oregon Department of Forestry (ODF) is mandated to collect data on fish distribution in order to provide technical guidance to private foresters. ODF works closely with Oregon Department of Fish and Wildlife to sample streams in which private foresters are proposing cuts. The data they collect is summarized in the form of a fish distribution map. This map (See figure 9-1) shows streams in which any species of fish has been found at any time of year. Sampling is typically done in March. Therefore, some streams shown on this map may run dry in the summer, but support fish earlier in the year. In some cases, fish distribution may be wider than shown here, as streams in which forestry activities have not been proposed have often not been sampled. Furthermore, fish distribution is not a constant, but varies from year to year, depending on runoff and other factors. In many cases, the upper range of fish distribution was estimated to extend to the confluence of two smaller tributaries. Despite these caveats, personnel at the ODF office in The Dalles, Oregon estimate that the map shown in figure 9-1 is 95% accurate (Theises, ODF, pers. comm.). Fish were found in all channel habitat types except VH (very steep headwater). Most SV (steep headwater, confined) and MH (moderate gradient headwater) reaches were also non-fish-bearing, with exceptions occurring only in Upper Mosier. Where acceptable reaches occurred upstream of SV reaches, the SV acted as a fish passage barrier.

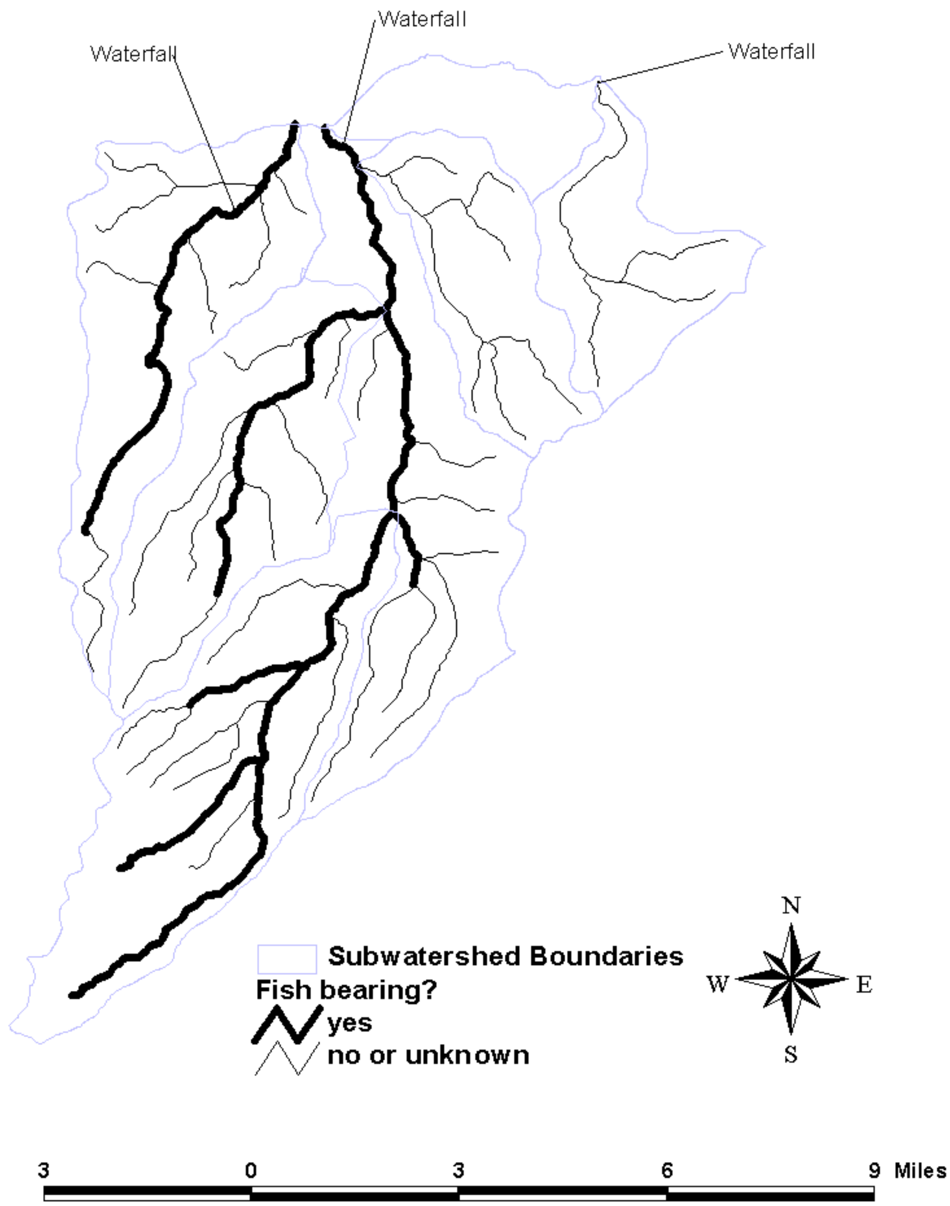
Dry Creek is not listed as having fish in any channel habitat type. However, Dry Creek may simply never have been sampled, since its lower reaches are not in forestry zones. Because it has the correct channel habitat types and no obvious fish passage barriers, it is likely that Dry Creek hosts fish during the spring, when it has extensive surface flow. No fish were noted in any reach of Rowena Creek either. This is probably accurate, as Rowena Creek has flow for only a short period of time, and has a waterfall near the mouth that acts as a fish passage barrier.

On September 20, 2001, Jen Dickson, an Americorps volunteer working for Gorge Trust, conducted a survey of Dry Creek and Rowena Creek, looking for surface water, fish, and culverts. She found no water whatsoever in Rowena Creek. In Dry Creek, she noted pools in 7 places, totaling 154 feet, each of them with water temperatures of between 62^o and 64^{o}F. None of the pools was more than 6 inches deep, and none of them had fish living in them at that time. Culverts were noted at the mouth and at Catron Road.

In 1993, the Forest Service conducted a stream survey on the portion of the Mosier Creek on the Mount Hood National Forest (upper 2.0 miles). They observed no fish on the Forest, confirming the upper end of distribution shown in figure 9-1 (USFS, 1993). They further found that Mosier Creek on the National Forest did not meet National Forest standards for large woody debris density or pool frequency.

Mosier Creek below the Forest Service boundary has not been surveyed for fish habitat (Pribyl, ODFW, pers. comm.). Because roads and culverts have not been surveyed, data on fish passage barriers and the effects of impassable barriers on resident fish is also lacking. These represent major data gaps.

Figure 9-1. Known fish-bearing streams in the Mosier Watershed. Noted waterfalls are barriers for migration of anadromous (ocean-migrating) fish. Source for fish distribution data: Oregon Department of Forestry and Oregon Department of Fish and Wildlife, The Dalles OR.



10) Upland Habitat

Native Plants

The Columbia Gorge is a transitional area between the maritime climates of Western Oregon and the dry, continental climate of Eastern Oregon and the Great Basin. Mosier is located in the eastern half of the Gorge, within the most dramatic transitional zone. It therefore boasts a high level of ecological diversity, as well as some unique species of plants. According to Russ Jolly's *Wildflowers of the Columbia Gorge* (1988), the Gorge is home to fifteen endemic wildflower species, and the pine-oak woodlands, within which the lower elevations of the Mosier Watershed sit, are home to five: two desert parsleys (*Lomatium suksdorphii, Lomatium columbianum*)*,* Poet's Shooting Star (*Dodecatheon poeticum*)*,* Broad-leafed Lupine (*Lupinus latifolius v. thompsonianus*)*,* and Hood River Milk Vetch (*Austragalus hoodianus*).

Barbara Robinson, Columbia Gorge Native Plant Society, notes six areas with outstanding native habitat (pers. comm.):

1. Top of Sevenmile Hill, just south of Rowena. The north-facing slope is home to a diverse collection of conifers, not generally found at that elevation in the east end of the Gorge. The south side, where it has not been farmed, has intact oak woodlands interspersed with meadows. Important species found there include bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), balsam root (*Balsamrizea,* spp), Paintbrush (*Castileja* spp), and Broad-leafed lupine (endemic, noted above).
2. Memaloose Overlook. This area is similar to the Sevenmile Hill area, but has fewer native grasses.
3. Headwaters of Dry Creek, south of Osborn Cut-off Road. This area is a pine-oak woodland with a dense and diverse undergrowth.
4. Rock Creek Road, particularly higher in the watershed. The forests in this area are wetter, and include a higher diversity of conifers than further north or east. Reportedly, the Native Americans gathered high quality cedar roots from this area (Robinson, pers. comm.).
5. Between Dry Creek Road and Morganson Road is notable for wildflowers.
6. Tom McCall Preserve. The Tom McCall Preserve is in better condition near the historic highway, and at the higher elevations. The Rowena Plateau around the ponds was subject to season-long grazing until 1981, while the upper end was not.

Robinson gives the following guidelines for recognizing good condition habitats:

- Meadows: look for perennial bunch grasses, balsam root, and lupine. In addition to the grasses noted above, look for June grass (*Koleria cristata*) and big blue wild rye (*Elymus glaucus*). In shallow soil, look for poet's shooting star, and in rocky locations, desert parsley.
- Wetlands: Look for camas (*Zigadenus* spp), which grows in vernal wetlands.
- Woodlands: Look for orchids. Orchids rely on relationships with surrounding plants to survive, as they do not produce all their own food. Some do not even photosynthesize. Therefore, they are extremely sensitive to soil disturbance, and serve as an indicator species. Notable species include Fairy Slipper (*Calypso bulbosa*), Coral root (*corallorhiza* spp) and rein orchids (*Habenaria* spp).

Noxious Weeds

Noxious weeds are a threat throughout the Western United States. Noxious weeds are plants that are not native to a particular location, have few or no natural enemies in the ecosystem, and spread rapidly, displacing native species. Noxious weeds provide little or no benefit to wildlife or livestock, generally cause economic losses to commercial agriculture, and often do not perform as well hydrologically as the species that they displace.

Wasco County maintains a Weed and Pest office, whose charge is to control noxious weed infestations along public right-of-ways, and to provide assistance to landowners who request it. According to Wasco Weedmaster, Merle Keyes, the Mosier area has a mild weed problem compared to other parts of

Wasco County. However, several species are problems. The most widespread noxious weed in the Mosier Watershed is diffuse knapweed (*Centaurea diffusa*). Other species that are localized problems include yellowstar thistle, puncturevine, Scotch Broom, houndstongue and rush skeleton weed.

Yellowstar thistle (*Centaurea solstitialis*) was found on Carroll Road in the Dry Creek watershed and was treated with herbicides in spring 2001.

Puncturevine (*Tribulus terrestris*) is found around the city of Mosier, in open, gravelly areas, such as parking lots, railroad right-of-way, and road margins.

Scotch Broom (*Cytisus scoparius*) is a major noxious weed in Western Oregon and the Columbia Gorge. Mosier currently represents the front line of Scotch Broom invasion. While the level of Scotch Broom in Mosier currently appears to be static, this species should be removed whenever sited, in order to avoid further infestations.

Houndstongue (*Cynoglossum officinale*) has been found and treated in a gravel quarry on Highway 30, and in Rowena Dell.

Rush skeletonweed (*Chondrilla juncea*) is spreading through the Mosier Area. This species moves easily in the Columbia Gorge, due to its light, wind-borne seeds.

11) Evaluation

Table 10-1 shows the major issues identified in this assessment by subwatershed. Table 10-2 shows data gaps that still exist. Mosier Watershed Council intends to use this information, along with other data to be collected to plan future monitoring and conservation activities.

Table 10-1. Major issues identified by watershed assessment

	Road Density (land use zone)	Summer Water Availability	% Inadequate riparian vegetation	Riparian roads mi./mi.	Channel Modification	Stream Temperature
Rowena	Medium (r.r.)	No natural summer flow	13%	0.30	No major channel modification	No natural summer flow
Columbia Tributaries	Medium (ag) High (others)	No natural summer flow	N/A	0.29	No major channel modification	No natural summer flow
Dry Creek	Medium (ag) High (r.r.)	No natural summer flow	13%	0.62	Residential & roads	No natural summer flow
Lower Mosier	Medium (ag) High (urban)	69% allocated	30%	0.58	Residential & roads	Exceeds state standards
Upper Mosier	Low	16% allocated	37%	0.57	Roads	Exceeds state standards
West Fork	Low	8% allocated	25%	0.46	Roads	Exceeds state standards
Rock Creek	High (urban)	Negligible natural flow	12%	0.46	Mining	Exceeds state standards

Table 10-2. Major data gaps in the Mosier Assessment:

Road and culvert conditions*	Rainbow v. cutthroat trout interactions
Wetlands condition	Urban Runoff and Sediment Analysis
Fish habitat surveys (outside of MHNF)	Water quality (other than temperature)*
Cropland and range erosion observations	Fish populations

* Mosier Watershed Council currently has a plan to fill part of these data gaps within one year.

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Appendix A: Photographic Examples of Major Channel Habitat Types found in Mosier Watershed

Photographs: Stan Loop, 2001.

MODERATELY STEEP
NARROW VALLEY CHANNEL

MV

CHANNEL ATTRIBUTES

Stream gradient:	4 -8 %, may vary between 3 to 1 0%
Valley shape:	Narrow, V-shaped valley
Channel pattern:	Single channel, relatively straight similar to valley
Channel confinement:	Confined
Oregon stream size:	Small to medium
Position in drainage:	Mid to upper
Dominant substrate:	Small cobble to bedrock

Rock Creek, upstream of Campbell Creek.

MODERATE GRADIENT CONFINED CHANNEL

MC

CHANNEL ATTRIBUTES

Stream gradient:	2-4%, may vary between 2 to 6%
Valley shape:	Gentle to narrow V-shaped valley, little to no floodplain development
Channel pattern:	Single, relatively straight or conforms to hill-slope control
Channel confinement:	Confined
Oregon stream size:	Variable
Position in drainage:	Middle to lower
Dominant substrate:	Coarse gravel to bedrock

Rock Creek, downstream of Campbell Creek.

MODERATE
GRADIENT
MODERATELY
CONFINED
CHANNEL

MM

Stream gradient:	Generally 2-4%
Valley shape:	Narrow valley with floodplain or narrow terrace development
Channel pattern:	Usually single channel, low to moderate sinuosity
Channel confinement:	Variable
Oregon stream size:	Variable, usually medium to large
Position 'in drainage:	Mid to lower portion of drainage basins
Dominant substrate:	Gravel to small boulder

Lower Mosier Creek on Mosier Creek Road.

STEEP NARROW VALLEY CHANNEL
SV

CHANNEL ATTRIBUTES

Stream gradient:	SV 8-16%, VH > 16%
Valley shape:	Steep, narrow V-shaped valley
Channel pattern:	Single, straight
Channel confinement:	Tightly confined
Oregon stream size:	Small, small-medium transition
Position in drainage:	Middle upper to upper
Dominant substrate:	Large cobble to bedrock

Seasonal tributary of Lower Mosier Creek.

Appendix B: Endangered Species Lists for Mosier Watershed including species migrating through Columbia River (US Fish and Wildlife Service, December 26, 2001)

ATTACHMENT A

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, AND CANDIDATE SPECIES THAT MAY OCCUR WITHIN THE AREA OF THE MOSIER WATERSHED ASSESSMENT PROJECT
1-7-02-SP-110

LISTED SPECIES[1/]

Mammals		
Canada lynx[2/]	*Lynx canadensis*	T
Birds		
Bald eagle[3/]	*Haliaeetus leucocephalus*	T
Northern spotted owl[4/]	*Strix occidentalis caurina*	CH T
Fish		
Steelhead (Middle Columbia River)[5/]	*Oncorhynchus mykiss*	**T
Steelhead (Upper Columbia River)[6/]	*Oncorhynchus mykiss*	** E
Steelhead (Snake River Basin)[6/]	*Oncorhynchus mykiss*	**T
Sockeye salmon Salmon River tributary to the Snake River, Idaho	*Oncorhynchus nerka*	CH **E
Chinook salmon (Upper Columbia River)[7/]	*Oncorhynchus tshawytscha*	** E
Chinook salmon Snake River spring/summer runs	*Oncorhynchus tshawytscha*	CH **T
Chinook salmon Snake River fall runs	*Oncorhynchus tshawytscha*	CH **T
Bull trout (Columbia River pop)[8/]	*Salvelinus confluentus*	T

PROPOSED SPECIES

Fish		
Coastal cutthroat trout (Southwestern Washington/Columbia River)	*Oncorhynchus clarki clarki*	PT

CANDIDATE SPECIES[9/]

Birds		
Yellow-billed cuckoo[10/]	*Coccyzus americanus*	
Amphibians and Reptiles		
Oregon spotted frog	*Rana pretiosa*	
Fish		
Coho salmon (Lower Columbia River)[11/]	*Oncorhynchus kisutch*	**CF
Plants		
Northern wormwood	*Artemisia campestris* ssp. *wormskioldii*	

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*

** *Consultation with National Marine Fisheries Service may be required.*

1/ *U. S. Department of Interior, Fish and Wildlife Service, October 31, 2000, Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12*

2/ *Federal Register Vol. 65, No. 58, Mar 24, 2000, Final Rule-Canada lynx*
3/ *Federal Register Vol. 60, No. 133, July 12, 1995 - Final Rule - Bald Eagle*
4/ *Federal Register Vol. 57, No. 10, January 15, 1992, Final Rule-Critical Habitat for the Northern Spotted Owl*
5/ *Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead*
6/ *Federal Register Vol. 62, No. 159, August 18, 1997, Final Rule-Upper Columbia and Snake River Steelhead*
7/ *Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon*
8/ *Federal Register Vol. 63, No. 111, June 10, 1998, Final Rule-Columbia River and Klamath River Bull Trout*
9/ *Federal Register Vol. 66, No. 210, October 30, 2001, Notice of Review - Candidate or Proposed Animals and Plants*
10/ *Federal Register Vol. 66, No. 143, July 25, 2001, 12-Month Finding for a Petition To List the Yellow-billed Cuckoo*
11/ *Federal Register Vol. 62, No. 87, May 6, 1997, Final Rule-Coho Salmon*